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Lana Bartholomew
Executive Director
Petroleum and Gas
Department of Resources
PO Box 15216 City East
Brisbane QLD 4002

29 March 2021

Dear Lana

RE: Potential Commercial Area (PCA) application 309

We refer to your letter dated 20 November 2020 regarding PCA application (**PCAA**) 309 over ATP 645. QGC Pty Limited, (**QGC**), on behalf of BNG (Surat) Pty Ltd (100%) (**BNG**), hereby provides the following requested information for PCAA 309.

Information Requested:

1) The Society of Petroleum Engineers Petroleum Resources Management System (SPEPRMS) states that *"the extent of the discovery within a pervasive accumulation is based on the evaluator's reasonable confidence based on distances from existing experience, otherwise quantities remain as undiscovered'.*

2) BNG has not yet established a petroleum discovery in the area of PCA 309.

3) BNG has not provided sufficient evidence to support the existence of a pervasive unconventional tight gas sand reservoir in the Tinowon Formation in the area of PCA 309:
   a. the three legacy exploration wells (Kinkabilla 1 (1966), Inglestone 1 (1982) and Kinkabilla Creek 1 (1987)) in the area did not specifically target tight gas resources.

   b. BNG has not provided evidence that the three wells were drilled outside any structural highs, and cannot rule out that the gas show in one of the three wells (Kinkabilla 1) may only be conventional resources in limited areas in close proximity to the well.

   c. BNG has only provided evidence for one location in the PCA 309 area to show that a gas-bearing reservoir might exist (no discovery made).

   d. BNG has not provided sufficient evidence to demonstrate that the Tinowon Formation is present across the whole of the area of PCA 309. The seismic evidence provided by BNG only relates to the area of PCA 305 which is generally 50 km north of the area of PCA 309.

   e. BNG has not provided any evidence to demonstrate its confidence in the extent of the gas show found in Kinkabilla 1 (no discovery made).

f. in the further information provided on 9 October 2020, BNG was unable to demonstrate that it has a basic level of knowledge of the Tinowon reservoir in the PCA 309 area. BNG was able to provide key parameters such as sand porosity, sand net to gross and sand net thickness over both the 3D seismic area and 2D seismic line to delineate the Tinowon reservoir over the area of PCA 305. In contrast, BNG was unable to provide similar parameters to delineate the Tinowon reservoir over the PCA 309 area. The department notes that the maps provided on 9 October 2020 show the parameter lines end around the boundaries of the PCA 305 area and do not extend over the PCA 309 area.

4) BNG stated in the application for PCA 309 that, *"It is the regional extension of these reservoirs along depositional strike into PCA 309 that support this application"*. However, information provided (detailed in (3)(f) above) does not support the extension of the reservoir identified in the area of PCA 305 to the area of PCA 309.

5) no gas has been flowed to surface from any wells in the PCA 309 area from the identified tight gas target (the Tinowon Formation). Only three legacy petroleum wells were drilled in the area between 1966 and 1987 and only one of them Kinkabilla 1) returned gas cut mud from the Tinowon formation (a gas show, not a gas discovery). Additionally, no wells specifically targeting tight gas have been drilled in the area of PCA 309.

6) no petroleum discovery has been established through coring, logging, or testing of wells in the area of PCA 309.

7) BNG has not demonstrated the presence of significant quantity of hydrocarbons in the area of PCA 309, or proximate to the area of PCA 309.

8) BNG has not demonstrated that any hydrocarbons in the area are commercial or will become commercial within the next 15 years. The gas cut mud in Kinkabilla 1 from 1966 only shows gas-bearing sand in the Tinowon formation and has not been tested with modern completion techniques.

9) even though significant amounts of recoverable gas and condensate resources (prospective resources) have been estimated for the area, BNG has not provided sufficient evidence to support the estimates:
   a. no local petroleum discovery has been established, while the established discoveries in the area of PCA 305 are 50km away and cannot be used to determine the extent of the nominated reservoir in the area of PCA 309;

   b. the nominated reservoir has not been sufficiently defined or characterised in the area of PCA 309.

BNG Response:

Tinowon Evaluation

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Exploration and Development Concept

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Conclusion

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If you require any further information, please contact Tyson Croll on 3024 7806 or email sch4p4(6) Per@shell.com.

Yours Faithfully,

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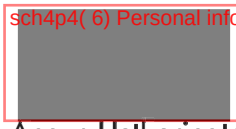

Angus Hetherington

Manager Access – QGC Pty Limited,

Authorised representative for BNG (Surat) Pty Ltd

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Figure 1: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 6: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

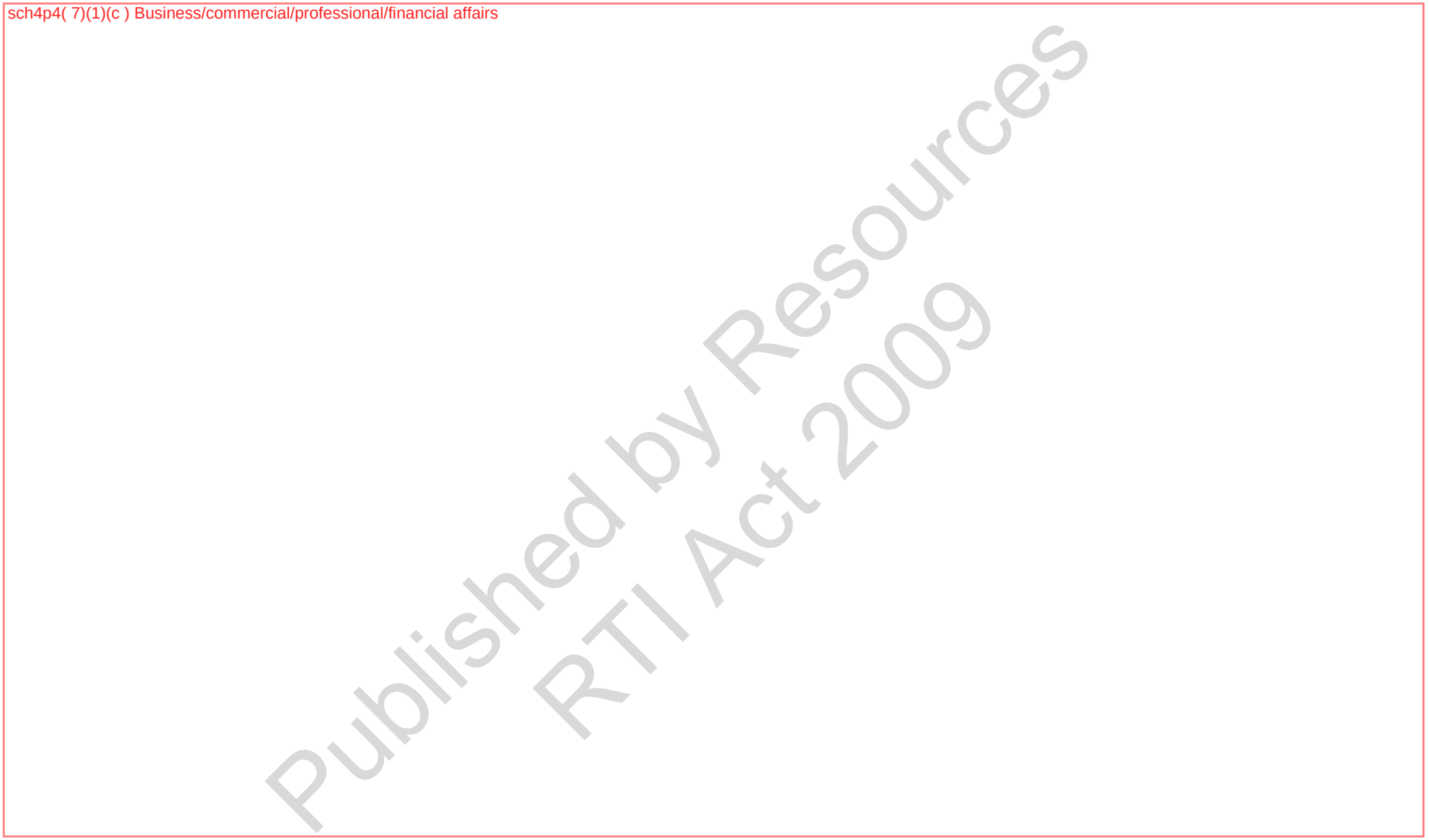
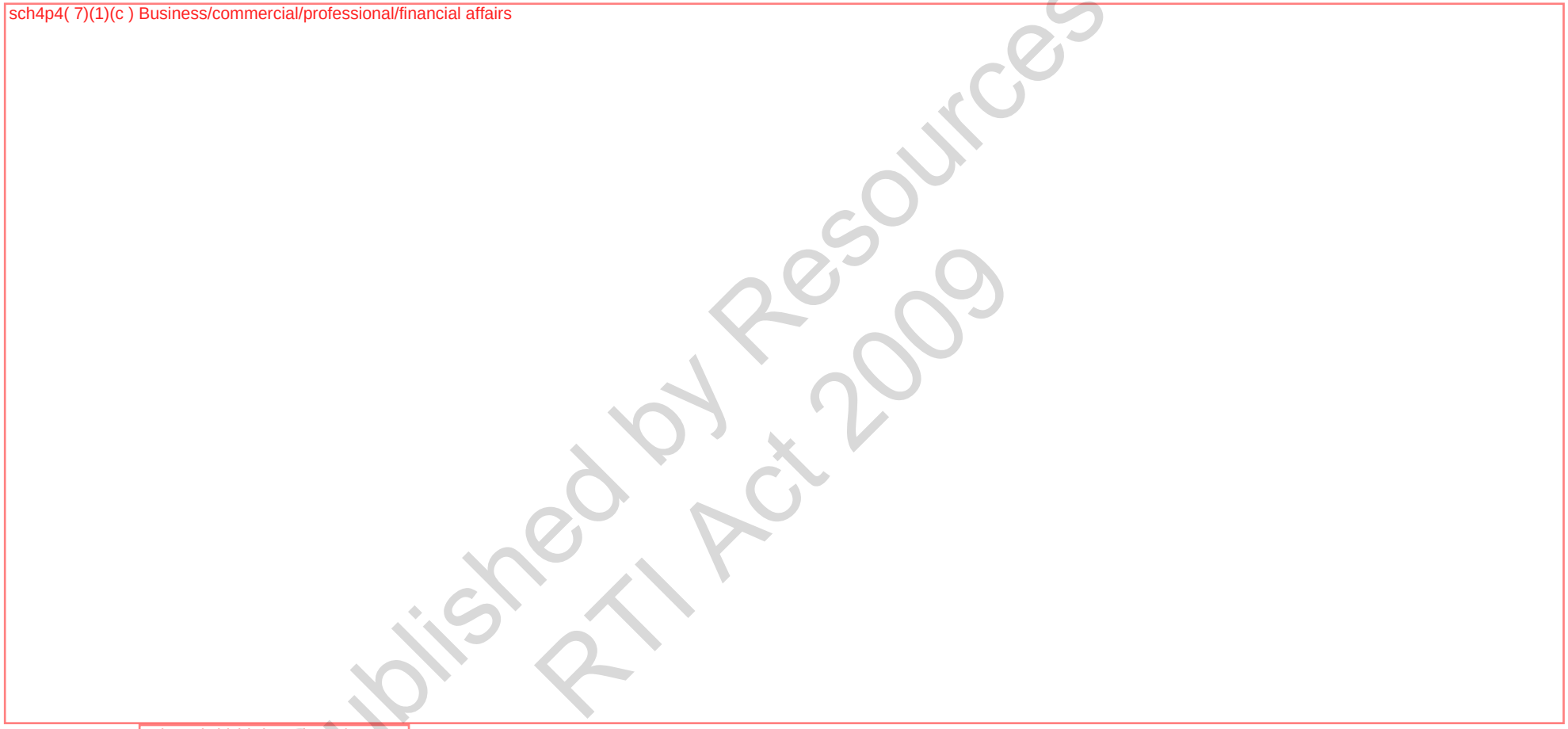


Figure 7: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs



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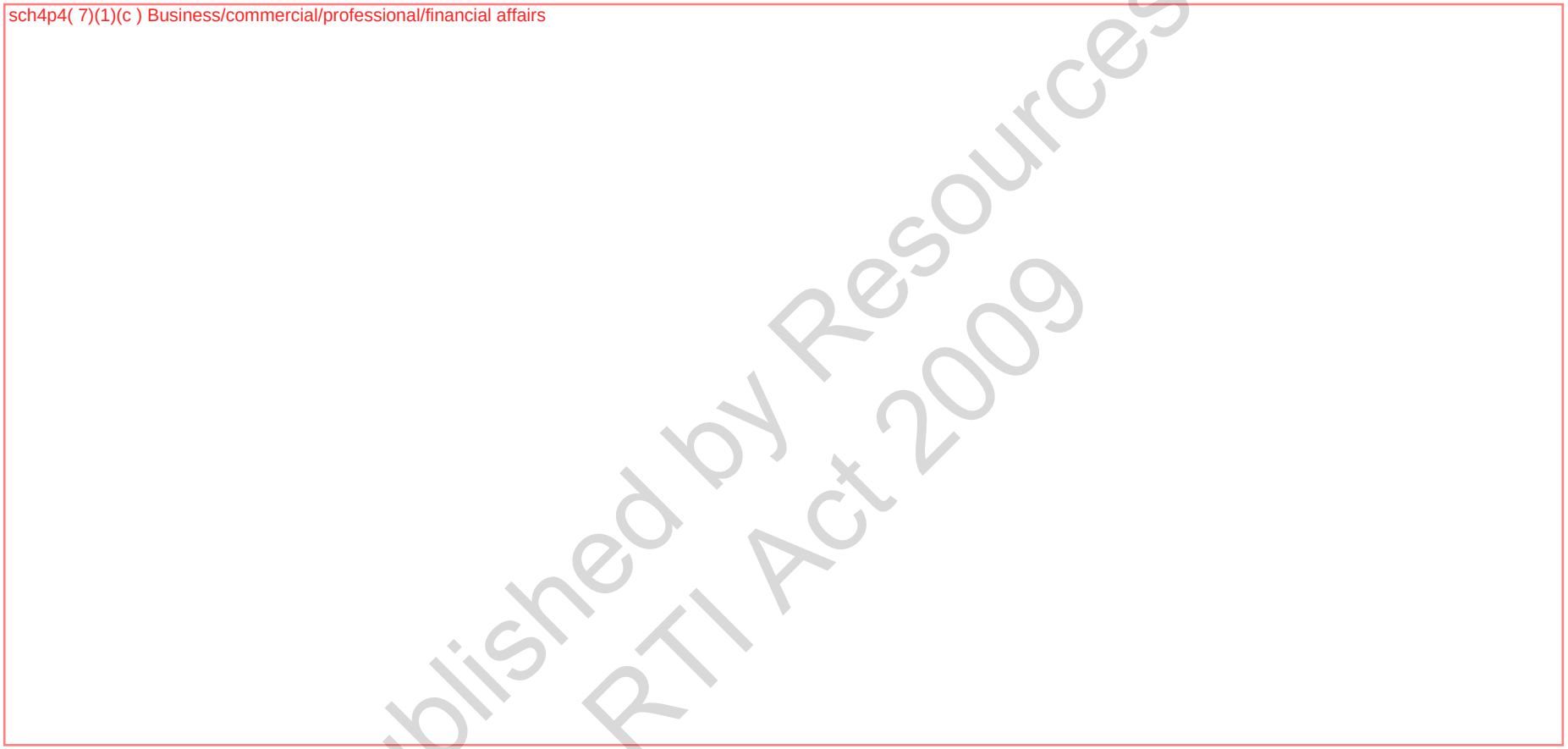

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Lana Bartholomew
Executive Director
Petroleum and Gas
Department of Natural Resources, Mines and Energy
PO Box 15216 City East
Brisbane QLD 4002

9 October 2020

Dear Lana

RE: Potential Commercial Area (PCA) applications 305 and 309

We refer to your letter dated 21 September 2020 regarding PCA applications (**PCAA**) 305 and 309 over ATP 645. QGC Pty Limited, (**QGC**), on behalf of BNG (Surat) Pty Ltd (100%) (**BNG**), hereby provides the following requested information for PCAAs 305 and 309.

1. **Further justification to support the area of PCA 309 is no more than is needed to cover the maximum extent of the natural underground reservoir, that allows the decision-maker to be satisfied of this requirement.**

The inclusion of the area of PCA 309 forms part of QGC's major campaign focussing on the exploration and development of tight gas sands (TGS) in the Permian and Triassic section within the Taroom Trough of the Bowen Basin. This play includes ATP 645, ATP 785 and Joint Venture (JV) partnerships with Santos in ATP 2040 and ATP 2045. It is important to note that the play and reservoirs associated with ATP 2045 are the same as those associated with the area of PCA 309, as they extend to the north and east into this tenure. Further complexities arise with PCA 309 being a stranded block, where is it not contiguous to PCA 305 and is surrounded on two (2) sides by ATP 2045 and adjacent ATP 785. The retention of the area under PCA 309 is critical to form a larger strategic development bolstered by potential finds within neighbouring ATP 2045 and ATP 785. Additionally, the inclusion of the area of PCA 309 into a larger development strategy by its declaration provides the probability of the earliest production royalty to the State as compared to being relinquished and the exploration to development clock restarting for this area.

Viewed in combination with previous conventional petroleum exploration drilling, new and legacy seismic, and by extension of data from adjacent areas, QGC has identified two prospective natural underground reservoir intervals in ATP 645. These are the Permian Tinowon Formation and Lorelle Sandstone, both part of the Back Creek Group. However, only the Tinowon Formation reservoir is present in the area of PCA 309, but which is the primary target in ATP 645 (PCA 305) and to date has provided the most encouraging prospectivity in ATP 645 and in surrounding areas. The figures further below include both a well stratigraphic cross section and a seismic section that confirm the presence of the reservoir section sought and underpinning that the entire area of PCA 309 is a valid candidate in area for PCA application, given the play concept described. Therefore, the Minister should consider that the

area of PCA 309 reasonably forms part of the maximum extent of the reservoir for this resource type, while taking into account the limitations that apply to the negative economics and development timeframes associated with an otherwise stranded block such as the area of PCA 309. Additionally, if the area was not declared a PCA and relinquished, the exploration work and expenditure undertaken on ATP 645 there to date (seismic review and G&G studies) by QGC on proving up existing resources present within PCA 309 would have been for nought and an unacceptable penalty for the financial and technical resources applied in that area.

2. Further justification to support the existence of the tight gas reservoir because no discovery has been established in the area of PCA 309.

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3. Details explaining how the resource estimate has been determined in this area including methods used to interpret data from legacy wells.

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4. A map that depicts the reservoir properties or extents that are consistent with the resources estimates to support the application.

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

5. The department requests that BNG provide any additional information to that may support the upgrading of current prospective resources to contingent resources in PCA 309.

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6. An updated map for the application for PCA 305 that depicts the reservoir properties and extents and is consistent with the resources estimates provided.

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7. Additional information to better understand what additional data BNG need to upgrade the current prospective resource estimates for the area to contingent resources for PCA 305.

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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If you require any further information or wish to discuss the responses provided above, QGC is more than happy to meet. Should you wish to discuss, please contact Tyson Croll on 3024 7806 or email sch4p4(6) Pers shell.com.

Yours Faithfully,

sch4p4(6) Personal informati

Ryan Dreibelbis

Manager Access – QGC Pty Limited,

Authorised representative for BNG (Surat) Pty Ltd

Figure 1 sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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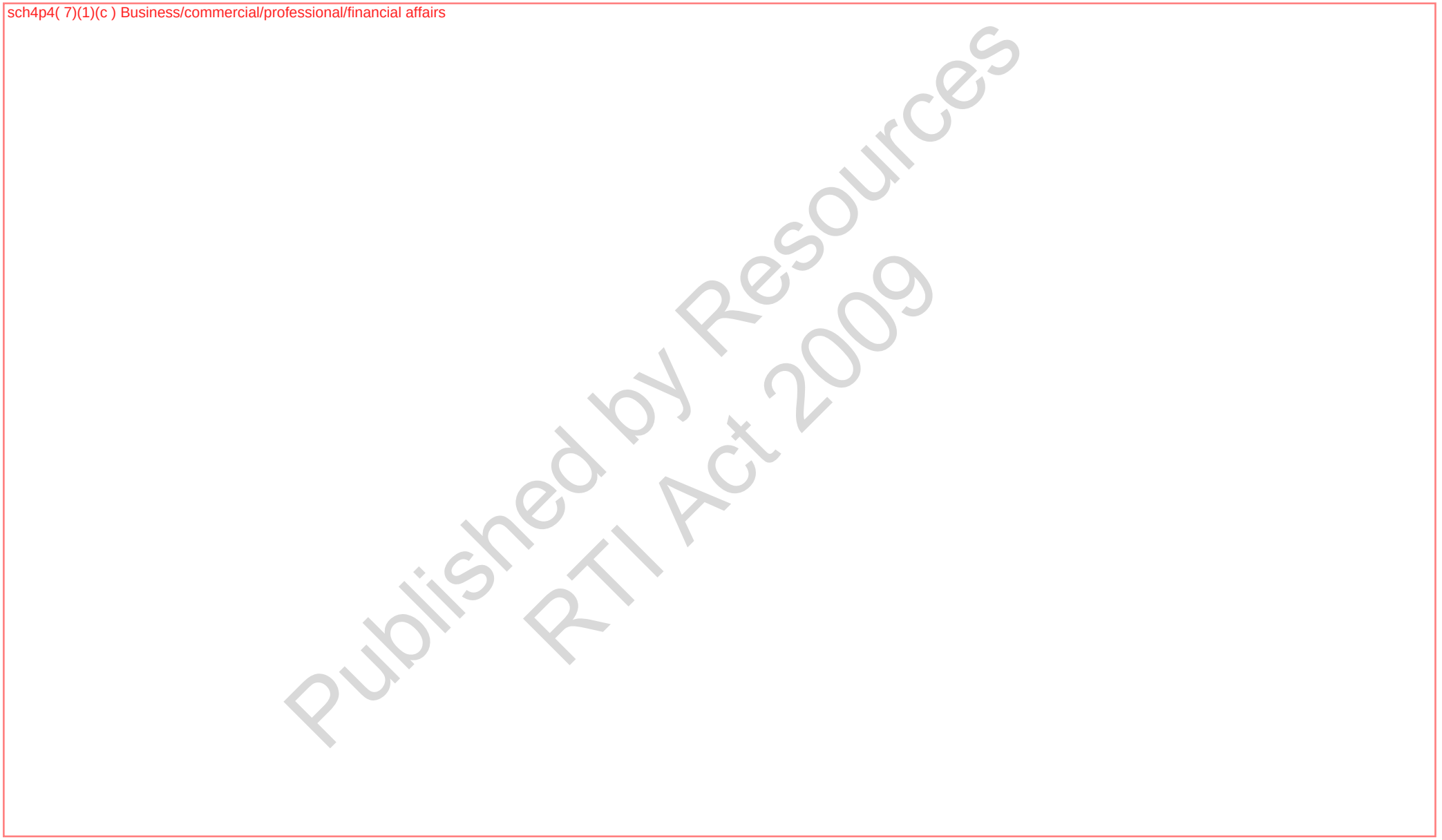

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Figure 4 – sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 5 – sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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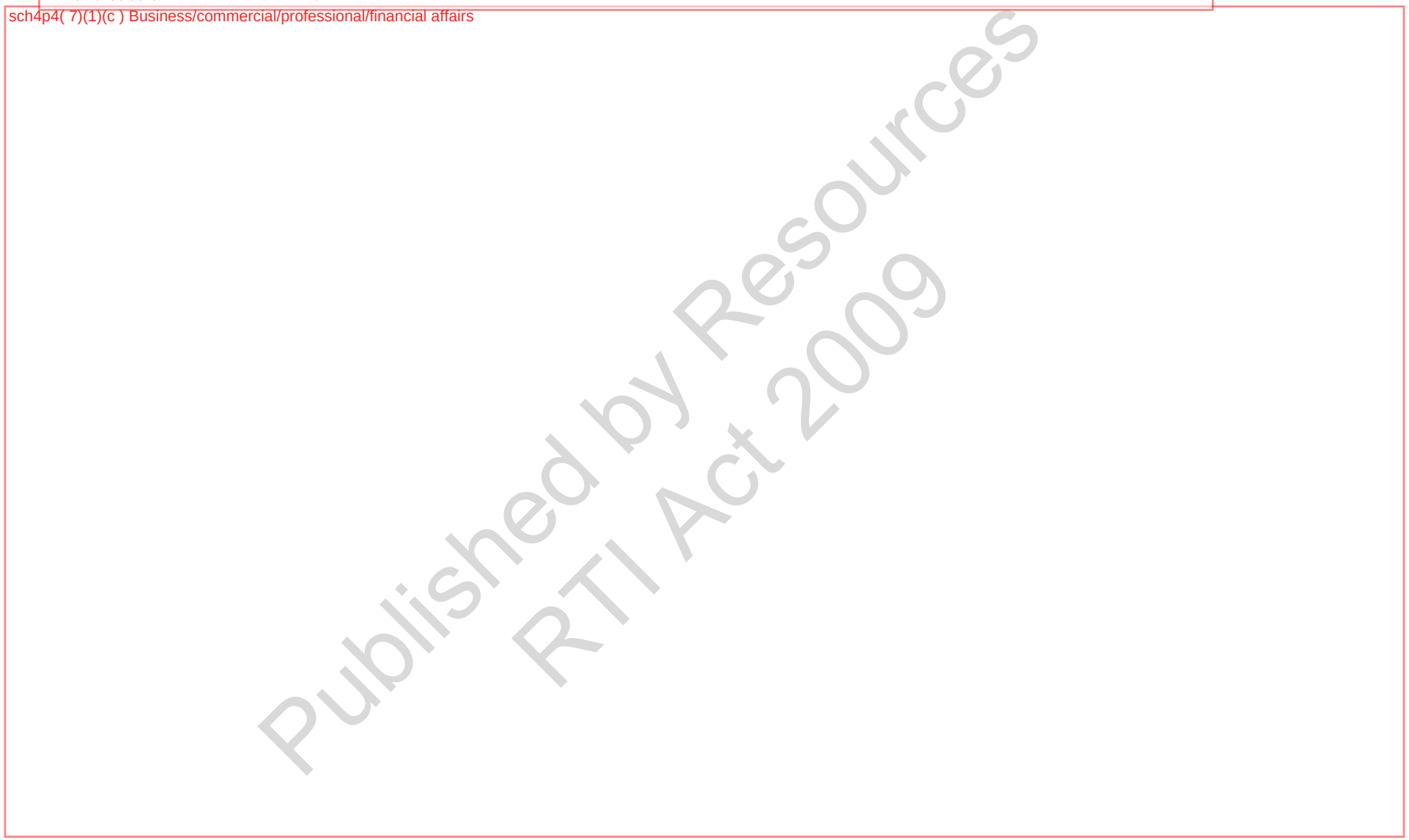

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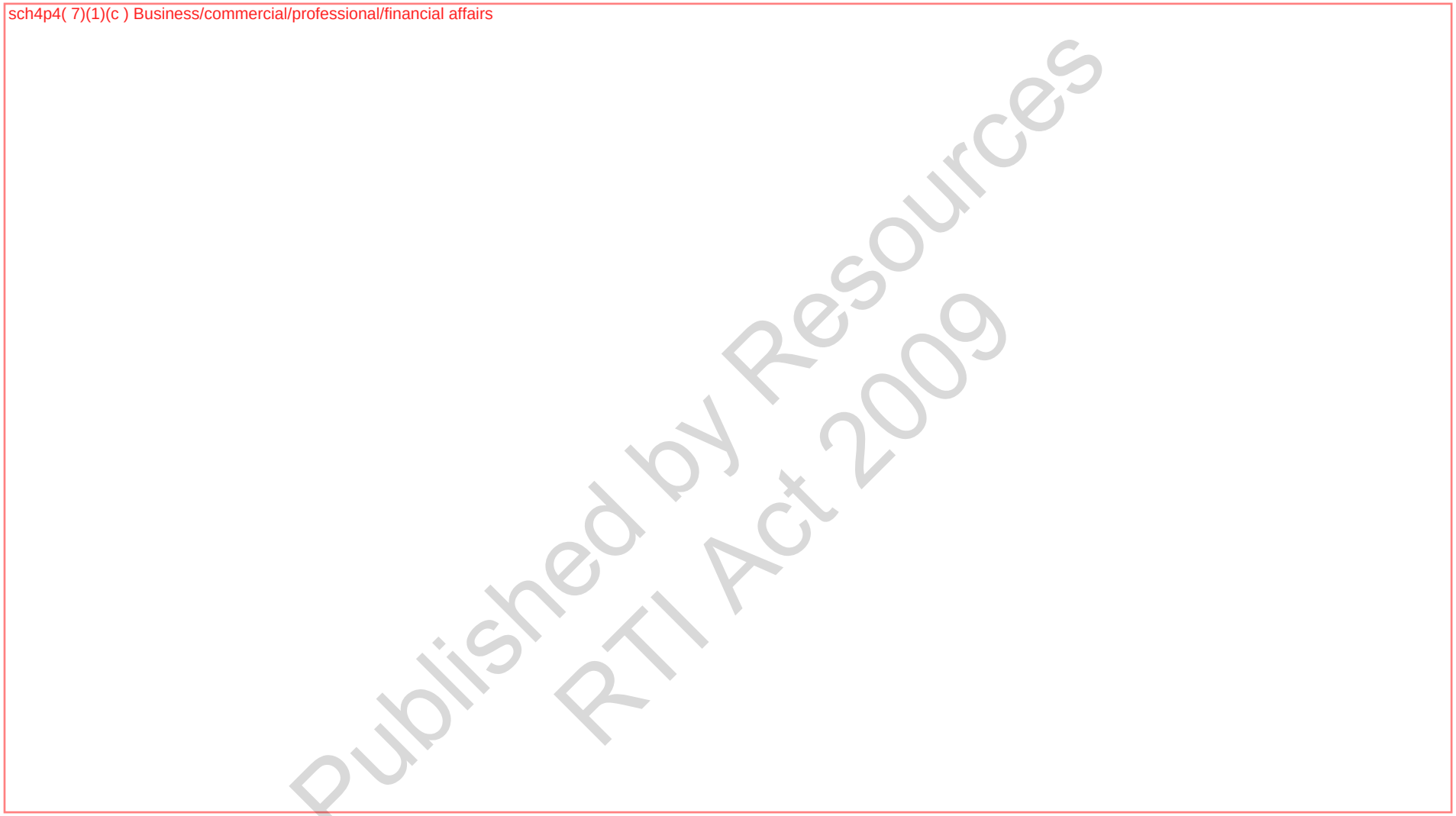

Figure 7 – sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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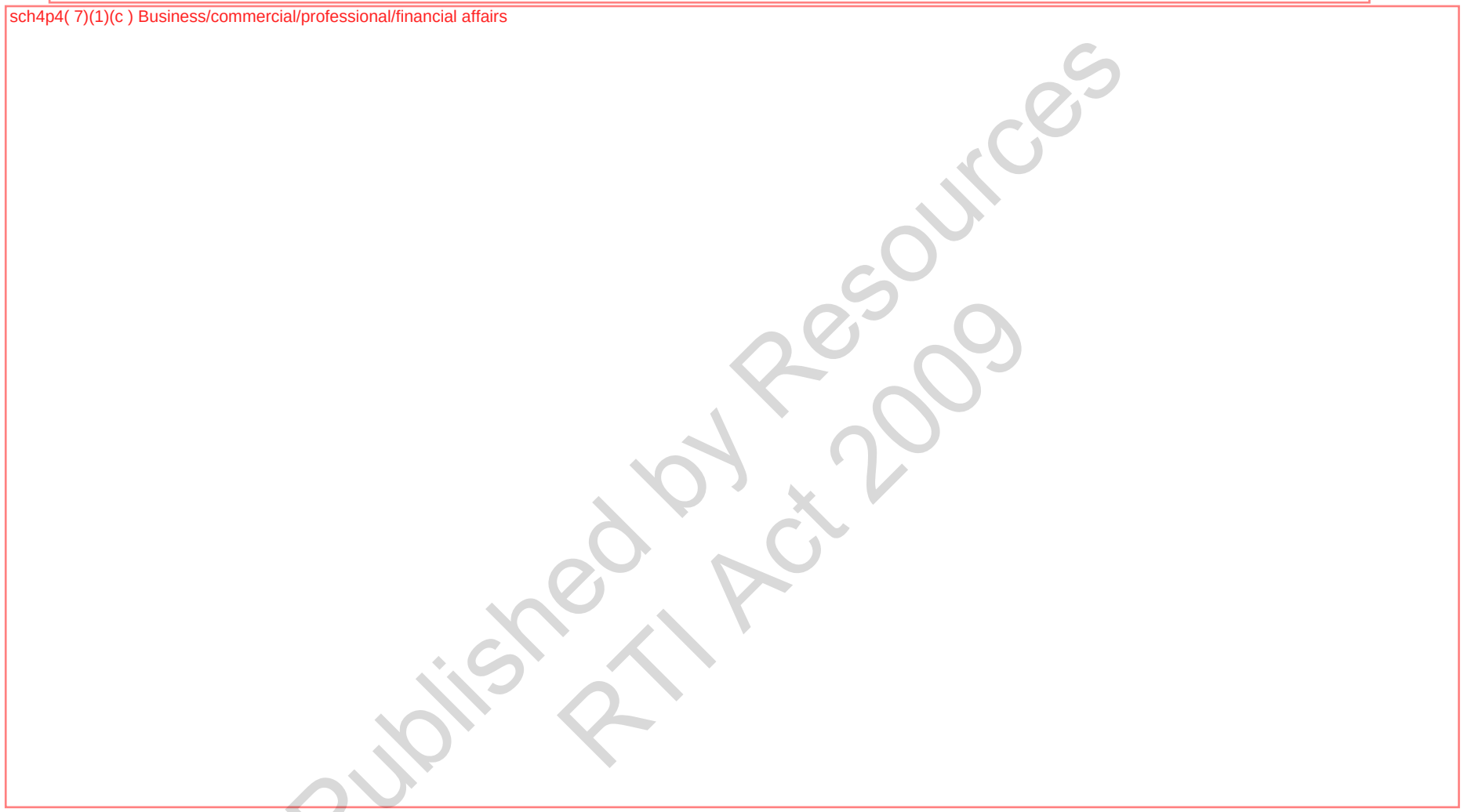

BOWEN TGS: PCA 305 (ATP 645) AMENDMENT APPLICATION

JUNE 2020

Contents

1 Introduction

1.1 ATP 645 Tenure History

ATP 645 is in the Bowen Basin, east of the town of Surat within the Western Downs and Maranoa Regional Council areas as shown in Figure 1.

The ATP was first granted under the Petroleum Act 1923 to BNG (Surat) Pty Ltd, a wholly owned subsidiary company of QGC Pty Limited (QGC), for 4 years commencing 1 January 2000 over an area of 31 graticular blocks. BNG (Surat) Pty Ltd extended an interest of 50% to Samson-International (Australia) Pty Ltd in 2003.

ATP 645P was renewed for a further 4-year term under the Petroleum Act 1923 on 1 January 2004 over an area of 24 graticular blocks. Departmental Policy Number MIN/2003/1192 saw both mid-term relinquishments waived with a 20% relinquishment (4 graticular blocks) required prior to renewal. In 2005 Samson-International (Australia) Pty Ltd assigned its 50% interest back to BNG (Surat) Pty Ltd.

ATP 645 became a converted ATP under section 876 of the Petroleum and Gas (Production and Safety) Act 2004 (P&G Act) on 31 December 2004 thereby ceasing its administration under the Petroleum Act 1923 and becoming an ATP under the P&G Act.

On 1 January 2008, ATP 645 was renewed for a further 12-year term over an area of 475 sub-blocks. An amendment to the area of ATP 645 to include previously excluded land subject to native title was recorded on 20 May 2014 with ATP 645 being subject to the Mandandanji People and QGC Pty Limited ILUA (QI2010/034) registered with the National Native Title Tribunal on 12 May 2011. On 31 July 2014 the current approved work program and relinquishment condition was statutorily extended by 2 years from 31 December 2015 to 31 December 2017.

The tenure is currently in its third and final four-year period of this renewal term, ending 31 December 2019. ATP 645 will continue to cover an area of 300 sub-blocks upon the declaration of 2 x Potential Commercial Area applications lodged

by BNG (Surat) Pty Ltd and operated by Shell QGC.

Under section 844 of the P&G Act this amendment application seeks to amend the area of PCA application 1 (305) lodged with DNRME on 28 November 2019 to include the areas of PCA application 2 (306), 3 (307) and 4 (308) as shown in Figure 4 to a larger single contiguous PCA as shown in Figure 5. The justification for the larger PCA will reduce the administrative burden on Shell QGC and DNRME in managing 1 PCA rather than 4. It will also bring efficiencies to Shell QGC when carrying out the approved activities due to economies of scale and the removal of having to manage the works across 4 discreet areas. Furthermore, this will allow for G&G studies to be done over a larger contiguous area providing greater interpretation of data across the play rather than individual studies. This amendment application proposes a PCA evaluation programme to support the ATP 645 LWP and help effectively address the key hurdles to economic resource development.

1.2 Compliance With Conditions of ATP 645

The approved current period later work program is shown in **Table 1**, extracted from the ATP instrument, reflecting the current later work program for the 2-year period 1 January 2018 to 31 December 2019. Tenure is in good standing with the current and past work programs contributing to the identification of several potential commercial areas.

Period 5	Minimum Approved Activities	Estimated Expenditure
One (1) year ending 31 December 2018	Geological & Geophysical and engineering studies	$100,000
One (1) year ending 31 December 2019	Geological & Geophysical and engineering studies Prospect selection, well planning & design	$100,000
	TOTAL	$200,000

The proposed later work program lodged for ATP 645 lodged on 27 October 2017 has been approved.

Table 1: ATP 645 Current Period Approved Later Work Program

1.3 Bowen TGS Exploration History

Early exploration in ATP 645 was undertaken by BNG (Surat) Pty Ltd) (at the time a wholly owned subsidiary of Sunshine Gas) during the early 2000's, focussed on defining the prospectivity of Permian and Triassic tight gas sand reservoirs through acquisition of the 193km^2 Overston 3D seismic survey and drilling of the Overston-1 & -2/2A and Narrene-1 wells.

Following the acquisition of Sunshine Gas by QGC, BNG (Surat) Pty Ltd subsequently became a wholly owned subsidiary of QGC Pty. Ltd. and from 2010, concurrent with the ongoing Surat Basin CSG activity, QGC embarked on a major exploration campaign focussing on tight gas sands (TGS) in the Permian and Triassic section within the Taroom Trough of the Bowen Basin. ATP 645 was one of a number of A's to P being assessed for TGS prospectivity, all of which were held 100% by QGC (or related entities). The project is internally referred to as Bowen TGS.

In September 2015, approval was granted to combine 100% QGC held ATP 645, ATP 785, ATP 768 and ATP 1101 into a project area, the Bowen TGS Project Area (BTPA).

In 2018, Shell entered into two non-operated joint ventures operated by Santos (QNT) Pty. Ltd. located adjacent to ATP 645 and ATP 785 with field activity commencing in 2019.

Figure 2 shows the significant amount of TGS exploration activity within the QGC operated tenures during the period from 2010 to present, whereby the presence of significant unconventional resource potential has been demonstrated in ATP 645 (by Dunk-1, Daydream-1 and Magnetic-1) and also at Fantome (ATP 632 / PCA 160).

Total expenditure over the course of this activity is in excess of AUD$ sch4p4(7)(1)(c) with work conducted in these tenures since 2010 including:

- 826km 2D seismic acquisition, initially to resolve broad geological structure for exploration planning and resource estimation, and where applicable, to calibrate the seismic with drilling results, to apply more sophisticated seismic

techniques;

- 4,151km 2D seismic re-processing (plus integration of 17,800km of 2D re-processing attributable to other exploration and development projects in QGC) and 193km^2 3D seismic re-processing of legacy surveys across the project area; and
- 7 wells drilled (4 fracture stimulated and production tested) which were the first designated basin centre penetrations in the Taroom Trough with total depth ranging from 3,180-4,694m. Three of these wells were drilled in ATP 645 (Daydream-1, Dunk-1 and Magnetic-1) testing stacked reservoirs on the western flank of the southern Taroom Trough.

This new data acquisition was in addition to information provided by legacy conventional petroleum exploration activity, and information from adjacent tenure acquired by data trade or as open file, providing significant information for QGC's initial exploration planning through to current resource understanding.

Shown in Figure 3, ATP 645 and the other Bowen TGS focus tenements are located within the Taroom Trough of the Bowen Basin with settings ranging from the western flank adjacent to the Roma Shelf, across the deepest part of the trough, through to the eastern side of the trough basinward of major basement cored anticlines along the Burunga-Leichardt Fault system.

1.4 Proposed Potential Commercial Area 1 (305) (ATP 645)

Potential Commercial Area 1 (305) (ATP 645) arises out of the large TGS exploration work program carried out by QGC as operator within the BTPA and non-BTPA tenures (including ATP 645). Appraisal of the Dunk-1 discovery drilled in 2014, and tested and flowed gas to surface at sustained rates of 700mscf/d in 2015, forms the basis of this application. Further support is lent to the application by the legacy wells in ATP 645, in addition to the other QGC wells; Daydream-1 which flowed gas to surface in 2013 and Magnetic-1 which confirmed gas bearing reservoir on logs.

The Commercial Viability Report (Section 2), prepared by QGC as Operator, addresses the requirements outlined in the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) for a PCA application. Figure 4 illustrates the area of

this PCA application, the area of ATP 645 sought to be retained through associated PCA applications and the extent of the two primary reservoir objectives, the Tinowon Formation and Lorelle Sandstone.

The primary TGS resource identified in ATP 645 is the Tinowon Formation, which is present across all graticular blocks in the tenure except for CHAR 2657 and CHAR 2729. The estimate of recoverable hydrocarbons in this reservoir across ATP 645 in the area covered by PCA 1 (305), on an unrisked P50 basis, is 3.0tcf sales gas and 252mmboe NGLs and condensate.

The secondary resource present in ATP 645 is the Lorelle Sandstone which is present across the western part of the tenure. The estimate of recoverable hydrocarbons in this reservoir across ATP 645 in the area covered by PCA 1 (305), on an unrisked P50 basis, is 400bcf sales gas and 17mmboe NGLs and condensate. Given the immaturity of tests information on this reservoir in the area and the level of seismic detail confirming extend the associated risk seen for Lorelle formation is high (COS <10%)

Despite the material recoverable volumes estimated, the resource has not yet been able to be demonstrated as economically viable. sch4p4(7)(1)(c) Business/commercial/professior

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Bu The focus of the LWP for ATP 645 is intend for demonstration of the Tinowon Sand formation, which is believed to have the highest chance of success given the known results seen to date from the previous 2010-2014 drilling campaign.

1.5 Description of Proposed PCA 1 (305) (ATP 645)

The proposed area of PCA 1 (305) (ATP 645) comprises 275 contiguous sub-blocks (825km^2) within the ATP 645 tenement as shown in Figure 5 and listed in Table 2. This area covers the extent of the reservoirs on tenure described in Section 2.

Block	Sub-blocks	# Sub-blocks
CHAR2657	all	25
CHAR2658	all	25
CHAR2659	all	25
CHAR2660	all	25
CHAR2729	all	25
CHAR2730	all	25
CHAR2731	all	25
CHAR2732	all	25
CHAR2802	all	25
CHAR2803	all	25
CHAR2875	all	25
TOTAL		**275**

Table 2: PCA 1 (ATP 645) sub-block listing.

1.6 PCA 1 (ATP 645) Application Rationale

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2 Commercial Viability Report

The areal extent of this PCA Application is shown in Figure 4 displayed in context with the associated ATP 645 PCA application areas. QGC, as operator of the BTPA, and ATP 632, has drilled 7 wells and acquired 4,151km of 2D seismic during exploration for deep gas resources in the Bowen Basin since 2010.

Viewed in combination with previous conventional petroleum exploration drilling, new and legacy seismic, and by extension of data from adjacent areas, QGC has identified two prospective natural underground reservoir intervals in ATP 645. These are the Permian aged Tinowon Formation and Lorelle Sandstone, both part of the Back Creek Group as shown in Figure 7.

While both of these reservoir intervals are present in the area of PCA 1 (305) (ATP 645), commercialisation of the area under application is considered by QGC to initially rely on successful commercialisation of the primary target, the Tinowon Formation, which to date has provided the most encouraging prospectivity in ATP 645 and in surrounding areas.

2.1 Geological Model

2.1.1 Regional Geology

The Bowen Basin covers over 160,000 km^2 of southern and central Queensland and has a maximum sediment thickness of about 10,000 metres concentrated in two north-south trending depocentres, the Taroom Trough in the east and the Denison Trough in the west (Figure 3). The basin first opened as a result of an Early Permian extensional tectonic phase. This set up a series of grabens and half-grabens into which fluvial-lacustrine sediments were deposited. This episode was also accompanied by extensive volcanics throughout the basin, but particularly along its eastern margin.

Following this extensional phase, a more passive thermal sagging phase occurred. This resulted in a basin wide marine transgression and saw a temporary cessation of volcanic activity along the eastern margin of the basin. Sediment was dominantly sourced from the west and deposited eastward over the antecedent grabens and half-grabens. Deltaic sediments prograded into the basin from the west, filling in

the various depocentres that are associated with coal deposition. The sediments deposited during this time comprise the mid-late Permian Back Creek Group.

By the Late Permian, a compressional phase led to foreland loading on the eastern margin of the basin. This event cut the basin off from the open sea and resulted in rapid infilling of dominantly coastal plain to alluvial plain facies. Substantial amounts of coal were cyclically deposited (the Kianga Formation and equivalents) throughout the basin. Renewed igneous activity brought about by the tectonic reactivation, several tuffaceous sediments are deposited during this time. By the middle to late Triassic, the basin was in filled with sediments although continued diastrophism was experienced resulting in further deformation of the rocks.

The southern half of the Bowen Basin, where ATP 645 is located, is overlain by the Surat Basin which most notably contains the Walloon Coal Measures underpinning supply to the various LNG projects on Curtis Island.

2.1.2 Description of Reservoirs

2.1.2.1 Back Creek Group

The Back Creek Group is a widespread succession of marine to fluvial sands, silts, shales, coals and tuffs that predominantly represent the thermal sag phase of Bowen Basin development. Sediment input during this time was predominantly from the west and as such the best reservoir development in this interval that has been encountered in the Taroom Trough is along the western flank of the south-west Taroom Trough on the basinward margin of the Roma Shelf.

Within the Back Creek Group, there are a number of discrete reservoir targets that are economic producers or form exploration targets on the Roma Shelf. The most significant of these are:

- Lorelle Sandstone: An early-mid Permian fan-delta system penetrated on the Roma Shelf and in a small number of wells on the western flank of the Taroom Trough. This is the oldest reservoir in the Back Creek Group and to date no economic production has been achieved from this reservoir despite being found to be gas-bearing in a number of wells. Given the depositional environment for this formation, a key challenge in its exploration is understanding reservoir distribution and quality variation with a relatively small number of well

penetrations.

- Tinowon Formation: The late Permian Tinowon Formation is divided into two distinct depositional sequences, the lower Tinowon/Wallabella Coal Member and the upper Tinowon. Both units represent separate transgressive successions separated by a sequence boundary at the top of the lower Tinowon/Wallabella Coal Member. Across the Roma Shelf, these intervals represent fluvial-alluvial deposition however moving basinward, indications of marine influence are seen with deposition interpreted to tend more coastal plain into the Taroom Trough. The upper Tinowon is the most prolific gas producing interval on the Roma Shelf with the largest gas fields in the province being reservoired in this interval. The lower Tinowon is productive but its prevalence as an economic producer is limited due mainly to localised depositional trends and generally poorer reservoir quality than the upper Tinowon.

2.1.2.2 Kianga Formation

The Kianga Formation is defined in the southern Taroom Trough and is the age equivalent to the late Permian Rangal Coal Measures and Baralaba Coal Measures in the northern Taroom Trough and Nebo Synclinorium. Deposition of the formation occurred during extensive foreland loading, in fluvial to marsh environments of a regional deltaic system. The lithology of these coal measures are predominately fine to medium grained lithic sandstones, inter-bedded with grey-brown siltstones abundant carbonaceous material and coals, tuffaceous shales and common tuff bands.

The Kianga Formation reaches a maximum thickness of over 1,000m thick in the Taroom Trough (up to 500m in the southern Taroom Trough) and thins onto the Roma Shelf. The reservoir potential on the Roma Shelf is poor with coals and carbonaceous mudstones dominating the section however, well penetrations in the Taroom Trough show sandstone beds up to 10's m thickness interbedded with coal seams generally up to several metres thick.

2.1.3 PCA 1 (305) (ATP 645) Geology

ATP 645 is located on the southwestern flank of the Taroom Trough with strata dipping gently down to the east (Figure 8). Drilling in the tenement area since the

early-2000's has focussed on testing TGS play potential of the Permian Back Creek Group and Kianga Formations with all wells drilled outside of any known conventional structure or stratigraphic trapping feature.

Prior to grant of ATP 645, a number of deep wells were drilled during the 1980's in the southern part of present-day ATP 645, with unstimulated flow tests recovering gas cut mud. These wells are in the part of ATP 645 covered by PCA 5.

The earliest activity under ATP 645 was undertaken by Sunshine Gas acquiring the Overston 3D and drilling the Overston-1, Overston-2/2A and Narrene-1/1A wells. Most recent activity has been the QGC-operated Bowen TGS Project where 2D seismic was acquired and 3 wells were drilled, Daydream-1, Dunk-1 and Magnetic-1.

Three vertical wells (Overston-2/2A, Daydream-1 and Dunk-1) have flowed gas and condensate to surface following fracture stimulation and sch4p4(7)(1)(c) Business/com

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sch4p4(7)(1)(c Dunk-1 is located in PCA 1 (305)(ATP645) and the Overston 3D seismic survey covers a large portion of the PCA area.

The Dunk-1 discovery (2015) provides the impetus for further appraisal in ATP 645 and the Magnetic-1 well (2015) located 10km to the south, close to the ATP 2040 boundary provides encouragement to further explore for the Lorelle Sandstone in ATP 645. The Daydream-1 well (2012), near the eastern boundary of the area of ATP 645 covered by PCA 1 (305) also flowed gas to surface from the Tinowon Formation in an unoptimized flow test.

Dunk-1 and Magnetic-1 both encountered gas-charged sandstone units within the Permian Back Creek Group. In Dunk-1 (Figure 9), the Upper Tinowon Sandstone within the Tinowon Formation was best developed, comprising a ~40 m thick gross interval with a Net-to-Gross (N:G) of almost 100%. A core was taken through ~29 m of the Upper Tinowon Sandstone, which proved critical in defining reservoir/fluid properties and depositional environment (interpreted as incised valley fill). sch4p4(7)(1)(

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The primary target in Magnetic-1, was the Lorelle Sandstone (part of the Muggleton Formation), found to be similarly well-developed as in the Narrene-1A offset well. As predicted, the Upper Tinowon was much siltier in character and of secondary interest. 45m of core was obtained from the Lorelle in Magnetic-1, which was found to be conglomeratic in the lower part of the reservoir; this was in contrast to the high-quality sandstones prognosed predrill (note that no core was taken in Narrene-1 which was the primary offset control). sch4p4(7)(1)(c) Business/commercial/professional/f

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Daydream-1 was drilled to test the Taroom Trough in less basinal location as QGC Fantome and Tasmania wells. A secondary objective of the well was also to penetrate a package identified on seismic, interpreted to be the Bowen Basin syn-rift section. The well encountered a sandy early Permian (including Tinowon Formation) section overlying volcanics. As the well was located close to the edge of the syn-rift package on 2D seismic, it is still uncertain whether the well actually penetrated the interpreted syn-rift section and it comprises volcanics, or, the well missed the edge of the syn-rift package and penetrated the Combarngo Volcanics seen regionally. This was the first well fracture-stimulated in the QGC Bowen TGS Project and despite a number of issues with these operations, including recovery of unbroken gel to surface during the clean-up and one stage being perforated incorrectly at 180º rather than at 60º as planned, sch4p4(7)(1)(c) Business/commercial/professi

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/pro As the well was still cleaning up when the test was stopped, a nitrogen coiled-tubing clean-out and gas lift was planned for later in the

campaign but was not executed due to budget constraints.

In Q1 2019, GLNG (Santos Operator) fracture stimulated and production tested the Upper Tinowon and Lorelle Formations in the Tinowon-2 well (drilled 2015 in ATP 2017), 15km NW of Dunk-1. Results of the production test are not known, however, the reported status at the end of Q1 2019 was that the well was "shut-in for a 6-month pressure build-up test to assess the connected volume in the accumulation."

While OGIP and gas flow to surface has been demonstrated in the PCA area, there is considerable uncertainty on reservoir characterisation due to the limited number of well penetrations. The Tinowon formation sand can be mapped on the Overston 3D seismic and onto the regional 2D grid (Figure 10). Encouraging indications of the ability to utilise seismic for reservoir characterisation have been seen but further drilling is required to provide further calibration (Figure 11). The ATP 645 LWP consists of further 2D seismic and drilling of two wells to calibrate the seismic response and allow extrapolation onto 2D seismic across ATP 645 and beyond to demonstrate materiality of the play.

To date, post-stimulation production testing has not yielded economic flow rates from vertical wells, posing a challenge to economic development of the tenure using the currently tested drilling and completion techniques. sch4p4(7)(1)(c) Business/com

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This PCA evaluation program supports the ATP 645 LWP to address the challenge of maturing an economic play by improving characterisation of the tight gas sand reservoirs in order to identify sweetspots and assessment of various drilling and completion techniques that may unlock deliverability in tight sands.

2.2 Resource Assessment

2.2.1 Standards for Resource Assessment

The estimate of hydrocarbon in the Tinowon and Lorelle reservoirs in ATP 645 are compiled in accordance with Shell's internal instructions and guidelines for

estimation and classification of petroleum resources which are based on the Society of Petroleum Engineers' Petroleum Resources Management System (SPE-PRMS).

Estimation of hydrocarbon resources within ATP 645 has been conducted through a recognisable industry approach where available information is combined to estimate a probabilistic range of original gas-in-place (OGIP) to highlight the range in uncertainty of the OGIP, and to estimate potentially recoverable hydrocarbons by applying recovery factors derived by dynamic reservoir modelling, informed by well production testing.

2.2.2 OGIP

Shell provides the following estimates of in-place hydrocarbons in the part of ATP 645 covered by PCA Application 1. The location and a verifiable estimate of the amount of hydrocarbon in each of the identified natural underground reservoirs is summarised in Table 3, which shows the distribution of the original gas-in-place (OGIP) estimates based on probabilistic methods.

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Table 3: sch4p4(7)(1)(c) Business/commercial/professio

The data used in the generation of the estimates in Table 3 is derived predominantly from the results of Dunk-1 and Magnetic-1 and includes reinterpretation of all available pre-existing seismic and well based data surrounding the area of interest to estimate potential range of reservoir properties.

The parameters used to derive these OGIP estimates are shown in Table 4.

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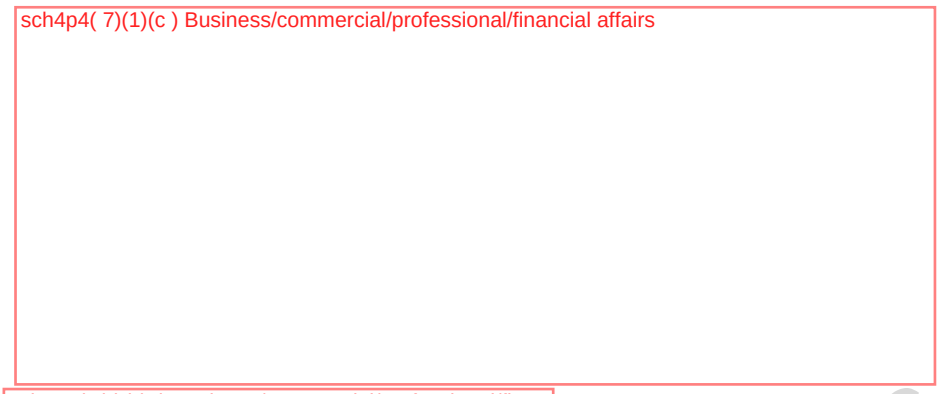

Table 4: sch4p4(7)(1)(c) Business/commercial/professional/financ

2.2.3 Recoverable Resource

The provided estimate of recoverable hydrocarbons in the part of ATP 645 covered by PCA Application 1 is estimated by applying a range of recovery factors derived from interpretation of dynamic reservoir data obtained from production testing in Dunk-1 and applying estimates of potential upside deliverability based on benchmarking against analogous North American reservoirs. Despite substantial OGIP, the challenge with commercialising tight sands in ATP 645 is that, based on current drilling and completion techniques for vertical wells, deliverability is sub-economic.

The range of recovery factors and resulting recoverable resource is based on a conceptual 160-acre horizontal development concept and is shown in Table 5. It is important to note that the recovery factor range reflects the uncertainty on interpretation of dynamic reservoir properties from one production test which, being an early-stage exploration well is recognised as being far from optimal.

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Table 5: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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2.3 Holder's Opinion on Commerciality

On the basis of the vertical well test deliverability, QGC cannot demonstrate a commercially viable project in ATP 645 at this time and as such is making these PCA applications over the tenure.

QGC asserts that, although not currently viable, the PCA area is potentially commercially viable within a timeframe of 15 years, and this can be demonstrated through execution of the ATP 645 LWP and the proposed PCA evaluation program (in support of the ATP LWP) to address the key aspects of this large but challenging resource. Some development enablers are:

- Significant in-place resource base;
- Encouraging seismic attribute support for reservoir characterisation across ATP 645 and beyond;

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- Proximity to infrastructure given location near to existing Roma Shelf production facilities; and
- Strong demand side support, including potential smaller local domestic demand for initial development, larger East Coast domestic demand for larger development, and LNG scale demand.

The key challenges that will impact commercialisation are routine to petroleum development and will be addressed as part of the proposed ATP LWP and PCA evaluation program. These include:

- Reservoir characterisation and "sweetspot" extent;
- Sustained well deliverability and well cost;
- Development cost and scale;
- Utilisation of existing infrastructure;
- Commercial aspects, such as co-ordination with neighbouring tenure holders or as part of combined development to give sufficient scale and optimisation of development concept for the basin.

2.3.1 Methodology for Assessing Commerciality

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2.3.2 Assessment of Commerciality

The results of the economic analysis show that should delineation of the resource estimated in Section 2.2.3 be successful, and with the development concept outlined above with assumed capex profiles, ATP 645 has the potential to contain commercial hydrocarbons.

Figure 12 shows a key outcome of the analysis with total project resources plotted against Value-to-Investment Ratio (VIR), a critical investment decision criteria, for the three price scenarios (base, high and low). sch4p4(7)(1)(c) Business/commercial/professional sch4p4(7)(1)(c) Business/commercial/professional/financial affairs .

It shows that at base and high price outcomes, a development of the Overston 3D area would be economic and beyond that, a development of wider ATP 645 would be commercial at all assumed prices.

A key consideration is the minimum economic field size that is required to yield a commercial development. sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/profession With price being a key uncertainty over the timeframe of these developments, this analysis demonstrates the need to maximise the appraisal area to maximise the chances of realising a commercial development.

To mature ATP 645 into an economic project, it will be required to:

1) Confirm extent of the resource and calibrate reservoir parameters over the maximum possible area;
2) Optimise the drilling and completion techniques deployed to realise the modelled type curves; and
3) Demonstrate ability to execute project within capex profile assumptions in the economic analysis.

Addressing these considerations forms the basis of the ATP 645 LWP and the evaluation program in this PCA, along with integration of ongoing work in the wider BTPA and third-party tenements.

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There is also additional upside with potential for acquisition of additional resources through winning acreage release tenders, or investigating potential collaboration opportunities with adjacent or nearby operators to improve development economics and optimise the overall basin development. These activities will also form part of the evaluation program.

3 Evaluation Program

Shell proposes a 15-year PCA evaluation program focused on addressing the main challenges of the resource contained in ATP 645 (including the PCA 1 (305)(ATP 645) area), described earlier in this application.

The evaluation program is in support of delivering the ATP 645 LWP for the period 1 January 2020 to 31 December 2023 and will inform future LWP scope. Separately, but giving oblique support to this program, it is recognised that this work has the added value of potential to inform, and to be informed by, evaluation of other areas within the BTPA and in Shell non-operated ventures.

This program includes multiple elements, some of which are discrete and can be proposed against a time line, (such as an update to the geological model) and some which are ongoing through the course of the entire period (such as monitoring commercial and market conditions). With this in mind, the program put forward by Shell follows the overall rationale of a robust staged review of potential commerciality of an unconventional resource discovery in conjunction with the current and subsequent Later Work Programs, as set out in Table 6.

The amalgamation of PCA applications 1-4 (305, 306, 307 & 308) sees a reduction in the overall expenditure over the proposed 15-year term from $3M to $1.125M. The reduction in expenditure results in increased synergies in a larger contiguous area and economies of scale when carrying out the proposed activities once, rather than assessing 4 individual areas i.e. not required to carry out 4 individual studies for front end loading and development planning etc. The larger area provides greater certainty and flexibility when assessing concept development planning and potential markets for the gas due to potential larger volumes associated with a larger area. It should also be noted, that there is no change in expenditure related to the ATP 645 renewal due to the amalgamation.

Year	Activity	Estimated Expenditure per PCA ($A)
1	Review and update of geological model, reservoir characterisation and in-place gas resource.	75,000
2	Review of existing and future potential technological options, including drilling, completion, stimulation and production optimisation for input into well design and program planning.	75,000
3	Review of well and seismic results and planning for future appraisal.	75,000
4	Review of well and seismic results and planning for future appraisal.	75,000
5	Studies in support of further appraisal and front-end loading development planning.	75,000
6	Studies in support of further appraisal and front-end loading development planning.	75,000
7	Studies in support of further appraisal and front-end loading development planning.	75,000
8	Studies in support of further appraisal and front-end loading development planning.	75,000
9	Studies in support of further appraisal and front-end loading development planning.	75,000
10	Studies in support of further appraisal and front-end loading development planning.	75,000
11	Selection of development concept.	75,000
12	Define development concept and update project economic evaluation.	75,000
13	Pre-FEED engineering studies. Negotiate gas sales agreement(s).	75,000
14	Pre-FEED engineering studies. Negotiate gas sales agreement(s).	75,000
15	Pre-FEED engineering studies. Reserves certification to underpin gas sales agreements and investment decision.	75,000

Table 6: Proposed evaluation program for PCA1 (305)(ATP 645) for a 15 year PCA term.

4 Figures

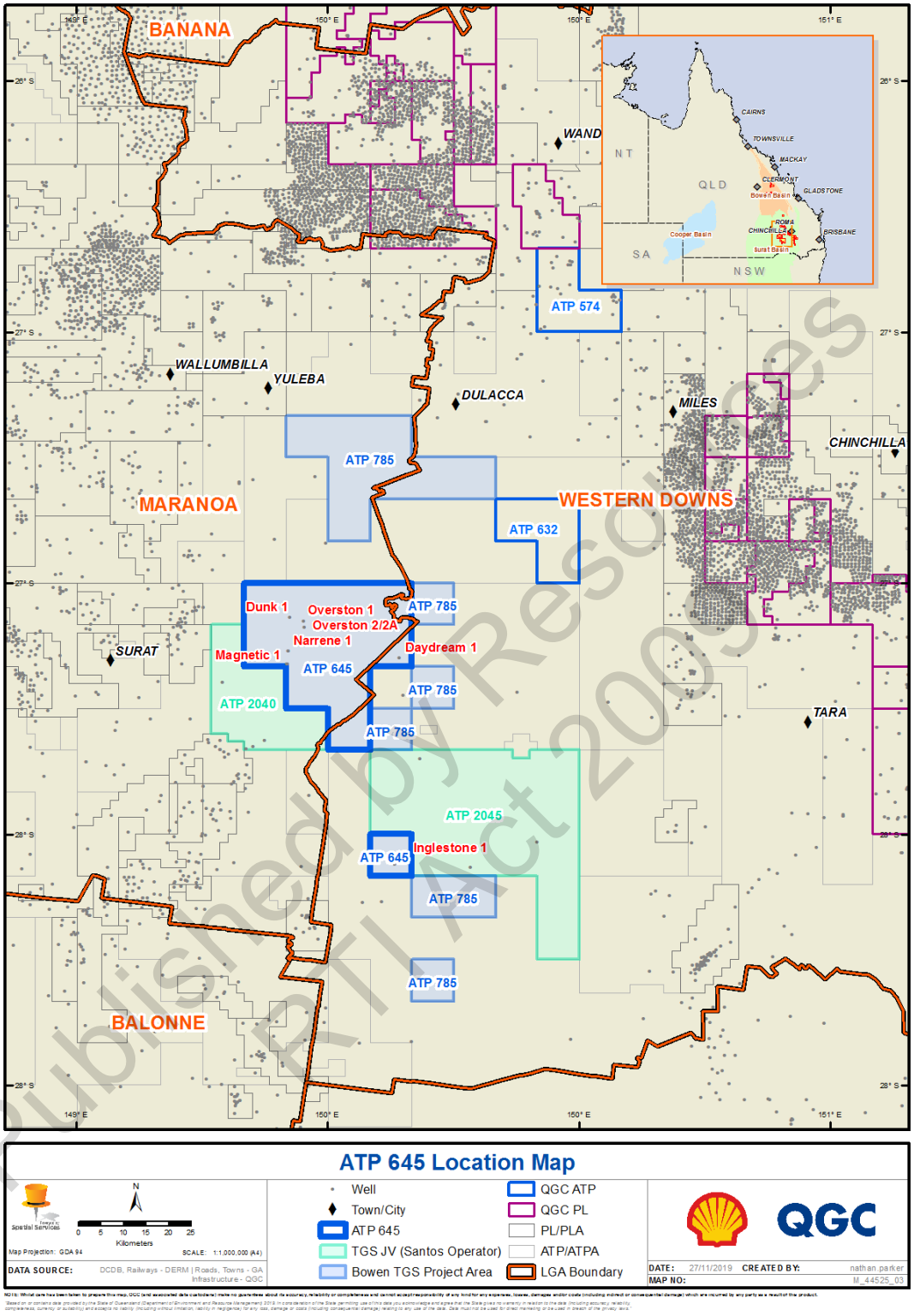

Figure 1: Location map showing ATP 645 and other Shell interests in southern Taroom Trough.

Figure 2: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs
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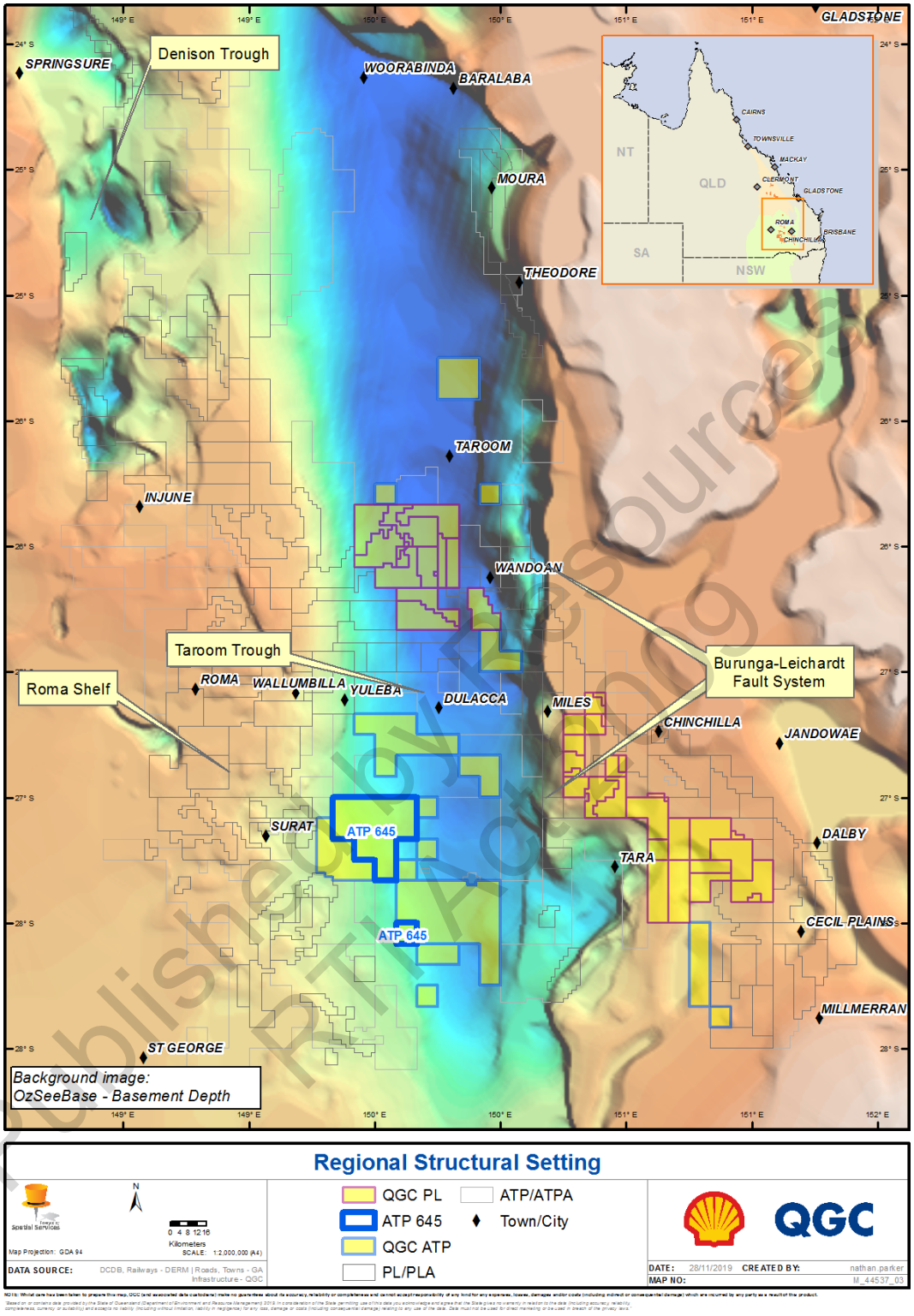

Figure 3: Geological setting of ATP 645 showing major regional features mentioned in the text.

Figure 4: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs
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Figure 5: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 6: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 7: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs
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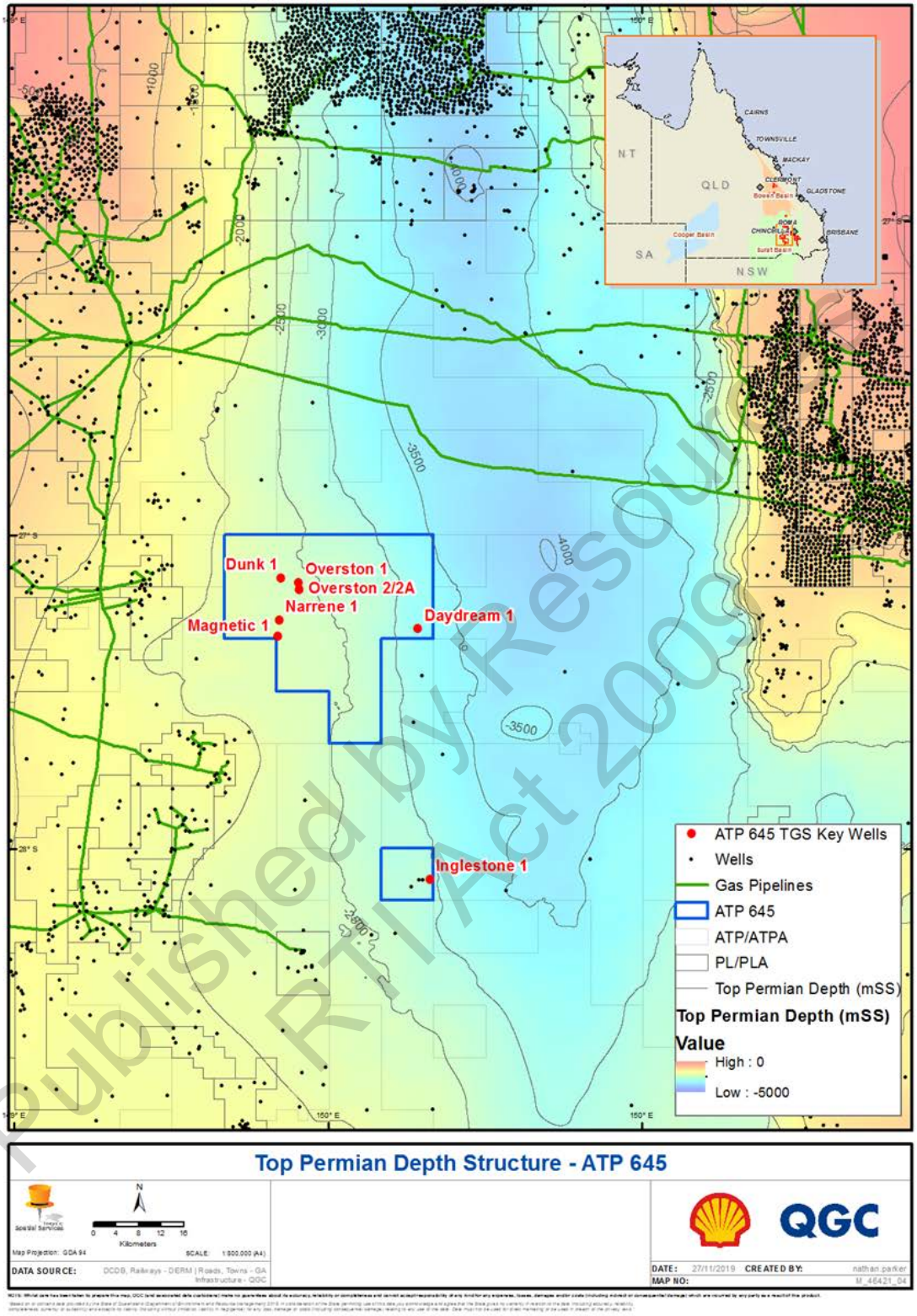

Figure 8: Depth structure map for Top Permian (Kianga Fm) in southern Taroom Trough showing location of ATP 645.

Figure 9: sch4p4(7)(1)(c) Business/commercial/

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Figure 10: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 11: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 12: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Potential Commercial Area (PCA) application – Technical Assessment

Unless otherwise stated, all references below to sections relate to the *Petroleum and Gas (Production and Safety) Act 2004 (P&G Act)*.

Enter permit number	**PCA 305**
Prerequisite permit number	**ATP 645**
Applicant	**BNG (Surat) Pty Ltd**
Contact Details	QGC Pty Limited GPO Box 3107 Brisbane QLD 4001 Email: QGC-Tenures@shell.com

Milestone: Summary	

PCA application 305 was assessed against the relevant requirements of the legalisation in conjunction with the operational policy and these matters are outlined thoroughly within this report.

The applicant has provided sufficient evidence to demonstrate the following:

(1) **Petroleum discovery** has been solidly established:
   a. Gas and condensate have been flowed to surface at sustained rates from the clearly identified targets (Tinowon tight sands) in three tight gas exploration wells within the PCA 305 area (Dunk 1 and Overston 2A in north-western part and Daydream 1 in south-eastern corner), and gas bearing reservoir has been confirmed on gas shows and logs in Magnetic 1 in the south-western corner of the area;
   b. Coring, logging and testing through fracturing stimulation in those multiple wells have been utilised in establishing the discovery status;
   c. Presence of significant quantity of hydrocarbons has been demonstrated;
   d. The applicant has demonstrated that the hydrocarbons are potentially commercial within the next 15 years.

(2) **Commerciality**:
   a. Significant amounts of recoverable (prospective) gas and condensate resources have been estimated even though no contingent resources have been achieved;
   b. The applicant has demonstrated the petroleum production is not commercially viable now, or would not soon, with the gas rates already or possibly achievable with the currently tested drilling and completion techniques (vertical wells and the single-staged fracturing stimulation);
   c. The applicant has convincingly demonstrated that petroleum production would potentially be commercially viable within 15 years with utilisation of horizontal wells and multi-staged fracturing stimulation in the area, by potentially improving well production rates and reducing total well/development costs through improving characterisation of the tight gas sand reservoirs in order to identify sweet spots and assessment of various drilling and completion techniques that may unlock deliverability in tight sands;

(3) **Area**:

The applicant has provided sufficient evidence to demonstrate that the required area for PCA 305 is no more than it needed to cover the maximum extent of the identified reservoirs, since:

a. SPE-PRMS has stated that "*the extent of the discovery within a pervasive accumulation is based on the evaluator's reasonable confidence based on distances from existing experience, otherwise quantities remain as undiscovered*";
b. The applicant has provided sufficient evidence in reasonable confidence to support its claimed existence of pervasive unconventional tight gas sand reservoirs in Tinowon sandstones over the whole PCA 305 area, such as:
   (a) All the seven exploration wells with gas flow or gas shows in the area were targeting specifically tight gas resources in the first place;
   (b) All the seven wells were drilled outside any structural highs, which has actually ruled out with high confidence of any conventional resources to be connected with the discovered petroleum in the wells;
   (c) The applicant has provided that the primary tight gas target, the Tinowon Formation is present across nine of the 11 graticular blocks of the PCA 305 area except the two blocks in the west, while the secondary target of tight gas resources in PCA 305, the Lorelle Sandstone is present across the western part of the area, thanks to the significant amounts of seismic data in the area (see below for the impressive 826 km new 2D seismic acquisition, the 4151 km 2D seismic reprocessing, and the 195 km2 3D seismic reprocessing);
   (d) The exploration wells with petroleum discovery have covered reasonably even and representative areas of PCA 305. The farthermost is less than 20 kilometres from the discovery wells, which is not a too far-reach in comparison with QLS's current practice in assessing the extent of discovery of the other pervasive unconventional petroleum resources like coal seam gas reservoirs;
c. The applicant has also demonstrated the need to maximise the appraisal area to maximise the chances of realising a commercial development due to the inherent high cost of developing unconventional tight gas and the uncertainty in gas price over the modelled timeframe of the forecasted development scenarios in its financial assessment on the commerciality of potential production.

(4) Significant local activities of exploration and appraisal focussing specifically on tight gas resources within the PCA 305 area since 2010 have provided strong support to the applicant's claims for the PCA 305 application, mainly including:
- Seven wells drilled;
- 826 km 2D seismic acquisition;
- 4151 km 2D seismic re-processing;
- 193 km2 3D seismic re-processing;
- Fracture stimulation and production testing in four of the newly drilled seven wells;
- In excess of $300 million expenditure.

(5) Sufficient financial data and economic analysis with reasonably forecasted development scenarios have been provided and the conclusions have provided strong support to the applicant's claim on commercial viability of potential petroleum production in the area;

(6) A appropriate evaluation program including LWP activities for the relevant renewal ATP 645 has been proposed, with impressive focus on solving the challenges of the currently identified contingencies for potential commercial petroleum production in the area, including filling the identified small gaps to sufficiently characterising the two reservoirs of tight gas and achieving estimates of contingent resources or even reserves in the area through further proving lateral extent of the gas-bearing reservoirs and employing best-practice unconventional drilling and completion practices. The proposed activities include drilling more wells and 2D seismic acquisition;

(7) Contingent resources have not been achieved (only a non-SPE-coded category "recoverable resources" has been provided, which could be substantially categorized as prospective resources) and the applicant has shown great honesty to report that (even though the holder has been so close to achieve it), which does not stop the area being eligible for being announced as a PCA since it satisfies the requirements for a PCA stipulated by the P&G Act

	which does not specifically include achieving contingent resources. SPE-PRMS has been strictly followed, and the provided estimate of recoverable (prospective) resources is sufficient for the PCA declaration.
Milestone: Recommendation	
It is recommended that, pursuant to section 90(1) of the *Petroleum and Gas (Production and Safety) Act 2004*, the Minister declare the areas of PCA 305 to be potential commercial areas for a term of 15 years.	
Name: Dawood Paracha Designation: Petroleum Engineer Date: 24/03/2020, 22/04/2020, 14/07/2020, 4/08/2020, 14/10/2020 Peer Reviewer/Contributor Name(s): Dingchuang Qu Designation: Senior Geoscientist/Engineer Date: 12/08/2020, 19/10/2020 Peer Reviewer/Contributor Name(s): Andrew McNamara Designation: Technical Manager Date: 24/04/2020, 14/07/2020, 4/08/2020, 30/10/2020	

Milestone: Overview	

PCA 305 application is for a Potential Commercial Area in ATP 645 which is fully operated and held by BNG (Surat) Pty Ltd, a wholly owned subsidiary of QGC (Pty) Limited and in turn Royal Dutch Shell. ATP 645 is a non-contiguous permit located in the Surat Basin, east of the town of Surat within the Western Downs Regional Council and Maranoa Regional Council areas in south-east Queensland, as shown in Figure 1.

ATP 645 covers two areas and a total of 300 sub-blocks. At the time the original application was submitted, ATP 645 was in its third and final four-year period of the renewed term ending 31 December 2019. PCA 305 forms the northern contiguous part of ATP 645, as shown in Figure 2.

A brief history of the prerequisite permit ATP 645 is provided below:

- ATP 645 was first granted under the *Petroleum Act 1923* (PA1923) for four years commencing 1 January 2000.
- ATP 645 was renewed for a further four years under the PA1923 on 1 January 2004.
- ATP 645 became a converted ATP under section 876 of the *Petroleum and Gas (Petroleum and Safety) Act 2004* (P&G Act) on 31 December 2004.
- On 1 January 2008, ATP 645 was renewed for a further twelve year term.
- On 22 September 2015, approval was given to combine 100% QGC held ATP 645, ATP 785, ATP 768 and ATP 1101 into a project area, the Bowen tight gas sands (TGS) Project Area (BTPA).
- In 2018, the applicant entered into two non-operated joint ventures (ATP 2040 and ATP 2045) operated by Santos (QNT) Pty Ltd located adjacent to ATP 645 with field activity commencing in 2019.

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Despite substantial resource, the challenge in commercialising tight sands within PCA 305 is that, based on current drilling and completion techniques for vertical wells, deliverability is sub-economic. The applicant has also proven through well tests that the area has produced gas, but a full scale development will require more work to develop the extent of the resource and optimise the drilling and completion techniques for deep tight gas required for commerciality of the project. The declaration of the proposed PCA 305 will facilitate reservoir characterisation to underpin decision to test application of unconventional drilling and completion techniques.

Amendment to application

On 29 November 2019, the applicant lodged five PCA applications to cover the entire extent of Authority to Prospect (ATP) 645. PCAs 305 – 308 applications were to cover the northern contiguous part of ATP 645 while PCA 309 was over the southern non-contiguous part.

An amendment application was later lodged by the applicant on 23 June 2020 for the purpose of amalgamating the areas of PCAs 306-308 into PCA 305 which will give the effect of having PCA 305 to cover the northern extent of ATP 645 while PCA 309 will cover the southern non-contiguous part of ATP 645 (Figure 2). sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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The larger PCA will reduce administrative burden, allow technical studies over a larger contiguous area and brings about economies of scale for the applicant and hence the technical assessor is recommending approval.

Additional information

Additional information was received from the applicant on 9 April 2020 providing an indicative timeline of ATP 645 activities outside of the proposed four year work program and over the applied 15 year period associated with the PCA applications. A summary of the additional information is provided below:

- Proposed activities for ATP 645 to support a 15-year PCA term mainly include drilling and production testing of multi-well design alternatives, technical studies, commercial agreements and approvals.

- Appraisal beyond the proposed work program will be dependent on the results and review of the proposed work program activities.
- Appraisal beyond the proposed work program will be dependent on the timeline and exploration programs of adjacent ATP 785, ATP 632 (PCA 160) and PLR2019-2-11 acreage (should the applicant be successful) as well as ATP 2040 and ATP 2045, which are operated as a joint venture with Santos (QNT) Pty Ltd.
- Review of the data gathered in the proposed work program from two wells and 150 kilometres (km) of 2D seismic will underpin the horizontal well design required for commerciality.

Additional information was provided by the applicant on 9 October 2020 in response to a letter from the department dated 21 September 2020. A summary of key information relevant to PCA 305 is provided below:

- The applicant has provided a cross section (Figure 5) and seismic map (Figures 6) which show that the main target formation within ATP 645, the Tinowan Formation is present within PCA 305. The technical assessor considers that these maps provide further evidence that the area of PCA 305 is no more than is needed to cover the maximum extent of the reservoir.
- The applicant has provided further details of the reservoir characterisation within PCA 305 derived from Overston 3D seismic and wells within the Overston 3D (Dunk 1, Overston 1, and Overston 2/2A). These maps show the porosity (Figure 8), net to gross (Figure 9) and sand thickness (Figure 10) of the Tinowan Formation within PCA 305. The technical assessor is satisfied that the applicant has sufficient knowledge of the target reservoir within PCA 305.
- The applicant has confirmed that contingent resources have not been achieved. Only a non-SPE-coded category "recoverable resources" has been provided, which could be substantially categorized as prospective resources. The technical assessor considers that the quantities of hydrocarbon within PCA 305 are prospective and not contingent. The applicant foresee that for contingent quantities to be established, a horizontal multi-frac well development involving production testing will be required.
- The applicant has identified a clerical error in the original gas in place (OGIP) estimate for PCA 305. The OGIP estimate for ATP 645, which reports the Lorelle Sandstone is incorrect and an amended OGIP estimate is provided for ATP 645.

Commented [JH1]: Provided in 9 October 2020 further submission.

Commented [JH2]: This was not a QGC seismic survey (samson-international). Publicly available through QGC open data portal.

Commented [JH3]: This was not a QGC well when initially drilled (samson international). Samson International has since been deregistered. It is stated by QGC in the original application for PCA 305 (pg.13) that these wells were drilled by BNG when it was a subsidiary of Sunshine Gas, it is now a subsidiary of QGC (acquired 2010). Public well testing results for Dunk 1, Overston 1 and Overston 2/2A are available through the QGC open data portal. Fracture stimulation was used to achieve flows for all three wells.

Commented [JH4]: These figures taken from the additional information provided by QGC in October 2020

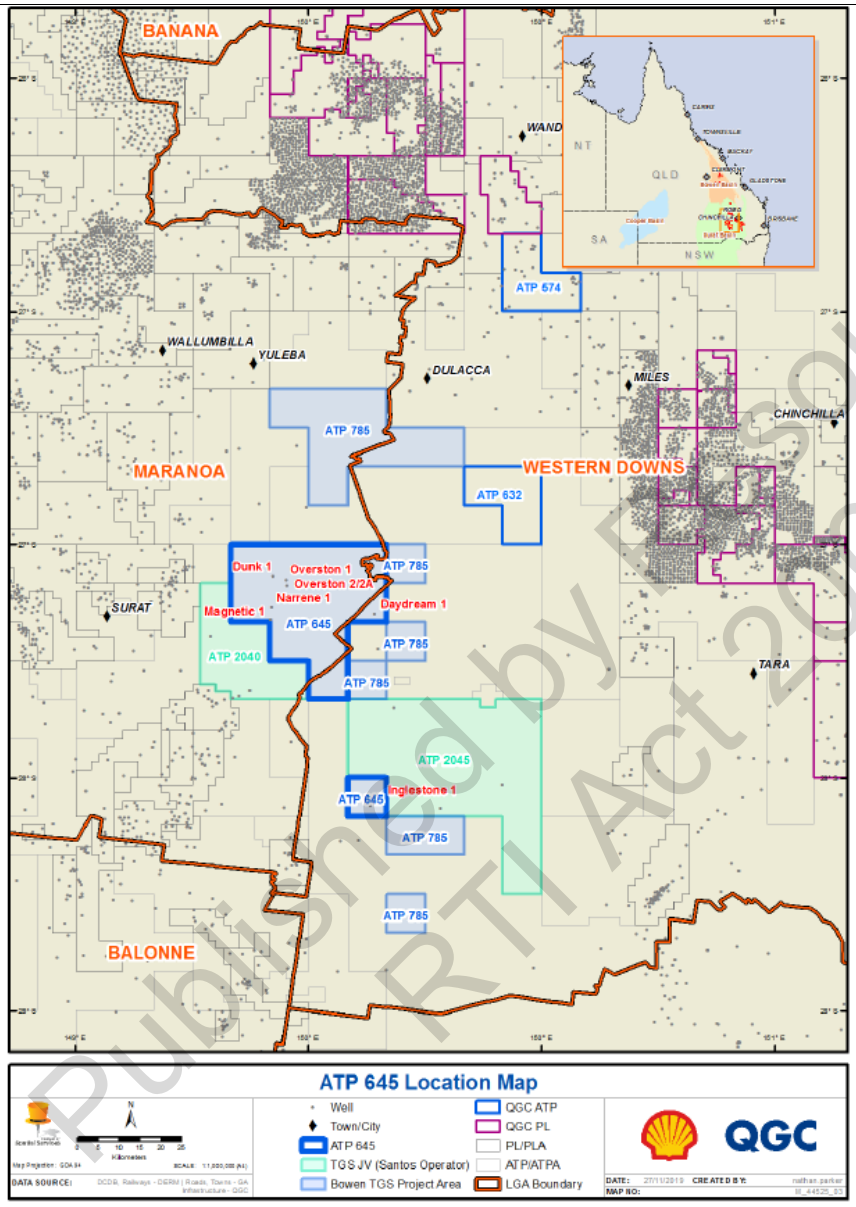

Figure 1: Location map showing ATP 645 and other Shell interests in southern Taroom Trough (Source: page 26, PCA 305 Amendment Application).

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 2: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Milestone: Area of proposed declaration			
1	Is the area no more than is needed to cover the maximum extent of a natural underground reservoir?	**Yes**	s.90(1)(a) and (2)

The technical assessor considers that the area applied for is sufficient and no more than required to cover the extent of the natural underground reservoirs, Tinowan Formation and Lorelle Sandstone. As a tight gas reservoir not bound by any particular structure, the target area can be quite large and laterally extensive.

The proposed area of PCA 305 is 275 sub-blocks (825 square kilometres (km2), as shown in Figure 3. The reservoirs of interest in PCA 305 is the Tinowan Formation and the Lorelle Sandstone. The reservoirs extends beyond the PCA area into adjacent tenure and open acreage, as can be seen in Figure 4. It can be seen in Figure 4 that the reservoir covers the extent of PCA 305.

Additional information was provided by the applicant on 9 October 2020 in response to a letter from the department dated 21 September 2020. The applicant has provided a cross section (Figure 5) and seismic map (Figure 6) which show that the main target formation within ATP 645, the Tinowan Formation is present within PCA 305. The technical assessor considers that these maps provide further evidence that the area of PCA 305 is no more than is needed to cover the maximum extent of the reservoir.

Commented [JH5]: Cross section derived from results of Dunk 1, overstone 1, overtson 2-2A, and inglestone 1. Inglestone one was drilled in the 80s by COHO exploration.

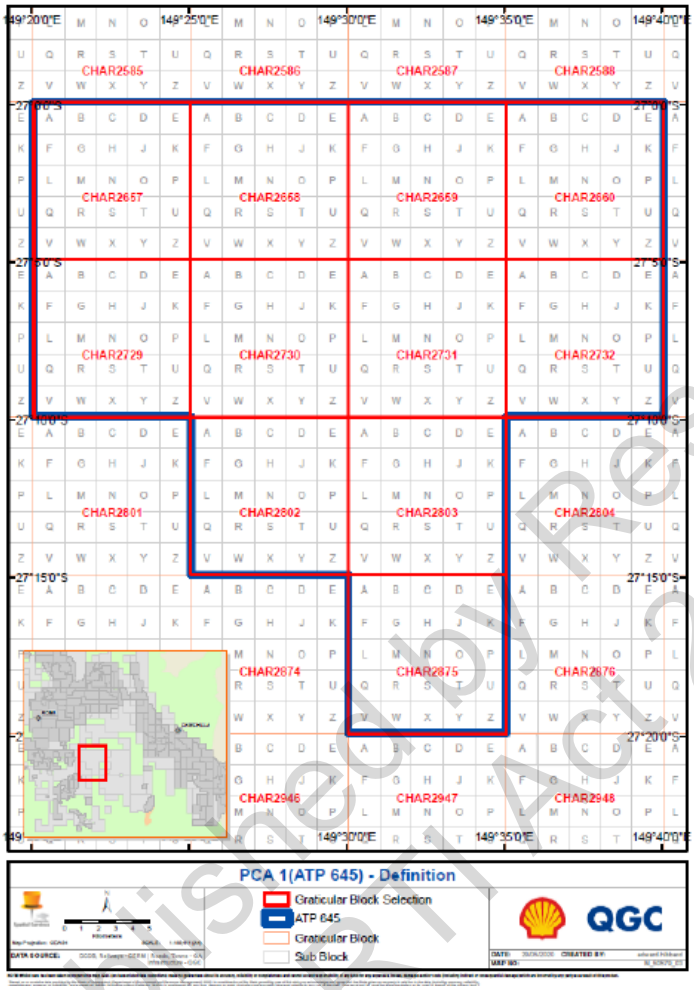

Figure 3: Sub-blocks forming part of PCA 305 application (Source: page 30, PCA 305 Amendment Application).

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Figure 4: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 5: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 6: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs
sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Milestone: Commercial viability	

2	Has the applicant provided sufficient details confirming: • each natural underground reservoir in the area; • an estimate of the amount of petroleum in each reservoir; • the standards and procedures used to make the estimate; • whether it is commercially viable to produce or store petroleum in the area; and • that in the holder's opinion, it will, within the next 15 years, be commercially viable to produce or store petroleum in the area.	**Yes** **Yes** **Yes** **No** **Yes**	s.89(5)(a) and s.231(1)(a) to (e)

The technical assessor considers that the applicant has provided sufficient details to address each criteria.

Natural underground reservoir

The applicant has provided sufficient details on the natural underground reservoir in the PCA area, namely the Tinowan Formation and the Lorelle Sandstone. This includes geological background, petrophysical analysis and drilling details. Tinowan Formation and Lorelle Sandstone are present within the Back Creek Group, which is a widespread succession of marine to fluvial sands, silts, shales, coals and tuffs that predominately represent the thermal sag phase of the Bowen Basin development.

As can be seen in Figure 2, PCA 305 areas contains both the Tinowan Formation and the Lorelle Sandstone. The Tinowan Formation is divided into two distinct depositional sequences, the lower Tinowan/Wallabella Coal Member and the upper Tinowan. The upper Tinowan is the most prolific gas producing interval on the Roma Shelf with the largest gas fields in the province being present in this interval. The lower Tinowan is productive but its prevalence as an economic producer is limited due mainly to localised depositional trends and generally poorer reservoir quality than the upper Tinowan. The applicant has also provided stratigraphy for the regions within the Bowen Basin, as shown in Figure 7. It can be seen that the Tinowan Formation is located in the South West Taroom Trough and belongs to the late Permian group.

Commented [JH6]: Provided in the amendment to application

The Lorelle Sandstones is an early-mid Permian fan-delta system penetrated on the Roma Shelf and in a small number of wells on the western flank of the Taroom Trough. Lorelle Sandstone is the oldest reservoir in the Back Creek Group and to date has had no economic production despite being found to be gas-bearing in a number of wells. The key challenge in its exploration is understanding reservoir distribution and quality variation with a relatively small number of well penetrations.

The PCA 305 area contains six wells, three of which have flowed gas and condensate to surface following fracture stimulation. The results of these wells has provided impetus for selecting Tinowan Formation as the primary target reservoir and the Lorelle Sandstone as the secondary target reservoir.

Commented [JH7]: The three which achieved flows through fracture stimulation are overstaton 2-2A, Dunk-1, and Daydream 1 (pg.13 original application)

Additional information was provided by the applicant on 9 October 2020 in response to a letter from the department dated 21 September 2020. The applicant has provided further details of the reservoir characterisation within PCA 305 derived from Overston 3D seismic and wells within the Overston 3D (Dunk 1, Overston 1, and Overston 2/2A). These maps show the porosity (Figure 8), net to gross (Figure 9) and sand thickness (Figure 10) of the Tinowan Formation within PCA 305. The technical assessor is satisfied that the applicant has sufficient knowledge of the target reservoir within PCA 305.

Figure 7: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

The following maps have provided new information on the real reservoir properties such as porosity (Figure 5), sand net to gross (Figure 6), and sand thickness (Figure 7) have been presented in those maps. Not only has the high-resolution aerial variation of those key reservoir properties surrounding the Overston area been presented, but also the less-resolution aerial variation of those properties along the 2D seismic lines. Although the high-resolution area does not cover the whole PCA 305 area, the new information provides further support of the broader extent of the petroleum discoveries in the PCA 305 area. The additional maps provide strong evidence for the claimed discovered reservoir which has extended from the discovery wells to cover almost the whole PCA 305 area.

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Figure 8: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 9: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 10: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Amount of petroleum in each reservoir

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- Commercial aspects, such as co-ordination with neighbouring tenure holders or as part of combined development to give sufficient scale.

Ability of the resource to be commercially viable within the next 15 years

The technical assessor considers that to develop PCA 305 application area into an economic project will require:

- Confirming the extent of the resource and calibrating reservoir parameters over the maximum possible area;
- Optimising the drilling and completion techniques deployed to realise the modelled type curves; and
- Demonstrating ability to execute project within capital expenditure profile assumptions in the economic analysis.

The applicant believes that over a period of 15 years and through addressing these considerations as part of the ATP 645 work program and the evaluation program for PCA 305, the application area will become commercially viable.

3	Has the applicant provided sufficient supporting data such as: • technical data relating to the geology of, and natural underground reservoirs in the area; and • market and financial data relevant to the opinions.	**Yes** **Yes**	s.231(1)(f) and (2)(a) and (b)

The technical assessor considers that the applicant has provided sufficient data to address the geology of the Tinowan Formation and the Lorelle Sandstones and the commerciality of the project area.

Geologic review

Prior to the grant of ATP 645, a number of deep wells were drilled during the 1980's in the southern part of ATP 645, with unstimulated flow tests recovering gas cut mud. These wells provided crucial support to the regionally pervasive nature of the gas-bearing reservoirs of the Back Creek Group and the tight-gas potential of the Tinowan Formation and the Lorelle Sandstones.

The earlier activity under ATP 645 was undertaken by Sunshine Gas acquiring the Overston 3D and drilling the Overston-1, Overston-2/2A and Narenne-1/1A wells. More recent activity has been undertaken by the current applicant through 2D seismic and 3 wells, named Daydream-1, Dunk-1 and Magnetic-1. Three wells (Overston-2/2A, Daydream-1 and Dunk-1) have flowed gas and condensate to surface following fracture stimulation and has provided encouraging indications of tight-gas sand reservoirs.

Through Dunk-1 drilling, core was taken of the Upper Tinowan Sandstone, which proved critical in defining gas saturation of approximately 75%. Dunk-1 was also fracture stimulated and production tested and peaked at 4 terajoule (TJ) PJ of gas per day before stabilising at 0.7 TJ of gas per day.

Daydream-1 was drilled to test the Taroom Trough and encountered the Tinowan Formation. This was the first well fracture-stimulated in the Bowen tight gas sand project area and despite a number of issues with these operations, including recovery of unbroken gel to surface during the clean-up and one stage being perforated incorrectly at 180º rather than at 60º as planned, gas and condensate were recovered at surface.

While OGIP and gas flow has been demonstrated in the PCA area, there is considerable uncertainty on reservoir characterisation due to the limited number of well penetrations. To date, post-stimulation production testing has not yielded economic flow rates from vertical wells, posing a challenge to economic development of the tenure using the current drilling and completion techniques. It is modelled that deliverability uplift through application of multi-stage fracture stimulated horizontal wells would result in a commercial development.

This PCA evaluation program support the ATP 645 work program to address the challenge of maturing an economic play by improving characterisation of the tight gas sand reservoirs in order to identify sweetspots and consideration of drilling and completion techniques that may unlock deliverability in tight sands.

Financial and market review

In order to assess commerciality, a development concept was devised based on North American unconventional play development as a base model. The key parameters of the development concept are:

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sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 16: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

4	Should the Minister be satisfied that petroleum production or storage in the area to be declared,	**Yes**	s.90(1)(b)

	is not, and will not soon be, commercially viable, but is likely to be viable within 15 years?		

The Minister should be satisfied that commercial production from the area is not currently viable, but is likely to be viable within 15 years. The applicant has submitted a robust evaluation program to develop the tight gas sand resource within the PCA area.

The applicant has also proven through well tests that the area has produced gas, but a full scale development will require more work to develop the extent of the resource and optimise the drilling and completion techniques for deep tight gas required for commerciality of the project.

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial These resource estimates are based on the results of Overston-2/2A, Daydream-1 and Dunk-1 which have flowed gas and condensate to surface within ATP 645. The technical assessor considers that the estimate of hydrocarbon in PCA 305 are consistent with the definition of prospective resources as per the SPE Petroleum Resources Management System (PRMS) 2018 definition.

This provides that the PCA 305 application areas hold excellent potential but due to the nature of the tight gas sand resource, the current exploration has not demonstrated commerciality. This is because the current wells within PCA 305 are all vertical ones with only one being fracture stimulated. To achieve commerciality, it is envisioned that horizontal multi-stage fracture stimulated wells will be needed. This represents an enormous expenditure and hence the PCA declaration will aid the applicant in assessing the reservoir quality, resource extent and drilling and completion techniques to reduce the project risks before applying for petroleum leases.

PCA 305 is in close proximity to infrastructure given its location near to existing Roma Shelf production facilities (Wallumbilla and Kincora Gas Plants) which would aid commerciality once initial hurdle of establishing the resource is overcome.

Milestone: Compliance with relevant ATP			
5	Has the work program of the relevant authority to prospect been substantially complied with?	**Yes**	s.90(3)

The technical assessor is satisfied that the applicant has substantially complied with the work program for ATP 645.

The current work program for ATP 645 is for the two year period 1 January 2018 to 31 December 2019 and is provided below:

Period 5	Minimum Approved Activities	Estimated Expenditure
One (1) year ending 31 December 2018	Geological & Geophysical and engineering studies	$100,000
One (1) year ending 31 December 2019	Geological & Geophysical and engineering studies Prospect selection, well planning & design	$100,000
	TOTAL	$200,000

Figure 17: ATP 645 current approved work program (Source: page 4, PCA 305 Amendment Application).

As can be seen in Figure 17, the current approved work program for ATP 645 comprises of technical studies, prospect selection and well planning. The technical assessor considers the applicant compliant with the work program since the applicant has demonstrated a good understanding of the reservoir and well planning in its

PCA applications. Work undertaken as part of the current approved work program has collectively led to two PCA applications over the entire ATP 645 area.

In addition, the applicant has provided a summary of exploration activities undertaken as part of the Bowen tight gas sand project since 2010. This is provided below and in Figure 18.

- 826 km 2D seismic acquisition.
- 4,151 km 2D seismic re-processing and 193 km^2 3D seismic re-processing of legacy surveys across the project area.
- Drilling of seven wells with total depth ranging from 3,180-4,694 m, four of which were fracture stimulated and production tested. Three of these wells were drilled within ATP 645.

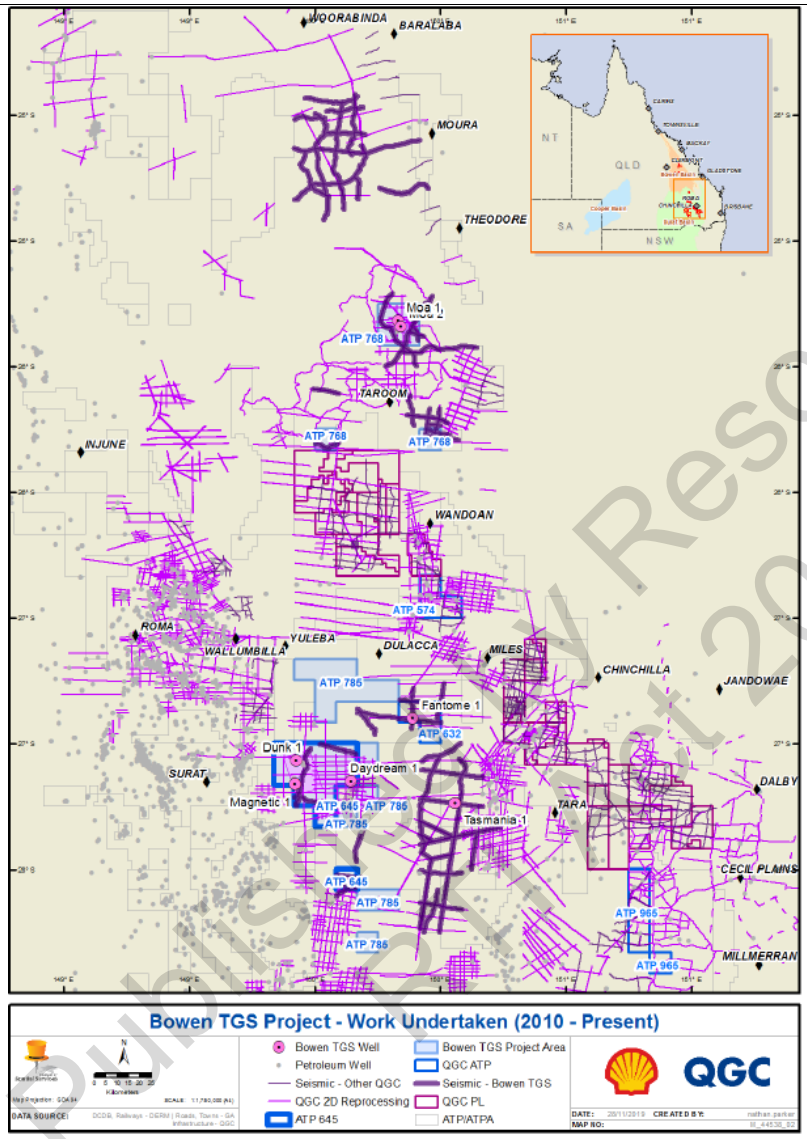

Figure 18: Summary of work undertaken as part of the Bowen tight gas sand project, including ATP 645 since 2009 (Source: page 27, PCA 305 Amendment Application).

Milestone: Evaluation program			
6	Has the applicant provided an appropriate program of work to evaluate the potential for petroleum production or storage and associated market opportunities?	**Yes**	s.89(5)(b)

The applicant has provided an evaluation program for PCA 305 for a 15 year declaration period.

The evaluation program does not contain any physical activities. In this instance it can be considered acceptable as the holder has drilled and tested three wells in the PCA area and proposed two wells as part of the ATP 645 work program from 1 January 2020 to 31 December 2023. Execution of the ATP 645 work program will be critical to supporting the evaluation program for PCA 305 to prove the tight gas sand resource.

The proposed ATP 645 work program for the period 1 January 2020 to 31 December 2023 is provided in Figure 20. ATP 645 is currently under assessment for a renewal term of 12 years expiring 31 December 2031.

Additional information was received from the applicant on 9 April 2020 providing an indicative timeline of ATP 645 activities outside of the proposed four year work program and over the applied 15 year period associated with the PCA applications. A summary of the additional information is provided below:

- Proposed activities for ATP 645 to support a 15-year PCA term are provided below in Figure 21 and mainly include drilling and production testing of multi-well design alternatives, technical studies, commercial agreements and approvals.
- Appraisal beyond the proposed work program will be dependent on the results and review of the proposed work program activities.
- Appraisal beyond the proposed work program will be dependent on the timeline and exploration programs of adjacent ATP 785, ATP 632 (PCA 160) and PLR2019-2-11 acreage (should the applicant be successful) as well as ATP 2040 and ATP 2045, which are operated as a joint venture with Santos (QNT) Pty Ltd.
- Review of the data gathered in the proposed work program from two wells and 150 km of 2D seismic will underpin the horizontal well design required for commerciality.

The evaluation program provided by the applicant addresses risks around the commerciality of the project. The applicant appears to address a number of these issues in the evaluation program provided through reviews of available technology, updating models and resource estimates and reviewing project economics.

The evaluation program is provided below:

Year	Activity	Estimated Expenditure per PCA ($A)
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Figure 19: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Permit Year	Authorised Activity	Expenditure
sch4p4(7)(1)(c) Business/commercial/professional/financial affairs		

Figure 20: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Year	Activity
	sch4p4(7)(1)(c) Business/commercial/professional/financial affai

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 21: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Milestone: Term of declaration			
7	Is the declaration for 15 years?	**Yes**	s.92(1)
8	If NO, does the shorter period consider the following: • when any petroleum discovery was made; and • any commercial viability report or independent viability assessment for, or that includes, the proposed potential commercial area.	**N/A**	s.92(2)

The applicant has applied for a 15 year declaration for PCA 305. The technical assessor is recommending a declaration of 15 years because of the following reasons:

- The technical assessor believes that a declaration term of 15 years is needed to confirm the resource extent, optimise drilling and completion techniques and finalise commercial aspects of the tight gas project.
- Three wells within PCA 305 application area have flowed gas and condensate to surface following fracture stimulation. This confirms presence of the resource and necessitates further evaluation.
- sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

With the target resource being tight gas where risk is generally higher, the 15 year declaration period is more acceptable. This will provide the applicant the required time to demonstrate commerciality before significant investment associated with multi-stage fracture stimulated horizontal wells, which will be required for commercial production.

The tight gas project could be of significant financial benefit for the State and any geological and engineering knowledge gained through the drilling and development of deep tight basin centred gas would also be of significant benefit.

The technical assessor recommends that the PCA 305 be granted for a period of 15 years.

Potential Commercial Area (PCA) application – Technical Assessment

Unless otherwise stated, all references below to sections relate to the *Petroleum and Gas (Production and Safety) Act 2004 (P&G Act)*.

Enter permit number	**PCA 305**
Prerequisite permit number	**ATP 645**
Applicant	**BNG (Surat) Pty Ltd**
Contact Details	QGC Pty Limited GPO Box 3107 Brisbane QLD 4001 Email: QGC-Tenures@shell.com

Milestone: Summary

PCA application 305 was assessed against the relevant requirements of the legalisation in conjunction with the operational policy and these matters are outlined thoroughly within this report.

The applicant has provided sufficient evidence to demonstrate the following:

(1) **Petroleum discovery** has been solidly established:
   a. Gas and condensate have been flowed to surface at sustained rates from the clearly identified targets (Tinowon tight sands) in three tight gas exploration wells within the PCA 305 area (Dunk 1 and Overston 2A in north-western part and Daydream 1 in south-eastern corner), and gas bearing reservoir has been confirmed on gas shows and logs in Magnetic 1 in the south-western corner of the area;
   b. Coring, logging and testing through fracturing stimulation in those multiple wells have been utilised in establishing the discovery status;
   c. Presence of significant quantity of hydrocarbons has been demonstrated;
   d. The applicant has demonstrated that the hydrocarbons are potentially commercial within the next 15 years.

(2) **Commerciality**:
   a. Significant amounts of recoverable (prospective) gas and condensate resources have been estimated even though no contingent resources have been achieved;
   b. The applicant has demonstrated the petroleum production is not commercially viable now, or would not soon, with the gas rates already or possibly achievable with the currently tested drilling and completion techniques (vertical wells and the single-staged fracturing stimulation);
   c. The applicant has convincingly demonstrated that petroleum production would potentially be commercially viable within 15 years with utilisation of horizontal wells and multi-staged fracturing stimulation in the area, by potentially improving well production rates and reducing total well/development costs through improving characterisation of the tight gas sand reservoirs in order to identify sweet spots and assessment of various drilling and completion techniques that may unlock deliverability in tight sands;

(3) **Area**:

The applicant has provided sufficient evidence to demonstrate that the required area for PCA 305 is no more than it needed to cover the maximum extent of the identified reservoirs, since:

a. SPE-PRMS has stated that "*the extent of the discovery within a pervasive accumulation is based on the evaluator's reasonable confidence based on distances from existing experience, otherwise quantities remain as undiscovered*";
b. The applicant has provided sufficient evidence in reasonable confidence to support its claimed existence of pervasive unconventional tight gas sand reservoirs in Tinowon sandstones over the whole PCA 305 area, such as:
   (a) All the seven exploration wells with gas flow or gas shows in the area were targeting specifically tight gas resources in the first place;
   (b) All the seven wells were drilled outside any structural highs, which has actually ruled out with high confidence of any conventional resources to be connected with the discovered petroleum in the wells;
   (c) The applicant has provided that the primary tight gas target, the Tinowon Formation is present across nine of the 11 graticular blocks of the PCA 305 area except the two blocks in the west, while the secondary target of tight gas resources in PCA 305, the Lorelle Sandstone is present across the western part of the area, thanks to the significant amounts of seismic data in the area (see below for the impressive 826 km new 2D seismic acquisition, the 4151 km 2D seismic reprocessing, and the 195 km2 3D seismic reprocessing);
   (d) The exploration wells with petroleum discovery have covered reasonably even and representative areas of PCA 305. The farthermost is less than 20 kilometres from the discovery wells, which is not a too far-reach in comparison with QLS's current practice in assessing the extent of discovery of the other pervasive unconventional petroleum resources like coal seam gas reservoirs;
c. The applicant has also demonstrated the need to maximise the appraisal area to maximise the chances of realising a commercial development due to the inherent high cost of developing unconventional tight gas and the uncertainty in gas price over the modelled timeframe of the forecasted development scenarios in its financial assessment on the commerciality of potential production.

(4) Significant local activities of exploration and appraisal focussing specifically on tight gas resources within the PCA 305 area since 2010 have provided strong support to the applicant's claims for the PCA 305 application, mainly including:

- Seven wells drilled;
- 826 km 2D seismic acquisition;
- 4151 km 2D seismic re-processing;
- 193 km2 3D seismic re-processing;
- Fracture stimulation and production testing in four of the newly drilled seven wells;
- In excess of $300 million expenditure.

(5) Sufficient financial data and economic analysis with reasonably forecasted development scenarios have been provided and the conclusions have provided strong support to the applicant's claim on commercial viability of potential petroleum production in the area;

(6) A appropriate evaluation program including LWP activities for the relevant renewal ATP 645 has been proposed, with impressive focus on solving the challenges of the currently identified contingencies for potential commercial petroleum production in the area, including filling the identified small gaps to sufficiently characterising the two reservoirs of tight gas and achieving estimates of contingent resources or even reserves in the area through further proving lateral extent of the gas-bearing reservoirs and employing best-practice unconventional drilling and completion practices. The proposed activities include drilling more wells and 2D seismic acquisition;

(7) Contingent resources have not been achieved (only a non-SPE-coded category "recoverable resources" has been provided, which could be substantially categorized as prospective resources) and the applicant has shown great honesty to report that (even though the holder has been so close to achieve it), which does not stop the area being eligible for being announced as a PCA since it satisfies the requirements for a PCA stipulated by the P&G Act

	which does not specifically include achieving contingent resources. SPE-PRMS has been strictly followed, and the provided estimate of recoverable (prospective) resources is sufficient for the PCA declaration.
Milestone: Recommendation	
It is recommended that, pursuant to section 90(1) of the *Petroleum and Gas (Production and Safety) Act 2004*, the Minister declare the areas of PCA 305 to be potential commercial areas for a term of 15 years.	
Name: Dawood Paracha Designation: Petroleum Engineer Date: 24/03/2020, 22/04/2020, 14/07/2020, 4/08/2020, 14/10/2020 Peer Reviewer/Contributor Name(s): Dingchuang Qu Designation: Senior Geoscientist/Engineer Date: 12/08/2020, 19/10/2020 Peer Reviewer/Contributor Name(s): Andrew McNamara Designation: Technical Manager Date: 24/04/2020, 14/07/2020, 4/08/2020, 30/10/2020	

Milestone: Overview	

PCA 305 application is for a Potential Commercial Area in ATP 645 which is fully operated and held by BNG (Surat) Pty Ltd, a wholly owned subsidiary of QGC (Pty) Limited and in turn Royal Dutch Shell. ATP 645 is a non-contiguous permit located in the Surat Basin, east of the town of Surat within the Western Downs Regional Council and Maranoa Regional Council areas in south-east Queensland, as shown in Figure 1.

ATP 645 covers two areas and a total of 300 sub-blocks. At the time the original application was submitted, ATP 645 was in its third and final four-year period of the renewed term ending 31 December 2019. PCA 305 forms the northern contiguous part of ATP 645, as shown in Figure 2.

A brief history of the prerequisite permit ATP 645 is provided below:

- ATP 645 was first granted under the *Petroleum Act 1923* (PA1923) for four years commencing 1 January 2000.
- ATP 645 was renewed for a further four years under the PA1923 on 1 January 2004.
- ATP 645 became a converted ATP under section 876 of the *Petroleum and Gas (Petroleum and Safety) Act 2004* (P&G Act) on 31 December 2004.
- On 1 January 2008, ATP 645 was renewed for a further twelve year term.
- On 22 September 2015, approval was given to combine 100% QGC held ATP 645, ATP 785, ATP 768 and ATP 1101 into a project area, the Bowen tight gas sands (TGS) Project Area (BTPA).
- In 2018, the applicant entered into two non-operated joint ventures (ATP 2040 and ATP 2045) operated by Santos (QNT) Pty Ltd located adjacent to ATP 645 with field activity commencing in 2019.

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Despite substantial resource, the challenge in commercialising tight sands within PCA 305 is that, based on current drilling and completion techniques for vertical wells, deliverability is sub-economic. The applicant has also proven through well tests that the area has produced gas, but a full scale development will require more work to develop the extent of the resource and optimise the drilling and completion techniques for deep tight gas required for commerciality of the project. The declaration of the proposed PCA 305 will facilitate reservoir characterisation to underpin decision to test application of unconventional drilling and completion techniques.

Amendment to application

On 29 November 2019, the applicant lodged five PCA applications to cover the entire extent of Authority to Prospect (ATP) 645. PCAs 305 – 308 applications were to cover the northern contiguous part of ATP 645 while PCA 309 was over the southern non-contiguous part.

An amendment application was later lodged by the applicant on 23 June 2020 for the purpose of amalgamating the areas of PCAs 306-308 into PCA 305 which will give the effect of having PCA 305 to cover the northern extent of ATP 645 while PCA 309 will cover the southern non-contiguous part of ATP 645 (Figure 2). sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

The larger PCA will reduce administrative burden, allow technical studies over a larger contiguous area and brings about economies of scale for the applicant and hence the technical assessor is recommending approval.

Additional information

Additional information was received from the applicant on 9 April 2020 providing an indicative timeline of ATP 645 activities outside of the proposed four year work program and over the applied 15 year period associated with the PCA applications. A summary of the additional information is provided below:

- Proposed activities for ATP 645 to support a 15-year PCA term mainly include drilling and production testing of multi-well design alternatives, technical studies, commercial agreements and approvals.

- Appraisal beyond the proposed work program will be dependent on the results and review of the proposed work program activities.
- Appraisal beyond the proposed work program will be dependent on the timeline and exploration programs of adjacent ATP 785, ATP 632 (PCA 160) and PLR2019-2-11 acreage (should the applicant be successful) as well as ATP 2040 and ATP 2045, which are operated as a joint venture with Santos (QNT) Pty Ltd.
- Review of the data gathered in the proposed work program from two wells and 150 kilometres (km) of 2D seismic will underpin the horizontal well design required for commerciality.

Additional information was provided by the applicant on 9 October 2020 in response to a letter from the department dated 21 September 2020. A summary of key information relevant to PCA 305 is provided below:

- The applicant has provided a cross section (Figure 5) and seismic map (Figures 6) which show that the main target formation within ATP 645, the Tinowan Formation is present within PCA 305. The technical assessor considers that these maps provide further evidence that the area of PCA 305 is no more than is needed to cover the maximum extent of the reservoir.
- The applicant has provided further details of the reservoir characterisation within PCA 305 derived from Overston 3D seismic and wells within the Overston 3D (Dunk 1, Overston 1, and Overston 2/2A). These maps show the porosity (Figure 8), net to gross (Figure 9) and sand thickness (Figure 10) of the Tinowan Formation within PCA 305. The technical assessor is satisfied that the applicant has sufficient knowledge of the target reservoir within PCA 305.
- The applicant has confirmed that contingent resources have not been achieved. Only a non-SPE-coded category “recoverable resources” has been provided, which could be substantially categorized as prospective resources. The technical assessor considers that the quantities of hydrocarbon within PCA 305 are prospective and not contingent. The applicant foresee that for contingent quantities to be established, a horizontal multi-frac well development involving production testing will be required.
- The applicant has identified a clerical error in the original gas in place (OGIP) estimate for PCA 305. The OGIP estimate for ATP 645, which reports the Lorelle Sandstone is incorrect and an amended OGIP estimate is provided for ATP 645.

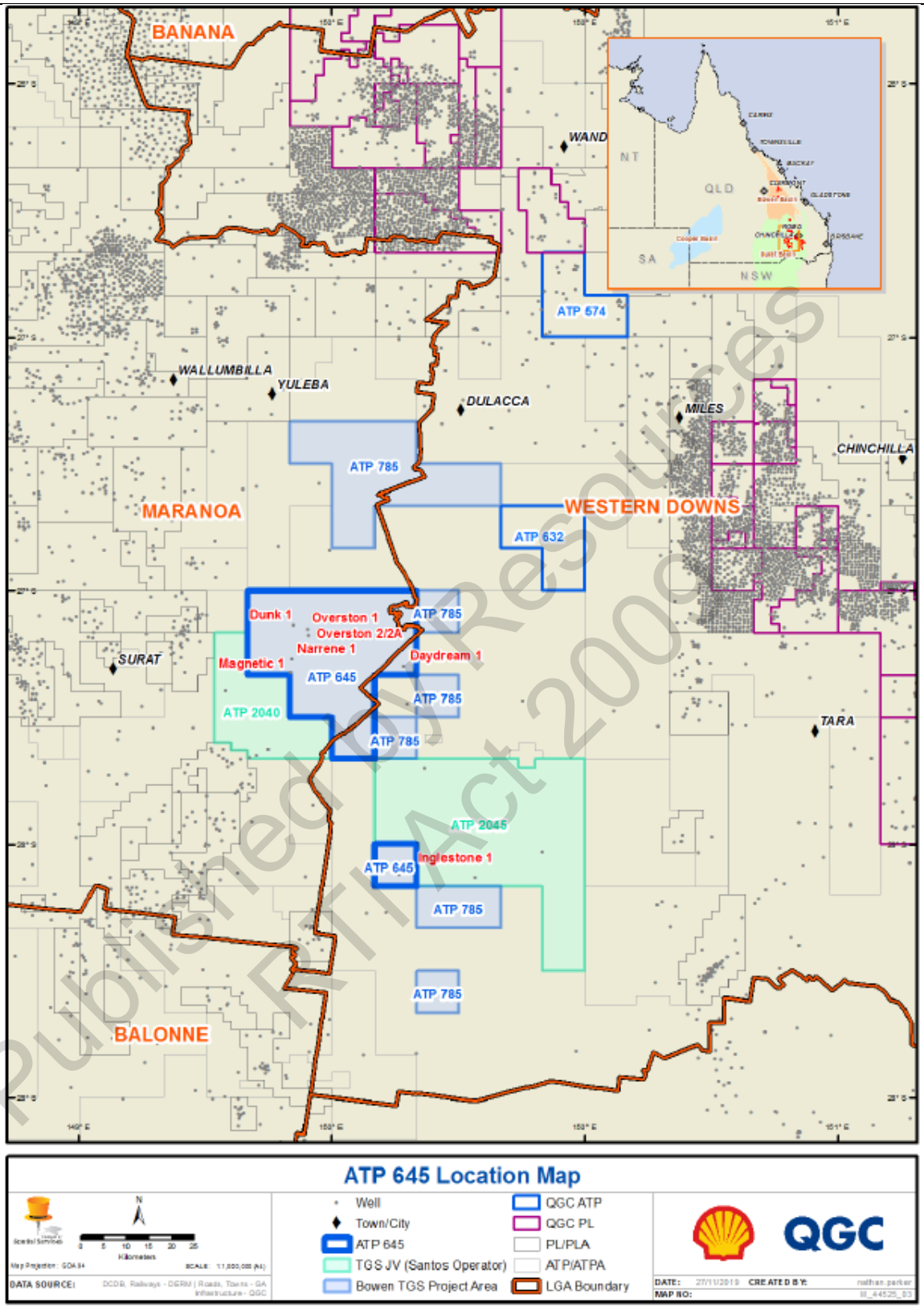

Figure 1: Location map showing ATP 645 and other Shell interests in southern Taroom Trough (Source: page 26, PCA 305 Amendment Application).

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 2: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Milestone: Area of proposed declaration			
1	Is the area no more than is needed to cover the maximum extent of a natural underground reservoir?	**Yes**	s.90(1)(a) and (2)

The technical assessor considers that the area applied for is sufficient and no more than required to cover the extent of the natural underground reservoirs, Tinowan Formation and Lorelle Sandstone. As a tight gas reservoir not bound by any particular structure, the target area can be quite large and laterally extensive.

The proposed area of PCA 305 is 275 sub-blocks (825 square kilometres (km2), as shown in Figure 3. The reservoirs of interest in PCA 305 is the Tinowan Formation and the Lorelle Sandstone. The reservoirs extends beyond the PCA area into adjacent tenure and open acreage, as can be seen in Figure 4. It can be seen in Figure 4 that the reservoir covers the extent of PCA 305.

Additional information was provided by the applicant on 9 October 2020 in response to a letter from the department dated 21 September 2020. The applicant has provided a cross section (Figure 5) and seismic map (Figure 6) which show that the main target formation within ATP 645, the Tinowan Formation is present within PCA 305. The technical assessor considers that these maps provide further evidence that the area of PCA 305 is no more than is needed to cover the maximum extent of the reservoir.

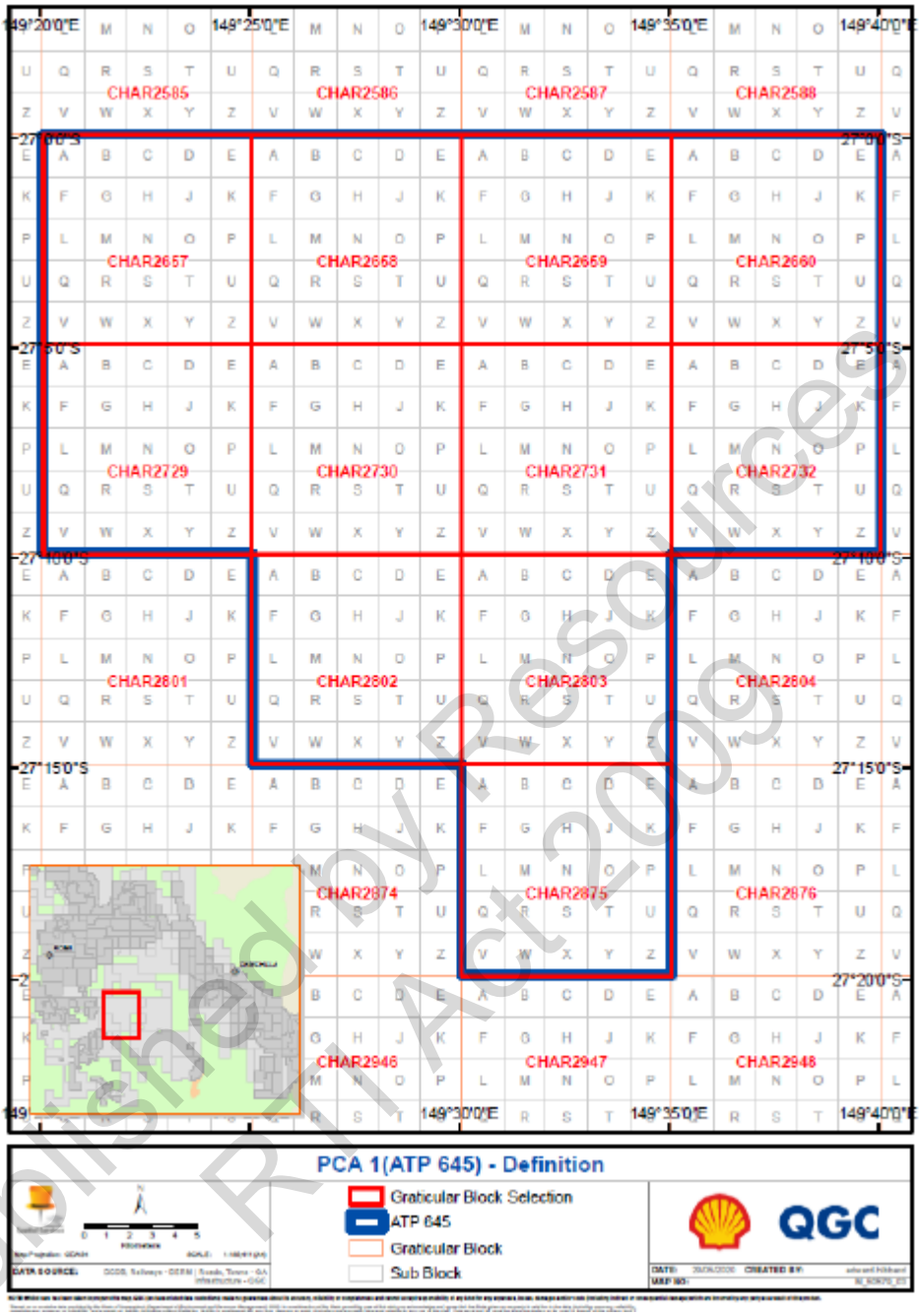

Figure 3: Sub-blocks forming part of PCA 305 application (Source: page 30, PCA 305 Amendment Application).

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Figure 4: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 5: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 6: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs
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Milestone: Commercial viability	

2	Has the applicant provided sufficient details confirming: • each natural underground reservoir in the area; • an estimate of the amount of petroleum in each reservoir; • the standards and procedures used to make the estimate; • whether it is commercially viable to produce or store petroleum in the area; and • that in the holder's opinion, it will, within the next 15 years, be commercially viable to produce or store petroleum in the area.	**Yes** **Yes** **Yes** **No** **Yes**	s.89(5)(a) and s.231(1)(a) to (e)

The technical assessor considers that the applicant has provided sufficient details to address each criteria.

Natural underground reservoir

The applicant has provided sufficient details on the natural underground reservoir in the PCA area, namely the Tinowan Formation and the Lorelle Sandstone. This includes geological background, petrophysical analysis and drilling details. Tinowan Formation and Lorelle Sandstone are present within the Back Creek Group, which is a widespread succession of marine to fluvial sands, silts, shales, coals and tuffs that predominately represent the thermal sag phase of the Bowen Basin development.

As can be seen in Figure 2, PCA 305 areas contains both the Tinowan Formation and the Lorelle Sandstone. The Tinowan Formation is divided into two distinct depositional sequences, the lower Tinowan/Wallabella Coal Member and the upper Tinowan. The upper Tinowan is the most prolific gas producing interval on the Roma Shelf with the largest gas fields in the province being present in this interval. The lower Tinowan is productive but its prevalence as an economic producer is limited due mainly to localised depositional trends and generally poorer reservoir quality than the upper Tinowan. The applicant has also provided stratigraphy for the regions within the Bowen Basin, as shown in Figure 7. It can be seen that the Tinowan Formation is located in the South West Taroom Trough and belongs to the late Permian group.

The Lorelle Sandstones is an early-mid Permian fan-delta system penetrated on the Roma Shelf and in a small number of wells on the western flank of the Taroom Trough. Lorelle Sandstone is the oldest reservoir in the Back Creek Group and to date has had no economic production despite being found to be gas-bearing in a number of wells. The key challenge in its exploration is understanding reservoir distribution and quality variation with a relatively small number of well penetrations.

The PCA 305 area contains six wells, three of which have flowed gas and condensate to surface following fracture stimulation. The results of these wells has provided impetus for selecting Tinowan Formation as the primary target reservoir and the Lorelle Sandstone as the secondary target reservoir.

Additional information was provided by the applicant on 9 October 2020 in response to a letter from the department dated 21 September 2020. The applicant has provided further details of the reservoir characterisation within PCA 305 derived from Overston 3D seismic and wells within the Overston 3D (Dunk 1, Overston 1, and Overston 2/2A). These maps show the porosity (Figure 8), net to gross (Figure 9) and sand thickness (Figure 10) of the Tinowan Formation within PCA 305. The technical assessor is satisfied that the applicant has sufficient knowledge of the target reservoir within PCA 305.

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Figure 7: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

The following maps have provided new information on the real reservoir properties such as porosity (Figure 5), sand net to gross (Figure 6), and sand thickness (Figure 7) have been presented in those maps. Not only has the high-resolution aerial variation of those key reservoir properties surrounding the Overston area been presented, but also the less-resolution aerial variation of those properties along the 2D seismic lines. Although the high-resolution area does not cover the whole PCA 305 area, the new information provides further support of the broader extent of the petroleum discoveries in the PCA 305 area. The additional maps provide strong evidence for the claimed discovered reservoir which has extended from the discovery wells to cover almost the whole PCA 305 area.

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Figure 8: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 9: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

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Figure 10: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Amount of petroleum in each reservoir

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Ability of the resource to be commercially viable within the next 15 years

The technical assessor considers that to develop PCA 305 application area into an economic project will require:

- Confirming the extent of the resource and calibrating reservoir parameters over the maximum possible area;
- Optimising the drilling and completion techniques deployed to realise the modelled type curves; and
- Demonstrating ability to execute project within capital expenditure profile assumptions in the economic analysis.

The applicant believes that over a period of 15 years and through addressing these considerations as part of the ATP 645 work program and the evaluation program for PCA 305, the application area will become commercially viable.

3	Has the applicant provided sufficient supporting data such as: • technical data relating to the geology of, and natural underground reservoirs in the area; and • market and financial data relevant to the opinions.	**Yes** **Yes**	s.231(1)(f) and (2)(a) and (b)

The technical assessor considers that the applicant has provided sufficient data to address the geology of the Tinowan Formation and the Lorelle Sandstones and the commerciality of the project area.

Geologic review

Prior to the grant of ATP 645, a number of deep wells were drilled during the 1980's in the southern part of ATP 645, with unstimulated flow tests recovering gas cut mud. These wells provided crucial support to the regionally pervasive nature of the gas-bearing reservoirs of the Back Creek Group and the tight-gas potential of the Tinowan Formation and the Lorelle Sandstones.

The earlier activity under ATP 645 was undertaken by Sunshine Gas acquiring the Overston 3D and drilling the Overston-1, Overston-2/2A and Narenne-1/1A wells. More recent activity has been undertaken by the current applicant through 2D seismic and 3 wells, named Daydream-1, Dunk-1 and Magnetic-1. Three wells (Overston-2/2A, Daydream-1 and Dunk-1) have flowed gas and condensate to surface following fracture stimulation and has provided encouraging indications of tight-gas sand reservoirs.

Through Dunk-1 drilling, core was taken of the Upper Tinowan Sandstone, which proved critical in defining gas saturation of approximately 75%. Dunk-1 was also fracture stimulated and production tested and peaked at 4 terajoule (TJ) PJ of gas per day before stabilising at 0.7 TJ of gas per day.

Daydream-1 was drilled to test the Taroom Trough and encountered the Tinowan Formation. This was the first well fracture-stimulated in the Bowen tight gas sand project area and despite a number of issues with these operations, including recovery of unbroken gel to surface during the clean-up and one stage being perforated incorrectly at 180º rather than at 60º as planned, gas and condensate were recovered at surface.

While OGIP and gas flow has been demonstrated in the PCA area, there is considerable uncertainty on reservoir characterisation due to the limited number of well penetrations. To date, post-stimulation production testing has not yielded economic flow rates from vertical wells, posing a challenge to economic development of the tenure using the current drilling and completion techniques. It is modelled that deliverability uplift through application of multi-stage fracture stimulated horizontal wells would result in a commercial development.

This PCA evaluation program support the ATP 645 work program to address the challenge of maturing an economic play by improving characterisation of the tight gas sand reservoirs in order to identify sweetspots and consideration of drilling and completion techniques that may unlock deliverability in tight sands.

Financial and market review

In order to assess commerciality, a development concept was devised based on North American unconventional play development as a base model. The key parameters of the development concept are:

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sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 16: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

4	Should the Minister be satisfied that petroleum production or storage in the area to be declared,	**Yes**	s.90(1)(b)

	is not, and will not soon be, commercially viable, but is likely to be viable within 15 years?		

The Minister should be satisfied that commercial production from the area is not currently viable, but is likely to be viable within 15 years. The applicant has submitted a robust evaluation program to develop the tight gas sand resource within the PCA area.

The applicant has also proven through well tests that the area has produced gas, but a full scale development will require more work to develop the extent of the resource and optimise the drilling and completion techniques for deep tight gas required for commerciality of the project.

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional These resource estimates are based on the results of Overston-2/2A, Daydream-1 and Dunk-1 which have flowed gas and condensate to surface within ATP 645. The technical assessor considers that the estimate of hydrocarbon in PCA 305 are consistent with the definition of prospective resources as per the SPE Petroleum Resources Management System (PRMS) 2018 definition.

This provides that the PCA 305 application areas hold excellent potential but due to the nature of the tight gas sand resource, the current exploration has not demonstrated commerciality. This is because the current wells within PCA 305 are all vertical ones with only one being fracture stimulated. To achieve commerciality, it is envisioned that horizontal multi-stage fracture stimulated wells will be needed. This represents an enormous expenditure and hence the PCA declaration will aid the applicant in assessing the reservoir quality, resource extent and drilling and completion techniques to reduce the project risks before applying for petroleum leases.

PCA 305 is in close proximity to infrastructure given its location near to existing Roma Shelf production facilities (Wallumbilla and Kincora Gas Plants) which would aid commerciality once initial hurdle of establishing the resource is overcome.

Milestone: Compliance with relevant ATP			
5	Has the work program of the relevant authority to prospect been substantially complied with?	**Yes**	s.90(3)

The technical assessor is satisfied that the applicant has substantially complied with the work program for ATP 645.

The current work program for ATP 645 is for the two year period 1 January 2018 to 31 December 2019 and is provided below:

Period 5	Minimum Approved Activities	Estimated Expenditure
One (1) year ending 31 December 2018	Geological & Geophysical and engineering studies	$100,000
One (1) year ending 31 December 2019	Geological & Geophysical and engineering studies Prospect selection, well planning & design	$100,000
	TOTAL	**$200,000**

Figure 17: ATP 645 current approved work program (Source: page 4, PCA 305 Amendment Application).

As can be seen in Figure 17, the current approved work program for ATP 645 comprises of technical studies, prospect selection and well planning. The technical assessor considers the applicant compliant with the work program since the applicant has demonstrated a good understanding of the reservoir and well planning in its

PCA applications. Work undertaken as part of the current approved work program has collectively led to two PCA applications over the entire ATP 645 area.

In addition, the applicant has provided a summary of exploration activities undertaken as part of the Bowen tight gas sand project since 2010. This is provided below and in Figure 18.

- 826 km 2D seismic acquisition.
- 4,151 km 2D seismic re-processing and 193 km^2 3D seismic re-processing of legacy surveys across the project area.
- Drilling of seven wells with total depth ranging from 3,180-4,694 m, four of which were fracture stimulated and production tested. Three of these wells were drilled within ATP 645.

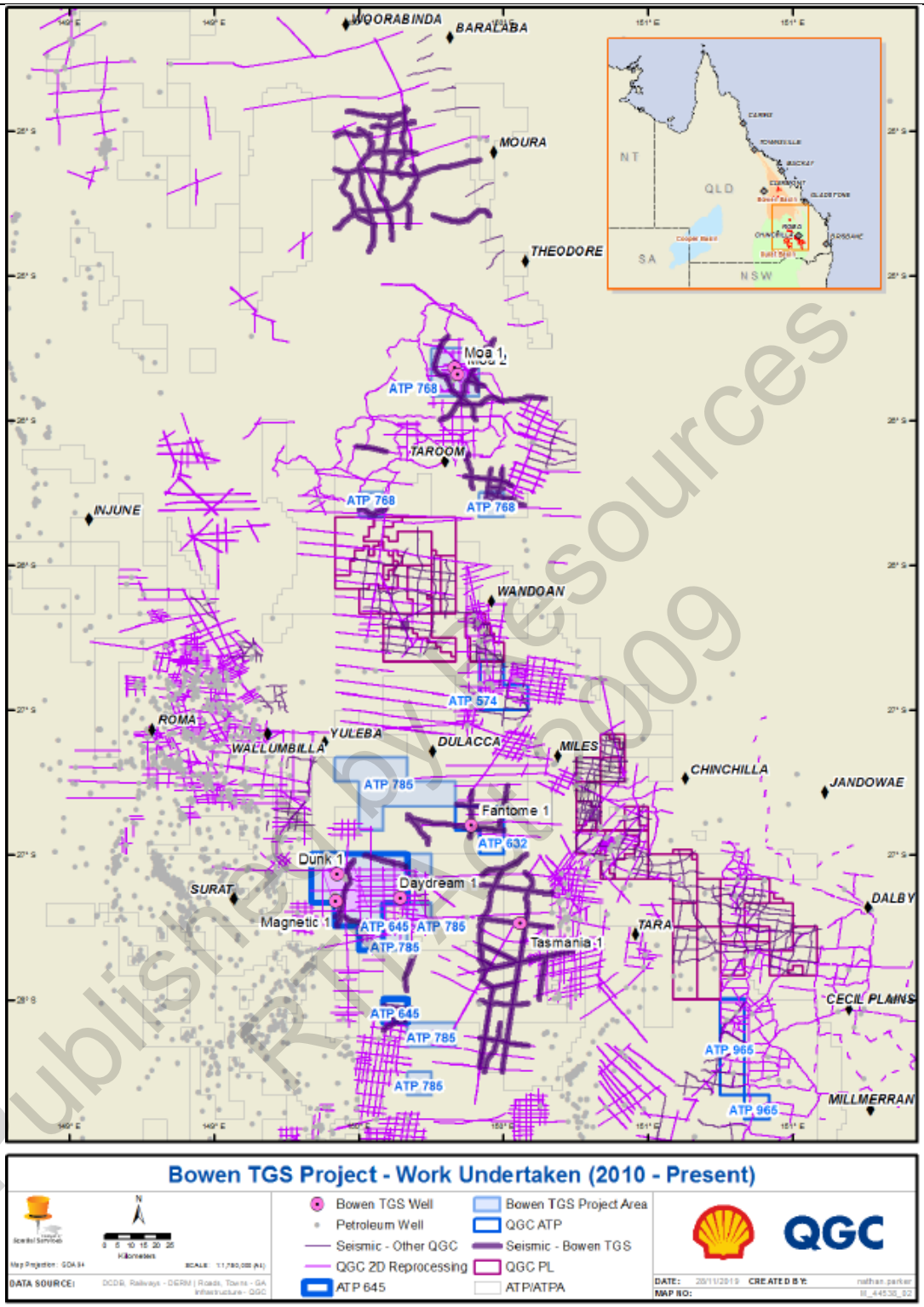

Figure 18: Summary of work undertaken as part of the Bowen tight gas sand project, including ATP 645 since 2009 (Source: page 27, PCA 305 Amendment Application).

Milestone: Evaluation program			
6	Has the applicant provided an appropriate program of work to evaluate the potential for petroleum production or storage and associated market opportunities?	**Yes**	s.89(5)(b)

The applicant has provided an evaluation program for PCA 305 for a 15 year declaration period.

The evaluation program does not contain any physical activities. In this instance it can be considered acceptable as the holder has drilled and tested three wells in the PCA area and proposed two wells as part of the ATP 645 work program from 1 January 2020 to 31 December 2023. Execution of the ATP 645 work program will be critical to supporting the evaluation program for PCA 305 to prove the tight gas sand resource.

The proposed ATP 645 work program for the period 1 January 2020 to 31 December 2023 is provided in Figure 20. ATP 645 is currently under assessment for a renewal term of 12 years expiring 31 December 2031.

Additional information was received from the applicant on 9 April 2020 providing an indicative timeline of ATP 645 activities outside of the proposed four year work program and over the applied 15 year period associated with the PCA applications. A summary of the additional information is provided below:

- Proposed activities for ATP 645 to support a 15-year PCA term are provided below in Figure 21 and mainly include drilling and production testing of multi-well design alternatives, technical studies, commercial agreements and approvals.
- Appraisal beyond the proposed work program will be dependent on the results and review of the proposed work program activities.
- Appraisal beyond the proposed work program will be dependent on the timeline and exploration programs of adjacent ATP 785, ATP 632 (PCA 160) and PLR2019-2-11 acreage (should the applicant be successful) as well as ATP 2040 and ATP 2045, which are operated as a joint venture with Santos (QNT) Pty Ltd.
- Review of the data gathered in the proposed work program from two wells and 150 km of 2D seismic will underpin the horizontal well design required for commerciality.

The evaluation program provided by the applicant addresses risks around the commerciality of the project. The applicant appears to address a number of these issues in the evaluation program provided through reviews of available technology, updating models and resource estimates and reviewing project economics.

The evaluation program is provided below:

Year	Activity	Estimated Expenditure per PCA ($A)
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Figure 19: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Permit Year	Authorised Activity	Expenditure
sch4p4(7)(1)(c) Business/commercial/professional/financial affairs		

Figure 20: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Year	Activity
	sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Figure 21: sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

Milestone: Term of declaration			
7	Is the declaration for 15 years?	**Yes**	s.92(1)
8	If NO, does the shorter period consider the following: • when any petroleum discovery was made; and • any commercial viability report or independent viability assessment for, or that includes, the proposed potential commercial area.	**N/A**	s.92(2)

The applicant has applied for a 15 year declaration for PCA 305. The technical assessor is recommending a declaration of 15 years because of the following reasons:

- The technical assessor believes that a declaration term of 15 years is needed to confirm the resource extent, optimise drilling and completion techniques and finalise commercial aspects of the tight gas project.
- Three wells within PCA 305 application area have flowed gas and condensate to surface following fracture stimulation. This confirms presence of the resource and necessitates further evaluation.
- sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

sch4p4(7)(1)(c) Business/commercial/professional/financial affairs

With the target resource being tight gas where risk is generally higher, the 15 year declaration period is more acceptable. This will provide the applicant the required time to demonstrate commerciality before significant investment associated with multi-stage fracture stimulated horizontal wells, which will be required for commercial production.

The tight gas project could be of significant financial benefit for the State and any geological and engineering knowledge gained through the drilling and development of deep tight basin centred gas would also be of significant benefit.

The technical assessor recommends that the PCA 305 be granted for a period of 15 years.