STAFF ANALYSIS
OF THE
NORTH AMETHYST
SATELLITE TIE-BACK
PROJECT

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1.0 PURPOSE

The purpose of this Staff Analysis is to assess Husky's North Amethyst Development Plan Application and to make a recommendation to the Board. Staff's analysis considered safety, environment, resource management and socio-economic impact aspects of the Application.

This Staff Analysis does not consider any Benefits aspects of the proposed project. Benefits are assessed in a separate Benefits Plan Staff Analysis document. The Board will review and make its decision on the Benefits Plan prior to making a decision on the Development Plan. This approach is consistent with 45(2) of the Accord Acts.

2.0 EXECUTIVE SUMMARY

On August 14, 2007, Husky Oil Operations Limited (Proponent) submitted to the Canada-Newfoundland and Labrador Offshore Petroleum Board (Board) on behalf of the ownership within the Significant Discovery Licences (SDL) 1024 and 1044, Production Licence (PL) 1006 and Exploration Licence (EL) 1045, the following documents (the Application):

North Amethyst Development Plan

- Development Plan North Amethyst Satellite Tie-back to SeaRose FPSO, August 2007
- North Amethyst Satellite Tie-back Development Application Project Summary, August 2007
- North Amethyst Satellite Tie-back Socio-economic Impact Assessment, August 2007

White Rose (FPSO Modifications)

- White Rose Development Plan Amendment - SeaRose FPSO Modifications, August 2007

Benefits Plan (Both Applications)

- Canada-Newfoundland and Labrador Benefits Plan North Amethyst Satellite Tie-back, August 2007
- North Amethyst Satellite Tie-back Canada Newfoundland and Labrador Benefits Plan Summary, August 2007

Other

- SeaRose Tieback Project Concept Safety Assessment, August 2007

Staff reviewed the Application and advised the Proponent that it constituted a Development Plan (North Amethyst Field) as well as a Development Plan Amendment to

the White Rose Development Plan. In September 2007, Staff informed the Proponent that additional information would be required to complete the Application. The Proponent submitted supplementary information *(Completeness Review of Husky Tie-Back Project Development Plan Documents, November 6, 2007)* and on November 30, 2007, the Proponent was advised the Application was complete.

An opportunity to comment on the Application (including Supplementary Information) was provided for the period of November 30, 2007 to January 7, 2008; no comments were received.

It should be noted that in a letter dated February 4, 2008, the Proponent informed the Board that the substantial modifications to the SeaRose FPSO topsides "are not currently required" and that they are withdrawing the "SeaRose FPSO Modifications August 2007" document at this time. Therefore, no amendment to the White Rose Development Plan is necessary. The Proponent's plan is to de-bottleneck the facility to accommodate future expansion.

With respect to investigating alternative modes of development for the tie-back project, the Proponent noted that it relied on the initial White Rose Development concept selection work and, based on this work, a steel FPSO facility was selected as the preferred mode. The Proponent then compared the options of using the existing SeaRose FPSO or a standalone greenfield FPSO. Based on an assessment of several factors including procurement options, development costs and schedule, the Proponent concluded that the tie-back to the SeaRose FPSO option was preferred. Staff concurs with this assessment.

The Proponent then examined two options to tie-back to the SeaRose FPSO:

a) tie-back from the North Amethyst Glory Hole directly via new flowlines and new dedicated riser systems; or

b) tie-back via new flowlines from the North Amethyst Glory Hole to existing subsea infrastructure (i.e. Southern Drill Centre or Central Drill Centre)

At the time of submission of the Application, each option was still being evaluated. However, in the Proponent's supplementary information dated November 6, 2007 they indicated that Option B (using the Southern Drill Centre) was the proposed method of development for the North Amethyst Field tie-back project. It should be noted that Option B does not require the vessel to come to shore. The Proponent also indicated in this correspondence that they have moved the first oil window up from late 2010 to late 2009.

With respect to the North Amethyst Glory Hole, it has a capacity of up to 16 wells but the tie-back is expected to require from seven to ten wells consisting of four production and three to six water injection wells thus leaving some flexibility for future expansion.

Staff reviewed the Application from an operations and safety, environment, resource management as well as a socio-economic impact perspective. The following is a summary of this review.

Operations and Safety

Based on the Proponent's plan to use Option B above, no safety concerns were identified which would preclude Staff from recommending approval of the Application. Activities in connection with this Application can be managed in accordance with established safety processes and procedures.

Staff will ensure that the following matters will be followed up with the Proponent in due course as the project proceeds:

1) When the project advances to the detailed engineering design phase, the Proponent must advise the Chief Safety Officer of the manner in which the recommendations

arising from the Atkin's "SeaRose Tieback Project Concept Safety Assessment" report have been addressed.

2) The scope of work of the Certifying Authority in respect of the White Rose project must be amended to include a review of any new subsea systems and flowlines to be installed as well as any modifications either to the SeaRose FPSO or to the existing subsea systems.
3) The Proponent must provide, within 120 days of commencing detailed engineering design, a summary of any upgrades that may be required to the SeaRose FPSO or existing subsea systems as well as a summary of the new subsea equipment to be added as part of the expansion. The Proponent's plans for testing and integrating these modifications into existing systems and procedures should be described together with the Proponent's plans for training personnel in respect of any new systems or upgrades.
4) When the project proceeds to the detailed engineering design phase, the Proponent must keep the Board Staff informed of the detailed schedule for the project, including a schedule for any ongoing or future safety studies.

As a matter of course, updates to the SeaRose Safety Plan to reflect the North Amethyst Development must be submitted to the Chief Safety Officer for approval. The Quantitative Risk Analysis (QRA) which is amended to include the actual North Amethyst development must be submitted to C-NLOPB. Any necessary changes to the ice management plan and any other operational updates to existing plans, processes and procedures must be made by the Proponent in accordance with its management of change process.

Protection of the Environment

With respect to assessing the potential environmental effects of the Application, Staff determined that a screening level assessment pursuant to the *Canadian Environmental Assessment Act* was required. The Proponent prepared an environmental assessment

(EA) report, and an addendum to the report to respond to comments from Staff, government agencies and the public. The conclusion of the environmental assessment was that, with the application of mitigation measures, the implementation of a Follow-up Program and adherence to C-NLOPB guidance material, significant adverse environmental affects associated with the project are not likely.

With respect to environmental protection planning for drilling and production operations, Staff will expect the Proponent to submit any necessary revisions to White Rose environmental protection plans (EPPs) for drilling and production operations prior to the commencement of these operations at North Amethyst.

Staff accepted the Proponent's evaluation that the re-injection of drill cuttings from synthetic-based drilling muds was unfeasible at North Amethyst, and noted that an ongoing feasibility analysis by the Proponent of produced water re-injection at White Rose also would cover activities at North Amethyst.

Staff also noted that the Proponent's Concept Safety Assessment did not consider target levels of risk to the environment, and that its approach to environmental aspects of risk assessment was qualitative rather than quantitative. Staff question the appropriateness of this approach and will follow up the issue further with the Proponent as the review of potential modifications to the Proponent's EPPs progresses.

In conclusion, no environmental concerns were identified that would preclude Staff from recommending approval of the Application. Therefore, Staff recommends that the Application be approved subject to the following condition:

> **The Proponent, prior to commencing drilling operations at the North Amethyst drill centre, shall submit for the approval of the Chief Conservation Officer an amended Environmental Effects Monitoring program design**.

Resource Management

Staff also performed a technical review of the proposed project from a resource management perspective. Staff has the following conclusions:

- Staff concurs with the Proponent's proposed depletion strategy, which consists of nine development wells (4 horizontal producers and 5 water injectors) with pressure support from water flooding. In the event that there are changes in the geological or reservoir model, well slots will be available for drilling.

- The Proponent has provided a resource management plan that includes a data acquisition, voidage replacement, and gas conservation. However, Staff notes that the Proponent has not adequately addressed the gas storage issue with respect to oil production at the North Amethyst Field. Therefore they will be required to provide a plan to the Board that addresses this issue.

- Pressure data, fluid analysis and geological interpretation confirm that the North Amethyst Field is separate from the White Rose Field.

- A large volume of gas is expected to be produced to recover oil during the early phase of production from the North Amethyst Field. Also, during the latter phase of development, water production will be significant. The SeaRose FPSO has the capacity to handle these volumes under the Proponent's base plan; however, there is limited excess capacity if volumes prove to be greater than planned. The Proponent will be expected to address this issue in a report to the Board.

- Staff acknowledges the range of reserve estimates presented by the Proponent for the North Amethyst Field and appreciate the uncertainty surrounding these estimates. However, the base case oil reserve estimate presented by the Proponent is

conservative, as there are several opportunities that may further increase the oil reserves. Furthermore, there is potential to produce the gas resources and natural gas liquid resources within the North Amethyst Field, which would further extend field life.

Staff concurs with the proposed Application from a resource management perspective, and recommend approval, subject to the followings conditions:

Condition 1:
The Proponent shall not initiate oil production from the North Amethyst Field until the Proponent submits and the Board approves a Gas Storage Strategy report.

Condition 2
The Proponent provide to the Board, as soon as possible, ideally not later than commencement of detail design, a report assessing the potential opportunities for de-bottlenecking of the facilities to accommodate any restrictions to oil production and the pace of deferred development.

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Condition 3
The Proponent shall submit to the Board within two years following initiation of production from the North Amethyst Field an updated evaluation of the full field (White Rose and North Amethyst) gas resources along with a description of activities to be undertaken and a drilling schedule and locations for delineation or pre-development wells.

Condition 4:
Prior to initiation of production from the North Amethyst development area, the Proponent shall notify the Board's Chief Conservation Officer that the commercial

agreements with interest owners of PL 1006, PL 1007 and PL1008 are in place and that the royalty owners concur with the commercial agreements.

Socio-Economic Impact Statement

Staff engaged a consultant to review the Proponent's Socio-Economic Impact Statement document (Appendix B). The consultant's conclusions concurred with the Proponent's assessment that:

- the project is so small that it is very unlikely to generate any negative social impacts or cause problematic demands on local infrastructure or public services; and
- that it could be a positive addition to economic activity within the province, is a reasonable assessment.

Staff concurs with this assessment.

In conclusion, Staff recommends that the Board approve the Application, subject to the conditions in the environmental protection and resource management sections of this report.

3.0 BACKGROUND

3.1 The Application

On August 14, 2007, Husky Oil Operations Limited (Proponent) submitted to the Canada-Newfoundland and Labrador Offshore Petroleum Board (Board) on behalf of the ownership within the Significant Discovery Licences (SDL) 1024 and 1044,
Production Licence (PL) 1006 and Exploration Licence (EL) 1045 the following documents (the Application):

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The Application proposes development of the North Amethyst Field within the Significant Discovery Licences (SDL) 1024 and 1044, Production Licence (PL) 1006 and Exploration Licence (EL) 1045. These were subsequently converted to Production Licences (PL) 1006, 1007 and 1008 (see Section 3.2 Commercial Discovery Area/ Production License).

Staff reviewed the Application and requested additional information in a letter dated September 18, 2007. The Proponent responded with supplemental information on November 6, 2007 and in a letter dated November 30, 2007, the Proponent was informed that the Application was complete.

The Board made the Application, and supplemental information, available to the public for comment on its website for the period November 30, 2007 to January 7, 2007 and no comments were received.

The Proponent examined two development options with respect to the tie-back to the SeaRose FPSO and selected Option B tie-back via new flowlines from the North Amethyst Glory Hole to existing subsea infrastructure (i.e. Southern Drill Centre). It should be noted that Option B does not require the vessel to come to shore. The Proponent also indicated in this correspondence that they have moved the first oil window up from late 2010 to late 2009.

The North Amethyst Glory Hole has a capacity of up to 16 wells but the tie-back is expected to require from seven to ten wells consisting of four production and three to six water injection wells thus leaving some flexibility for future expansion.

On February 4, the Proponent informed the Board that it was no longer considering doing the topside modifications for water and gas handling on the SeaRose FPSO and were therefore withdrawing the SeaRose Modifications Development Plan Amendment

document at this time. The Proponent's plan is to de-bottleneck the facility to accommodate future capacity expansion.

The Proponent estimates 11.1 million m^3 (70 million barrels) of recoverable oil from the North Amethyst Field with an estimated cost of $1.5 billion for Option B. These are estimated by the Proponent as follows:

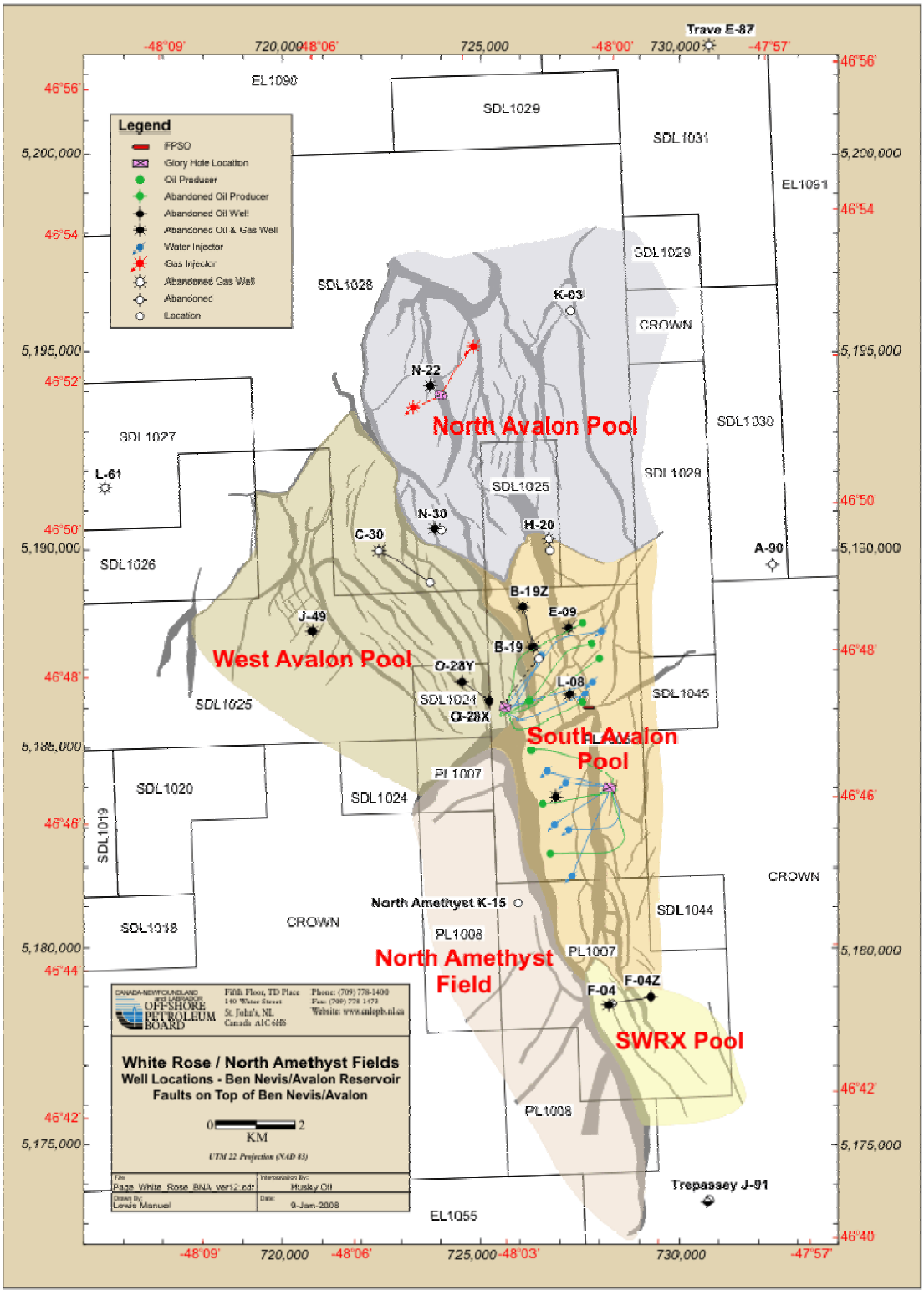
Drilling and completions	$ 705 million
Subsea Systems	$ 587 million
Project Management and Engineering	$ 137 million
Glory Hole Construction	$ 32 million
FPSO modifications	$ 7 million

3.2 Commercial Discovery Area / Production Licences

On May 25, 2007, the Board received the document *Application for an Extension to the Commercial Discovery Area, White Rose Region North Amethyst/White Rose Structure*. The Board reviewed this document and identified several deficiencies that prevented proper consideration of its merits. On July 9, 2007, the Board received an *Application for a Commercial Discovery Declaration North Amethyst Structure* (2 volumes). This application is based on the oil and gas reserves defined in the North Amethyst structure by the K-15 discovery well and considers an area of 14 sections equalling 4,956 hectares. On October 24, 2007, the Proponent was notified of successful application defining the North Amethyst Commercial Discovery Area (CDA) covering six sections 2, 12, 13, 24, 25, 26.

On November 2, 2007, the Proponent submitted a Commercial Discovery Declaration Application for a Production Licence from the White Rose and North Amethyst Commercial Discovery Areas. The Proponent was notified by the Board, on November

21, 2008 that the Production License had been issued and approved resulting in the current land regime. The North Amethyst Field is now defined by PL 1006, 1007 and 1008 as shown below.



3.3 Glory Hole Construction

The glory hole for North Amethyst was dredged during the summer of 2007 by the MV Vasco da Gama. Since there was no development plan in place at the time of authorization for this work, approval was granted by special decision of both levels of government.

3.4 History/Context

The White Rose Field was discovered in 1984 by the drilling and testing of the Husky et al Whiterose N-22 exploratory well. The field is located approximately 350 km east of St. John's, Newfoundland and Labrador on the eastern edge of the Jeanne d'Arc Basin in an area where the water depth ranges between 115 and 130 meters.

The recoverable oil reserves in the White Rose Field are estimated, and expressed at a 50 percent probability level by the Board, to be 45 million m^3 (283 million barrels). Most of the hydrocarbons are contained in the Ben Nevis Formation. Pressure measurements and fluid contacts indicate that the oil and gas accumulation in the Ben Nevis Formation are divided into four separate oil pools, each with an associated gas cap: the South Avalon pool, the North Avalon pool, the West Avalon pool, the South White Rose Extension (SWRX) pool. Commercial oil production began at the South Avalon Pool on November 12, 2005.

The South White Rose Extension (SWRX) is an expansion to the White Rose Development within Significant Discovery Licences 1043 and 1044. This expansion proposed a subsea tie-back to the SeaRose FPSO through the existing Southern Glory Hole (SGH) and utilizes a new glory hole to be constructed approximately 4km south of the SGH. The C-NLOPB estimates that 22 million barrels of oil is recoverable from the SWRX pool.

The SWRX pool was approved by governments on September 7, 2007. Expected first oil for this pool is late 2012.

The North Amethyst Field was discovered in 2006 by the drilling of the Husky Oil et. al. North Amethyst K-15 well into the North Amethyst structure. The K-15 well defined the presence and quality of a hydrocarbon-bearing reservoir in a geological feature previously interpreted to be devoid of adequate reservoir. The well encountered an extensive gas over oil hydrocarbon interval within the Ben Nevis Formation. The resources identified by the K-15 well are approximately 600 metres shallower than those in the South Avalon Pool of the White Rose Field.

A note of clarification is required regarding the naming convention used in the Application. The reservoir section was termed the “Avalon Formation” in the Proponent’s White Rose Development Plan Application (2001), and in the Board’s Decision 2001.01. It is now believed the reservoir section lies upon the mid-Aptian unconformity, is middle Aptian-Albian in age, and is an overall fining-upward package within a transgressive systems tract, and is now interpreted to be the “Ben Nevis Formation”.

4.0 RESOURCE MANAGEMENT

Resource management is the essence or core feature of any Development Plan Decision. This statement is not meant to detract from the importance of other aspects of the decision such as safety, environmental protection or benefits. However, all of these are to some extent driven by the choice that is made in determining the general approach to the development of the hydrocarbon resources.

The legislative and regulatory philosophy which guides this decision process is generally described as “Conservation of the Resource”.

Resource conservation is perhaps the most complex and technically challenging aspect of the Development Plan Decision, involving the integrated application of a wide array of geological and engineering factors. The Accord Legislation stipulates that a central feature of the general approach must be the prevention of waste. The overriding principle here is one of good reservoir management practice. This principle, and the legislative requirement to prevent waste, must be the basis of the Staff’s recommendation in this area.

It is the recommendation of the Staff from a Resource Management perspective that the North Amethyst Development Plan be approved, subject to the proposed conditions established in this Analysis.

The recommendation is based on the North Amethyst Field development using a tieback of a satellite field via the SeaRose FPSO facility as described in the Application.

4.1 Resource Management Review

This section focuses on resource management aspects of the Application. The statutes and regulations administered by the Board require that oil and gas resources be produced in accordance with good oil field practise, having proper regard for the efficient recovery of the resource and the prevention of waste. The Proponent's Application sets out:

- interpretation of the geology and reservoir characteristics of the North Amethyst Field;
- estimates of hydrocarbon reserves and resources;
- the strategies to recover oil reserves and the conservation of the gas resources; and
- modes of development.

In any oil or gas field development, it is impossible to resolve all of the geological, geophysical and reservoir ambiguities prior to proceeding with development. Several uncertainties, which are discussed in the sections of this analysis, may affect the depletion scheme to be employed and the recoverable reserves.

Staff reviewed the Application and the Proponent's electronic copies of their seismic data and reservoir simulation model, as well as conducted a review of reservoir and geological data. Also, updated South Avalon well, production and other relevant data was included in the analysis. Collectively, this information was sufficient to allow the assessment of the Proponent's overall resource management plan. The following sections of this report presents the Board staff's review, determinations and recommendation.

4.2 Geology/Geophysics/Petrophysics

4.2.1 Regional Geology

In the original White Rose Development Plan (2001) the Proponent extensively details the regional geologic history of the Jeanne d'Arc Basin. In light of both the Board's and

general industry understanding of the Basin, this discussion adequately describes the tectonic evolution of the White Rose and North Amethyst areas. The following summary is extracted from various sources including: the Proponent's original White Rose Development Plan Application, the Terra Nova Development Plan Application and literature describing the regional geology of the Jeanne d'Arc Basin.

The North Amethyst field is located on the eastern margin of the Jeanne d'Arc Basin, about 50 km east of both the Hibernia and Terra Nova fields. This northeast trending basin is bounded to the west by the Bonavista Platform, to the east by the Ridge Complex, to the south by the Avalon Uplift, and to the north by the Cumberland Ridge.

The Mesozoic depositional sequences contained in the basin were strongly controlled by regional tectonic events occurring on the North Atlantic continental margin from Late Triassic to mid Cretaceous time. Sediments were initially deposited during the Late Triassic to Early Jurassic rift phase within a northeast trending graben. This episode was followed by a Jurassic post-rift phase, during which subsidence and deposition of marine sediments, such as shale and limestone, occurred. The organic-rich shales, limestones and marlstones of the Rankin Formation deposited at the end of this phase are of particular importance because they are considered the primary source rock for most of the oil generated in the basin.

A second phase of east-west oriented rifting occurred in the Late Jurassic. The deposition of the fluvial sandstones and conglomerates of the Jeanne d'Arc Formation followed the uplift and erosion of the underlying Rankin Formation in this period. Basinward, the Jeanne d'Arc Formation grades into shales of the Fortune Bay Formation. Braidplain and deltaic sandstones of the Hibernia Formation continued to fill the basin until Early Cretaceous time. Following this, a post-rift period of subsidence and deepening basin conditions occurred which is reflected by the "B" Marker and "A" Marker limestones, marine sandstones of the Catalina Formation and the Whiterose Formation shale.

The final phase of rifting, a southwest-northeast extension, occurred in the mid-Cretaceous. During this time, the fluvial to marine sandstones of the Ben Nevis/Avalon Formations and basinward, the shales of the Nautilus Formation, were deposited. Since the Late Cretaceous, the entire basin has subsided and the sediments deposited include fluvial-deltaic and deeper marine clastics and minor limestones. This was followed in the Quaternary by glaciation and the subsequent transgression of the ocean into the area.

4.2.2 Geology of North Amethyst

The North Amethyst Field is located on a rotated fault block adjacent to the Terrace portion of the White Rose South Avalon pool. The principle reservoir consists of shallow marine, fine-grained, quartzose sandstones of the Ben Nevis Formation. This southwest-northeast trending sequence was likely deposited along a paleoshoreline located east of the field (Figure 4.1). Movement along the fault bounding the North Amethyst structure occurred after the deposition of the Ben Nevis sands, with similar thicknesses of the reservoir occurring in the North Amethyst structure and in the South Avalon pool. The resources identified by the K-15 well are approximately 600 metres shallower than those of the South Avalon Pool (Figure 4.2). This shallower burial has resulted in increased porosity and permeability of the North Amethyst reservoir, as compared to the South Avalon Pool.

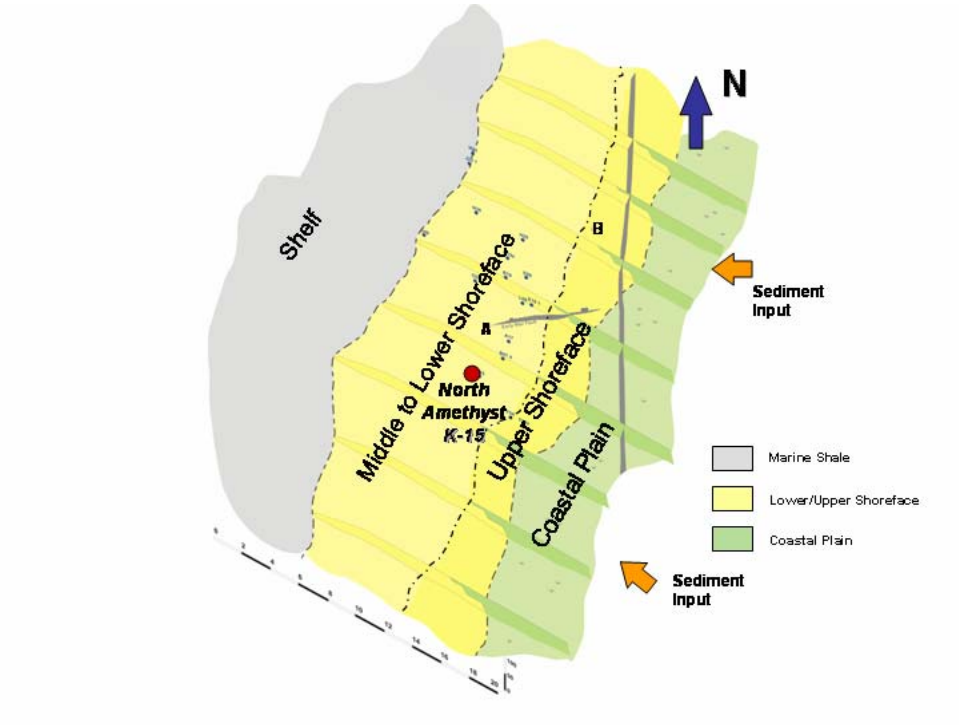


Figure 4.1: Schematic of aerial distribution of shoreface sandstones and early moving faults related to the initial phases of Ben Nevis deposition (Source: Husky, 2007)

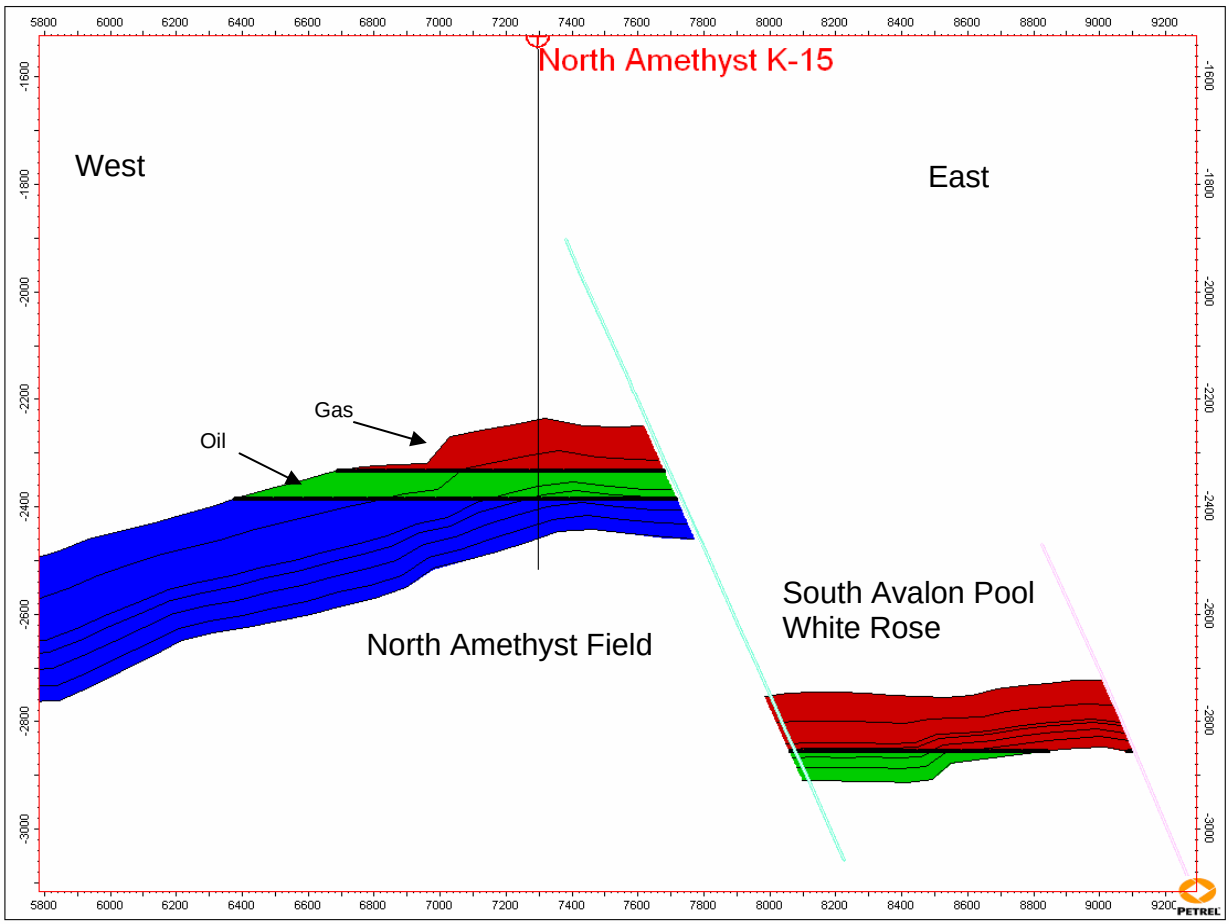


Figure 4.2: West to East Structural cross-section through the North Aethyst area and adjacent South Avalon Pool (Source: CNLOPB)

The Proponent defines the Ben Nevis Formation using three main facies associations:

1) Lower shoreface storm deposits consisting of well-sorted, very fine-grained sandstones that form the main reservoir rock type in the region.
2) Lower shoreface fair-weather deposits consisting of heavily bioturbated siltstone to silty-sandstone.
3) Marine silty shale and shale deposits with minor bioturbated intervals that represent the distal component of the White Rose region deposition.

The sandstone reservoir facies are incorporated into the geological model for reservoir simulation purposes. The division between reservoir and non-reservoir units is identified by porosity and permeability cut-offs, which are obtained from the calibration of core and petrophysical data.

4.2.3 Geophysics

The North Amethyst Field is covered by three separate seismic surveys, PGS-97, Breton 1990 and GSI 1985. PGS-97 and Breton 1990 are modern three-dimensional (3-D) seismic surveys, while the GSI 1985 is an exploration reconnaissance pseudo 3-D survey. Subsequent reprocessing and merging of all datasets was completed by the Proponent in 2000 and the White Rose Merge dataset was used as the primary seismic volume for the structural interpretation of the North Amethyst Field.

The Proponent has used two primary wells, K-15 and G-57, to correlate seismic data and key seismic markers in the North Amethyst Field. The K-15 synthetic seismic trace generated from sonic and density logs has provided a strong tie to the merged seismic dataset. The North Amethyst area has been mapped by the Proponent for three seismic markers, the Base Tertiary Unconformity, the Top Ben Nevis Avalon (BNA) and the Mid-Aptian Unconformity. The interpretation and correlation was described by the Proponent as challenging given the low impedance contrast of the Ben Nevis Avalon reservoir and surrounding geology as well as fault complexity.

All three surfaces mapped by the Proponent over the North Amethyst Field were tied to the White Rose Field using numerous adjacent wells. The Base Tertiary Unconformity marker is a regional seismic surface mapped as a strong positive peak through the North Amethyst Field and surrounding White Rose Area. Limited faulting and a strong impedance contrast allows for confident interpretation of the regional marker. The Top

Ben Nevis Avalon Formation is mapped as the top of the hydrocarbon-bearing reservoir; this horizon represents a low impedance contrast that can be a difficult pick in North Amethyst and the White Rose fields. The Mid-Aptian Unconformity defines the Base of the Ben Nevis Avalon reservoir interval. A medium to high amplitude horizon, this surface is mapped with a higher level of confidence. The reservoir interval is imaged seismically as low amplitude sequence indicative of the low impedance siltstone reservoir. Overall, the North Amethyst Field is less structurally complex then the adjacent White Rose Field. The north-south elongated westerly dipping North Amethyst ridge is separated to the east and north by major faults: the West Terrace Fault and North Terrace Fault, respectively (Figure 4.3).

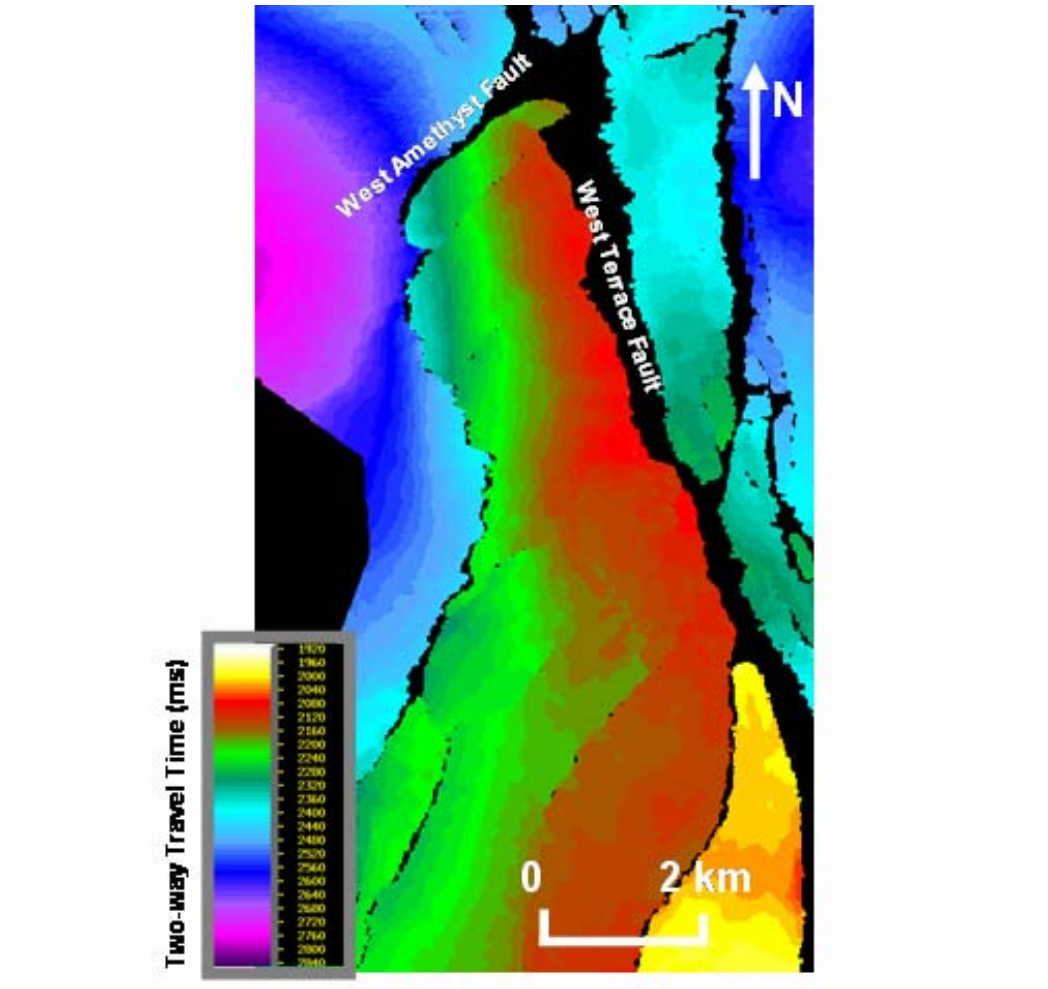


Figure 4.3: North Amethyst Field, Top Ben Nevis time structure map (Source: C-NLOPB)

The Proponent has supplied supplemental information on time-to-depth conversion, and all seismic surfaces have been converted using the Vo,K method to be input into geologic modelling. All seismic datasets and geophysical surfaces were provided to the Board for review and audit. Variations in the interpretation are minimal and staff has concluded that the geophysical interpretation presented is acceptable.

Staff conclude that the geophysical analysis by the Proponent is considered reasonable and acceptable at this time.

4.2.4 Petrophysics

The Proponent has conducted a comprehensive logging and coring program while drilling the exploration, delineation and development wells in the White Rose Field. In the Application, the Proponent summarized their petrophysical interpretation of the Ben Nevis / Avalon reservoir for all wells in the approved development area as well as for the North Amethyst K-15 well, southwest of the developed region. The Proponent supplied supplemental information on the methodology, assumptions and criteria used in their petrophysical analysis.

Staff reviewed the petrophysical data and determined that the Proponent's petrophysical interpretation matches Staff's assessment with slight differences attributed to different methodology, assumptions and criteria used in interpreting the data. Based on its analyses, Staff believe the interpretation presented by the Proponent is reasonable and appropriate for the evaluation this Application.

4.2.5 Reservoir Geologic Modeling

Staff continues to build and update their geological models for the North Amethyst Field using the 3D modeling software package Petrel (Schlumberger). The Board's models cover the entire North Amethyst development area, as well as the White Rose Field.

Specific effort was focused on the construction of a sector model of the North Amethyst area for this evaluation. With this sector model, Staff evaluated the oil and gas in place and oil reserves presented by the Proponent.

The geological model of the North Amethyst area is bound by geophysically controlled structural map surfaces of the top and bottom of the reservoir as supplied to the Board by the Proponent. The model was adjusted based on information acquired from wells drilled in the area. Fault mapping in the Board's model is derived from fault polygons supplied by the Proponent, modified to suit the most recent and applicable structural input surfaces**.**

The surfaces and fault polygon sets were imported and manipulated in Petrel. Well data, in the form of the Board's petrophysical analysis, were also imported into the modeling software. The model is shown in Figure 4.4.

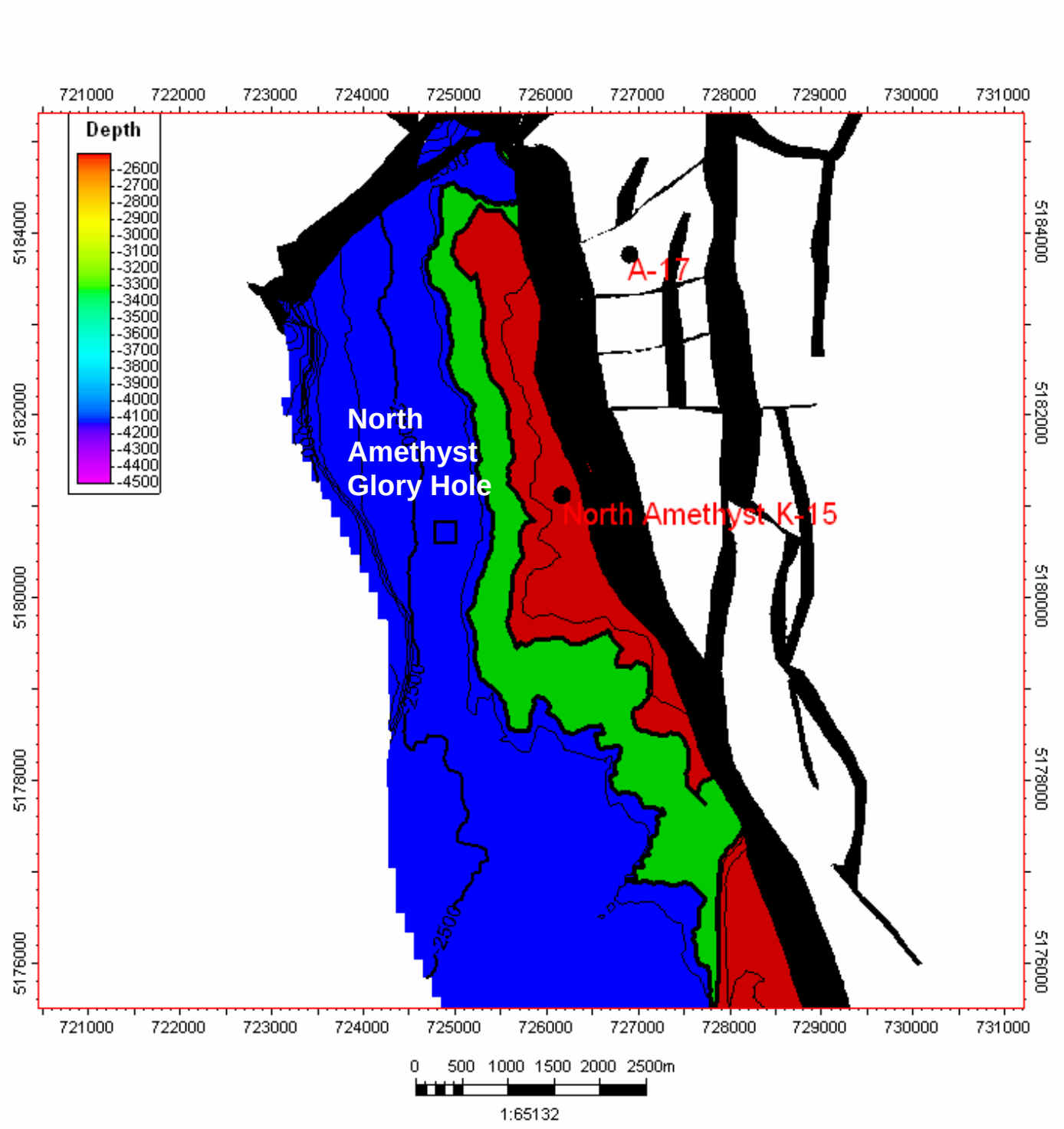


Figure 4.4: North Amethyst geological model: Top structural surface (Ben Nevis Formation), showing gas-oil contact, oil-water contact, and interpreted faults (Source: C-NLOPB)

A 3-D, sloping fault geo-cellular model was constructed with the above data, using cell sizes of approximately 100 x 100 x 4 metres. Key reservoir properties for the North Amethyst model (ie. porosity and water saturation) were scaled up from log scale (0.1524 metres/sample) to reservoir scale (approx 4 metres/sample) in Petrel (Figure 4.5). Using Sequential Gaussian Simulation (SGS), the scaled up well parameters for porosity and water saturation were distributed throughout the model. This maintains the statistical distribution of the original data and the inverse correlation coefficient relationship between the porosity and water saturation data (Figures 4.5, 4.7). Other parameters key to the resource/reserve calculations (i.e. oil formation volume factor, $\mathbf{B_o}$, gas formation volume factor, $\mathbf{B_g}$, gas–oil ratio, **GOR**, recovery etc.) are fixed scalar quantities, and are entered into the software.

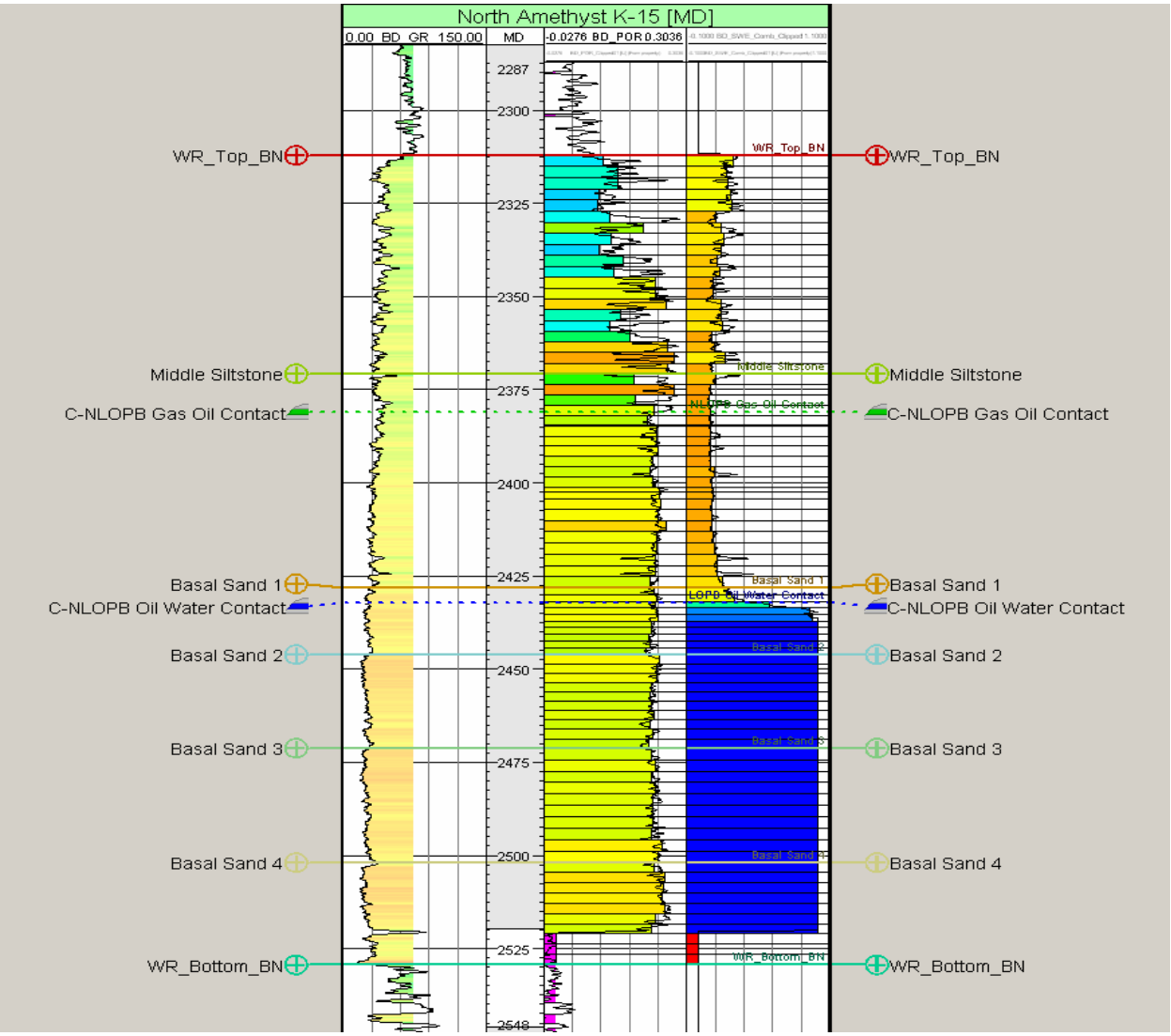


Figure 4.5: North Amethyst K-15 showing Gamma Ray, Porosity and Water Saturation Logs and Property Scale Up (see text) (Source: C-NLOPB)

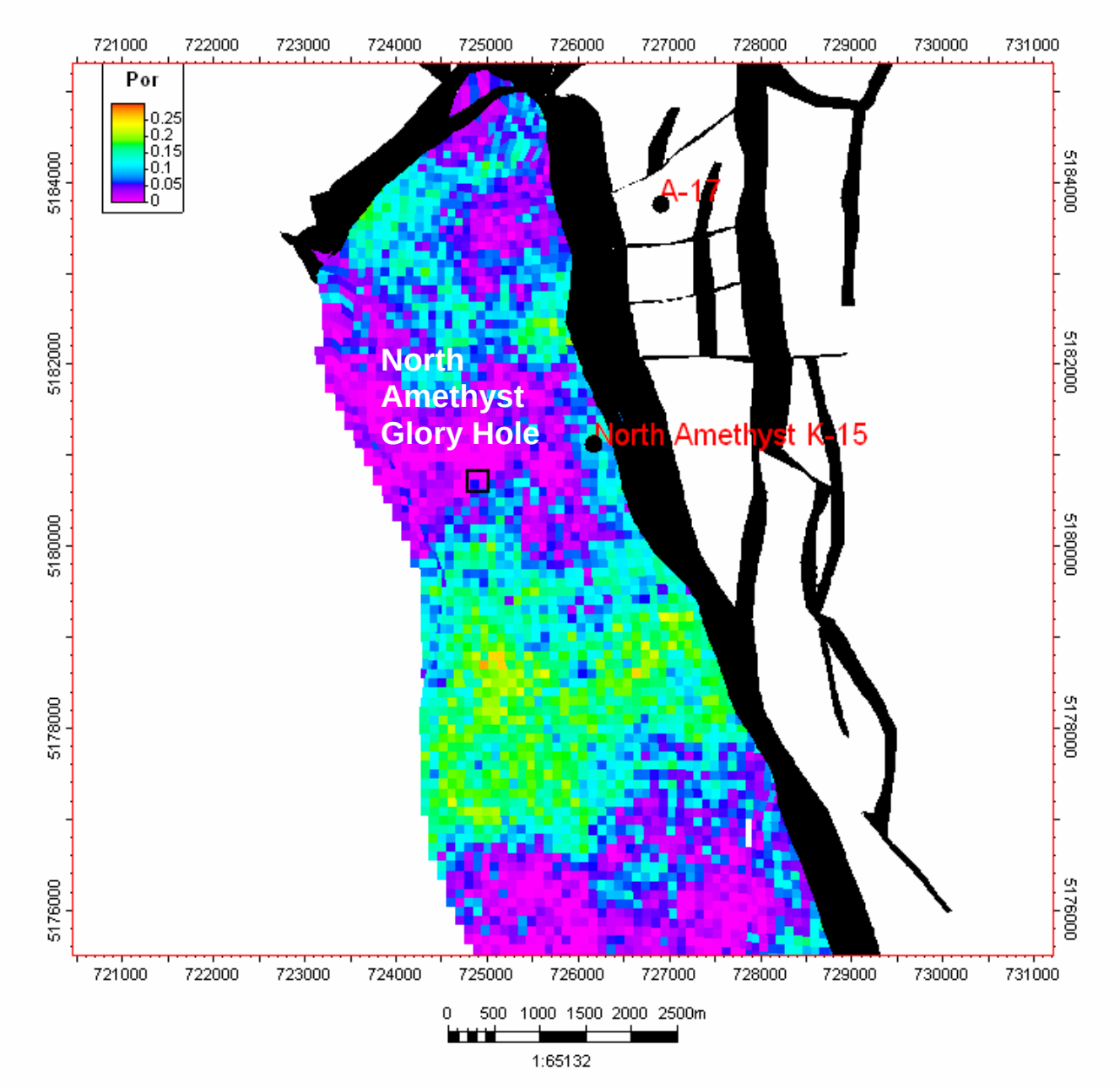


Figure 4.6: Example of porosity distribution in the North Amethyst geological model (Source: C-NLOPB)

The Proponent continues to work on its geophysical and geologic models for the North Amethyst Field, which is typical for any field under production. Staff believes that the Proponent's geological model is reasonable and appropriate to evaluate this Application.

4.3 Oil in Place, Gas in Place and Reserve Estimates

Consistent with Board practice for reserve/resource determinations, fifty separate porosity and corresponding water saturation realizations, each controlled by a random number statistical seed, were used for the Board's North Amethyst geological model. This provides a statistical range for the hydrocarbon pore volume determination (HCPV). Scalar quantities (Table 4-1), convert $HCPV_{oil}$ and $HCPV_{gas}$ to oil and gas in place and recoverable oil. The recovery factors assigned were not completely based on Proponent's reservoir simulation studies as these are viewed to be optimistic. Rather, the recovery factors are based on the Staff's engineering and geologic work.

Table 4-1: Parameters and assumptions used to determine resources/reserves for the North Amethyst area

Oil formation volume factor (Rm^3/STm^3)	1.27
Gas formation volume factor (Rm^3/Sm^3)	.005
Gas Oil Ratio (m^3/m^3)	100.6
P90 Oil Recovery (fraction)	0.17
P50 Oil Recovery (fraction)	0.27
P10 Oil Recovery (fraction)	0.40

Staff assessed the oil-in-place for the North Amethyst Field presented by the Proponent and the resource estimates based on the Board's geological model. A comparison of the Proponent's, and the Board's volumetric oil-in-place estimates, for the North Amethyst area, are shown in Table 4-2.

Table 4-2: Comparison of Husky and C-NLOPB Probabilistic (Volumetric) Resources in Place, North Amethyst Field

	P90		P50		P10	
	Husky	C-NLOPB	Husky	C-NLOPB	Husky	C-NLOPB
OOIP (million Barrels)	211	213	259	251	310	288
OOIP (million m3)	34	34	41	40	49	46
OGIP (Gas Cap BCF)	114	147	149	173	210	216
OGIP (Gas Cap (BM3))	3.2	4.2	4.2	4.9	5.9	5.5
OGIP (Solution BCF)	122	120	150	142	181	162
OGIP (Solution (BM3))	3.5	3.4	4.2	4.0	5.1	4.6

With respect to reserves, Table 4-3 show that the Board's estimates are in close agreement with the Proponent's for the North Amethyst Field. **Staff feels that the reserve estimates are realistic but conservative in light of the fact that one well was drilled**.

Table 4-3: Comparison of Husky and C-NLOPB Oil Reserves, North Amethyst Field

	P90		P50		P10	
	Husky	C-NLOPB	Husky	C-NLOPB	Husky	C-NLOPB
Oil Recovery Factor	0.15	0.17	0.27	0.27	0.40	0.40
Recoverable Oil (million Barrels)	31.7	36.2	69.8	67.9	124.0	115.2
Recoverable Oil (million m3)	5.0	5.8	11.1	10.8	19.7	18.3

Staff believe the Proponent's oil and gas-in-place estimates are reasonable for planning purposes. If the results of development drilling indicate any significant change in the premise upon which the present plan is based, the Proponent will be required to submit to the Chief Conservation Officer an amended plan that takes this new information into account.

4.4 Reservoir Engineering Review

The review of the Proponent's reservoir engineering component of the Application includes the following:

- An overview of alternative development opportunities,
- A review of the reservoir engineering data;
- An assessment of the depletion and reservoir management;

- A review of the reservoir simulation model;
- A review of the exploitation plan and sensitivities to the reservoir simulation;
- A base case production forecast for North Amethyst and production forecasts for South Avalon pool and full field development; and

4.4.1 Development Opportunities

The Application noted that the Proponent considered several development and production optimization opportunities. These included:

- Steel FPSO facility
- Concrete FPSO facility
- Steel floating, production, drilling, storage, offloading (FDPSO) facility
- Concrete gravity base structure (GBS)
- Steel semi-submersible facility with and without integral storage
- Concrete semi-submersible facility
- Disconnectable concrete tension leg platform (TLP)
- Concrete barrier wall with floating production unit (FPU)

With respect to investigating these alternative modes of development for the tie-back project, the Proponent noted that it relied on the initial White Rose Development concept selection work and, based on this work, a steel FPSO facility was selected as the preferred mode. The Proponent then compared the options of using the existing SeaRose FPSO to a standalone Greenfield FPSO. Based on an assessment of several factors including procurement options, development costs and schedule, the Proponent concluded that the tie-back to the SeaRose FPSO option was preferred.

With respect to using a FPSO as the mode of development, two options were chosen by the Proponent for review as follows:

1) a sub-sea development to a new steel FPSO facility;or

2) a sub-sea tie-back system to the existing SeaRose FPSO facility;
    a) North Amethyst Satellite Tie-Back (directly to SeaRose)
    b) North Amethyst Satellite Tie-Back via Southern Drill Centre or Central Drill Centre

The Proponent selected option 2(b) above as its preferred approach with a tie-back using the Southern Drill Centre. According to the Proponent, the main drivers in the decision making process are technical and economic factors.

In assessing these options, the Staff's review focused on data provided by the Proponent including reservoir engineering data, simulation modelling, facility capabilities and its related costs. As well, the current production profile from the South Avalon pool and SeaRose facility efficiencies was considered because of the Proponent's preferred option. **In that regard, Staff feel that the Proponent's assessment of selection of the mode of development was reasonable.**

4.4.2 Reservoir Engineering Data

The K-15 exploration well, drilled in 2006, is located to the southwest of the White Rose field on White Rose Significant Discovery Licence 1044. The well, which reached a depth of 2566 m, targeted the North Amethyst structure with the intention of testing for Ben Nevis reservoir. Gas-oil and oil-water contacts were established 2933.9 mTVDss, and 2380.39 mTVDss, respectively. These contacts are shallower than any encountered in South Avalon Pool wells.

Reservoir Pressure

The reservoir pressure observed at the K-15 well was 23,800 kPa @2333 mTVDss. The gas, oil and water gradients observed at the K-15 well were 1.83 kPa/m, 7.01kPa/m and 9.90 kPa/m, respectively (Figure 4.7).

To investigate whether North Amethyst is a separate field from White Rose, Staff reviewed and compared the pressure data acquired from White Rose wells with the K-15 pressure data, and are satisfied that the North Amethyst oil is separate from the White Rose accumulations.

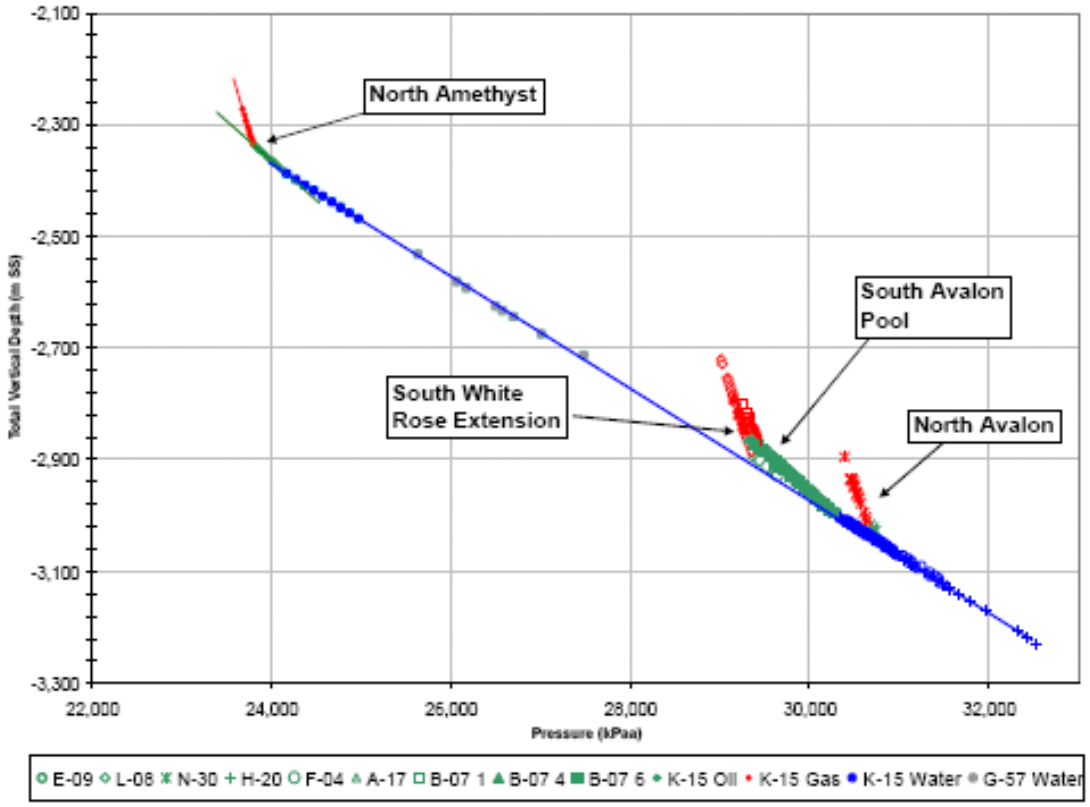


Figure 4.7: Pressure vs Depth graph of White Rose Area (Source Husky)

Gas-Oil and Oil-Water Contacts

The location of the gas-oil and oil-water contact will affect the computed reserves and may affect the location of development wells. Staff conducted an assessment of the data

to define the contacts (Table 4.4). **Staff concur with the Proponent's gas-oil and oil-water contacts**.

Table 4-4: Proponent's Gas-Oil and Oil-Water Contacts (Source: Husky)

Ben Nevis Formation : Proponent's Gas-Oil and Oil-Water Contacts		
Pool	Gas-Oil Contact (mss)	Oil-Water Contact (mss)
South Avalon	2872	3009
North Avalon	3014	3073
West Avalon	3064	3127
North Amethyst	2333.9	2386.4

Fluid Characterization

Six oil samples, three gas samples and three water samples were taken from the K-15 well. Analysis of two separator flash tests and one differential liberation test of the fluid oil samples were provided in the Application. Using a Pressure-Volume-Temperature (PVT) correlation package (MBAL), a PVT table was constructed to estimate the fluid properties. These estimates were later confirmed with the Proponent's final lab analysis, and were used in the Eclipse reservoir simulation model for the North Amethyst Field.

The K-15 PVT analysis results indicate an average initial gas-oil ratio and formation oil volume factor of 104 Sm^3/Sm^3 and 1.27 Sm^3/Sm^3, respectively. The South Avalon pool has an average initial gas-oil ratio and formation oil volume factor of approximately 137 Sm^3/Sm^3 and 1.39 Sm^3/Sm^3, respectively.

Analysis of gas samples and water samples are similar to ones of samples from South Avalon pool.

Staff considers the Proponent's oil, gas and water characterizations to be reasonable.

Reservoir Core Data

The Proponent used the K-15 well core data to illustrate that the porosity and permeability aligns with previous well data from the South Avalon pool, and to emphasize the consistent facies relationship across the White Rose region. At the K-15 well, the calculated air permeability ranges from 200 mD to 800 mD within the oil and water sections and from 10 mD to 500 mD within the gas sections of the reservoir. This is consistent with the Proponent's geological model, which has less permeable bioturbated intervals in the upper sections.

The Proponent uses a vertical to horizontal permeability ratio (K_v/K_h) of 0.5 in their Eclipse reservoir model simulation. The K_v/K_h ratio is measured from core to ensure that upscaling routines from log scale to reservoir simulation are appropriate. **Staff concur with the core analysis provided by the Proponent.**

It should be noted that the K_v/K_h ratio assumption may be optimistic considering the MDT (Modular Dynamic Tester) data indicates a ratio of 0.12. The discrepancy could be due to the scale involved in the testing for permeability with a MDT test versus permeability from core testing. Considering similar analysis in South Avalon Pool also had discrepancies between MDT and K_v/K_h ratios from core data, the Proponent's estimate for North Amethyst Field by the Proponent is consistent.

Reservoir Water Saturations

The Proponent has established water saturations from J – Function methodology, which are calculated from K-15 well log and core data. The Proponent identifies two major rock

types: laminated and bioturbated, which are consistent with their geological model. **Staff concur with methodology.**

Special Core Analysis

The Proponent has conducted a comprehensive core analysis program. However, SCAL (Special Core Analysis) data is not available from the K-15 well at this time. Consequently, data from the South Avalon White Rose pool was used for the North Amethyst reservoir simulation model. The relative permeability curve endpoints for K_r and S_w were predicted from correlation plots. These values correspond with laminated and bioturbated intervals in the geological model.

Considering the lack of well control and SCAL data available for the North Amethyst Field, the Staff concur with the Proponent's approach and analysis to determine relative permeability and water saturation at this time. However, the Proponent should review entire core analysis once the SCAL data becomes available, as was done for the South Avalon pool. This review will help identify any gaps in the data and be able to link the back to the geological and reservoir models.

MDT / DST results

The Proponent conducted a MDT and two vertical interference tests in the K-15 well. These tests were designed to assess vertical communication, permeability and skin values in the formation. Reservoir permeabilities in the range of 155 to 450 mD were observed.

No large DST or production tests were done on the North Amethyst Field from the K-15 well. Consequently, predicted production and pressure performance were estimated by reservoir simulation. This presents an area of concern in estimating the overall reservoir performance and planning. With no production history except what was predicted in

reservoir simulation and in analogs (South Avalon Pool), challenges could arise due to unforeseen differences in the geological or reservoir model.

The Proponent has recognized this productivity issue by having the base case depletion plan with horizontal wells. The Proponent has also provided a data acquisition program similar to the one used in South Avalon pool that addresses this concern. Early production monitoring and data collection, as well as an adaptable drilling schedule, will be critical to accommodate changes in reservoir models or production. Staff will work with the Proponent in monitoring this issue.

4.4.3 Development Strategy

With respect to the depletion plan for the North Amethyst Field, the Proponent intends to use the existing SeaRose FPSO to produce the North Amethyst oil and inject the associated produced gas into the North Avalon pool. The displacement strategy for North Amethyst Field involves water injection for pressure support and secondary recovery. Primary oil production (no pressure support) and gas injection were also considered as displacement strategies. However, the Proponent has demonstrated that water flooding is the preferred recovery mechanism, based on ultimate oil recovery and current SeaRose FPSO gas handling capacities.

The Proponent indicates that four horizontal producers, with support from five water injectors, will provide optimal drainage of the North Amethyst Field. (Figure 4.8) Because the reservoir is interpreted as unfaulted and continuous, there is a reliance on long reach horizontal production wells to achieve and sustain reasonable oil production. The proposed production wells trend northwest-southeast and are placed updip near the eastern boundary fault in the midpoint of the oil column. Proposed vertical water injection wells are located west of the oil producers, and are placed downdip in the water

leg. Use of vertical injectors will permit the appropriate placement of water to maximize sweep and provide optimal pressure maintenance.

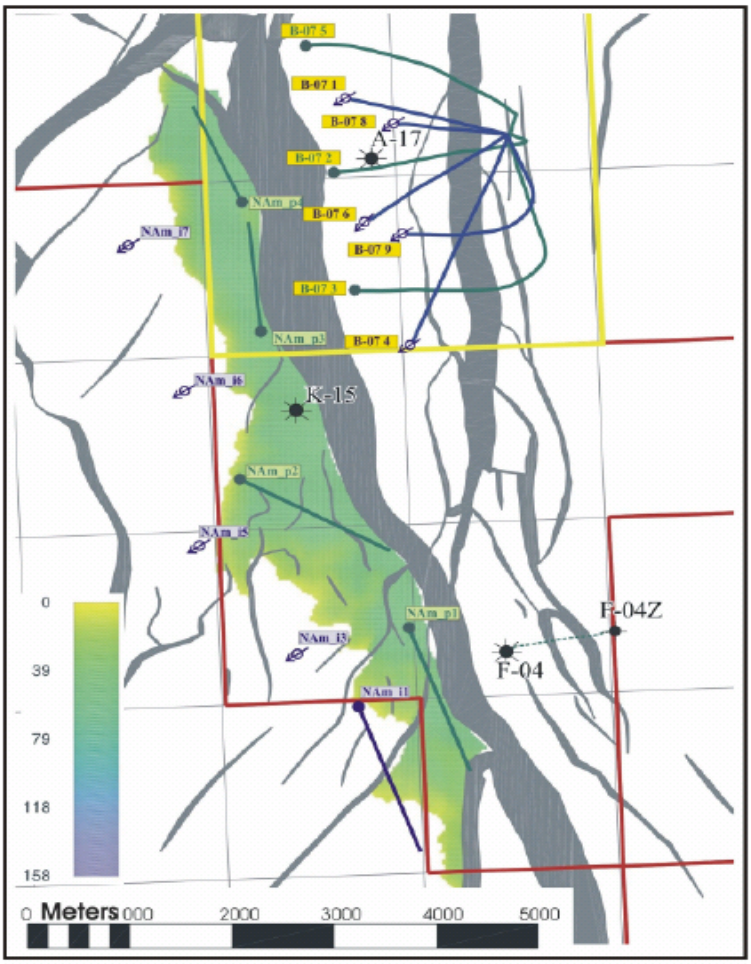


Figure 3-12 Proposed North Amethyst Well Locations

Figure 4.8: Proposed North Amethyst Well Locations (Source Husky Development Plan 2007)

Staff reviewed the Proponent's displacement strategy for the North Amethyst Field and concurs with the depletion plan.

Reservoir Management Plan

The Proponent plans to incorporate the current reservoir management strategy in place at the South Avalon Pool, which is at bubble point pressure with an overlying gas cap and underlying water leg. At the South Avalon pool, a voidage replacement ratio between 1.0 and 1.2 is maintained. The current bubble point pressure at North Amethyst Field is 21.10 MPa with initial reservoir pressure of 24.03 MPa, which suggests that pressure maintenance will be required to remain above bubble point pressure.

According to the Proponent, proper data collection programs will be designed similar to the ones in South Avalon pool and will be implemented to meet reservoir management objectives. Staff believes that the data acquisition activities which the Proponent describes are consistent with the requirements of the *Newfoundland Offshore Area Petroleum Production and Conservation Regulations and the Newfoundland Offshore Petroleum Drilling Regulations.*

Staff have reviewed the Proponent's North Amethyst Field Reservoir Management strategy and concur with the proposed voidage replacement aspect of the depletion plan.

According to Proponent, produced gas from the North Amethyst Field will be re-injected in the North Avalon pool for storage purposes. Staff reviewed the produced gas management strategy and are concerned with this aspect of the gas conservation.

The North Avalon pool is currently being injected with produced gas from the South Avalon pool. The subsurface storage licence **(#1001)** for North Avalon pool has a maximum capacity of 5.5×10^9 m^3. The combined volume of gas from predicted South Avalon pool and the North Amethyst Field is expected to exceed 5.5×10^9 m^3 early in North Amethyst oil production history. Thus, the Proponent needs to identify additional gas storage in order to produce the oil from North Amethyst Field in conjunction with the South Avalon Pool and other potential satellite developments. The Proponent has

indicated in technical briefings that they are evaluating several gas storage options for the North Amethyst Field, which include:

- Injection in the West Avalon White Rose pool;
- Injection in the South Avalon White Rose pool;
- Combined water and gas injection in North Amethyst Field.

All of these options would require additional Board approval, in terms of changes to the current Subsurface Gas Storage licence, Development Plan Amendment to the South Avalon pool or a development plan amendment of North Amethyst Field**. Staff believes the Proponent must resolve the gas storage issue before North Amethyst oil is produced, as surplus gas flaring will not be permitted above the authorized flaring allowance**.

Condition 1:
The Proponent shall not initiate oil production from the North Amethyst Field until the Proponent submits and the Board approves a Gas Storage Strategy report.

4.4.4 Reservoir Simulation Model

Staff have reviewed the results of the Proponent's North Amethyst Field simulation model. This model includes the North Amethyst resources within the development area and the facility constraints of the SeaRose FPSO.

The Proponent's reservoir simulation model was generated from their latest geological model, which was updated in January 2006. The reservoir model was initialized with 50 x 326 cells that represent areal dimensions of 100m by 100m. The total number of active cells is approximately 342,415.

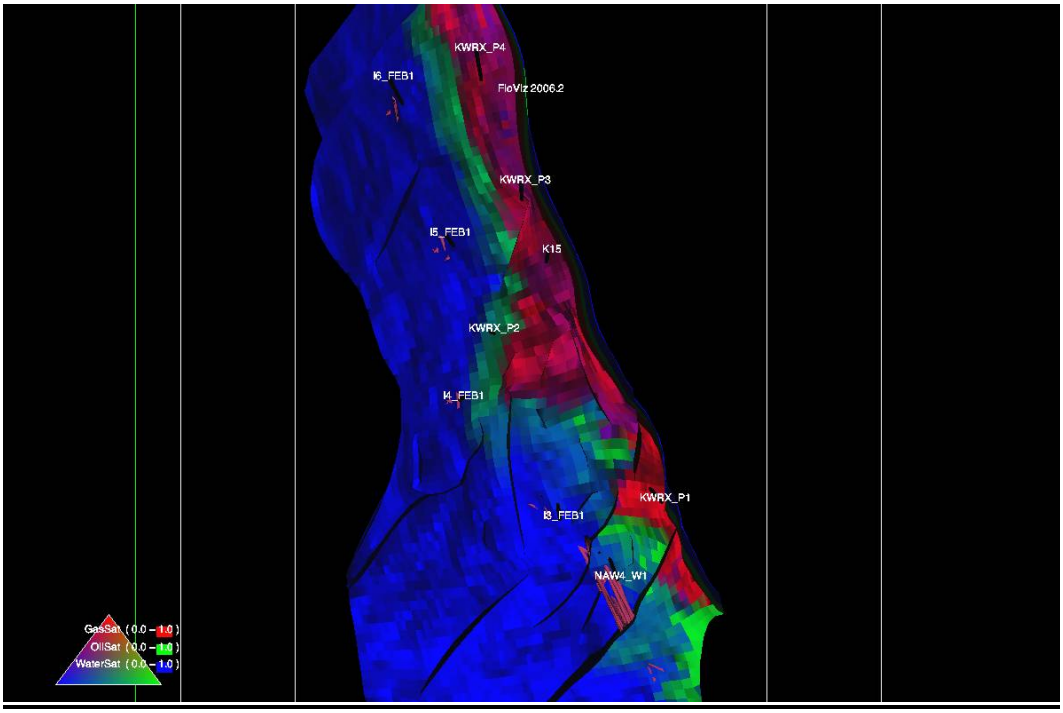


Figure 4.9: Plan view of the Tertiary diagram of the reservoir simulation model of the North Amethyst Field. (Source C-NLOPB)

Figures 4.9 and 4.10 show the tertiary plan and cross-sectional views of the Proponent's base case reservoir simulation model. The model depicts a gas cap (red colour) adjacent to the eastern bounding fault, a 50 m oil column (green colour), and a large water column dipping to the west. The four horizontal producers are placed midway in the oil column between the gas and water legs and are parallel to the northwest – southeast trending fault. The five water injectors are situated on the west flank of the field in the water column to provide optimal pressure support.

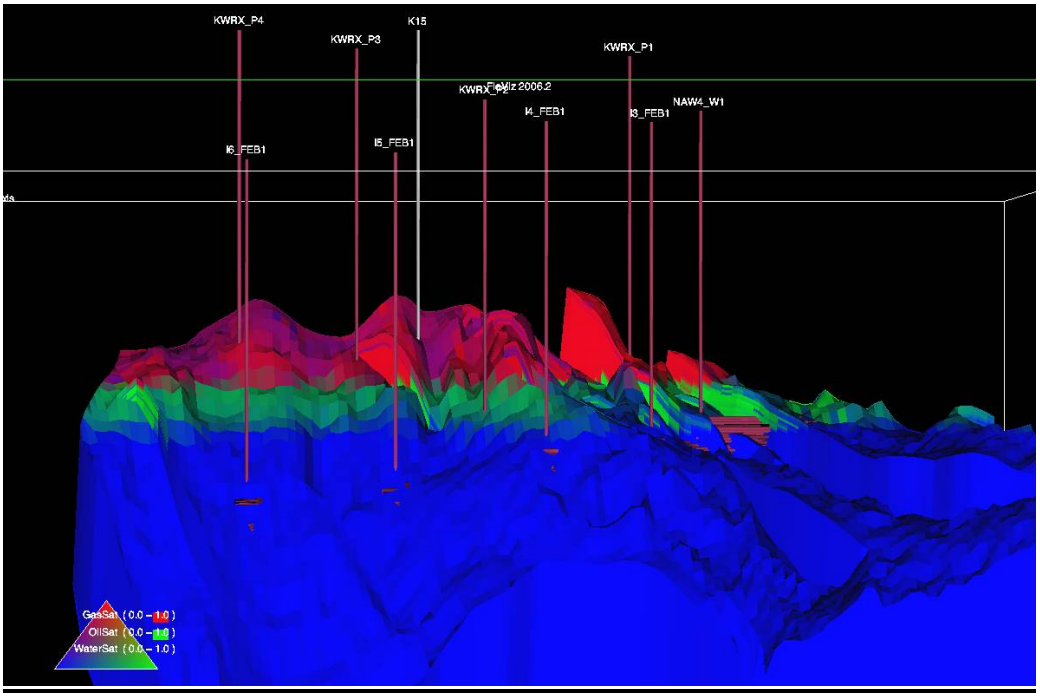


Figure 4.10: Westward looking side view of the Tertiary phase view of the North Amethyst field at Year 0 (Source: C-NLOPB)

The Proponent's current SeaRose FPSO and reservoir model facility constraints are set at the following levels:

- Oil Production Rate 19, 081 m^3/d
- Water Production Rate 28,000 m^3/d
- Total Fluid Production Rate 33,000 m^3/d
- Total Gas Production Rate 4.2 X 10^6 m^3/d
- Maximum Total Gas Lift Rate 1.6 X 10^6 m^3/d
- Peak Field Gas Injection Rate 3.7 x 10^6 m^3/d
- Peak Field Water Injection Rate 44,000 m^3/d

The Proponent has indicated in its completeness letter dated November 6, 2007 that sensitivities to these controllable constraints will be available in a report in the first quarter of 2008. Staff will follow up on this commitment by the Proponent, as these

sensitivities will help illustrate the impacts of the controllable parameters on estimated field recovery.

Overall, the Proponent's reservoir simulation models and the assumptions used are reasonable and appropriate.

Results of Reservoir Simulation

Oil

Reservoir simulation was used to predict the production forecast and performance of the North Amethyst Field for its base case. The Proponent's reservoir model has predicted that oil production will average 7500 m^3/day by the second year of production, but will then begin to decline (Figure 4.11). Maximum oil production is expected to range between 10,000 m^3/day and 12,000 m^3/d during the first three years of production. The simulation model considers production from both North Amethyst Field and South Avalon Pool under the constraints of the SeaRose FPSO facility. The resulting North Amethyst Field production profile reflects these factors.

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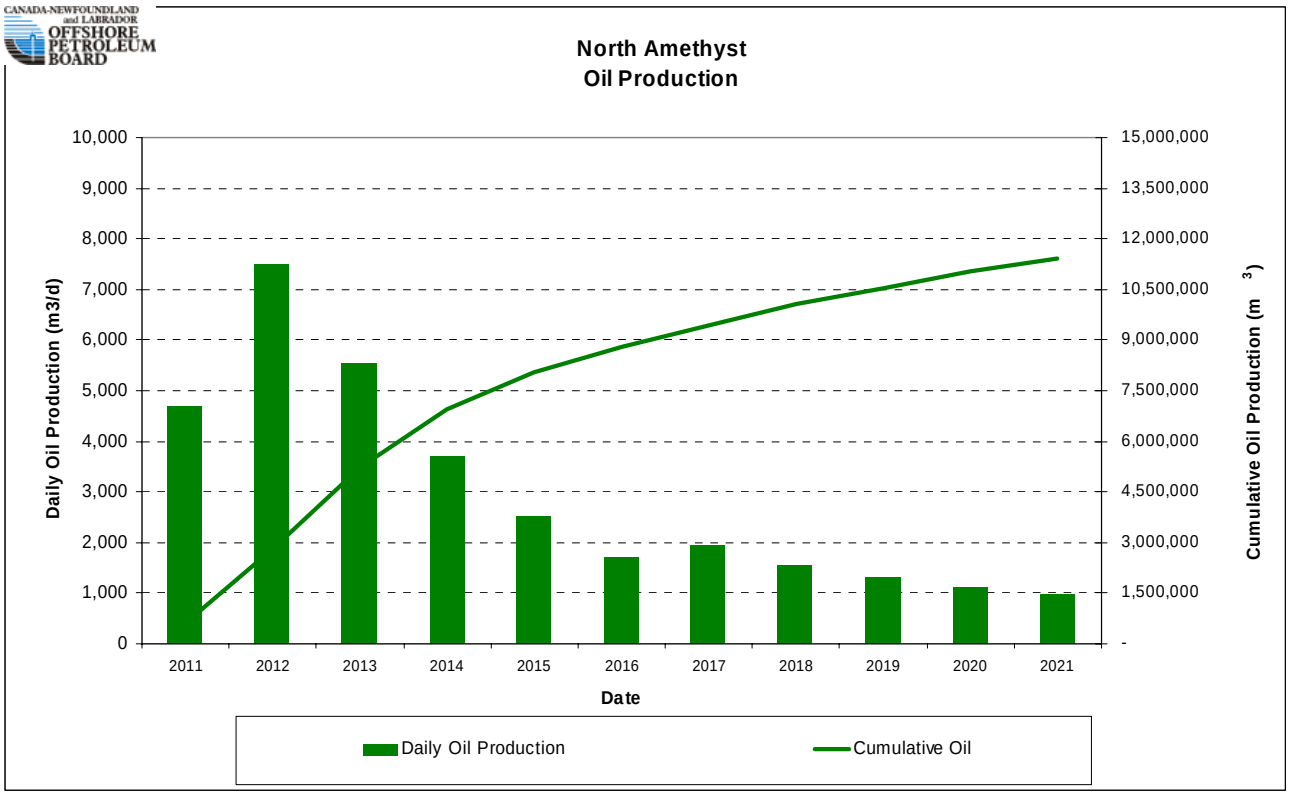

Figure 4.11: North Amethyst Oil Production Forecast (Yearly Average) (Source C-NLOPB)

Figure 4-12 shows the entire simulated oil production for the North Amethyst Field, which extends past the Proponent's suggested field abandonment in 2020. This simulation suggests that the North Amethyst reservoir could produce an additional 2.5 million m^3 at an average field production rate of 500 m^3/d for an additional ten years. However, the simulation does not take other factors, such as costs or other facility limitations, into consideration. Staff recognize that future opportunities could extend the life of the field beyond the Proponent's estimated cut off date of 2020 and will work with the Proponent to assess future opportunities as the field matures.

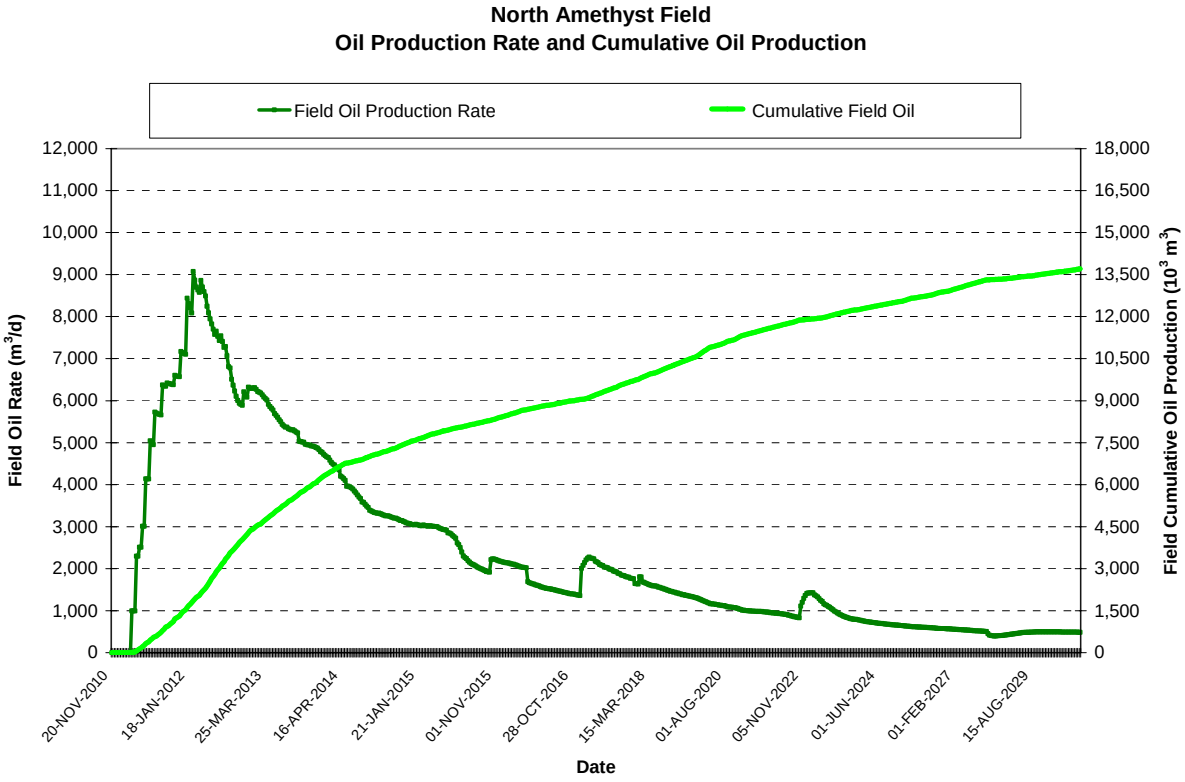

Figure 4.12: North Amethyst Simulation Model Oil Production Forecast (Daily Average Oil Rate) (Source C-NLOPB)

Gas

Figure 4.13 depicts the gas production profile from the Proponent's simulation model. This profile indicates that gas production will occur early in the life of the field, with the GOR reaching 600 m^3/m^3 within the first five years.

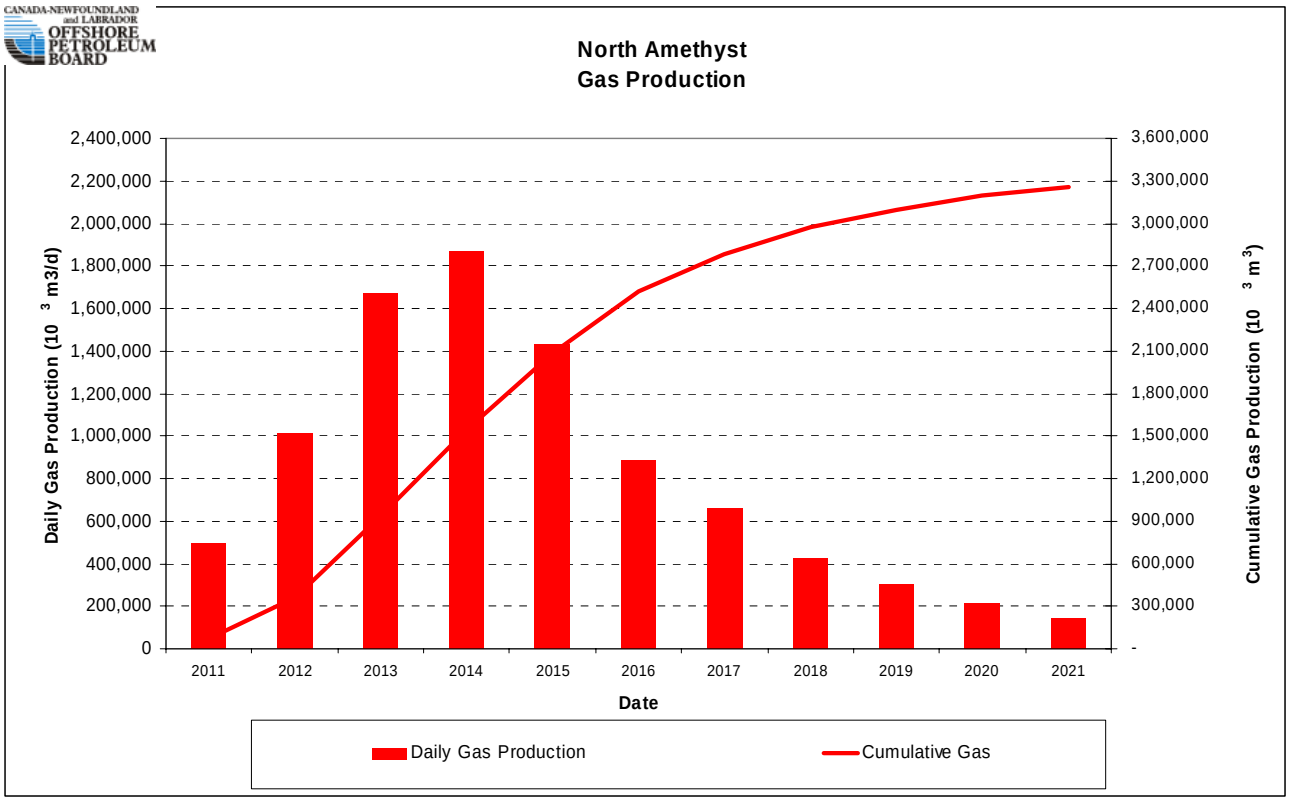

Figure 4.13: North Amethyst Gas Production Forecast (yearly Average) (Source:C-NLOPB)

Produced Water

The Proponent's simulated water production profile (Figure 4.14) indicates water production early in the life of the field and water cuts approaching 70% by the end of the first five years of production.

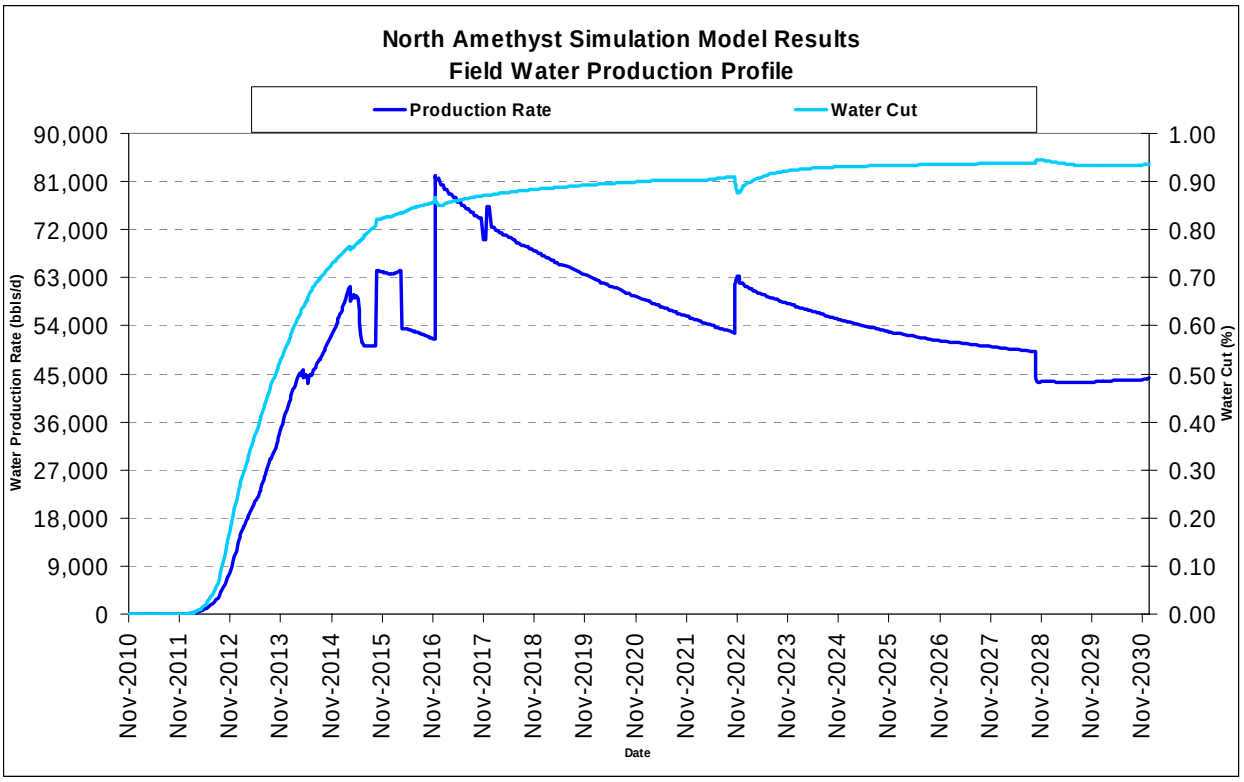

Figure 4.14: North Amethyst Simulation Model Water Production Forecast (Monthly Average) (Source: C-NLOPB)

The Proponent acknowledges the North Amethyst Field gas and water production profiles in the Application result from relatively high vertical sand continuity in the reservoir. The Proponent also recognizes that gas and water production will be a major issue in developing the North Amethyst Field, as gas and water are predicted to be produced more rapidly than in the South Avalon pool. Thus, the gas and water handling capacity of the SeaRose FPSO will play a significant role in the ultimate oil recovery for the North Amethyst Field.

A key consideration for the Board's staff is whether the current production facilities maximizes oil and gas recovery from the North Amethyst Field in accordance with sound economic and engineering principles. **Staff analysis concluded that the anticipated production related to approval of this Application can be handled by the current facilities except for storage of produced gas.**

4.4.5 Exploitation Scheme

The Proponent conducted several reservoir simulation runs to assess the exploitation options for the North Amethyst Field. The sensitivities examined by the Proponent include:

- Rate sensitivity for the entire North Amethyst and South Avalon pools at 120,000 bbls/d;
- Rate sensitivity for the entire North Amethyst and South Avalon pools at 140,000 bbls/d;
- Gas flood plan, and;
- Primary depletion only

The results of the Proponent's enhanced recovery simulations runs are shown in Table 4.5

Table 4-5: Comparison of Proponent's Exploitation simulation cases

Case	Ultimate Recovery at 2020 (million Sm^3)	Recovery Factor
North Amethyst Development Base Case Waterflood, Annualized production rate of 120,000 bbl/d	11.25	27.51%
Waterflood, Annualized production rate of 140,000 bbl/d	11.34	27.75%
Gasflood, Annualized production rate of 120,000 bbl/d	3.99	9.76%
Primary Recovery, North Amethyst Development Base Case	5.04	12.33%

Primary recovery, using only four oil producers, achieved 12% recovery, which is consistent with primary recovery in South Avalon oil pool.

A gas flood simulation model was also considered by the Proponent. However, gas injection increased the facility gas handling requirements due to earlier and more significant breakthrough volumes, and thus reduced the project ultimate oil recovery to 9.76%.

Staff also reviewed a water flood strategy for exploitation of the oil in the North Amethyst Field by the Proponent. Waterflooding has been an effective displacement strategy in the South Avalon pool, as well as other oil producing fields in the Jeanne d'Arc Basin. In implementing this strategy, oil movement into the gas cap (which could lead to a reduction in oil recovery) must be prevented by maintaining the gas-oil contact at its current elevation. This can be achieved through a reservoir management plan of voidage balance and avoidance of gas production from a gas cap.

Preliminary investigation of the Proponent's reservoir simulation model suggests that in some areas of the simulation model this is not the case. This may be due to voidage replacement rate applied in the simulation model or the drawdown on a particular oil producer. The Proponent has indicated further optimization of the primary producing wells is ongoing. Staff will require a report, prior to drilling of the first development well for North Amethyst, summarizing the optimization of voidage replacement and producing rate for the individual wells. The report will need to address minimizing oil movement into the North Amethyst field gas cap (which leads to a reduction in oil recovery)

The Proponent's water flood simulation shows that the ultimate oil recovery via water flooding achieved a recovery factor of approximately 27%. Sensitivities were run on full field (i.e. including South Avalon Pool) with the proposed North Amethyst base case of four oil producers and five water injectors. As noted by the Proponent, there is very little difference between the ultimate recovery for the 19,081 m3/d and the 22,261 m3/d simulation runs. Thus, the full field production oil rate above 19,081 m3/d has no effect on North Amethyst oil recovery.

Staff concur with Proponent's conclusion that gas injection is less suitable than water injection for the North Amethyst Field and that water flooding is the preferred exploitation mode.

Reservoir simulation is a valuable tool to assess exploitation options and provide input to estimating recovery efficiency. However, Staff is cognizant about solely using recovery efficiencies from simulation studies. It has been the Staff's view that the recovery efficiencies indicated from reservoir simulation studies may be optimistic. The technical experts use judgement and take all factors into consideration when assigning recovery efficiencies which include simulation, operations, reservoir management plan and analog reservoirs. The Proponent's base case involves a four oil producer and five water injector exploitation plan. However, the Proponent has indicated that the well templates and wellhead systems will have the expansion capacity within the glory hole to add 6 extra wells. This should allow for future changes in the exploitation plan in terms of more producers or injectors and the Proponent's ability to optimize the recovery efficiency.

Development Well Requirements

In the Application, the Proponent has determined that the horizontal well locations are placed midway between the gas oil contact and oil water contact. These wells were placed there to maximize oil recoveries while extending the time to when water and gas breakthrough will occur and thus minimize the potential for water coning and gas cusping.

By displacing the oil below the well via a bottom water flood (to reduce the risk of gas coning), this could potentially leave a significant volume of "attic" oil trapped above the well. While concurring with the Proponent's plan, staff note that the Proponent is required by the *Newfoundland Offshore Area Petroleum Production and Conservation*

Regulations to examine opportunities to exploit this resource prior to termination of oil production activities.

The Proponent states in Section 3.2.2 in the Application that "further optimization and well design work scope will be conducted and as such well counts and well plans may change." Staff will require a report, prior to drilling of the first development well for North Amethyst, summarizing the sensitivity of well counts and well location to ultimate oil recovery.

For the South Avalon pool, the Proponent provided a preliminary drilling sequence which described the objectives for each of the wells and how the information acquired will be utilized to assist in the decisions for subsequent wells before oil production. The Proponent has indicated it is working on such a report. Staff will require this work, prior to the drilling of the first development well for North Amethyst Field, summarizing the preliminary drilling sequence which describes the objectives for each of the wells and how the information acquired from the wells will be utilized to assist in decisions for subsequent wells. Staff will follow up with the Proponent on the timing of this report.

Because of the nature of the reservoir, there is a reliance on long reach horizontal wells to achieve and sustain reasonable oil production and water injection rates. **Staff believes that this is the right approach to development of the oil resources at North Amethyst**.

Alternative Oil Recovery Techniques

According to the Proponent, due to the initial reservoir pressure, reservoir temperature, large gas cap and underlying water leg, miscible flooding was not considered a viable option. Polymer flooding and other types of viscous floods are not considered viable due to the relative low permeability of the reservoir. The Proponent considers carbon dioxide,

compressed air or other gas injection options not viable because they would suffer from the same produced gas handling restrictions that reservoir gas re-injection would have, i.e. unreasonably large expensive gas compression facilities. These are relatively new and unproved technologies that do not have an historic offshore application. It is the Proponent's opinion that the alternative options would increase the development costs due to increased facilities requirements and increased operating costs as a result of adding another process stream to operations without increasing overall oil recovery.

Staff concurs with the Proponent's opinion concerning alternative recovery mechanisms. However, consistent with the requirement of the *Newfoundland Offshore Area Production and Conservation Regulations*, the Proponent must continue to evaluate miscible flood and other enhanced recovery schemes during production.

Field Hydraulics

The Proponent has conducted well flowing modelling for both flowing and gas lift scenarios in the reservoir simulation models. According to the Proponent's reservoir simulation the flowing well model suggest that oil rates between 2500 m^3/d and 3000 m^3/d are possible from horizontal wells completed with 177.8 mm tubing. All producers will be equipped with gas lift operating valves.

The maximum gas lift rate profile for the full field model is 1.6 x 10^6 m^3/d. Gas lift is estimated to commence in both the North Amethyst wells by 2014. It is expected to commence in South Avalon pool wells in 2008-2009. Figure 4.15 depicts the importance of gas lift for optimum oil recovery within the field. Approximately 23 % of the recoverable reserves of North Amethyst field are dependent on the gas lift capabilities of the SeaRose FPSO.

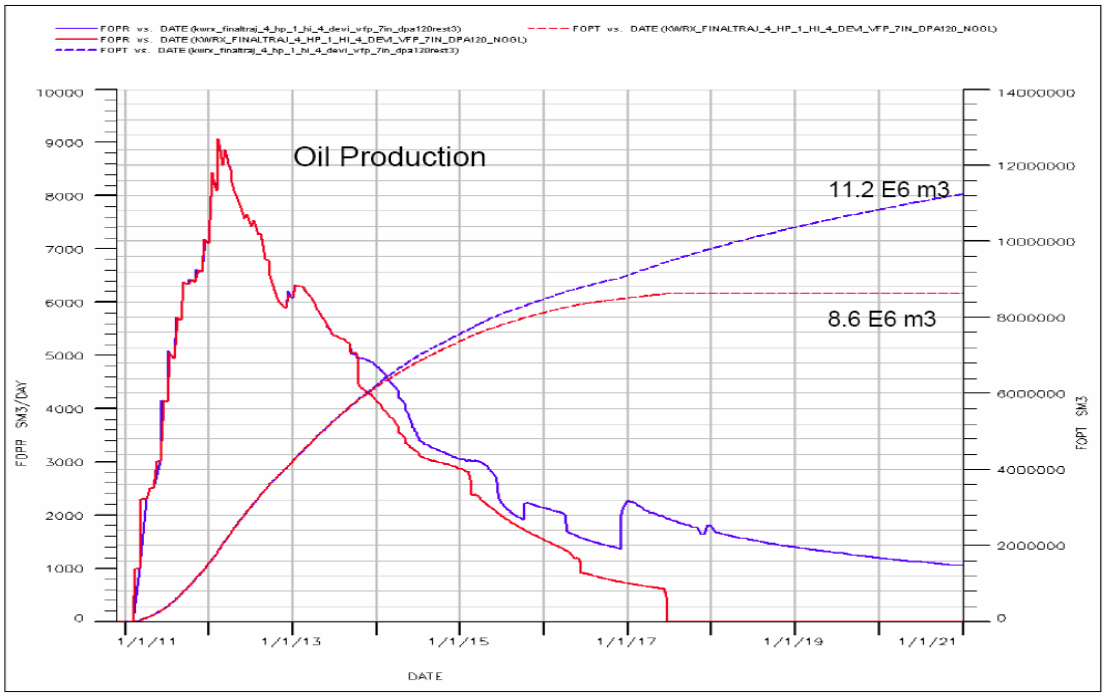

Figure 4.15: Oil Production from North Amethyst field with and without gas lift (Source: Husky)

Staff notes that the Proponent has not completed technical studies to optimize the field's hydraulic performance. These studies will assess flow performance from the reservoir to the process facilities and include an assessment of the effects of the current FPSO location on oil recovery. Staff will require submission of these studies prior to finalizing the design concept.

4.4.6 Production Forecast

Review of White Rose South Avalon Field Production

Production from the South Avalon pool began on November 17, 2005. As of January 2008, 18 wells have been drilled and completed (nine-water injection, two-gas injection and seven oil producers)

In September 2007, the Board approved an increase in the maximum daily production rates from 100,000 bopd to 140,000 bopd.

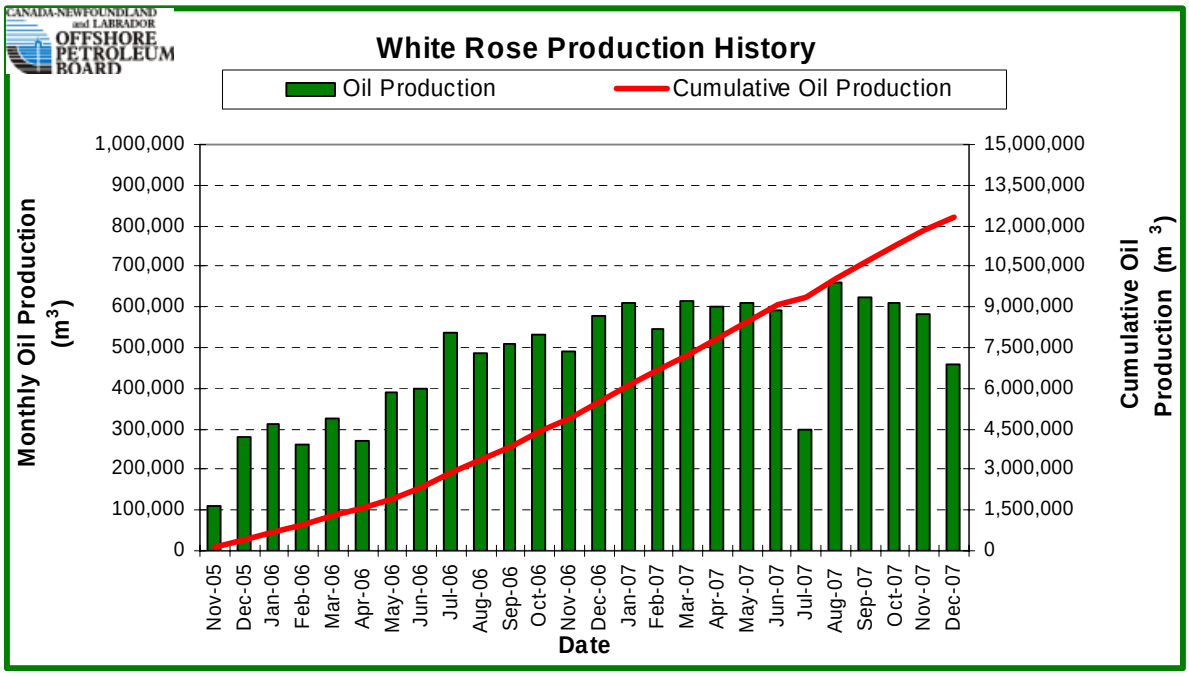

Figure 4.16: White Rose Field Oil Production (Source: C-NLOPB)

Cumulative production, as of January 1, 2008, was 12.29 million m^3 of oil, 1.67 billion m^3 of gas and 278,000 m^3 of water (Figure 4.16). The South Avalon pool production is currently at plateau, with initial water showing in 2007 (Table 4.6).

Table 4-6: South Avalon Pool Oil Production (Source: CNLOPB)

White Rose Total Production			
Year	**Oil (m^3)**	**Gas (10^3 m^3)**	**Water (m^3)**
2005	392,027	59,251	354
2006	5,095,773	69,1571	8,313
2007	6,806,954	924,122	269,163
Totals	**12,294,755**	**1,674,945**	**277,831**

Oil production at the South Avalon Pool is comparable to that predicted in reservoir model simulations (Figure 4.17). This forecast was updated with the approved oil production rate increase from 15,898 m^3/d to 22,258 m^3/d detailed in Decision 2007.01. However, as seen in the forecast, oil production from the South Avalon pool is expected to commence decline in 2008.

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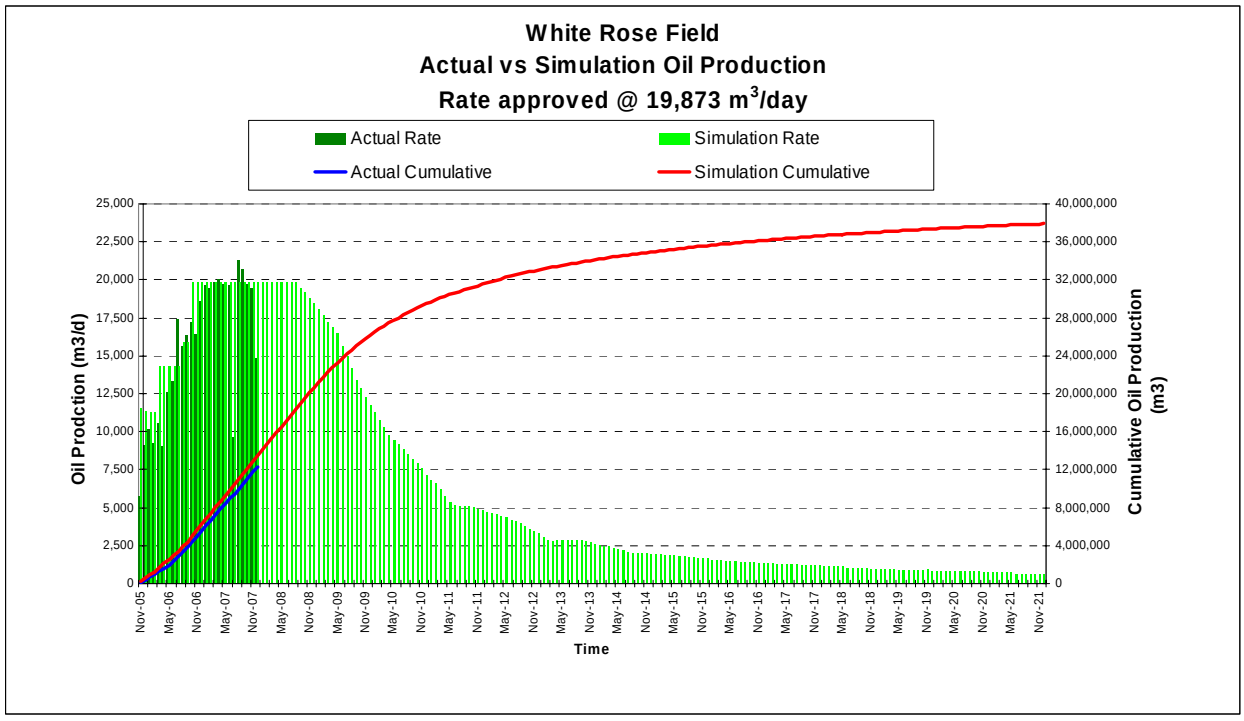

Figure 4.17: White Rose Field Actual vs Simulated Oil Production (Source: C-NLOPB)

A complete description of the performance of the South Avalon pool is included in Decision 2007.01 (Production Rate Increase).

Full Field White Rose Production Forecast

The Board's staff reviewed the full field oil production forecasts provided by the Proponent (Table 4.4). The Proponent's oil production forecast for the South Avalon pool

and North Amethyst Field is shown in Table 4.7. The South White Rose Extension, approved by the Board in 2007, is not included in this forecast.

Table 4-7: Combined North Amethyst and South Avalon Base Case Production Profile (Source: Husky)

Year	Annual Oil Production	
	South Avalon Sm^3	North Amethyst Sm^3
2005	390,392.6	0.0
2006	5,142,242.1	0.0
2007	6,639,840.0	0.0
2008	6,969,810.4	0.0
2009	5,810,110.8	0.0
2010	3,017,850.4	0.0
2011	2,885,512.8	1,530,554.0
2012	1,842,174.7	2,694,708.5
2013	1,256,805.4	2,001,060.7
2014	963,144.9	1,352,688.0
2015	771,245.9	905,849.0
2016	622,599.5	623,872.6
2017	417,918.2	704,404.1
2018	379,781.3	556,442.1
2019	345,213.1	469,202.6
2020	317,281.8	407,439.8
Total (Sm3):	**37,771,924**	**11,246,221**
Total (bbl):	**237,577,847**	**70,736,483**

It should be noted that the Proponent indicated in the Application that first oil from North Amethyst would occur in 2011. Subsequent to this, the Proponent has revised this first oil window to late 2009. Staff's review uses January 2010 as a potential first oil date. Staff felt that by moving the original forecast back one complete year it could still perform its assessment without asking the Proponent to re-submit the Application.

Figure 4.18 shows the full field White Rose oil production forecast. The addition of North Amethyst oil production, starting in 2010, will offset the decline by two years. Staff included oil production from the South White Rose Extension (SWRX), which is

expected to commence in 2012, in its production forecast. This addition reduces the rate of oil production decline for the full field once SWRX begins production.

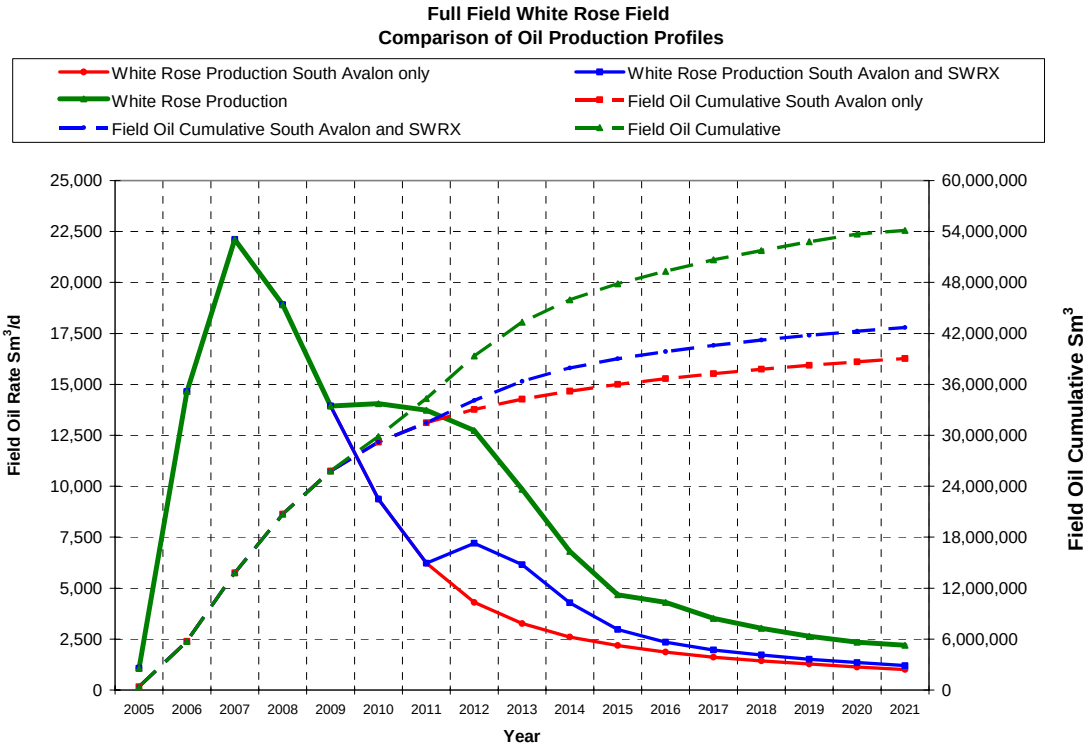

Figure 4.18: Full Field White Rose Oil Production Forecast, (South Avalon, SWRX and North Amethyst production) (Source: C-NLOPB)

According to the Proponent's simulation model, the oil production forecast is based on an operating efficiency of 85 percent, relative to a facility design rate of 22,258 m^3/d and recoverable oil reserves of 54.1 x 10^6 m^3. The Proponent's field abandonment life cut-off is 2020; however, Staff note that potential development of other oil resources such as the West and/or North pool could extend oil production life.

The Proponent's gas production forecast (Figure 4.19) reaches a maximum daily gas rate in 2008 of 4.2 x 10^6 m^3 /d, which is the SeaRose maximum facility gas compression capacity. For 2007, the average daily total gas production was 2.5 x 10^6 m^3 /d, increasing to 3.0 x 10^6 m^3 /d in the last four months. The most recent gas production is 75% of the maximum daily gas rate.

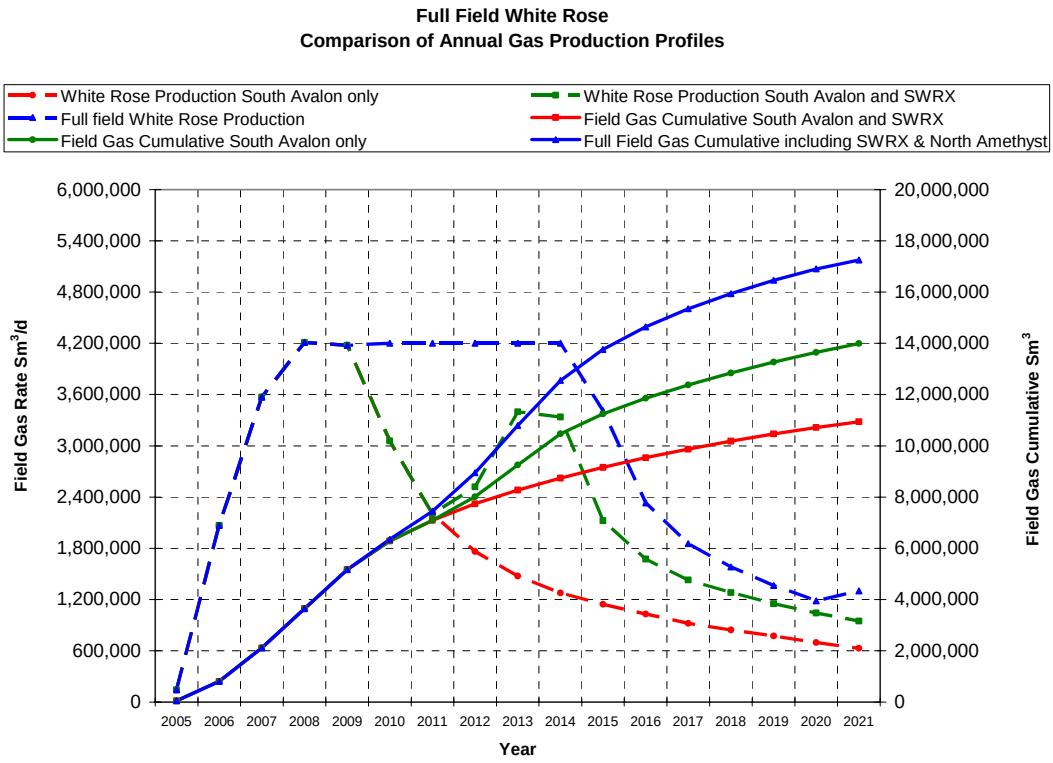

Figure 4.19: Full Field White Rose Gas Production Forecast, (South Avalon, SWRX and North Amethyst production) (Source: C-NLOPB)

The Proponent has shown in Figure 4.20 that the reason that gas compression capacity is maximized is due to the introduction of gas lift in 2010 which will be utilized by both North Amethyst and South Avalon wells.

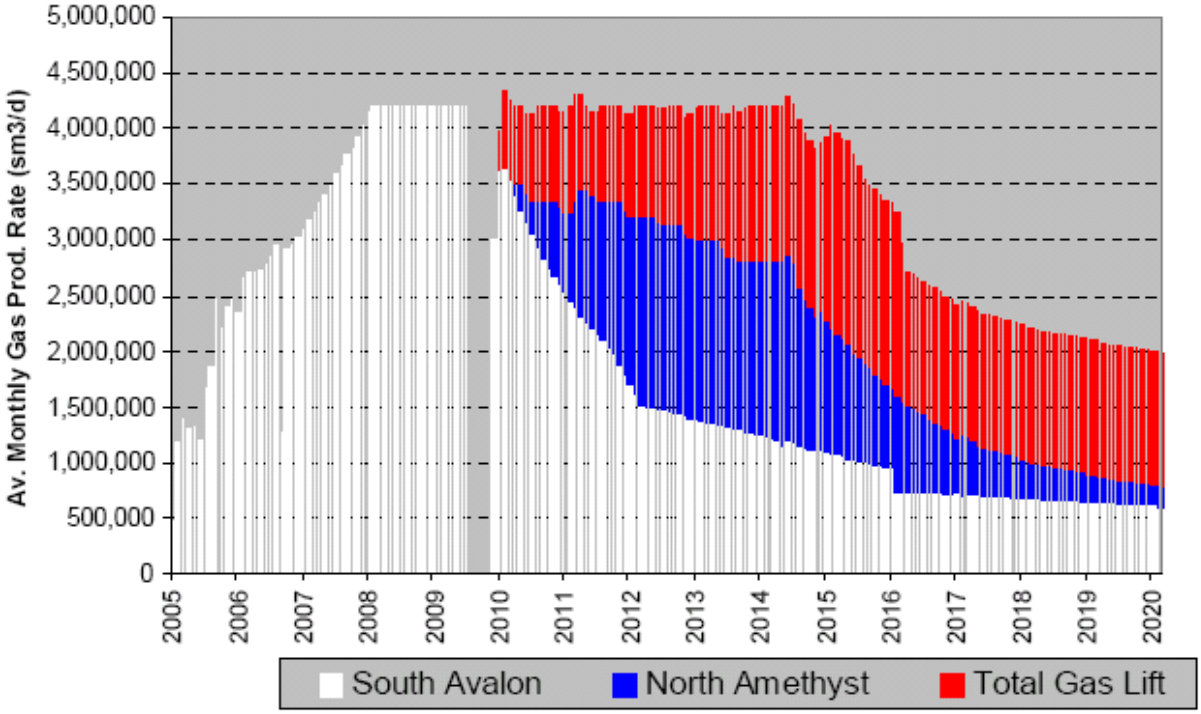

Figure 4.20 : Combined North Amethyst and South Avalon Average Monthly Gas Plot) (Source: Husky)

Staff note that gas production from the full field forecast will plateau for six years, due to North Amethyst Field performance exceeding a GOR of 600 Sm^3/m^3, before producing 20% of its original oil in place.

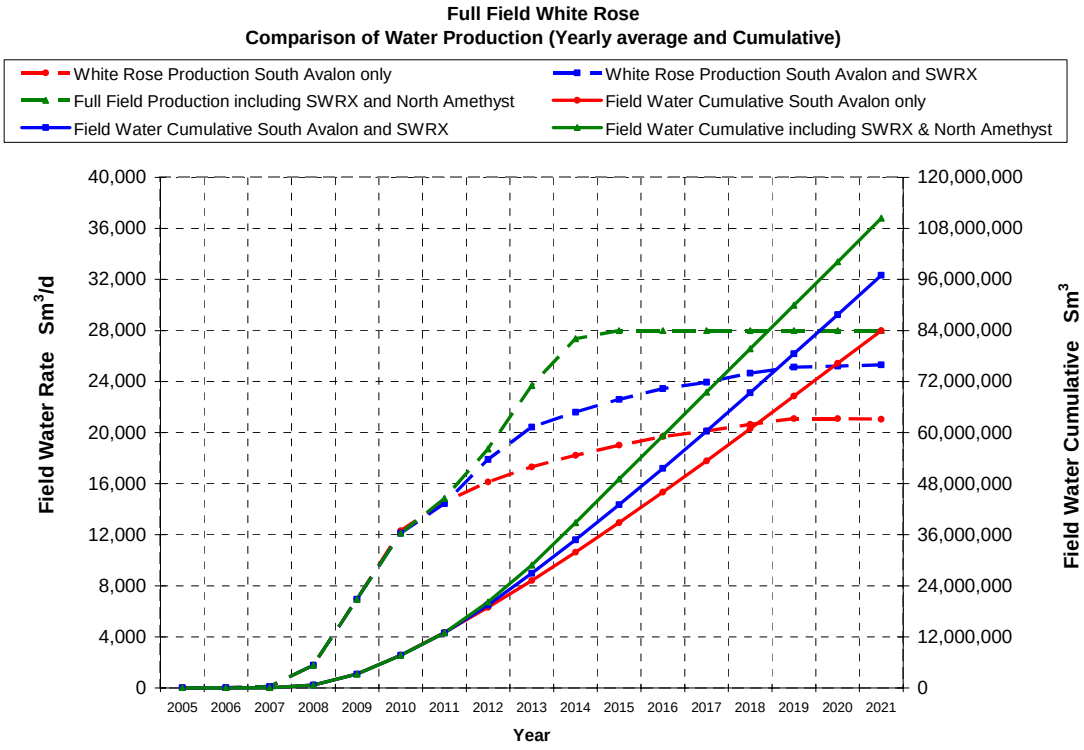

Figure 4.21: Full Field White Rose Water Production Forecast, (South Avalon, SWRX and North Amethyst production) (Source: C-NLOPB)

The Proponent's water production forecast reaches a maximum daily water rate of 28,000 m^3/d in 2014 (Figure 4.21). This rate will bring the facility to its maximum handling capacity earlier than predicted by the South Avalon water production forecast alone, and suggests that the full field water cut will be accelerated with the addition of North Amethyst production (Figure 4.22). However, Staff note that the Proponent has more time to address this issue as compared to gas handling capacity issue which is expected to occur shortly after North Amethyst Field oil production in 2010.

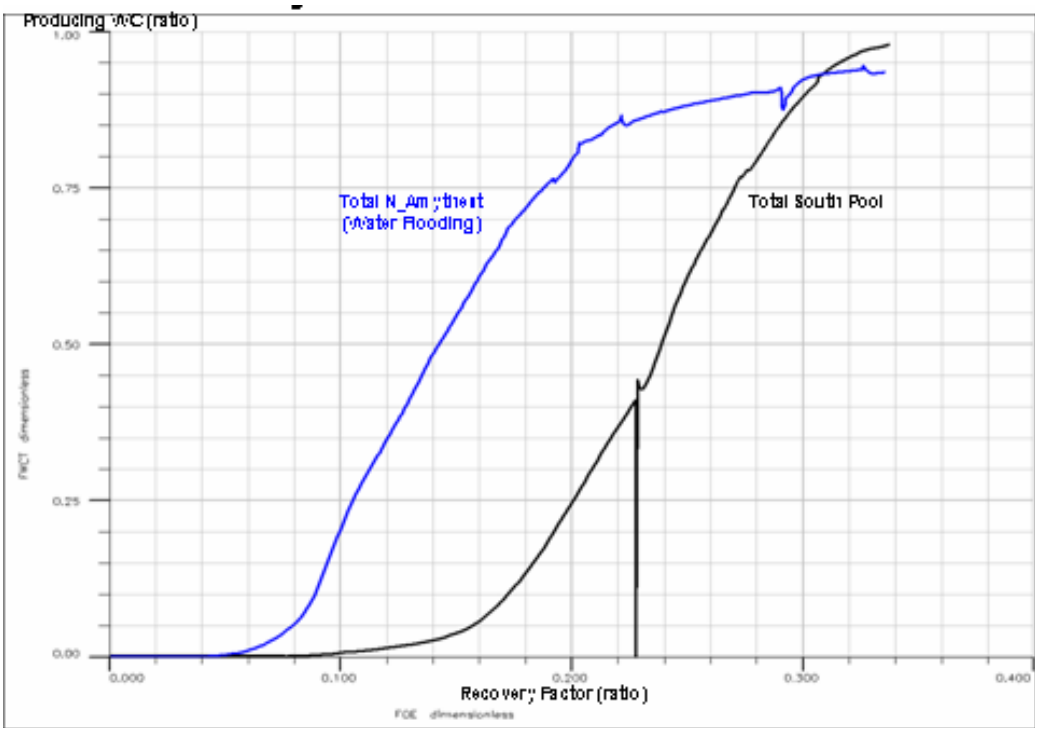

Figure 4.22: North Amethyst and South Avalon Base Case Watercut versus Recovery Factor)

The full-field water injection profile reaches a maximum between 2013 and 2015 at 44,000 m^3/d. During the peak years of North Amethyst oil production, the profile indicates a 90% capacity, which implies that there is extra capacity to ensure voidage replacement in the reservoir. The Proponent has a voidage management plan of 1.0 -1.2 to ensure that North Amethyst Field pressure remains above the bubble point pressure.

The total liquid production profile for the full field model reaches a maximum between 2014 and 2016, at 33,000 m^3/d. This profile also runs at 90% efficiency during the peak years of North Amethyst oil production.

Decision 2001.01 for the South Avalon pool notes that the most significant factor affecting oil recovery is the gas processing capacity and water handling capacity. As shown in Figures 4-14 and 4-15, it is evident that current facilities on the SeaRose will be fully utilized with the addition of North Amethyst production. This may pose a

restriction to oil production and the pace of development of other opportunities if the proposed depletion plan changes for the South Avalon Pool and North Amethyst Field. This circumstance is not unusual for offshore production facilities and the Proponent plans to deal with this issue by assessing the potential opportunities for de-bottlenecking of the facilities.

Staff concludes that the anticipated production related to approval of this Application can be handled by the current facilities. Nevertheless, the Staff has concerns with respect to the longer-term utilization of facilities in the context of ultimate oil recovery and other development opportunities. Staff is aware that the Proponent is planning to assess de-bottlenecking the SeaRose FPSO topsides to address this issue.

Condition 2

The Proponent provide to the Board, as soon as possible, ideally not later than commencement of detail design, a report assessing the potential opportunities for de-bottlenecking of the facilities to accommodate any restrictions to oil production and the pace of deferred development.

4.5 Project Economics

An independent consultant was engaged to:

- compare the alternative tie back modes of development for the North Amethyst Field (i.e. Greenfield Leased FPSO vs. existing SeaRose FPSO);
- assess the economics of North Amethyst oil development alone; and
- assess North Amethyst oil development on full field White Rose Project.

The consultant's assessment (See Appendix C) resulted in the following conclusions:

- the Greenfield mode is not commercially attractive when compared to using the existing FPSO;
- the tie-back model to the existing SeaRose FPSO offers good prospects for economic viability;
- the tie-back would likely result in full recovery of North Amethyst's recoverable reserves and generate substantial revenues for governments via the associated corporate income taxes and royalties.

These conclusions are robust with respect to various assumptions about future oil prices, probable levels of recoverable reserves in the field, and which tie-back option is ultimately adopted.

According to the consultant, the White Rose project, without any tie-backs, is likely to be quite successful in terms of profitability and public-sector revenues. However, as it nears the late stage of its oil production profile, if the price of oil is not sufficiently high, there is a chance that full recovery of reserves may not be achieved. The main positive impact of the North Amethyst tie-back on the White Rose development is that it enhances the prospects for continued operation of the SeaRose, which, in turn, makes it more likely that full recovery of the White Rose reserves will be realized.

Finally, if the South White Rose Extension pool is also developed as a tie-back to the SeaRose, as is planned, then it would increase with likelihood of full recovery of White Rose's reserves.

4.6 Deferred Development

Gas and Natural Gas Liquids Resources (NGL's)

In addition to the oil reserves, the gas and natural gas liquids resources (NGL) within the North Amethyst Field are additional resources for future development. Recent reserve/resource assessments conducted by the Staff estimate the potential recoverable gas resources to be 6.9 billion m^3 (245 bcf) at the North Amethyst Field. These estimates assume an original gas-in-place that includes solution gas and a gas cap.

The solution gas resource will be either stored, used as fuel or flared. Reservoir simulation indicates that 87% of this solution gas will be available for storage. The gas cap recovery is estimated to be 70%.

Table 4- 8: North Amethyst Gas Resources (Source: C-NLOPB)

	OGIP	Recovery Factor	Recoverable Gas
Gas Cap (BCF)	173	0.7	121.1
Gas Cap (BM^3)	4.9	0.7	3.4
Solution Gas (BCF)	142	0.87	123.5
Solution Gas (BM^3)	4	0.87	3.5
Total (BCF)	**315**		**244.6**
Total (BM^3)	**8.9**		**6.9**

Future exploitation of gas resources will extend the economic life of the White Rose Field and permit additional oil recovery (NGL's). The timing of gas availability at the White Rose Field for commercial purposes is dependent on economic and technological factors.

Staff has reviewed the Proponent's evaluation of NGL volumes at North Amethyst and concur with the estimate of 1.1 million m^3 (7.6 million barrels).

4.7 North Avalon Gas Resource and Storage Area

The gas produced at South Avalon pool (solution gas) is presently injected into the North Avalon pool through the J-22 1 and J-22 2 wells. The maximum storage approved in the North Avalon area for gas produced from the South Avalon pool is 5.5×10^9 Sm^3. The amount of gas expected to be produced from the South Avalon pool ranges from 3.7 – 6.0 x 10^9 Sm^3. With 3.2×10^9 Sm^3 gas expected to be produced from North Amethyst, the current approved North Avalon gas storage area contains insufficient volume to accommodate the predicted amounts produced gas from the North Amethyst Field. The Proponent is currently evaluating several options for storing excess gas.

These include storage in the gas cap:

- near the C-30 well in the West Pool (west of N-30 well);
- within the South Avalon pool; or,
- within the North Amethyst field.

The first option is preferred because of the existing gas cap near the C-30 well and the proximity to the existing glory hole and gas infrastructure in the North Avalon area. This glory hole has two available slots for additional gas injection wells. The other two options would require detailed analysis and amendment to the development plans in those respective areas.

Staff have reviewed the full field gas production forecast for the White Rose field and conclude that the Proponent's current gas storage plan is inadequate. The Proponent must

prepare a plan acceptable to the Board as stated in Condition #2. This plan should include drilling schedules and storage space requirements adequate to meet future gas production.

Summary of Deferred Development

Staff notes that no depletion plan has been presented for development of the West and North Avalon pool, Eastern Shoals and Hibernia oil resources and the White Rose field gas resources. The Proponent is required to submit an amendment to the development plan outlining its depletion plans should the Proponent elect to proceed with development of these resources.

Condition 3

The Proponent shall submit to the Board within two years following initiation of production from the North Amethyst Field an updated evaluation of the full field (White Rose and North Amethyst) gas resources along with a description of activities to be undertaken and a drilling schedule and locations for delineation or pre-development wells.

4.8 Commercialization of North Amethyst

Staff concurs with the proposed depletion scheme for the North Amethyst development area. However, it is important that the commercial agreements be in place and filed with the Board's Chief Conservation Officer, in order for the Board to discharge its duties and for prudent resource management.

In addition, the interests of the royalty owners must be considered as the licences may be subject to different royalty arrangements. Therefore, prior to permitting production from the North Amethyst development area, the Staff advise that the commercial agreements be filed with the Board along with royalty owners' concurrence with the agreements.

Staff advises that if the Board elects to approve the Application that it include as a condition of approval the following:

Condition 4:

Prior to initiation of production from the North Amethyst development area, the Proponent shall notify the Board's Chief Conservation Officer that the commercial agreements with interest owners of PL 1006, PL 1007 and PL1008 are in place and that the royalty owners concur with the commercial agreements.

4.9 Conclusion

The South Avalon field, reservoir water flood and gas injection at the North Avalon storage are in the initial stages of development, and are just reaching plateau. Sustaining current oil production rates from these South Avalon areas will become challenging as wells experience water and gas breakthrough. Development of the oil reserves in the North Amethyst development area will provide an opportunity to offset oil production decline and increase the likelihood that the South Avalon Pool oil reserves will be fully depleted. However, oil production will be challenged by the SeaRose FPSO gas and water handling capabilities. The Proponent's plan is adequate in terms of the development of the North Amethyst Field but does not address concerns of gas storage capacity for a full field life in the White Rose area. The Board staff require that the Proponent address this issue.

Staff acknowledges the range of reserve estimates presented by the Proponent for the North Amethyst Field and appreciate the uncertainty surrounding these estimates. However, as noted previously, the base case oil reserve estimate presented by the Proponent is conservative, as there are several opportunities that may further increase the

oil reserves. In addition, there is potential to produce the gas resources and natural gas liquid resources within the North Amethyst Field, which would further extend field life.

To ensure that additional plans to exploit these resources can be executed within the life of the production facility, assessments of development potential that identify well and facility requirements need to be conducted early. These assessments will assist in ensuring the maximum recovery of oil, gas and natural gas liquid resources.

Given the stage of production activity at the White Rose Field, a long term exploitation plan for the oil, natural gas and natural gas liquid resources needs to be developed**.** This is a complex issue which must be addressed in a timely manner. However, this assessment and exploitation plan will not be required prior to making a decision on this Application.

4.10 Recommendations

It is the recommendation of the Staff from a Resource Management perspective that the North Amethyst Development Plan be approved, subject to the proposed conditions established in this Analysis.

Condition 1:
The Proponent shall not initiate oil production from the North Amethyst Field until the Proponent submits and the Board approves a Gas Storage Strategy report.

Condition 2
The Proponent provide to the Board, as soon as possible, ideally not later than commencement of detail design, a report assessing the potential opportunities for de-bottlenecking of the facilities to accommodate any restrictions to oil production and the pace of deferred development.

Condition 3

The Proponent shall submit to the Board within two years following initiation of production from the North Amethyst Field an updated evaluation of the full field (White Rose and North Amethyst) gas resources along with a description of activities to be undertaken and a drilling schedule and locations for delineation or pre-development wells.

Condition 4:

Prior to initiation of production from the North Amethyst development area, the Proponent shall notify the Board's Chief Conservation Officer that the commercial agreements with interest owners of PL 1006, PL 1007 and PL1008 are in place and that the royalty owners concur with the commercial agreements.

5.0 Operations and Safety

The safety review of the Application focused on an assessment of the Proponent's conceptual plans for Option B to tie-back the North Amethyst project to the *SeaRose FPSO* via existing facilities in the southern drill centre.

The plan to develop this area by excavating a glory hole, tying in the production and water injection manifolds via subsea flowlines and a subsea electro-hydraulic control umbilical and drilling the development wells utilizing a semi-submersible drilling installation is consistent with the approach approved in the original development plan for the White Rose Development. In this regard, the Proponent is not planning to use any unconventional technology.

Consistent with this approach, the Proponent is planning to use a glory hole as the means of protecting the subsea templates, wellheads, production trees and manifolds against scouring icebergs. This is an acceptable methodology for subsea developments as approved in the original White Rose Development Plan. The Proponent designed the subsea system in the existing southern drill center with sufficient flexibility to accommodate the tie-in of new production centers. This allows North Amethyst to be tied back to the *SeaRose FPSO* via the southern drill center.

The SeaRose production system was designed to handle up to 33 subsea wells. The White Rose development contemplated 21 wells with 18 for the base case. The North Amethyst development contemplates 10 wells with seven wells for the base case. Therefore, the capacity of the Sea Rose production system will be reached with this development. Additional capacity would have to be added to develop other fields.

5.1 Concept Safety Analysis

The Proponent established seven criteria for the target levels of safety for the White Rose project. The Proponent used those White Rose targets for the North Amethyst development. The concept safety analysis (CSA) submission used the same approach and consultant as used for the White Rose development. The CSA submission includes discussion of risk from all potential tiebacks to the SeaRose: North Amethyst, South White Rose Extension and West White Rose extension. Overall risks for five different cases were studied:

1) Topsides modifications without tie backs.
2) Case 1 with south White Rose and West White Rose extensions tied back via White Rose drill centers.
3) Case (2) with North Amethyst tied back directly to FPSO.
4) Case (2) with west White Rose extension tied back directly to FPSO.
5) Case (1) with south White Rose extension tied back via White Rose drill center and North Amethyst and west White Rose extension tied back directly to FPSO.

All five cases satisfied the target levels of safety criteria. The five cases do not exactly represent the proposed North Amethyst development. However, the risk associated with the proposed North Amethyst development will be within the range of risks associated with the five cases evaluated and would be the same as the South White Rose extension. As detailed design progresses the quantified risk analysis (QRA) for an updated Safety Plan will represent the risks associated with the North Amethyst development.

The concept safety analysis made the following recommendations:

1) As the North Amethyst Project progresses, it is recommended that this safety assessment be updated to reflect any changes that may occur to the design. It is particularly important that assumptions made within this study are reviewed and updated to ensure that the conclusions drawn remain valid.
2) A review of the traffic management procedures at the White Rose Field should be undertaken by Husky to ensure that there are sufficient measures in place to protect the new subsea equipment, and any MODU working at the new Glory Holes, from vessels passing through the field.

3) A White Rose Field specific traffic survey should be undertaken to provide a better understanding of the vessels that may pass through the field. The results of this study should be used to develop a ship collision assessment that determines the collision risk to the FPSO as well as any MODU that may be operating in the field.
4) Husky should also review in more detail the potential for icebergs to cause damage or scouring of equipment in the new glory holes or flowlines. The review should also include the ice management procedures to ensure that the new equipment can be protected to a similar level as existing subsea equipment.
5) The project should review the impact on blowdown rates for the SDC production / test and gas lift lines as a result of the inclusion of the SWRX pool. Similarly, the impact of the WWRX pool on CDC flowlines should be considered. Any increase in the blowdown rates and time may affect the time taken to release the riser buoy via the QCDC system in the turret during a controlled disconnect operation.
6) The ESD shut down times for the new facilities should also be reviewed to ensure that the time to close valves is optimized and does not prolong the period of packing that may occur at the FPSO after the ESD valves have closed in the turret.
7) The potential for MODU mooring chains to damage the flowlines or umbilicals has previously been assessed by the White Rose project. However, the potential damage that drifting anchors could cause to the flowlines or umbilicals in the expanded field area has not been assessed in this report and should be reviewed to ensure that the potential frequency of damage is acceptable.

These recommendations must be dealt with by the Proponent as it moves from the FEED phase through the detailed engineering design phase. Staff will confirm that each of these matters are addressed and closed out by the Proponent in due course. As part of this process, the Proponent will be required to keep the Board's Chief Safety Officer updated on the progress of these matters as the design phase proceeds. The Proponent will also be required to keep Staff informed of the detailed schedule for the project, including a schedule for any ongoing or future safety studies.

5.2 Design

The Proponent has prepared a North Amethyst project execution plan that references the regulations, codes and standards for the project. The references reflect the engineering, design practice used for the White Rose development, and represent the latest revision of the documents. Requirements for each piece of equipment are included in the project execution plan. The certifying authority for the project will review the detailed design. The Proponent proposes to maximize standardization of equipment for the project.

5.3 Construction and Commissioning

The Proponent excavated a glory hole for the North Amethyst Project in 2007 to accommodate up to sixteen wells. Safety risks to personnel will arise during the remaining construction and installation phases of the development, including the drilling program, the subsea flowline installation program, the diving program to tie in the flowlines to the manifolds in the glory holes and the modifications to the topsides. The Proponent will use the existing management of change process for the modifications on the SeaRose. The Board's Safety staff will perform a safety assessment of each of these programs. The safety assessment examines the adequacy of the Proponent's safety plan for each proposed activity to confirm that the Proponent has identified and adequately addressed all safety hazards. The safety standards for the proposed construction and installation activities are based on experience with similar previous programs. In particular, the C-NLOPB will require the Proponent to address the simultaneous operations issues associated with tie-in activities in the southern drill centre. Otherwise, the construction activities associated with the proposed North Amethyst development do not raise any new safety concerns from the Staff's perspective particularly as the Proponent has demonstrated the ability to execute successfully such programs in the past.

In addition, some minor modifications are required in the topsides to accommodate North Amethyst development. The Master Control Centre and the subsea simulator will be expanded to accommodate the North Amethyst wells. The capacities of the methanol and chemical injection systems and subsea electrical power and hydraulic power units are under review to determine whether any modifications will be required.

The certifying authority for the project will review and survey the fabrication, installation and commissioning of the subsea templates, flowlines, umbilicals, expansion of the master control system, and modifications, if any to the methanol and chemical injection systems, and subsea electrical power and hydraulic power units.

5.4 Operations

The safety plan will require amendment to incorporate the North Amethyst development. The Proponent proposes to use the same practices and principles that it used for the development and operation of the White Rose Field. The existing White Rose documentation will be used for the North Amethyst development with amendments, if needed, to the documents. The current set of documents was effective for the development and operation of the White Rose field. The Proponent's ice management plan will need to be amended in due course to expand the ice management zone around the *SeaRose FPSO* to include the facilities in the North Amethyst glory hole. All operational changes of this nature including any necessary updates to the SeaRose Safety Plan must be effected in accordance with the Proponent's management of change process.

The operations and maintenance procedures will be modified to include the equipment associated with the North Amethyst development. The Certifying Authority approved the inspection and monitoring, the maintenance and the weight control programs for the

White Rose project. Amendments to the programs to include North Amethyst development will require Certifying Authority approval.

The seafloor footprint of North Amethyst facilities falls outside the safety zone for the White Rose field. On November 21, 2007, the Proponent applied for a change to expand the current White Rose safety zone in appropriate nautical charts and Notices to Mariners. This application is being processed.

5.5 Decommissioning

The North Amethyst facilities will be designed to minimize the risk to persons and the environment when the field reaches the end of its useful life. As the field nears the end of its useful life, studies will be conducted to determine the best option for disposal of the facilities.

5.6 Conclusions and Recommendations

No safety concerns were identified which would preclude Staff from recommending approval of the Application. Activities in connection with this Application can be managed in accordance with established safety processes and procedures.
Staff will ensure that the following matters will be followed up with the Proponent in due course as the project proceeds:

1) When the project advances to the detailed engineering design phase, the Proponent must advise the Chief Safety Officer of the manner in which the recommendations arising from the Atkin's "SeaRose Tieback Project Concept Safety Assessment" report have been addressed.
2) The scope of work of the Certifying Authority in respect of the White Rose project must be amended to include a review of any new subsea systems and flowlines to

be installed as well as any modifications either to the SeaRose FPSO or to the existing subsea systems.

3) The Proponent must provide, within 120 days of commencing detailed engineering design, a summary of any upgrades that may be required to the SeaRose FPSO or existing subsea systems as well as a summary of the new subsea equipment to be added as part of the expansion. The Proponent's plans for testing and integrating these modifications into existing systems and procedures should be described together with the Proponent's plans for training personnel in respect of any new systems or upgrades.
4) When the project proceeds to the detailed engineering design phase, the Proponent must keep the Board Staff informed of the detailed schedule for the project, including a schedule for any ongoing or future safety studies.

As a matter of course, updates to the SeaRose Safety Plan to reflect the North Amethyst Development must be submitted to the Chief Safety Officer for approval. The QRA which is amended to include the actual North Amethyst development must be submitted to C-NLOPB. Any necessary changes to the ice management plan and any other operational updates to existing plans, processes and procedures must be made by the Proponent in accordance with its management of change process.

6.0 Protection of the Environment

Environmental Assessment

Staff reviewed the Application to determine whether it raised any environmental concerns that were not previously assessed in the White Rose Comprehensive Study Report (CSR)[1] or in Decision 2001.01[2]. It was determined that the proposed construction of a new drill centre with a capacity of up to 16 wells, installation of subsea equipment, and tie-back to the SeaRose FPSO are outside the scope of project assessed in the White Rose Comprehensive Study Report.

The C-NLOPB determined that an environmental assessment pursuant to the *Canadian Environmental Assessment Act*[3] (CEA Act) was required. Activities proposed by the Proponent in the Application constitute a Project under the CEA Act. In addition, these activities are listed under the Inclusion List Regulations[4], and therefore require that a Screening Level of assessment (Screening) be undertaken. The Board is a Responsible Authority (RA) under the CEA Act. Department of Fisheries and Oceans (DFO) and Environment Canada (EC) are also RAs in the Screening for the issuance of an authorization for the harmful alteration, disruption and destruction of fish habitat and the issuance of an ocean disposal permit for the construction of the drill centres respectively.

In fulfillment of the requirements of the CEA Act EA process, the Proponent submitted a project description[5] for the North Amethyst Development on January 13, 2006. The project description included a description of all project activities associated with the construction, installation, operation, modification, and abandonment of the proposed NA

[1] Husky Oil Operations Limited. "*White Rose Comprehensive Study Report*". (2001). 94 p.
[2] C-NLOPB. *Decision 2001.01 Application for Approval White Rose Canada-Newfoundland Benefits Plan; White Rose Development Plan*. (2001). 185 p.
[3] 1992, c. 37
[4] Sections 2, 19.1 - SOR/94-637
[5] Husky Energy. *White Rose Development Project New Drill Centre and Construction Operations Program: Project Description.* (2006).

Development. In consideration of potential additional development activities at or near the White Rose Field, the project description included the construction and operations program for an additional three drill centres, the drilling of up to 38 additional wells, and sub-sea installations with tieback to the FPSO. Although the construction and operational activities associated with these additional drill centres were considered in the environmental assessment under the CEA Act, they are not included in the Application and Staff are not considering these additional activities as part of the present review. Any construction or operations arising from these additional drill centres will require separate approvals from the Board.

The C-NLOPB, DFO and EC (RAs) commenced a Screening for the project on January 31, 2006. The RAs prepared a scoping document[6] that outlines the scope of the project, scope of assessment and factors to be included in the assessment. In fulfillment of the requirements of the Scoping Document, the Proponent submitted an environmental assessment (EA) report[7] to the C-NLOPB on September 6, 2006. The EA report provided an environmental assessment of the construction and operation of four drill centres, installation of sub-sea equipment and tieback to the SeaRose FPSO, and the drilling of up to 30 wells. Staff, and federal and provincial departments with expertise in environmental and fisheries management provided comment on the report. In addition, the EA report was available on the Board's web-based environmental assessment registry for the public to view and provide comment. The Fish, Food and Allied Workers Union and One Ocean submitted comments.

Subsequent to the submission of the EA report, the Proponent informed the Board that it was intending to modify the project description to include an additional drill centre. In

[6] White Rose Drill Centre Construction/Operation Program Scoping Document. March 28, 2006. C-NLOPB
[7] Husky White Rose Development Project: New Drill Centre Construction and Operation Program Environmental Assessment. LGL. 2006.

order to address the project changes the Proponent submitted an addendum to the EA report[8] (Addendum). The Addendum provided for an environmental assessment of the construction and operation of up to five drill centres, with sub-sea tie back to the SeaRose FPSO, and the drilling of up to 54 wells. The report was made available on the Board's web-based environmental assessment registry. Comments were received from DFO, EC and One Ocean.

During preparation of its EA report, the Proponent consulted with the FFAWU, One Ocean, commercial fish processors, DFO, EC and non-governmental organizations regarding the proposed project activities. The EA report summarizes these consultation sessions and reports on comments and issues raised. Documentation associated with the Screening was also posted on the Board's Environmental Assessment Public Registry website, providing members of the public to provide comment at anytime in the Screening process. There were no comments received from the public.

Comments received throughout the EA review process were forwarded to the Proponent for response and comment. The Proponent's responses were satisfactory and the RAs were able to complete the Screening process.

The EA report and Addendum provided an acceptable assessment of the environmental interactions of the activities associated with North Amethyst. DFO, EC and the C-NLOPB completed a Screening Report for the environmental assessment. The report concluded that, with the application of mitigation measures, the implementation of a Follow-up Program and adherence to C-NLOPB guidance material, significant adverse environmental affects associated with the project are not likely.

[8] Husky White Rose Development Project: New Drill Centre Construction and Operation Program Environmental Assessment Addendum. LGL. 2007

The Proponent will be required to implement a follow-up program, pursuant to the CEA Act. It will be required to undertake a monitoring program of the dredged spoils disposal area, and will be required to amend the White Rose environmental effects monitoring (EEM) program to include monitoring of drilling and production discharges associated with operations at North Amethyst. The amended EEM plan should be consistent with the strategy in the existing White Rose Development EEM Design Report, discuss any changes that may be required to existing sampling stations, and consider the necessity for collection of baseline data at the new drill centre location.

Environmental Protection Planning for Drilling and Production Operations

Staff also reviewed the Application in consideration of environmental protection planning for operations associated with North Amethyst.

Environmental protection plans (EPPs) currently exist for production operations on the White Rose field using the SeaRose FPSO, and for drilling operations using the MODU GSF Grand Banks. The Proponent indicated that prior to the commencement of drilling operations at North Amethyst, these EPPs will be reviewed to determine if any updates or revisions are required. Staff expects the Proponent to submit the results of this review, and any necessary amendments to its drilling EPP, its production EPP or both, prior to undertaking North Amethyst drilling and production operations respectively.

The August 2002 *Offshore Waste Treatment Guidelines* state that operators of development drilling and production installations should examine, in their application documents, the feasibility of alternatives to marine discharge of synthetic-based drill cuttings and produced water respectively. The Application did not address these issues. Staff requested that the Proponent address both topics in consideration of the original White Rose application and *Decision 2001.01*. The Proponent indicated that it is currently undertaking a feasibility analysis of produced water re-injection pursuant to

Condition 37(ii) of *Decision 2001.01*. It also indicated that its conclusion that cuttings re-injection was not feasible for the White Rose project was unchanged in light of the Application. Staff accepts the Proponent's conclusion regarding cuttings re-injection, and will ensure that the Proponent's feasibility analysis of produced water re-injection also considers production activities associated with North Amethyst.

The *Newfoundland Offshore Petroleum Installations Regulations* require, at paragraph 43(3), that a concept safety analysis submitted at the time of application for development plan approval define "target levels of safety for the risk to life and the risk of damage to the environment associated with all activities within each phase of the life of the production installation". However, the *SeaRose Tieback Project Concept Safety Assessment, August 2007* that forms part of the Application states (Page 12) that

> **The risks to the environment from the White Rose Extension Developments have not been considered in this report. Since the White Rose Development Application was submitted, Husky has determined that environmental risk is more appropriately defined through a qualitative, rather than quantitative, assessment. The qualitative assessment provides a number of environmental objectives and provides protection measures to ensure these objectives are met.**

Staff are not currently persuaded that the Proponent's stated approach to definition of environmental risk is appropriate, particularly since its environmental assessment report describes a number of potential environmental risks in quantitative terms. This matter will be followed up with the Proponent as the review of potential modifications to the Proponent's environmental protection plan progresses.

Conclusion

No environmental concerns were identified that would preclude Staff from recommending approval of the Application. Staff recommends that the Application be approved subject to the following condition:

The Proponent, prior to commencing drilling operations at the North Amethyst drill centre, shall submit for the approval of the Chief Conservation Officer an amended Environmental Effects Monitoring program design.

7.0 Socio-Economic Impact Statement

A Socio-Economic Impact Statement (SEIS) was submitted as part of the original White Rose Development Plan. Staff informed the Proponent to update this plan in the context of the North Amethyst Field development.

The Proponent's North Amethyst SEIS is composed of four main sections.

The first deals with a review of the socio-economic impacts that were realized as a result of the development of the White Rose Field, which is the most recent field to have been development in the offshore area. Those impacts are discussed according to the following categories:

- business and employment impacts
- impacts on community social infrastructure and services
- education
- health and community services and infrastructure
- income support and employment services
- security and safety: policing and fire protection
- recreation
- impacts on community physical infrastructure
- housing
- ports and airports
- industrial and commercial land, warehousing and office space.

The second main section provides an overview of the current circumstances in Newfoundland and Labrador. It provides an update on the economic and demographic

situation and then discusses other aspects of the province's circumstances where that discussion is organized according to the same categories used for the review of White Rose project's impacts. Each is addressed for the province as whole and then separately for the three geographic areas that are expected to be most affected. Those regions are: the St. John's area, the Isthmus of Avalon area, and the Marystown area.

The third main component of the SEIS is an assessment of the impacts of North Amethyst. Anticipated impacts are described for each of the same categories as used in the discussion of White Rose project's impacts. That is also done for the entire province as well as each of three regions mentioned above. The assessments are articulated in qualitative terms rather than quantitatively.

The fourth substantive section of the SEIS document deals the Proponent's approach to sustainable development. This is done in the broad context of offshore development and is not limited to the proposed North Amethyst development project. It summarizes the Proponent's approach to environmental concerns as well as that corporation's tactics for ensuring benefits to the community through employment and business opportunities, including skills development and R&D support. Also, it highlights how Husky supports community activities.

The Proponent's overall conclusion is that the North Amethyst development will have positive economic impacts, will have no significant adverse social impacts, and will not cause any bottlenecks for existing physical infrastructure. The economic impacts, however, will be small relative to those of previous offshore developments, i.e., Hibernia, Terra Nova, and White Rose. That simply reflects the fact that the North Amethyst tie-back is a much smaller project involving a much smaller oil field. In fact, it is that small size that also provides the basis for concluding that there will be no significant adverse social and community impacts.

Those conclusions remain the same even if the modifications to the SeaRose had proceeded. The economic impacts would have been increased due to the short-term work associated with those modifications to the extent that the work may be done within Newfoundland and Labrador. Still, those impacts, while positive, would have been small in comparison to those associated with the previous, much larger, offshore developments.

The rationale behind the SEIS's conclusions may be summarized as follows. First, its review of the White Rose project's socio-economic impacts concluded that this project has generated and continues to positive economic benefits for the province, with significant impacts in the regions where development activity took place. The review of the White Rose development impacts also concluded that the effects that were identified as potentially adverse turned out to be minor and not significant. For instance, there was no significant increase in crime, housing shortages were localized and were not long-lasting, and there was no apparent excess demand on public services. Secondly, Husky points out that the scale of the North Amethyst tie-back development is quite modest relative to prior developments, including White Rose. Thus, the logic is that since the White Rose development had no significant adverse effects and the North Amethyst development is much smaller; then there is therefore even less chance that North Amethyst, by itself, could have negative community or infrastructure effects.

Over the years since the Hibernia development first began, the level of oil-related skills and work experience have been increasing in Newfoundland and Labrador, and local businesses have gained more expertise in servicing and supporting the oil sector. In addition, workers have gained experience through oil-related work in other parts of the world, notably Alberta. Also, the communities that were affected by the Hibernia and the other two offshore developments were able to cope effectively with the consequent demands on their public services and community infrastructure. As well, since the Hibernia development there have been some infrastructure improvements, such as airport expansion. Thus, as a general proposition one can argue that Newfoundland and

Labrador has more capacity now to capture gains from offshore projects than in the past. At the same time, through the experience of having had three successful offshore developments, it is now better able to address any related pressures on public services and public infrastructure.

Turning specifically to the North Amethyst project, its small size is such that, as the Proponent's SEIS suggests, it is very unlikely to generate any negative social impacts or cause problematic demands on local infrastructure or public services. At the same time, it would be a positive addition to economic activity within the province.

In light of these considerations, the qualitative conclusions of the Proponent's SEIS seem reasonable.

Appendix A: Glossary

bbls (Barrels)
1 bbl = 0.15898 m^3

BNA
Ben Nevis and Avalon

BOARD
The Canada-Newfoundland and Labrador Offshore Petroleum Board

C-NLOPB
Canada-Newfoundland and Labrador Offshore Petroleum Board

Completion
The activities necessary to prepare a well for the production of oil and gas or injection of a fluid.

Delineation well
Well drilled to determine the extent of a reservoir.

Development well
Well drilled for the purpose of production or observation or for the injection or disposal of fluid into or from a petroleum accumulation.

ESD
Emergency shutdown system

Fault
In the geological sense, a break in the continuity of rock types.

FEED
Front end engineering and design.

Flooding
The injection of water or gas into or adjacent to, a productive formation or reservoir to increase oil recovery.

Injection
The process of pumping gas or water into an oil-producing reservoir to provide a driving mechanism for increased oil production.

Logging
A systematic recording of data from the driller's log, mud log, electrical well log, or radioactivity log.

mmbbls
Million barrels of oil

MODU
Mobile offshore drilling unit

m^3
1 m^3 = 6.2898 bbls

OGIP
Original gas in place

OOIP
Original oil in place

Petrel
Geologic modelling software. Trademark of Schlumberger product group.

Petrophysics
The science and application of measuring borehole rock properties and establishing relationships between these properties

Pool
A natural underground reservoir containing or appearing to contain an accumulation of petroleum that is separated or appears to be separated from any such other accumulation

Produced water
Water associated with oil and gas reservoirs that is produced along with the oil and gas.

Production platform
An offshore structure equipped to produce and process oil and gas.

Production well
A well drilled and completed for the purpose of producing crude oil or natural gas.

Proven Reserves
Hydrocarbons that have been confirmed by drilling and testing or where sufficient geological and geophysical data exist to project the existence of hydrocarbons in adjacent fault blocks. A high confidence level is placed on recovery of these hydrocarbons.

Probable Reserves

Hydrocarbons that are projected to exist in fault blocks adjacent to those that have been tested by wells and into which the geologic trends may extend. Also, where fluid contacts have not been defined within the area drilled, these contacts may reasonably be projected to exist. However, additional drilling is required to substantiate the existence of hydrocarbons. These hydrocarbons may reasonably be expected to be recovered under normal operating conditions yet have a degree of risk, either geologic or reservoir performance related, associated with their exploitation.

QCDC

Quick connect/disconnect

Reserves
The volumes of hydrocarbons proven by drilling, testing and interpretation of geological,geophysical and engineering data, that are considered to be recoverable using current technology and under present and anticipated economic conditions. Hibernia,TerraNova, and Whiterose are classified as reserves.

Reservoir
A porous, permeable rock formation in which hydrocarbons have accumulated.

Reservoir pressure
The pressure of fluids in a reservoir.

Sandstone
A compacted sedimentary rock composed of detrital grains of sand size.

SCAL
Special Core Analysis

Seismic
Pertaining to or characteristic of earth vibration. Also, process whereby information regarding subsurface geological structures may be deduced from sound signals transmitted through the earth.

Appendix B: North Amethyst Satellite Tie-back Socio-economic Impact Statement

Appendix C: The North Amethyst Development Plan: An Economic Assessment