STAFF ANALYSIS
OF THE
WHITE ROSE DEVELOPMENT PLAN
AMENDMENT APPLICATION

WEST WHITE ROSE PILOT SCHEME

2010-06-24

ISBN *978-1-897101-84-1*

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1.0 Purpose

The purpose of this Staff Analysis is to provide the Board with the staff's assessment of Husky Oil Operations Limited (Proponent) White Rose Development Plan Amendment for the West White Rose Pilot Scheme. The staff's analysis considered safety, environment, resource management and industrial benefits aspects of the Application.

2.0 EXECUTIVE SUMMARY

On November 3, 2009, the Proponent submitted to the Canada-Newfoundland and Labrador Offshore Petroleum Board (Board) on behalf of its partners Suncor Energy and Nalcor Energy-Oil and Gas the following document – "White Rose Development Plan Amendment – West White Rose – Pilot Scheme (October 2009)".

The proposed pilot scheme is an amendment to the existing White Rose Development Plan (Decision 2001.01). The objective of the pilot scheme is to obtain additional information on the West White Rose pool and to provide an assessment of whether full development of this pool is feasible. The Proponent is proposing that the pilot scheme consists of two wells – an oil producer and a water injector over a two-year period. These wells will be drilled from the existing White Rose Central Drill Centre (CDC) on Production License 1006. The capital cost estimates for the West White Rose pilot scheme total $250 million (Cdn) consisting of $130 million (Cdn) for drilling and completions and a $120 million (Cdn) for subsea infrastructure. The Proponent, depending upon the results of the pilot scheme, may decide to proceed with the full development of the West White Rose pool. Under the Accord Acts, this would require a development plan amendment for the Board's consideration.

Staff reviewed the above document, and on December 17, 2009 requested additional information from the Proponent. On March 23, 2010 and April 23, 2010, the Proponent submitted supplementary information. On April 29, 2010, the Proponent was advised the Application was complete. This supplementary information along with the document submitted on November 3, 2009 constitutes the Application and is the subject of this staff analysis.

With respect to industrial benefits, Board staff assessed the Application and determined that the pilot scheme would not require an amendment to the existing White Rose Benefits Plan (Decision 2001.01). However, if the Proponent decides to proceed with the

full development of the West White Rose pool a Benefits Plan Amendment will be required.

At the October 27, 2009 Board meeting it was decided that a public review was not necessary for this Application.

Staff reviewed the Application from an operations and safety, environment and resource management perspective. The following is a summary of this review.

Operations and Safety

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. The Proponent should follow up with the C-NLOPB on the following matters as the project proceeds:

- When the project proceeds to the engineering design phase, the Proponent will keep 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 operational procedures must be made by the Proponent in accordance with its management of change process.

- As a matter of course, the Simultaneous Operations Risk assessment process be completed to examine the risks associated with the West White Rose pilot scheme and submitted to the C-NLOPB for review.

Protection of the Environment

The Board's staff has concluded that the Application does not require additional environmental assessment pursuant to the Canadian Environmental Assessment Act and recommends that no environmentally related conditions be attached to the current approval.

Resource Management

With respect to resource management assessment aspects of the Application, staff concluded:

- Pressure data, fluid analysis and geological data confirm that the West White Rose pool is consistent with other pools in the White Rose Field. However, the West White Rose pool is significantly more geologically complex than the producing South Avalon pool. This complexity implicates numerous technical risks, including vertical barriers to fluid flow, fault seal, reservoir compartmentalization, reservoir connectivity and reservoir quality.
- Staff acknowledge the uncertainty associated with in-place volumetric estimates presented by the Proponent for the West White Rose Pool, and expect that technical information obtained from the pilot pair scheme will reduce this uncertainty. Staff note that reserve estimates were excluded from the Application as the pilot pair scheme objectives include constraining the recovery factors, which are essential for estimating the recoverable hydrocarbons. Detailed volumetric and reserve estimates for individual fault blocks and reservoir subdivisions will be required in the pilot pair final report and subsequent development plan application for full-scale West White Rose pool development.
- The proposed location for the pilot pair is within the highest quality reservoir encountered to date within the West White Rose Pool. The high reservoir quality will permit a better evaluation of faulting and barrier influences. Staff concur with placing

the pilot pair in the region delineated by O-28Y well in the context of obtaining clear, indicative results to evaluate the development potential of the West White Rose pool.

- Staff concur with the sequence and objectives of the Proponent's pilot scheme. It is expected that results of the pilot pair will be the basis for a full depletion plan for the West White Rose area as outlined in the Proponent's Application.
- The Proponent's reservoir modelling and simulation are reasonable and appropriate within the context of a pilot scheme.
- Reservoir simulation indicates that the SeaRose FPSO facilities can adequately handle production from the proposed pilot well pair with minimal impact on South Avalon and North Amethyst production.

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

Condition 1:

Six months after first oil from the pilot scheme an interim report outlining the primary production results from the pilot producer must be submitted and accepted by the Board.

Condition 2:

No later than two years after first oil from the pilot scheme, the Proponent must provide a report, which is acceptable to the Board, on the analysis of the pilot pair results. This report will outline how the results relate to a better understanding of West White Rose pool in terms of recoverable reserve ranges and a depletion strategy.

Condition 3:

If reservoir performance and/or characteristics vary significantly from that predicted in the Proponent's Application and/or if it is determined that the pilot scheme is adversely affecting potential petroleum recovery in

the West White Rose pool, the Board may reassess the merits of the pilot pair scheme.

Condition 4:

The Proponent must not alter the pilot scheme as outlined in the Application without Board approval.

Condition 5:

Prior to initiating production from the West White Rose Pilot Scheme, a unitization agreement among licence holders for the White Rose Significant Discovery Area shall be submitted to the satisfaction of the Chief Conservation Officer.

3.0 BACKGROUND

3.1 The Application

On November 3, 2009, the Proponent submitted to the Board on behalf of its partners Suncor Energy and Nalcor Energy-Oil and Gas the following document – "White Rose Development Plan Amendment – West White Rose – Pilot Scheme (October 2009)".

The document proposes implementing a pilot pair scheme in the West White Rose Pool within the Significant Discovery Licences (SDL) 1024. The West White Rose Pool was addressed as deferred development in the White Rose Development Plan Application (Decision 2001.01). The Board concurred that the highly stratified and faulted West Pool required a greater level of detail and understanding in order for development of the pool to proceed. On March 24, 2009, the Proponent and Board staff met to discuss the merits of a pilot well pair in the West White Rose pool. In November 2009, the Board received the pilot pair project as a development plan amendment.

Staff reviewed the document and requested additional information in a letter dated December 17, 2009. The Proponent responded with supplemental information on March 23, 2010 and April 23, 2010. In a letter dated April 29, 2010, the Proponent was informed that the Application was complete.

The Proponent plans to drill a highly deviated oil producer well and a slightly deviated water injection well from two available slots in the Central Drill Centre, which is currently being used for White Rose South Avalon production. The pilot pair will

acquire additional information to further assist and guide the evaluation of the full West White Rose Pool.

Subsea equipment required for the scheme includes christmas trees, wellhead equipment, rigid and stacked spools, gas lift jumpers, subsea control distribution equipment and gas lift distribution systems. The drilling and completions activities will be executed using the Proponent's existing White Rose field processes and systems.

The Proponent estimates a stock tank original oil in place (STOOIP) of 66.3 million cubic metres (417 million barrels (MMbbls)) in the West White Rose Pool, with 12.5 million cubic metres (79 MMbbls) in the proposed pilot region. The Proponent did not provide reserve estimates in this Application as this would be one of the Proponent's objectives of the pilot pair.

The capital cost estimates for the West White Rose pilot scheme total $250 million (Cdn) consisting of $130 million (Cdn) for drilling and completions and a $120 million (Cdn) for subsea infrastructure.

3.2 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 water depths ranging from 115 to 130 meters. The greater White Rose Development area encompasses the adjacent North Amethyst Field, which was discovered in 2006 by the drilling of the Husky Oil et. al. North Amethyst K-15 well.

A note of clarification is required regarding the naming convention of the main reservoir within the White Rose Development area. 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, is an overall fining-upward package within a transgressive systems tract, and is interpreted as the "Ben Nevis Formation". The terms "Ben Nevis" (BN) and "Ben Nevis Avalon" (BNA) are used interchangeably throughout this analysis.

The recoverable oil reserves, expressed at a 50 percent probability level, within the Ben Nevis Avalon formation at the White Rose field are estimated by the Board to be 45 million cubic meters (283 million barrels). Pressure measurements and fluid contacts indicate that the oil and gas accumulation in the Ben Nevis Formation is 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 (Figure 3.3.1). This Application deals with the implementation of a pilot pair scheme in the West Avalon Pool.

The Board estimates, at a 50 percent probability, that the White Rose Field contains recoverable resources of 76.7 $x10^9$ m^3 (2.7 TCF) of natural gas, and 13.8 million m^3 (86 MMbbls) of natural gas liquids within the Ben Nevis formation. However, this Application does not propose exploitation of these resources at this time.

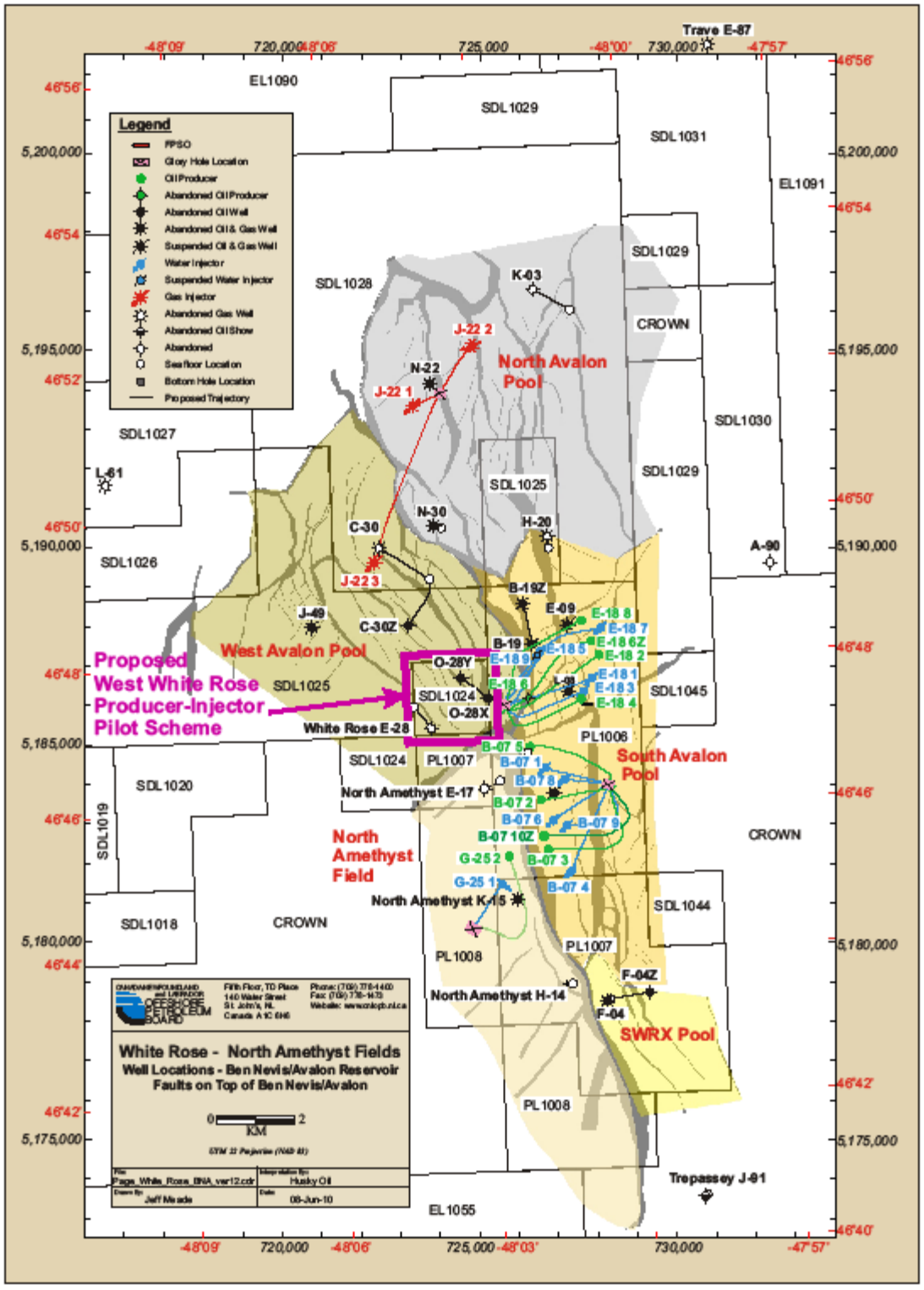


Figure 3.3.1: Map of the White Rose Development area, identifying well locations, pool boundaries, North Amethyst Field and Proposed West White Rose Pilot Scheme area (Source: C-NLOPB)

At present, the White Rose Significant Discovery Area incorporates fourteen Significant Discovery Licences (SDL). As well there is two production licences (Production Licence 1006 and 1007) located in the White Rose significant discovery area as can be seen in Figure 3.3.2.

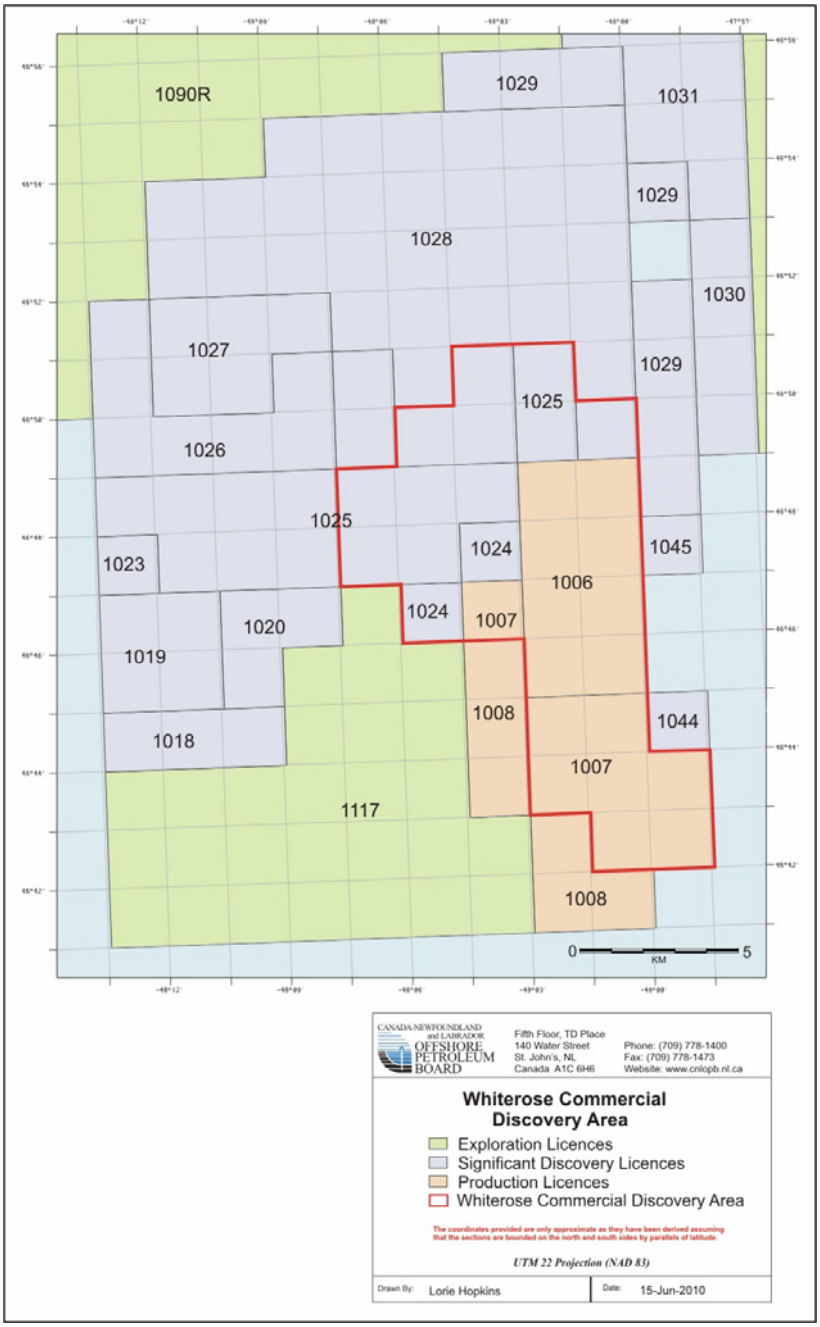


Figure 3.3.2: Map of the White Rose Significant Discovery Area, identifying exploration licences, significant discovery licences and production licences (Source: C-NLOPB)

Commercial oil production began at the South Avalon Pool on November 12, 2005. As of April 30, 2010, twenty-two development wells have been drilled and 22.8 million m^3 (143.5 million barrels) of oil have been produced from the White Rose South Avalon pool. Nineteen delineation wells have been drilled in the field, including five within the West White Rose region. This drilling has provided a substantial quantity of new information to assess reservoir and facility performance and to construct geological and reservoir simulation models.

The South White Rose Extension (SWRX) is an expansion to the White Rose Development within Significant Discovery Licences 1043 and 1044. This expansion proposes a subsea tie-back to the SeaRose FPSO through the existing Southern Glory Hole (SGH) and a new glory hole to be constructed approximately 4km south of the SGH. The SWRX pool was approved by governments on September 7, 2007. The C-NLOPB estimates that 22 million barrels of oil is recoverable from the SWRX pool.

4.0 RESOURCE MANAGEMENT

4.1 Resource Management Review

In 2001 the Proponent addressed the West White Rose Pool as a deferred development in the White Rose Development Plan Application. In Decision 2001.01, the Board concurred that the highly stratified and faulted West Pool required a greater level of detail and understanding in order for development of the pool to proceed. At that time, only the J-49 delineation well had been drilled in the West Pool.

Since the approval of the initial development plan (Decision 2001.01), further delineation within the West Pool was conducted with the drilling of the O-28Y, O-28X, C-30, C-30Z, E-28 and J-22 3 wells. However, uncertainty with the West Avalon pool geological model and development feasibility remains.

Staff reviewed the Application, which included the Proponent's seismic interpretation and reservoir simulation model. Staff also conducted a review of reservoir, geological and production data acquired to April 2010 and used this data to construct a geological model for the West White Rose Pool.

4.2 Geological/Geophysical/ Petrophysical Model Review

4.2.1 Regional Geology

In Decision 2001.01, the Proponent extensively details the regional geologic history of the Jeanne d'Arc Basin. In light of the general industry understanding of the Basin, this discussion adequately describes the tectonic evolution of the White Rose region and a similar discussion is not required for this Application.

4.2.2 Geology of White Rose

The principle reservoir at White Rose field consists of shallow marine, fine-grained, quartzose sandstones of the Ben Nevis Avalon Formation (BNA). This southwest-northeast trending sequence was likely deposited along a paleoshoreline located east of the field (Figure 4.2.1). The original White Rose Development Plan application presented three main facies associations and identified diagenetic components in the formation:

1) Lower shoreface storm deposits consisting of well-sorted, very fine-grained, low angle laminated sandstones, massive sandstone and parallel laminated sandstones. These deposits form the main reservoir rock type in the region.

2) Lower shoreface fair-weather deposits consisting of heavily bioturbated siltstone to silty-sandstone, with primary structures rarely preserved.

3) Laminated and massive marine silty shale and shale deposits with minor bioturbated intervals, representing the distal component of the White Rose region deposition.

4) Diagenetic components include calcite cement nodules that are round and laterally discontinuous or lenticular and associated with shell lag intervals, and locally present siderite nodules.

These facies and diagenetic components are carried into the West White Rose area.

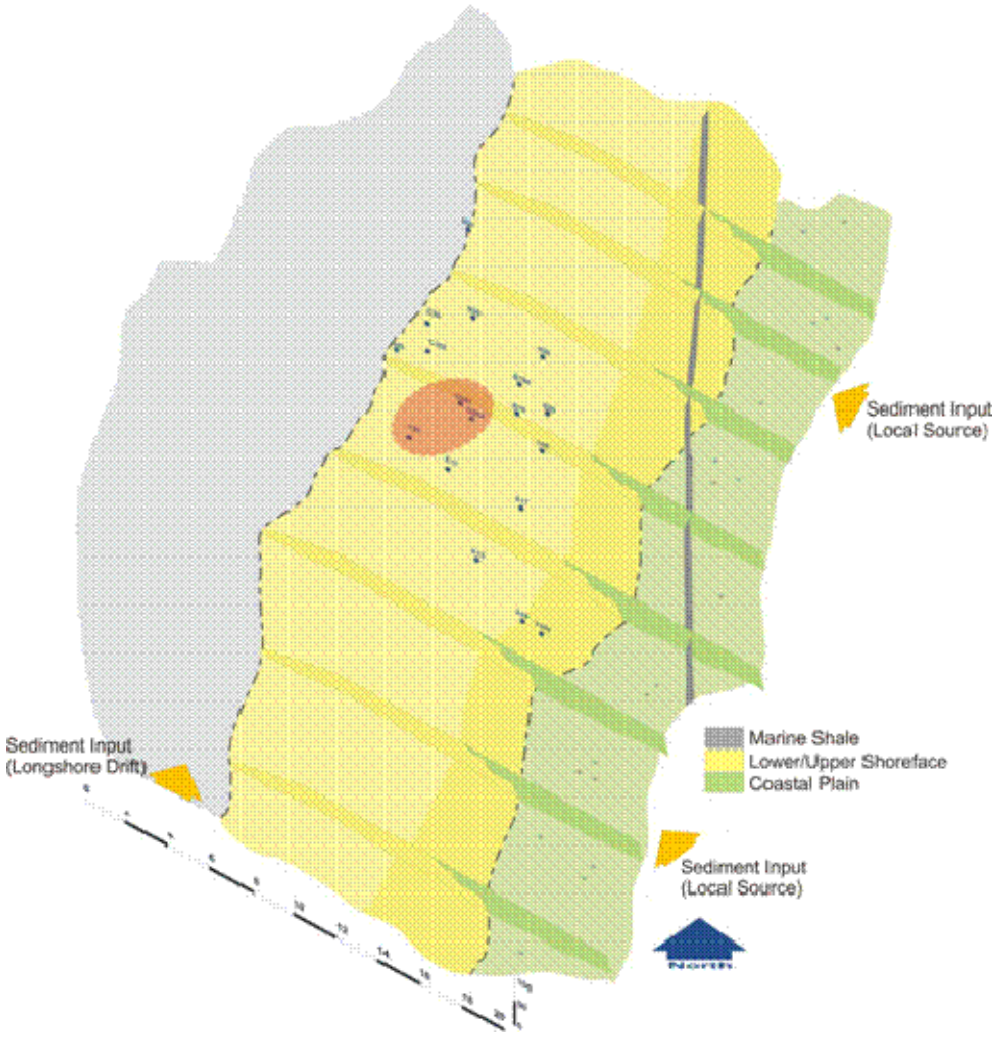


Figure 4.2.1: Schematic of aerial distribution of shoreface sandstones and early moving faults related to the initial phases of Ben Nevis deposition. White Rose delineation wells and the proposed pilot location, in red, are identified in relation to the paleogeography (Source: Husky, 2007)

The Proponent has subdivided the Ben Nevis/ Avalon into several parasequence sets that correspond to coarsening upwards, backstepping cycles. These sequences are most evident in moderately distal wells and become less distinct in proximal and distal settings where the net to gross ratio is very high or very low. The Proponent has mapped the internal BNA sequences from South Avalon into the West White Rose region, but the correlation is highly interpretational.

4.2.3 Geology of West White Rose

The West White Rose Pool is a more distal expression of the BNA, resulting in a higher proportion of fine grained sediment interbedded with good quality laminated sands and poor quality bioturbated sands and shales. The number and variability of coarsening upwards cycles evident in the West White Rose Region suggest a more complex stratigraphy than the South Avalon Pool (Figure 4.2.2).

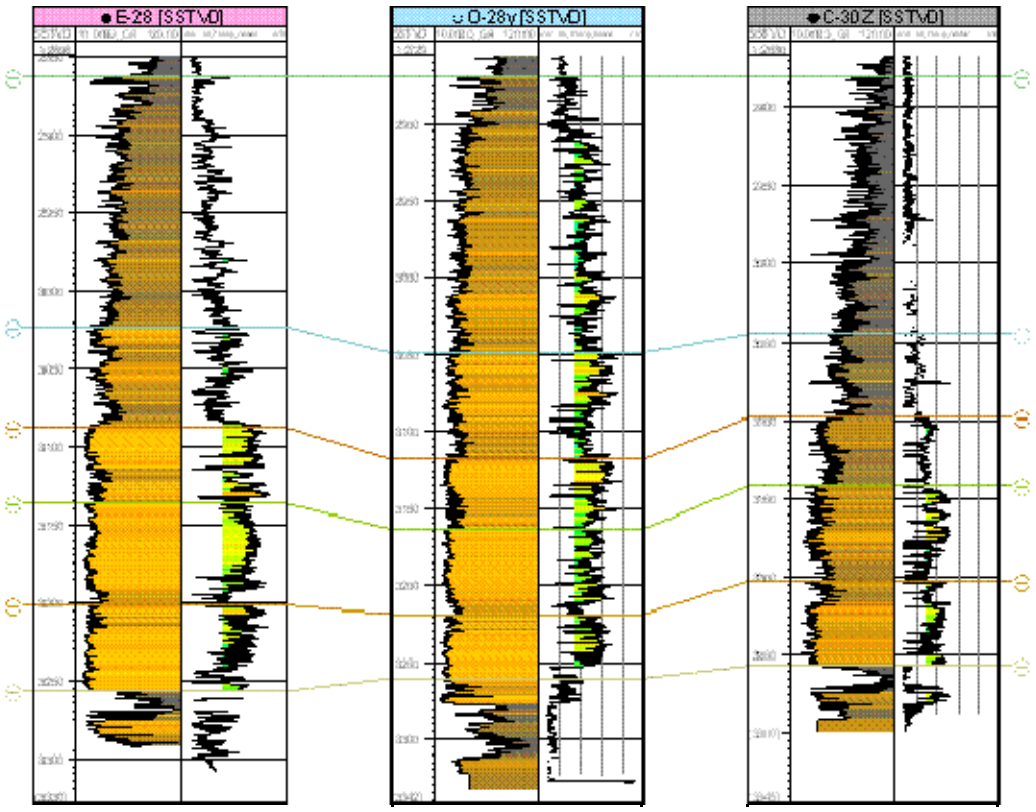


Figure 4.2.2: Well cross-section showing variable coarsening upwards stratigraphic sequences within West White Rose (Source: C-NLOPB)

These coarsening upwards cycles are a consideration for reservoir planning, as they may be baffles or barriers to fluid flow. For example, the South Avalon E-18 9 development well encountered a 7,000 kPa pressure differential over 14 m, which the Proponent attributes to a sequence boundary.

West White Rose reservoir is more structurally complex than South Avalon reservoir. The West pool is segregated into several complex fault blocks by post-depositional normal faults with throws ranging from <20m to 300m. A southwest-northeast trending post -depositional syncline also contributes to the complex structure (Figure 4.2.3).

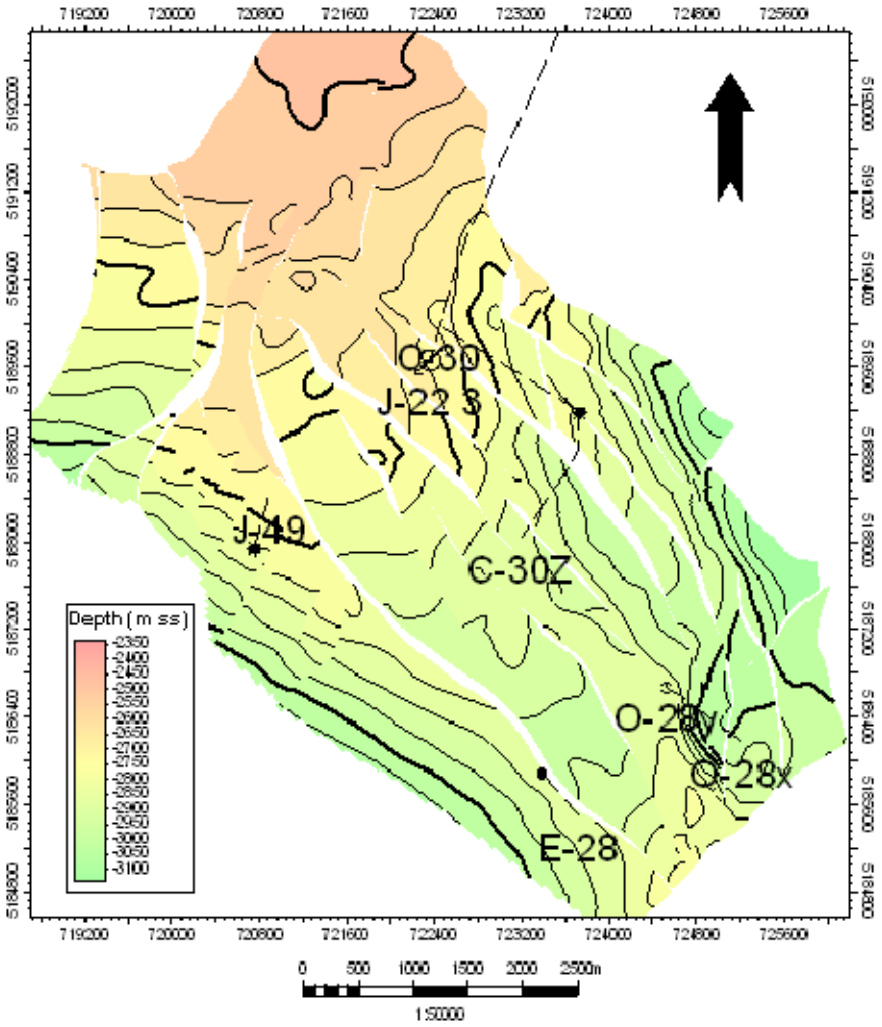


Figure 4.2.3: Map of the top Ben Nevis siltstone in West White Rose (Source: C-NLOPB)

The higher degree of faulting and structural uncertainty results in significant risk of reservoir compartmentalization in the West. The Proponent indicates that fault throws within the pool are not large enough to offset the entire BNA formation, but the decreasing net-to-gross ratio and complex structure to the northwest allows for full offset

of the reservoir section (Figure 4.2.5). This offset permits different fluid contacts within the West White Rose Pool.

The Proponent indicates that the bulk of the West White Rose oil reserves are expected to occur within the region delineated by the O-28Y, C-30Z and E-28 wells, as they have better reservoir quality, are oil bearing and did not encounter gas. Staff concur with the Proponent's geological assessment.

4.2.4 Geophysics

Seismic data quality in the West White Rose Region is fair to good. The reservoir interval is imaged seismically as a low amplitude sequence indicative of a low impedance siltstone reservoir. The seismic interpretation is challenging given the low impedance contrast of the Ben Nevis Avalon reservoir and surrounding geology, as well as the fault complexity (Figure 4.2.4). The Proponent supplied geophysically controlled structural interpretations in support of the Application. These surface and fault data were audited and verified by the Board's geophysical staff. Three main seismic markers define the reservoir interval in the White Rose West Pool: the top Ben Nevis Avalon (top reservoir), the BN_200 surface (internal reservoir pick) and the Mid-Aptian Unconformity (base reservoir). The top Ben Nevis Avalon Formation is a difficult seismic pick in the White Rose region because of the low impedance contrast. In the West Pool, the upper Ben Nevis reservoir sandstones become more distal, resulting in an even lower impedance contrast moving north. Additionally, multiple energy interferes with the pick in the northern extent of the pool. The Mid-Aptian Unconformity is a medium to high amplitude horizon mapped with a higher level of confidence. Reservoir mapping within the West pool is further guided by the BNA 200 pick, which represents a transgressive surface within the reservoir. All three surfaces were tied to relevant West Pool delineation wells: O-28Y, E-28, J-49, and C-30Z.

The Proponent acquired a new seismic survey in 2008 and is currently working on an interpretation of this data. The objectives are to improve fault placement and resolve internal Ben Nevis markers. This interpretation, in conjunction with the pilot scheme results, will improve the understanding of the West White Rose region and help define the development potential of the pool.

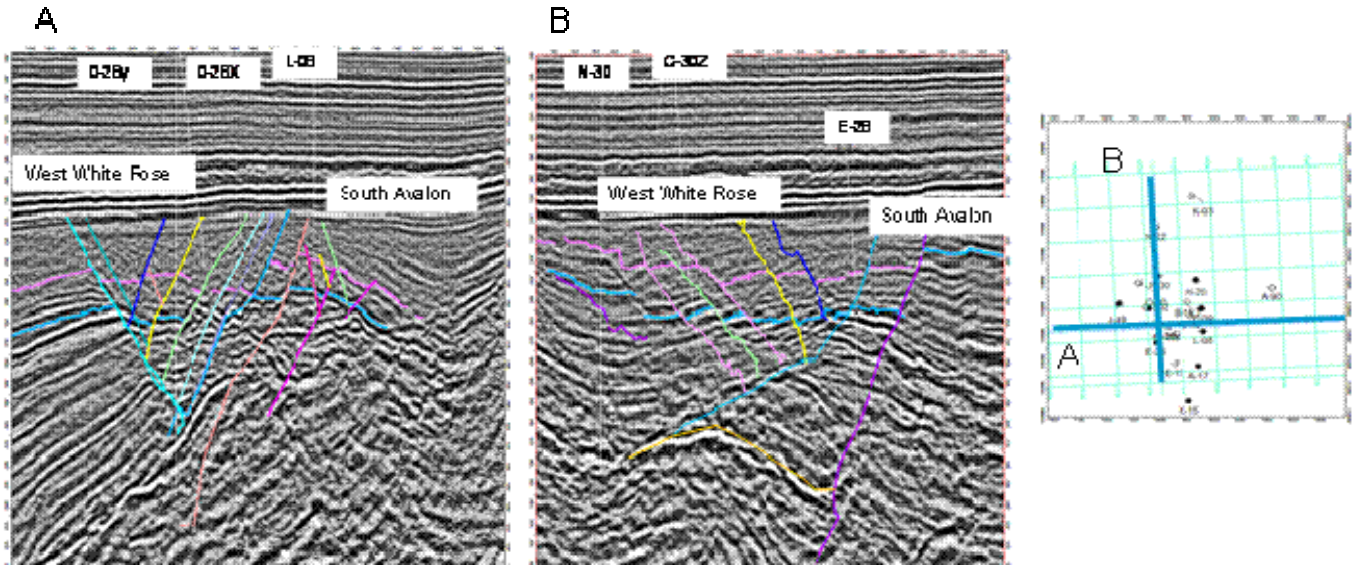


Figure 4.2.4 Seismic sections showing complex fault structure within the West White Rose region (Source: Husky 2009)

4.2.5 Petrophysics

The Proponent has conducted a comprehensive logging and coring program while drilling the six delineation wells and one gas injection development well in the West White Rose region. In the Application, the Proponent summarized their petrophysical interpretation of the Ben Nevis-Avalon reservoir for all wells in the pilot scheme area. 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, Board staff believes the interpretation presented by the Proponent in support of this Application is reasonable and appropriate.

4.2.6 Reservoir Geologic Model

Board staff continue to review, build and maintain three dimensional (3D) geological models of the White Rose Development area. Specific effort was put into constructing an updated model of the West White Rose Pool to aid in the evaluation of this Application. Seismic fault and horizon interpretations, submitted by the Proponent, were used to define the 3D structural grid. Stratigraphic well picks, combined with the seismic horizon interpretation, guided the internal layering of the C-NLOPB model.

Both facies and petrophysical analysis were incorporated into the model. Log and core data were used to interpret facies, and the interpretation was upscaled into the 3D grid. The facies model was populated as a shoreface depositional system using a Truncated Gaussian algorithm constrained by defined depositional trends. Different scenarios were created by varying the curvature and direction of the transition zones, as well as the aggradational angle between each facies. The petrophysical analysis was upscaled at each well location and populated through the grid using a Sequential Indicator Gaussian algorithim guided by statistical analysis and linked to the facies models.

Fluid properties, such as the oil formation volume factor (B_o), gas formation volume factor (B_g), and gas–oil ratio (GOR), were estimated from pressure-volume-temperature (PVT). This information was incorporated into the geological model. A range of in-place

hydrocarbon volume estimates were calculated based on the facies and petrophysical models, fluid properties, and hydrocarbon contacts.

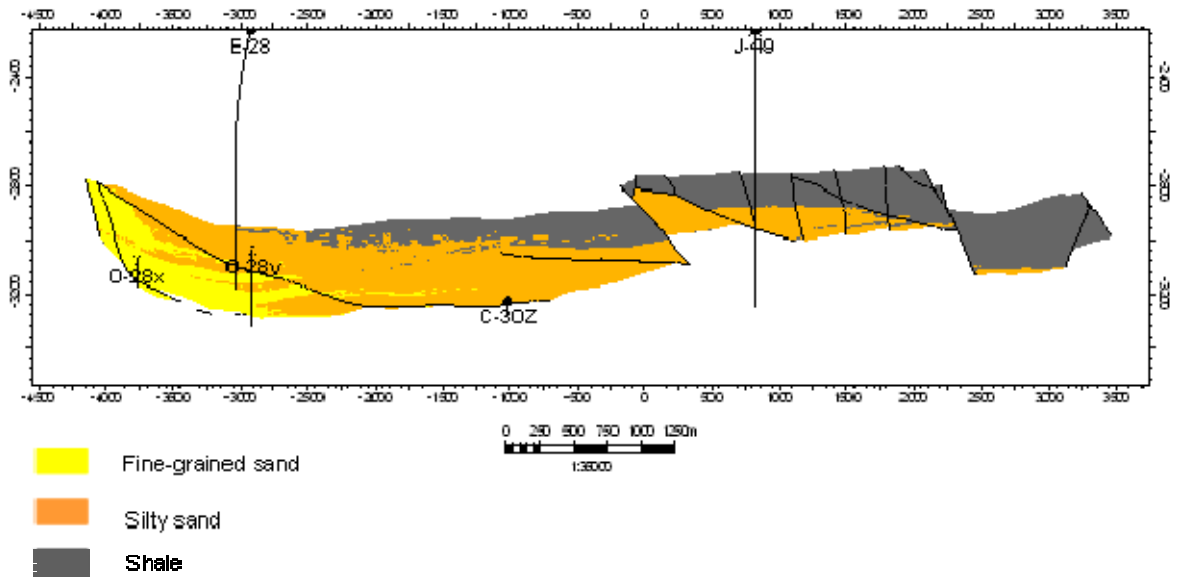


Figure 4.2.5 Cross-section through shoreface facies model indicating facies transition to northwest and potential for full offset of the reservoir section (Source: C-NLOPB)

Significant uncertainty is associated with the geological model with respect to reservoir structure, reservoir quality, fluid contacts, and the net to gross ratio. Full offset of the reservoir section is also possible due to the structural complexity and the facies transition (Figure 4.2.5). It is these uncertainties that lead to the Proponent's lack of volumetric reserve estimates in the Application. Board staff recognize that the pilot project objectives including obtaining static and dynamic production data to gauge the recovery factor, which will constrain the reserve and resource estimates. The pilot project results will aid in determining volumetric, reserve and resource estimates for each individual fault block and reservoir subdivision in West White Rose pool, which will be required for any subsequent development.

4.3 Oil In Place, Gas In Place and Reserve Estimates

A comparison of the Proponent's and the Board's volumetric oil-in-place (OOIP), original gas in place (OGIP) (gas cap) and original gas in place (OGIP) (solution) estimates for the West White Rose and pilot scheme areas, are shown in Tables 4.3.1 and 4.3.2. These are probabilistic in place resource estimates - P90 (downside case), P50 (most likely case) and P10 (upside case).

	P90		P50		P10	
	Husky	C-NLOPB	Husky	C-NLOPB	Husky	C-NLOPB
OOIP (Million bbls)	219	176	417	381	585	562
OOIP (Mm^3)	34.8	28.0	66.3	60.6	93.0	89.4
OGIP (Gas Cap BCF)	116	240	317	311	656	584
OGIP (Gas Cap (Bm^3))	3.3	6.8	8.9	8.8	18.5	16.5
OGIP (Solution BCF)	N/A	49.9	N/A	65.8	N/A	81.6
OGIP (Solution (Mm^3))	N/A	1.4	N/A	1.9	N/A	2.3

Table 4.3.1: Comparison of Husky and C-NLOPB Probabilistic Resources in Place, West White Rose area

	P90		P50		P10	
	Husky	C-NLOPB	Husky	C-NLOPB	Husky	C-NLOPB
OOIP (Million bbls)	43	28	79	60	124	113
OOIP (Mm^3)	6.8	4.5	12.5	9.5	19.7	18.0

Table 4.3.2: Comparison of Husky and C-NLOPB Probabilistic Resources in Place, Pilot Pair area

The Board's volumetric STOOIP estimates differ with the Proponent's by approximately 10% in the West White Rose area (Table 4.3.1). Differences between the Board and the Proponent can be attributed to slightly different methodology with respect to the petrophysical and facies analysis, and differences in the modelling approach. Staff note that the differences in the estimates are acceptable as the uncertainty associated with the volumetric estimates is high.

4.4 Reservoir Engineering

Analysis of the Proponent's reservoir engineering component of the Application included a review of the following items:

- Reservoir engineering data
- Fluid data
- C-30Z well test data
- J Functions
- Special Core Analysis

4.4.1 Reservoir Engineering Data

Six delineation wells and one development/gas injection well have been drilled to date in the West Pool, providing a significant amount of reservoir engineering data.

Reservoir pressures in the West White Rose pool were obtained in wells J-49, O-28Y, C-30, C-30Z, J-22 3 and E-28 using Schlumberger's Repeat Formation Tester (RFT) or Modular Dynamic Tester (MDT). A plot of the MDT pressure versus depth is shown in Figure 4.4.1.

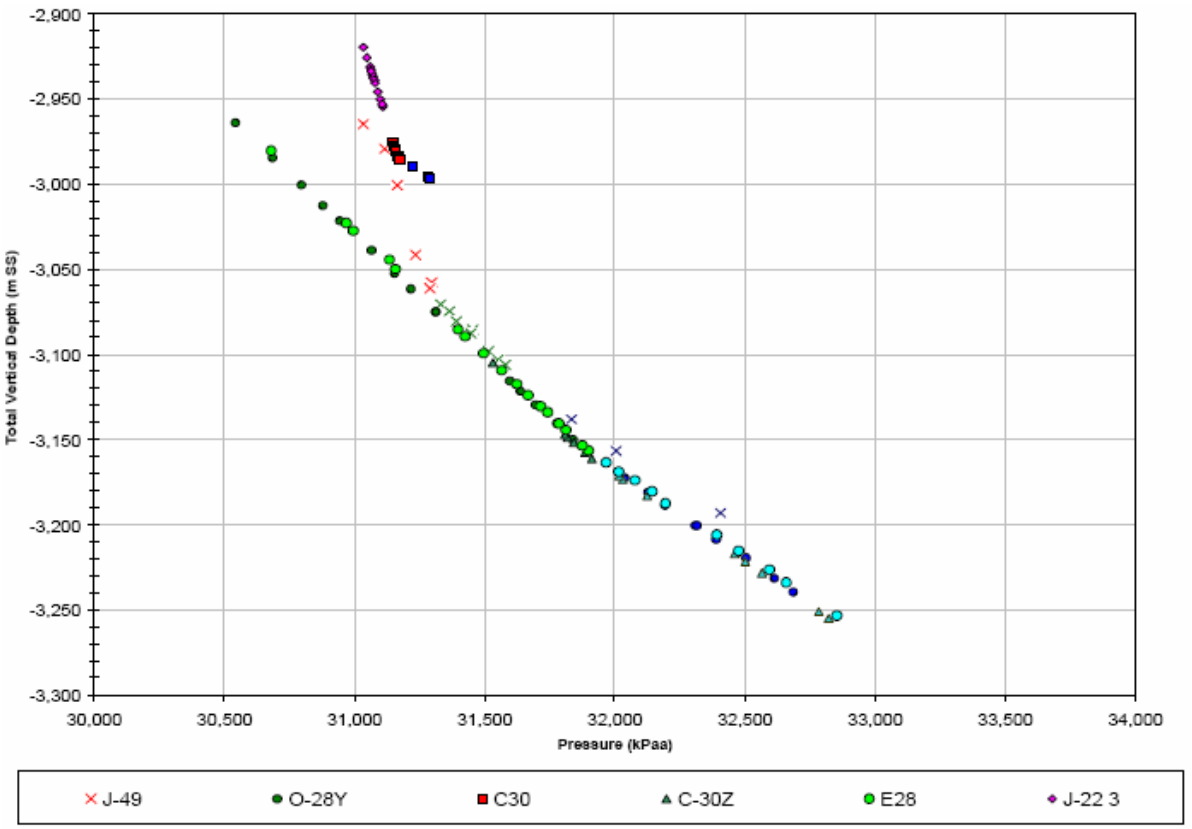


Figure 4.4.1 - West White Rose MDT Pressure Versus Depth (Source: Husky)

The fluid gradients and the hydrocarbon contacts encountered in the wells define the West White Rose pool. The fluid gradients for gas, oil and water are listed in Table 4.4.1, and are similar to the those encountered in the other areas of the White Rose field.

Well	Reservoir Gas Gradient (kPa/m)	Reservoir Oil Gradient (kPa/m)	Reservoir Water Gradient (kPa/m)
J-49	1.78	6.85	N/A
O-28Y	N/A	6.9	9.7
C-30Z	N/A	6.74	9.66
C-30	2.5	N/A	N/A
J-22 3	2.11	N/A	N/A
E-28	N/A	7.24	9.82

Table 4.4.1 – Husky's West White Rose Fluid Gradients

There is good agreement between the Proponent's and the Board's gas-oil and oil-water contacts. The fluid contacts encountered in the West White Rose Wells are shown in Table 4.4.2.

Well	Formation	Contact	Subsea Depth (m SS TVD)
J-49	Ben Nevis	Gas/Oil Oil/Water	3069.7 3131.1
O-28Y	Ben Nevis	Oil/Water	3170.1
O-28X	Ben Nevis	No fluid contacts were encountered	
C-30Z	Ben Nevis	Oil/Water	3172.7
C-30	Ben Nevis	No fluid contacts were encountered except gas	
J-22 3	Ben Nevis	Gas injection well. No fluid contacts were encountered	
E-28	Ben Nevis	Oil/Water	3170.1

Table 4.4.2 – Husky's West White Rose Fluid Contacts

The Proponent used a combination of logging tools in wells O-28X, O-28Y, C-30Z and E-28 to measure formation temperature. The measurements indicate an expected formation temperature range of 110^{o}C to 117^{o}C in the West White Rose pool.

In order to assess the permeability, vertical communication and skin values in the BNA formation, the Proponent conducted vertical interference testing utilizing the MDT tool in the O-28Y well. This test found reservoir permeability to be in the range of 60 *m*d, while the ratio of vertical permeability to horizontal permeability was approximately 0.08. The testing also found the well to have a skin factor of 3.7.

Board staff concur with the Proponent's analysis.

4.4.2 Fluid Data

The Proponent collected fluid samples from the O-28Y, C-30, C-30Z, E-28 and J-22 3 wells and conducted detailed PVT analysis of the gas, oil and water samples. Detailed PVT analysis reports for each well were submitted to the Board with the exception of E-28 and J-22 3, as analysis of those samples was still ongoing at the time of this staff analysis.

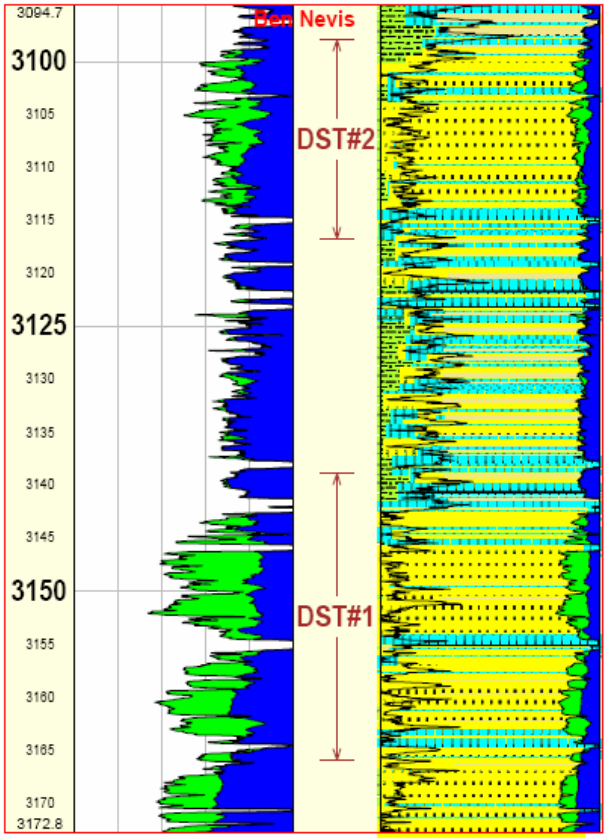
The Proponent selected the PVT analysis conducted on an O-28Y oil sample (sample #1365) as representative of the West White Rose pool oil accumulation. The analysis indicated an average initial gas-oil ratio and formation oil volume factor of 127 Sm^3/Sm^3 and 1.356, respectively.

The fluid analysis conducted by the Proponent indicates that the West Avalon oil, gas and water samples are consistent with those of the South Avalon Pool.

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

4.4.3 C-30Z Well Test

The Proponent conducted two separate drill stem tests (DST's) at the C-30Z well over the upper and lower Ben Nevis/Avalon intervals. The lower interval was tested at rates of 1,200 bbl/d during the main flowing period while the second interval did not flow to surface. Details on the upper and lower interval can be seen in Figure 4.4.2.



Pay Cutoff:phi>10%, Sw<50%, k>3md

DST#2 : 3098 – 3117 TVDSS

Net Oil Pay	3.5m
Gross	19m
N/G	19%
(Avg) Phi 12.2	Sw 39
Vsh 17	K 21 md

DST#1: 3139 - 3166 TVDSS

Net Oil Pay:	11.5m
Gross	27m
N/G	42%
(Avg)Phi 15.2	Sw 35
Vsh 10	K 64 md

Figure 4.4.2– C-30Z DST Intervals (Source: Husky)

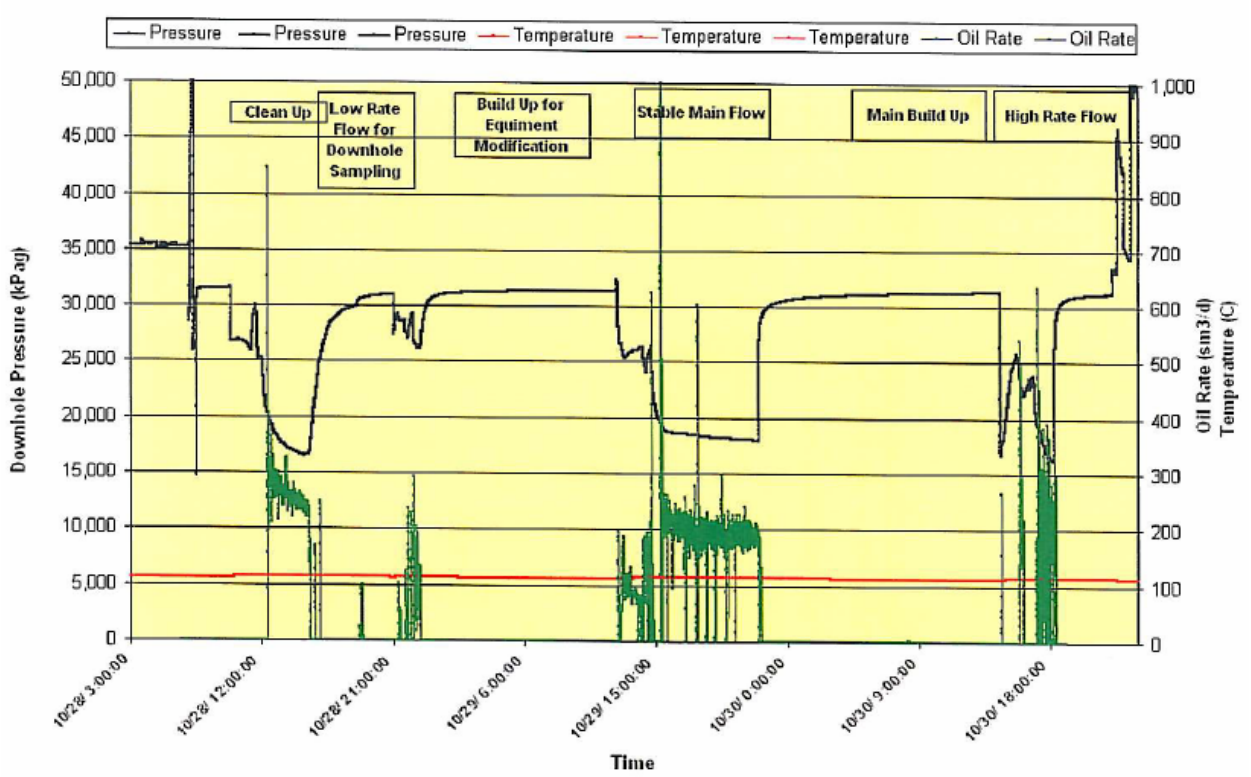


Figure 4.4.3 – C-30Z DST #1 Flow and Build-ups (Source: Husky)

Staff reviewed the DST results and the Proponent's interpretations of the DST pressure build-ups and found them to be reasonable.

4.4.4 J Function

The Proponent used J Functions, calculated from log data acquired within the oil zone in the West White Rose pool, to determine the water saturation distribution for the reservoir simulation. The functions represent the laminated facies and bioturbated functions identified by the geological model. Although the calculated J functions of the laminated facies function fit with the measured log data, the bioturbated J function is somewhat optimistic. Staff concur with the Proponent's approach in calculating water saturation and agree that the J functions are adequate at this time for the West White Rose reservoir simulation.

4.4.5 Special Core Analysis

The Proponent states that, at the time of the Application submittal, special core analysis for the West White Rose pool was unavailable. The Proponent used the normalized relative permeability curves for the main South Avalon pool in the reservoir simulation model. Staff concur with the Proponent that this is reasonable but will require the results of the special core analysis to be provided to the Board at the end of the pilot pair project.

4.5 Pilot Scheme Strategy

4.5.1 Pilot Pair Objectives

The geological complexity of the West White Rose pool creates numerous technical risks, including vertical barriers/baffles, fault seal, compartmentalization, and reservoir quality. The Proponent indicates that these risks create significant uncertainty for reservoir performance in the West White Rose pool with respect to productivity, connectivity and communication. The Proponent's proposed pilot scheme objectives are to improve understanding of the technical risks, obtain dynamic productivity and injectivity information and further evaluate the West White Rose pool for development. This approach will help assess the level to which the geological complexities contribute to productivity and recovery risk.

4.5.2 Pilot Scheme Proposed Location

The pilot scheme will consist of an oil producer and water injector pair drilled in the O-28Y delineation well area as shown in Figure 4.5.2.1. Although the Proponent outlined a "target area" for the location of the pilot producer and injector, no details were given in the initial Application on the proposed well trajectories or on the targeted reservoir facies intervals.

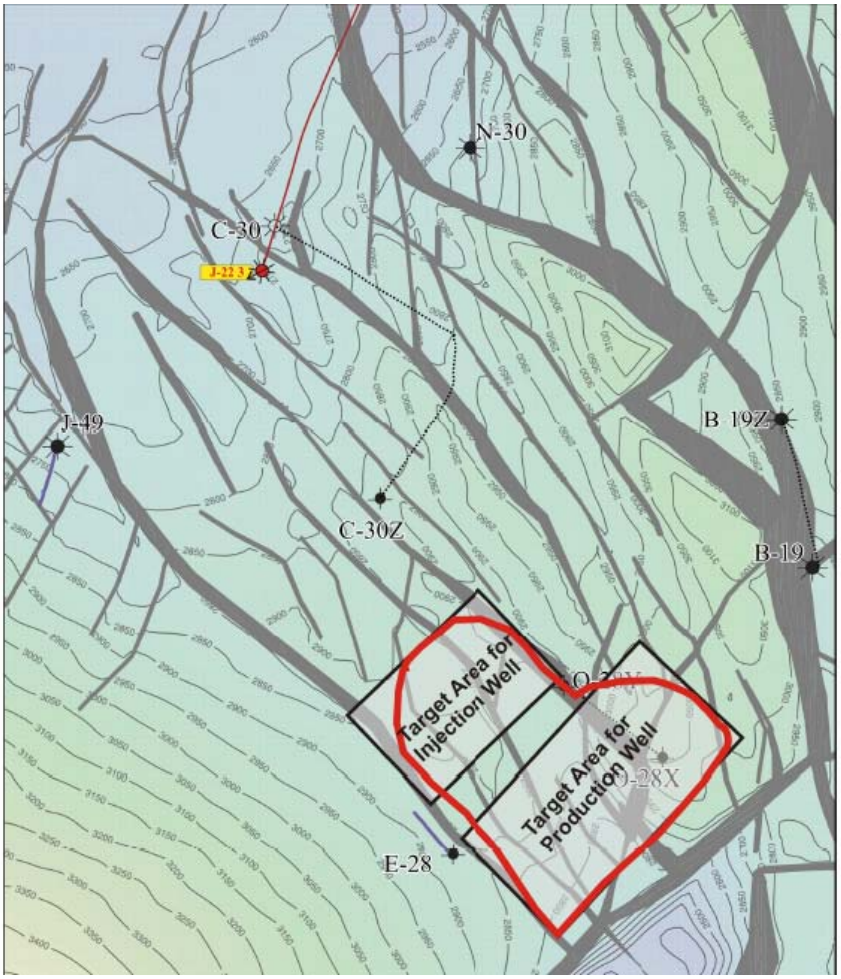


Figure 4.5.1 Preliminary Target area for Pilot project (Source: Husky)

Board staff requested this additional information and were subsequently informed that the producer would be highly deviated and target all Ben Nevis Avalon facies above the OWC (3170m TVDss), while the injector would be slightly deviated and target all facies. Details of the Proponent's well trajectories and proposed locations are indicated in Figure 4.5.2.2.

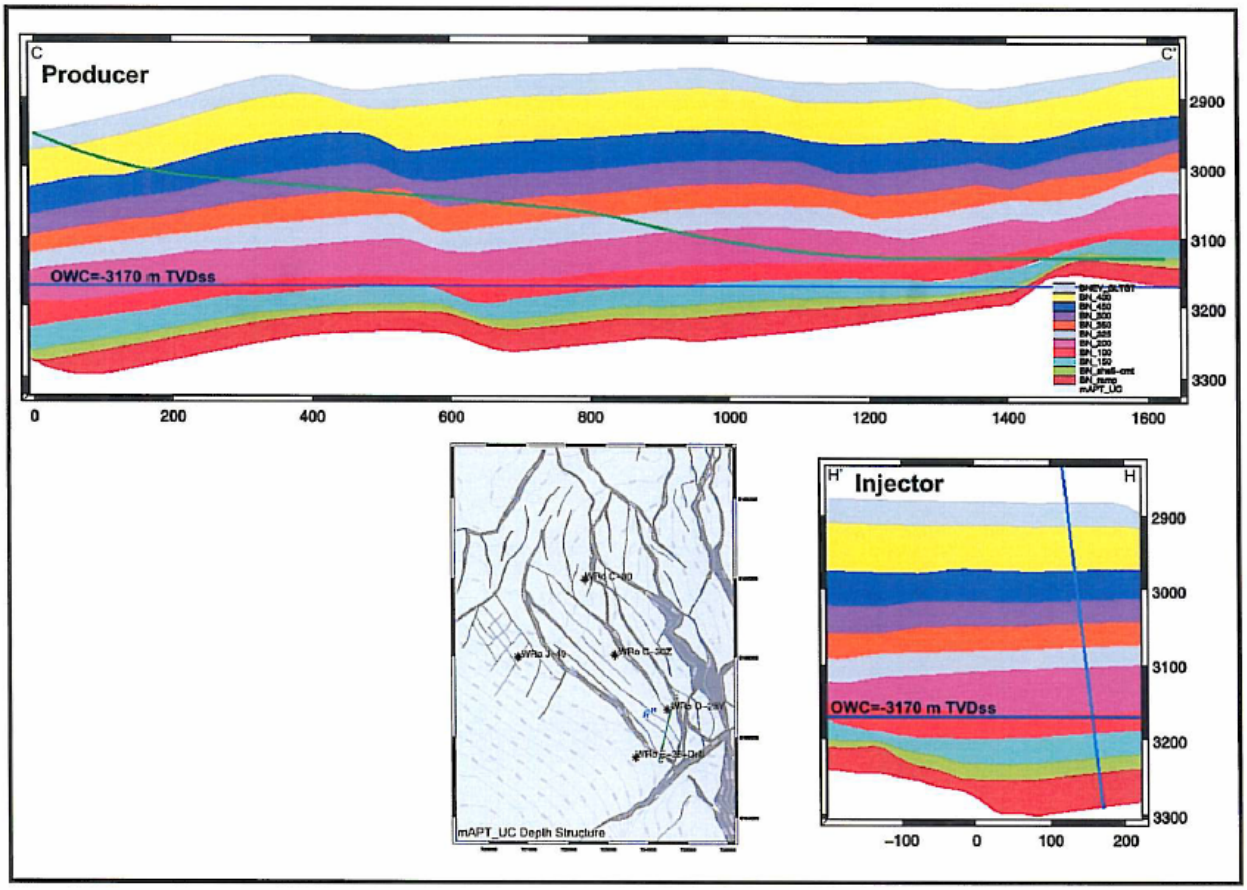


Figure 4.5.2 Proposed well trajectories and targeted facies intervals for the pilot well pair (Source: Husky)

Board staff also requested additional information pertaining to the selection of the proposed “target area” in relation to the pilot scheme objectives. In particular, Board staff wanted to understand how the pilot would reduce risk and uncertainty in the more distal areas of the West White Rose pool.

The Proponent indicated that the location was selected based on the proximity to the O-28Y well, which will be used for landing out the pilot producer’s heel. This is important in understanding the potential stratigraphic barriers with higher quality sand in this area. The selected location and trajectory also permits intersection with a maximum range of facies sequences. Other pilot scheme locations were reviewed by the Proponent, but the selected region is expected to provide the best opportunity for clear indicative results

while reducing uncertainties. If productivity in the pilot producer well is found to be lower than expected, it will place a high risk on productivity in the rest of West White Rose Pool. However, if an acceptable level of productivity is obtained, any connectivity issues between the pilot wells will be a result of faults or barrier influences and not due to poor reservoir quality. The knowledge gained from the pilot testing, whether positive or negative, will assist in determining how to go forward with the full West pool development.

The Proponent plans to evaluate the productivity of the poorer quality upper reservoir section through various methods of data acquisition. The results of this evaluation will help gauge the productivity of more distal areas within West White Rose.

Staff concur with placing the pilot pair in the region delineated by O-28Y in the context of obtaining clear, indicative results to evaluate the development potential of the West White Rose pool.

4.5.3 Pilot Pair Implementation and Evaluation Schedule

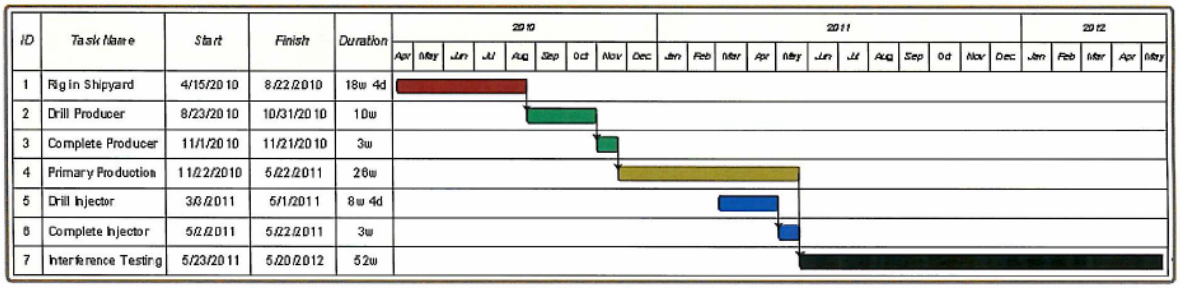
The Proponent plans to drill the pilot oil producer and place it on primary production for a six-month period to evaluate productivity and connectivity. If the results of the primary production period warrant continuation of the pilot scheme, the Proponent will drill and complete the water injection well. **Staff concur with the Proponent's primary production strategy for the purpose of data acquisition as indicated in the Application (Figure 5-3), but will require an interim report outlining the primary production results. This report must be submitted after six months of primary production. The Board will review this report in the context of how the pilot project will continue.**

Pressure profiling, using reservoir pressure points, will be conducted during drilling of the water injection well to help determine if communication exists between the oil producer and injector through identification of depleted zones. The Proponent has indicated the water injector may be equipped with an intelligent completion to permit extended vertical interference testing between the oil producer and water injector at various injection points/depths in the wellbore.

The water injection well will allow the Proponent to test the effectiveness of a bottom water injection support scheme versus an alternate water flood scheme designed for horizontal sweep. This is possible from interference testing of the well pair, which will enable evaluation of both vertical and lateral communication. A horizontal displacement, designed to target specific zones or units, will be utilized if vertical barriers are found. If the faults are significantly sealing, causing compartmentalization, the water flood scheme will need to be designed to preferentially support individual fault blocks. Staff concur that the information obtained from the producer and injector will be valuable for evaluating potential development planning for the entire West White Rose pool.

The Proponent must provide an analysis of the pilot pair results, no later than two years after first oil from the pilot scheme. This report will outline how the pilot scheme results relate to a better understanding of West White Rose pool in terms of recoverable reserve ranges and a full field depletion strategy.

The preliminary schedule for development of West White Rose pilot scheme was provided in the Application. However, it should be noted that this schedule is outdated. The Proponent stated the timeline provided is preliminary and that the order, sequence and durations are subject to change. At the time of staff analysis, the pilot producer for the West White Rose is scheduled to be completed in April 2011.



ID	Task Name	Start	Finish	Duration
1	Rig in Shipyard	4/15/2010	8/22/2010	18w 4d
2	Drill Producer	8/23/2010	10/31/2010	10w
3	Complete Producer	11/1/2010	11/21/2010	3w
4	Primary Production	11/22/2010	5/22/2011	26w
5	Drill Injector	3/8/2011	5/1/2011	8w 4d
6	Complete Injector	5/2/2011	5/22/2011	3w
7	Interference Testing	5/23/2011	5/20/2012	52w

Figure 4.5.3 Proposed Timeline and Development schedule for West White Rose Pilot Scheme (Source: Husky)

Staff concur with the overall proposed preliminary schedule of the pilot scheme. The order, sequence and durations proposed by the Proponent seem reasonable and allow enough time to obtain testing information. Staff realize that due to issues such as rig availability, weather etc., the proposed dates and durations may change. **However if there is significant alteration from the pilot scheme as outlined in the Application, the Proponent will require approval from the Board.**

The Application indicates that data acquisition for the pilot scheme will be conducted as per the approved White Rose Acquisition Data Program and detailed data acquisition plans for the wells will be submitted for approval as part of the Approval to Drill a Well. Board staff agree with the proposed data acquisition, but strongly recommend that a core sample be taken during the drilling of the water injector at the Ben Nevis Avalon zone. This will help reduce some of the uncertainty in the transitional area of the West White Rose pool.

The reservoir management plan for the West White Rose Pilot Scheme will also be incorporated into the existing criteria currently used to manage the South Avalon pool.

4.6 Pilot Pair Reservoir Simulation Model

Staff reviewed the results of the Proponent's West White Rose Pool simulation model. The Proponent's reservoir simulation model was generated from a single realization of the RMS geological model, which encompasses the entire West White Rose region. The simulation model was initialized with 69 by 75 by 421 cells representing areal dimensions of 100m by 100m by 1 m. However, the simulation cases were limited to the proposed pilot development area. Consequently, cells outside the proposed pilot area were deactivated, leaving only 1,410, 212 active grid cells.

The simulation model incorporates the proposed pilot production well (WWRX_P9) and injection well (WWRX_I5), along with delineation wells drilled to date in the West White Rose Pool development area (Figure 4.6.1). Development wells outside the pilot region were purposely excluded from the model as the pilot scheme objectives include evaluating reservoir connectivity, which is essential for guiding the placement of additional development wells.

Figure 4.6.1 and 4.6.2 are the tertiary plan and cross-sectional views of the Proponent's base case reservoir simulation model, which indicate the highest concentration of oil (in green) within the west-southwest region of the pool, proximal to the O-28Y and O-28X delineation wells. The model depicts high gas concentrations to the north, where NG4 (J-22 3) is located. This section of the West White Rose pool is part of Husky's gas storage area. The south-west portion of the field is modeled as entirely water saturated.

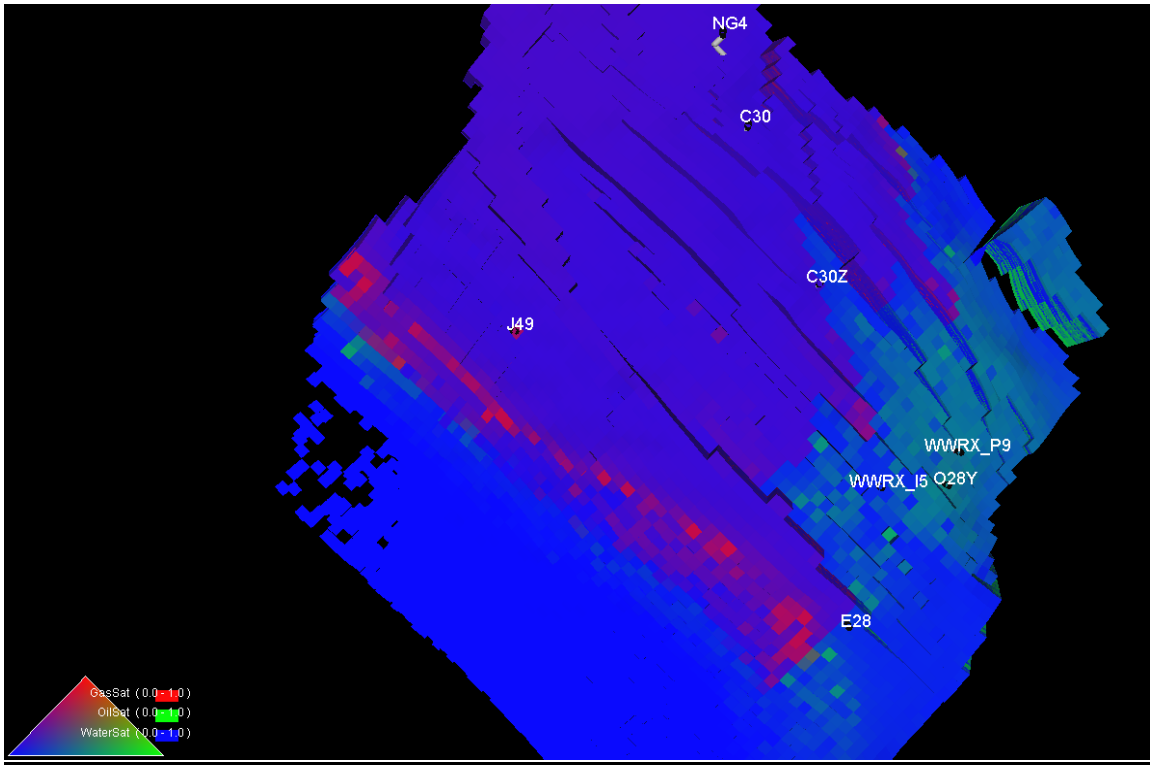


Figure 4.6.1: Plan view of the Tertiary diagram of the reservoir simulation model of the West White Rose Field. (Source: C-NLOPB)

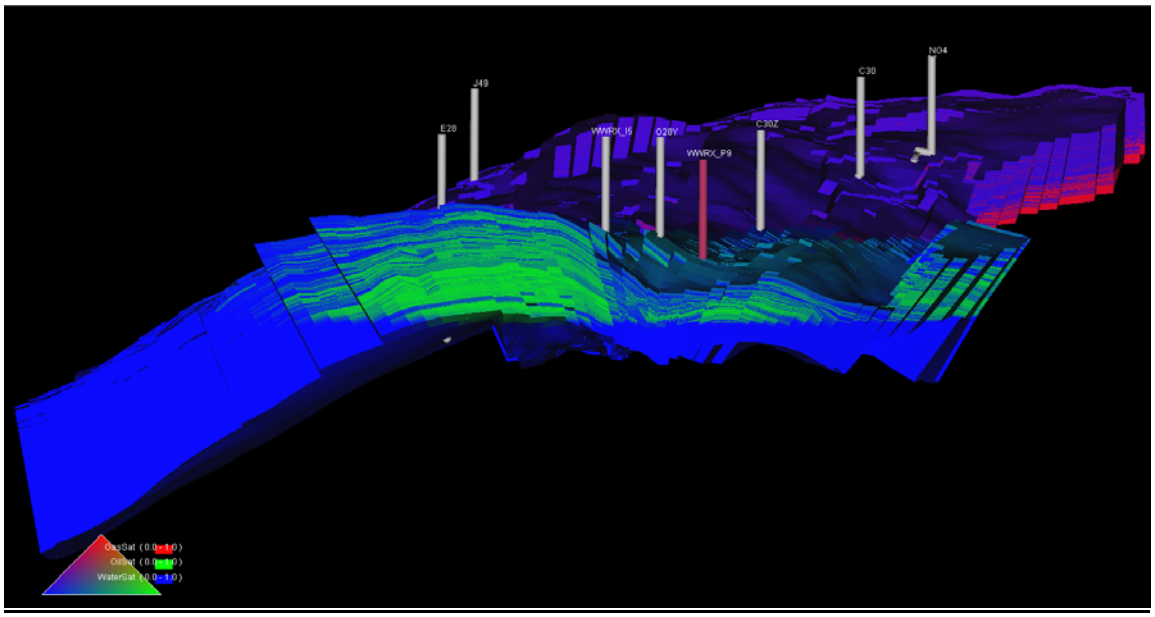


Figure 4.6.2: Westward looking side view of the Tertiary phase view of the West White Rose field at Year 0 (Source: C-NLOPB)

Figure 4.6.3 is an eastward looking, cross-sectional slice of the West White Rose Pool depicting a gas gap overlying the oil leg in the area of the E-28 delineation well.

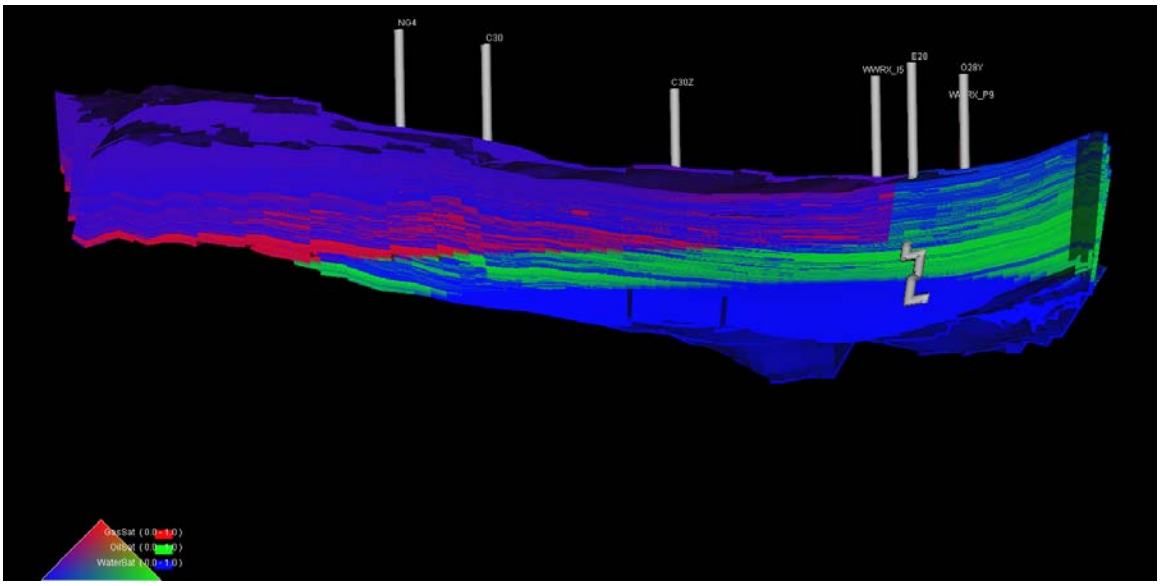


Figure 4.6.3: Eastward looking side view of the Tertiary phase view of the West White Rose field at Year 0 (Source: C-NLOPB)

The reservoir simulation model assumes production from the West White Rose pilot well pair from 2010 to 2030; however, the timing of the submission of the development plan along with the current drilling schedule makes 2011 the most likely time for first oil from the West White Rose Pool. Although the reservoir simulation model runs to 2030, the Proponent indicates that the field life of the West White Rose Pool development area will depend on utilizing the SeaRose FPSO and the actual performance and economic limit of the pilot pair, making 2025 the most likely production end date. Reservoir simulation results presented assume an end date of 2025.

The Proponent uses Petroleum Experts Software IPM (Integrated Production Model) to predict well performance. This software accounts for the Eclipse results and considers the hydraulic model for the well and subsea infrastructure when preparing a prediction. The reservoir simulation results presented in this document are the results from Eclipse without applying adjustment from the IPM software.

The Proponent submitted four reservoir simulation cases, namely a base case and low, medium, and high cases. The geological model for the West White Rose Pool used permeability values based on the petrophysical analysis of the delineation wells. According to the Proponent, horizontal permeability was not adequately represented in the upscaled reservoir model, so permeability multipliers were used in each of the simulation cases. In the base and medium cases a multiplier of 1.5 was used, the high case used a multiplier of 3.0 and the low case used a multiplier of 0.75. The use of these multipliers was reviewed and corroborated by three independent methods: streamline modeling, petrophysical re-assessment of log vs. core permeability and well-test modeling of C-30z. The other major difference between each of the simulation cases was the manner in which faulting was treated. In the high and base cases, fault transmissibility was based on fault analysis software employed by the Proponent, which is an acceptable practice when developing a reservoir simulation model. The medium and low cases assumed all faults to be sealing. The low case also assumed certain vertical barriers to be sealing, and a more pessimistic relative permeability relationship.

The low, medium and high cases are presented in this analysis. These results are based on the reservoir simulation models submitted by the Proponent, but run independently by Board staff. Results were also time shifted to assume first oil from the West Pilot Project in January 2011 and run until 2025. Any influence from further development of the West, or other satellite to be developed by the Sea Rose was not taken into consideration when running these cases.

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

- Oil Production Rate 22, 000 m^3/d (138,376 bbls/d)
- Water Production Rate 28,000 m^3/d (176,114 bbls/d)
- Total Fluid Production Rate 33,000 m^3/d (207,563 bbls/d)

- Total Gas Production Rate 4.2 x 10^6 m3/d (1.5 x 10^8 scf/d)
- Peak Field Water Injection Rate 44,000 m^3/d (276,751 bbls/d)
- Water Injection Rate per Glory Hole 30,000 m^3/d (188,694 bbls/d)

In addition to these field constraints, the Proponent set well constraints to the pilot well pair. These well constraints are set at the following levels:

- Maximum Oil Production Rate 5,000 m^3/d (31,449 bbls/d)
- Maximum Surface Liquid Rate 5,000 m^3/d (31,449 bbls/d)
- Maximum Reservoir Fluid Rate 9,000 m^3/d (56,608 bbls/d)
- Gas Lift 100,000 m3/d (3.5 x 10^6 scf/d)
- Minimum Tubing Head Pressure 5,500 kPa
- Maximum Water Injection Rate 5,000 m^3/d (31,449 bbls/d)
- Maximum Bottom Hole Pressure 65,000 kPa
- Maximum Tubing Head Pressure 30,000 kPa

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

4.7 Results of Reservoir Simulation and Production Forecasts

4.7.1 Oil Production

Reservoir simulation was utilized to generate the production profiles of the West White Rose Pool for its base, high, medium and low case. The Proponent's high case reservoir model predicts that oil production will initially peak at 2000 m^3/day (high case), but will then begin to decline (Figure 4.7.1.1) to 1500 m^3/d before the end of the first year of production. The low case reservoir model predicts that oil production will initially peak at 830 m^3/day (low case), but will decline (Figure 4.7.1.2) to 450 m^3/d before the end of the

first year of production. The simulation model considers production from the West White Rose Pool along with the North Amethyst Field and South Avalon Pool under the constraints of the SeaRose FPSO facility. The resulting West White Rose Pool production profile reflects these factors.

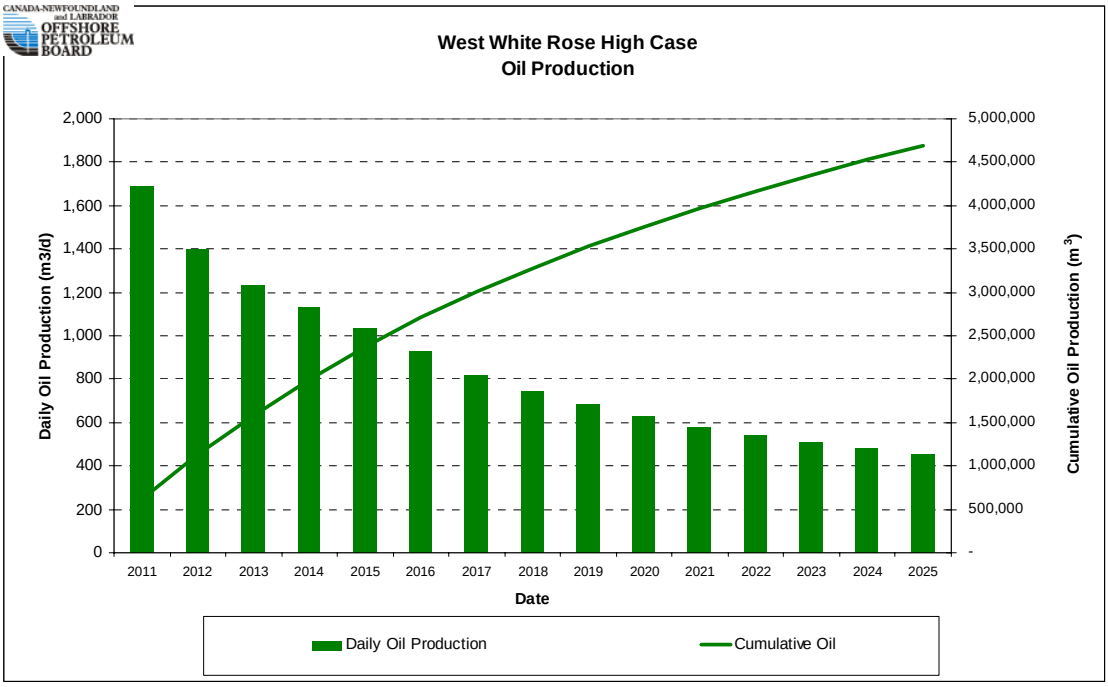


Figure 4.7.1: West White Rose High Case Oil Production Forecast (Yearly Daily Average) (Source: C-NLOPB)

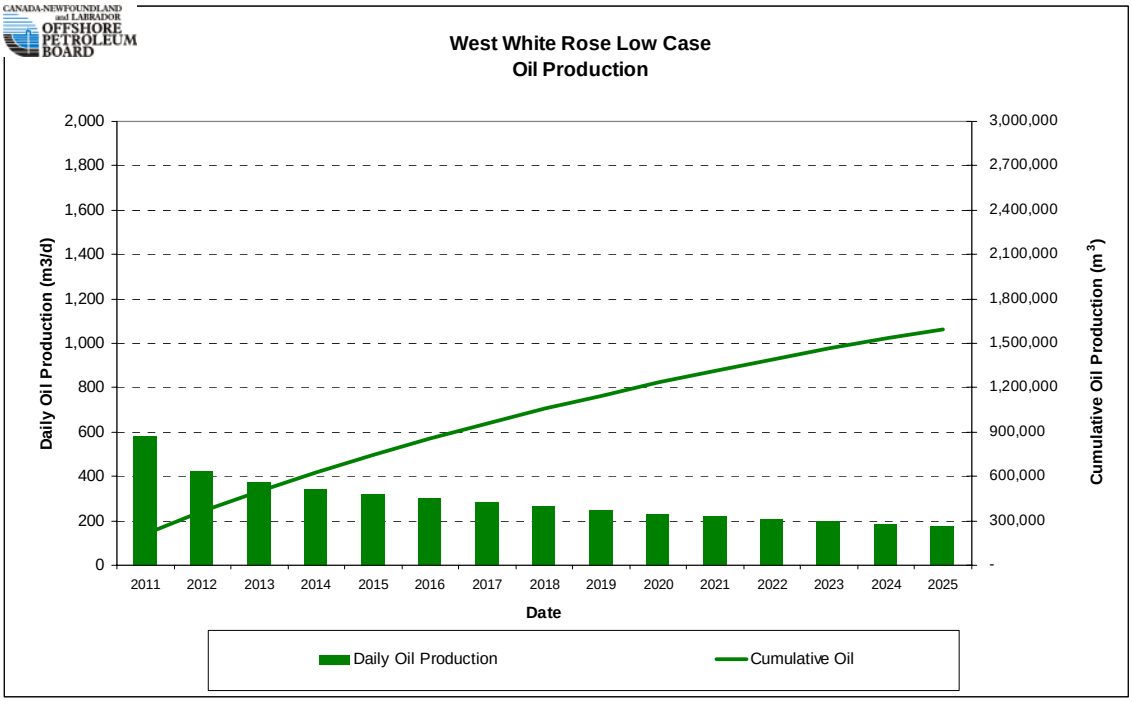


Figure 4.7.2: West White Rose Low Case Oil Production Forecast (Yearly Daily Average) (Source C-NLOPB)

Figure 4.7.1.3 shows the High, Medium and Low Case plotted together. By observing cumulative production to the end of 2025, the range of ultimate recovery from the West White Rose pilot well pair ranges from the low case of 1.60 million m^3 (10 MMbbls) to the high case of 4.69 million m^3 (29.5 MMbbls), with the medium case being 2.96 million m^3 (18.6 MMbbls).

For the period of the pilot pair scheme (two years) the amount of oil production that is anticipated ranges from the low case of 0.371 million m^3 (2.33 MMbbls) to the high case of 1.17 million m^3 (7.34 MMbbls), with the medium case being 0.702 million m^3 (4.41 MMbbls).

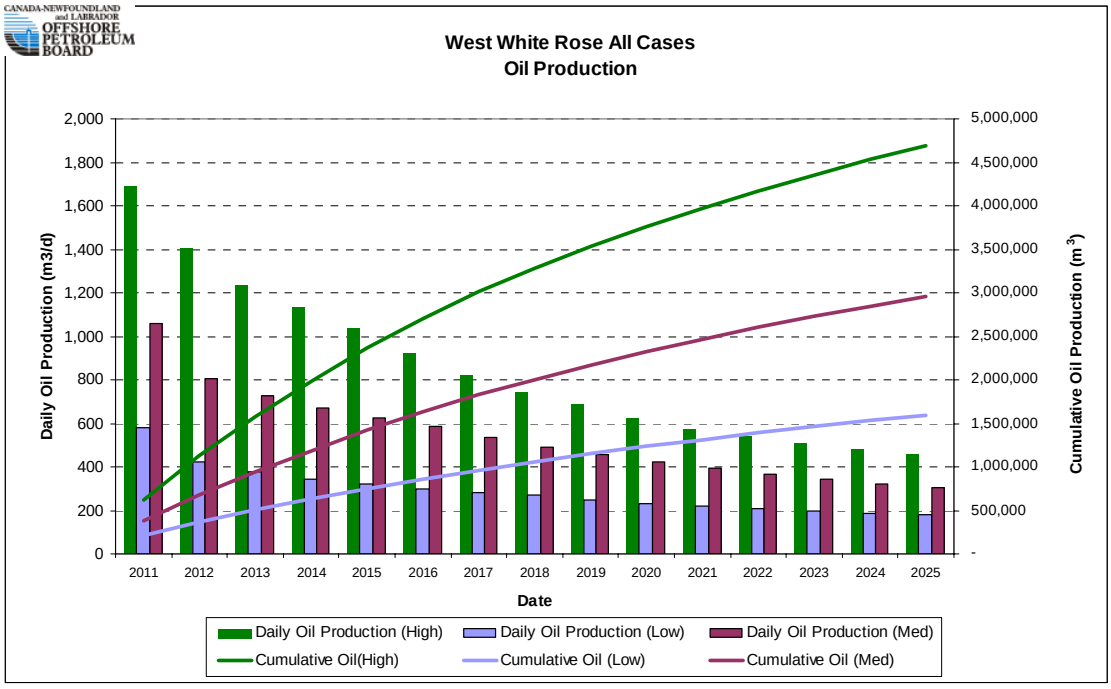


Figure 4.7.3: North Amethyst Simulation Model Oil Production Forecast (Yearly Daily Average Oil Rate) (Source: C-NLOPB)

4.7. 2 Gas Production

Figures 4.7.2.1 and 4.7.2.2 depict the gas production profile from the Proponent's High and Low case simulation model. In all cases, the GOR remains consistent throughout the life of the pilot well pair, indicating that gas production is a function of oil production.

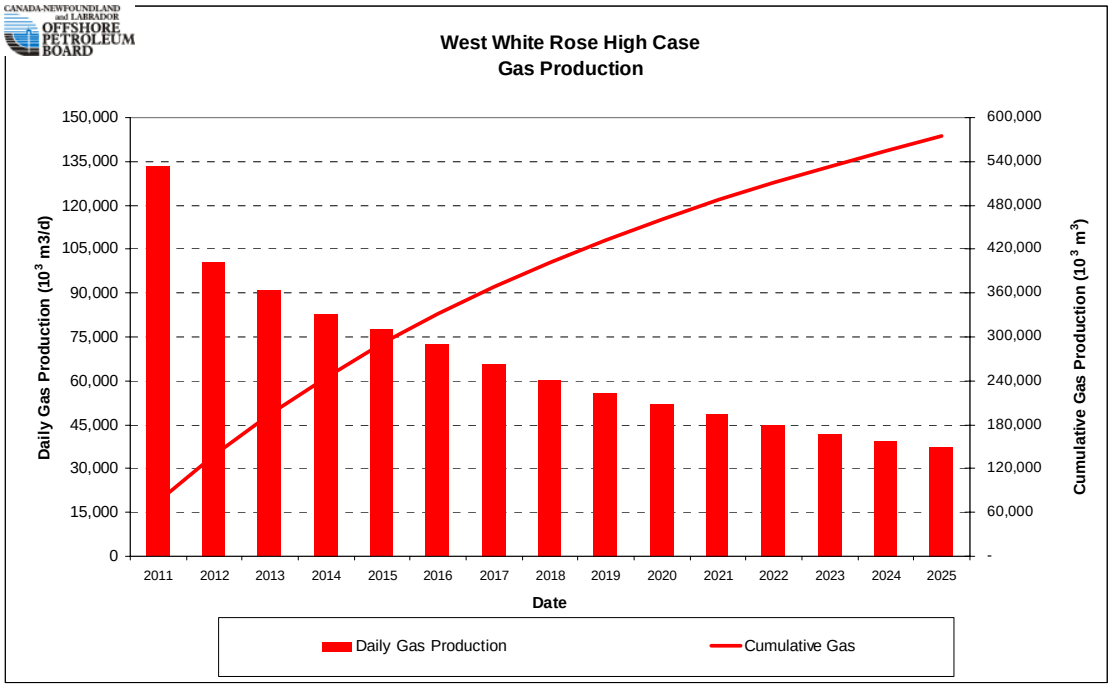


Figure 4.7.4: West White Rose High Case Gas Production Forecast (Daily Average) (Source: C-NLOPB)

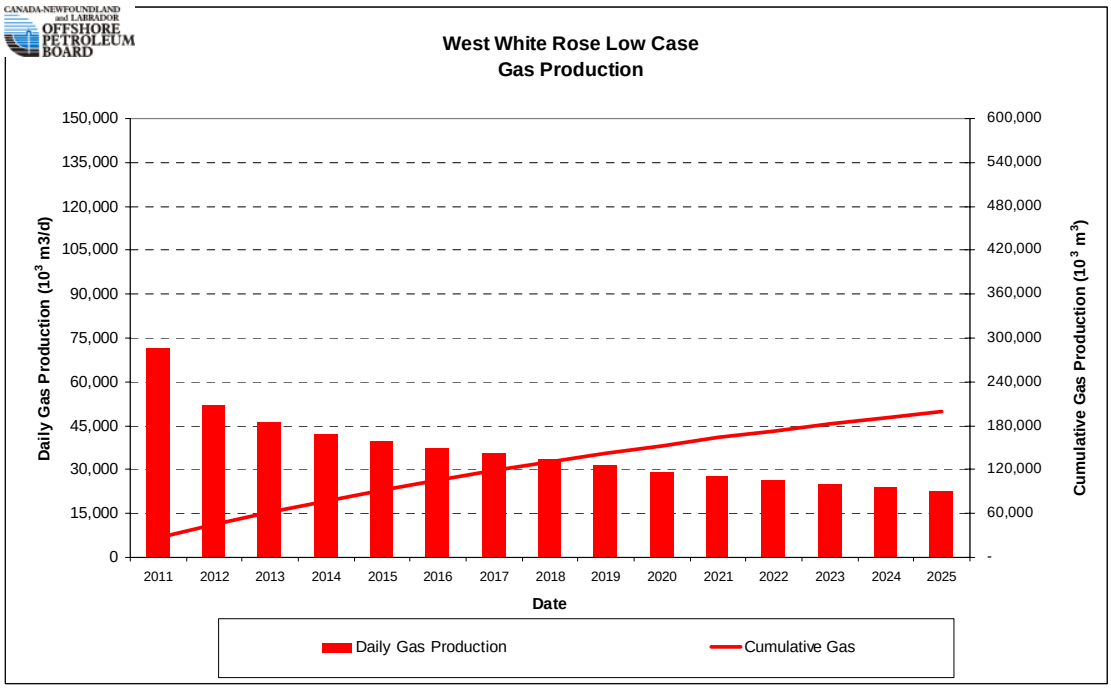


Figure 4.7.5: West White Rose Low Case Gas Production Forecast (Daily Average) (Source: C-NLOPB)

4.7.3 Produced Water

In high case, the Proponent's simulated water production profile (Figures 4.7.3.1) indicates water production early in the life of the pool with gradually increasing water cuts as high as 45% at the end of the production period (2025). A similar trend was found in the other cases.

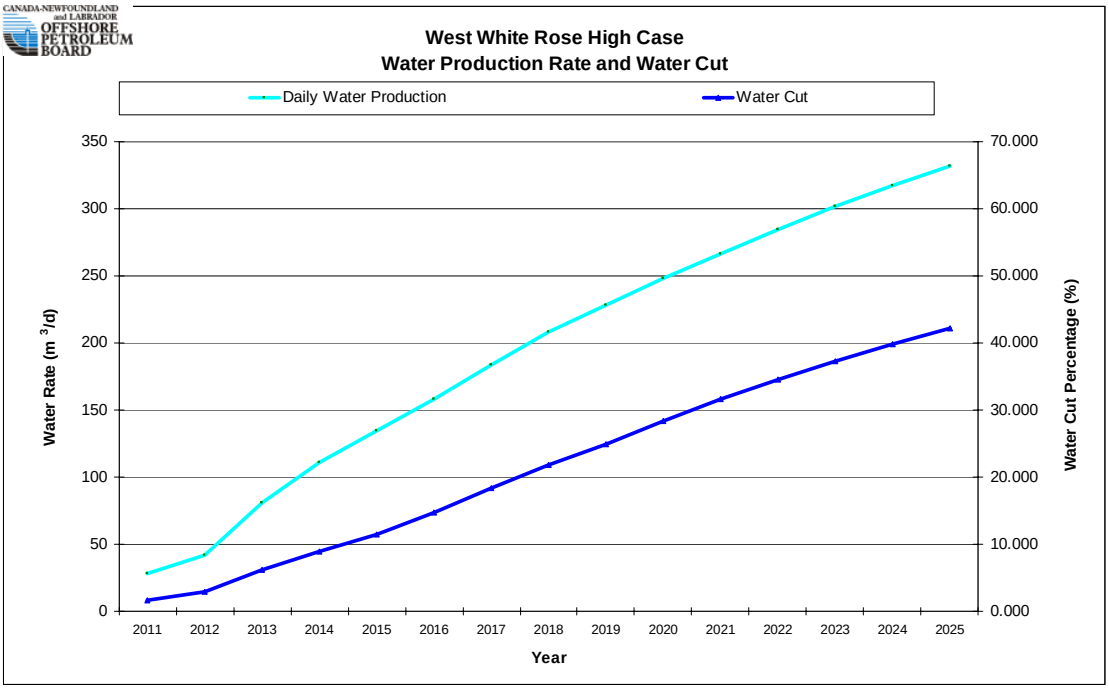


Figure 4.7.6: West White Rose High Case Simulation Model Water Production Forecast (Daily Average) (Source: C-NLOPB)

Water production from the West White Rose pilot well pair is low in relation to the SeaRose produced water handling constraint of 28,000 m^3/d, as it only reaches 332 m^3/d in the high case. This amount represents less then 1% of the SeaRose water handling capacity, and as such is not considered to pose any significant challenges.

4.7.4 Reservoir Pressure from West White Rose Reservoir Simulation

The field pressure profile relative to bubble point is presented for each simulation case for the two-year evaluation period (Figure 4.7.4.1). The bubble point used for the West White Rose Pilot Region (29,710 KPa) was taken from the O-28Y Differential Liberation Oil PVT Summary. As depicted in Figure 4.7.4.1, the regional pressure drops in all cases during the initial six-month primary production period. Following this period, pressure slowly increases as the injector comes on line. In the case of the medium and high cases, regional pressure drops below bubble point, but in the high case, regional pressure gets back to bubble point following nine months of injection. In the medium case, regional pressure stabilizes just below bubble point. In the low case, regional pressure does not drop below bubble point during the initial six month primary production period. However, pressure continues to drop once injection has been established, suggesting very poor communication between the producer and the injector.

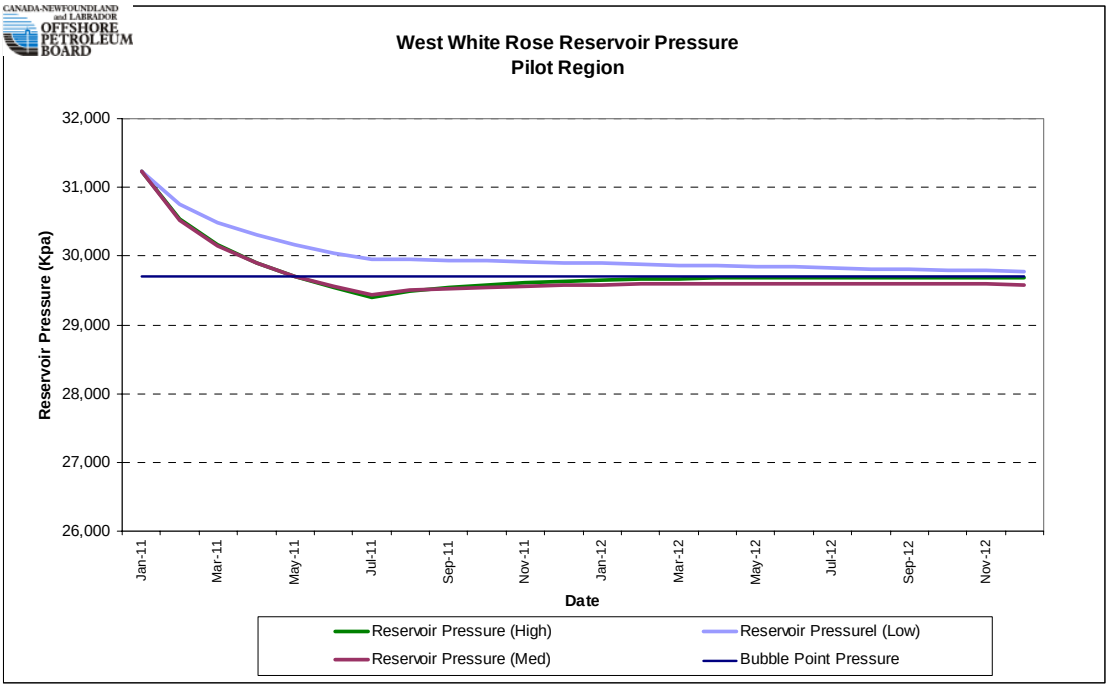


Figure 4.7.7: West White Rose Pilot Region Reservoir Pressure (Source: C-NLOPB)

The effects of producing the pilot production well on primary for a six month period raised concerns for Board staff as it is normally preferable for pressure to be maintained

above bubble point. However, in the context of a pilot project, the pressure management scheme outlined by the Proponent is reasonable given the need to understand issues like injectivity and communication between the producer and injector. In addition, reservoir simulation cases were run by the Proponent to evaluate the effects of the primary production period and it was found to have negligible long term effects on ultimate oil recovery from the pilot producer, as illustrated in Figure 4.7.4.2.

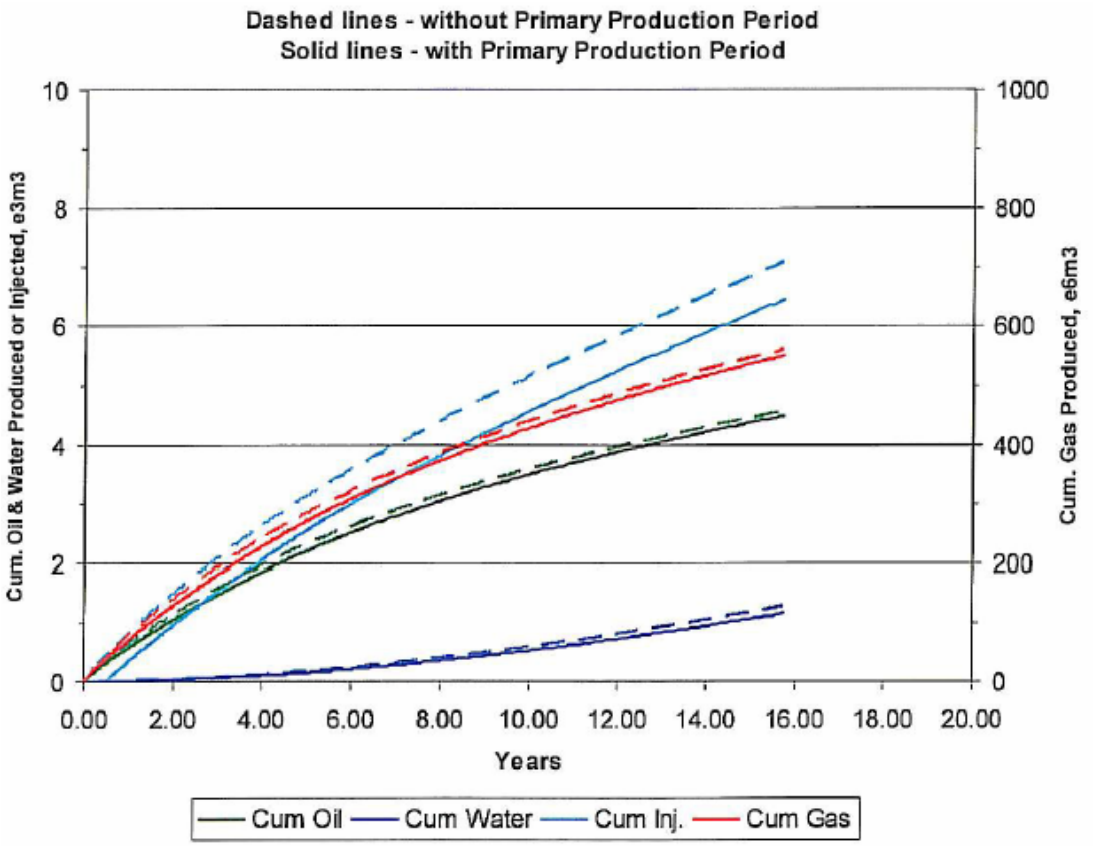


Figure 4.7.8 – Effects of Primary Production (source Husky)

Staff agree with the Proponent's proposed six month primary production period. However, the Proponent must not significantly alter the pilot scheme as outlined in the Application without Board approval.

4.7.5 Reservoir Simulation Summary

The Proponent used the available geological and reservoir engineering information to develop a reasonable reservoir simulation model. The model and cases submitted concentrate on the pilot area addressed by the Proponent's application without addressing further full field development of the West White Rose pool. Staff analysis indicates the current West White Rose reservoir simulation is adequate in the context of a pilot scheme. Further reservoir simulation work to develop a depletion plan strategy will be required in a full field development.

4.8 West White Rose Pilot Scheme In Relation To Full White Rose Field Development

Staff had concerns with potential effects of implementing a pilot scheme in the West White Rose Pool on South Avalon and North Amethyst production. The pilot well scheme will utilize two slots from the Central Glory hole. The Proponent indicated in the response to the request for additional information that the two 10" production lines from the Central Glory Hole have adequate hydraulic capacity to ensure the predicted well deliverability can be achieved without impacting the overall recoverable reserves from South Avalon and North Amethyst over the life of the field. This is illustrated in Figure 4.8.1 which was generated by the Proponent using their Integrated Production Model (IPM). Overall, no impact on the manifold or development in South Avalon and North Amethyst is anticipated.

Also the Proponent has indicated that pilot producer will have equivalent equipment and testing allocation as the current South Avalon CDC wells. The well will have the same model for well estimation (Idun) as South Avalon and be able to routed to test separator for routine testing. It will operate within the approved White Rose Flow System Application.

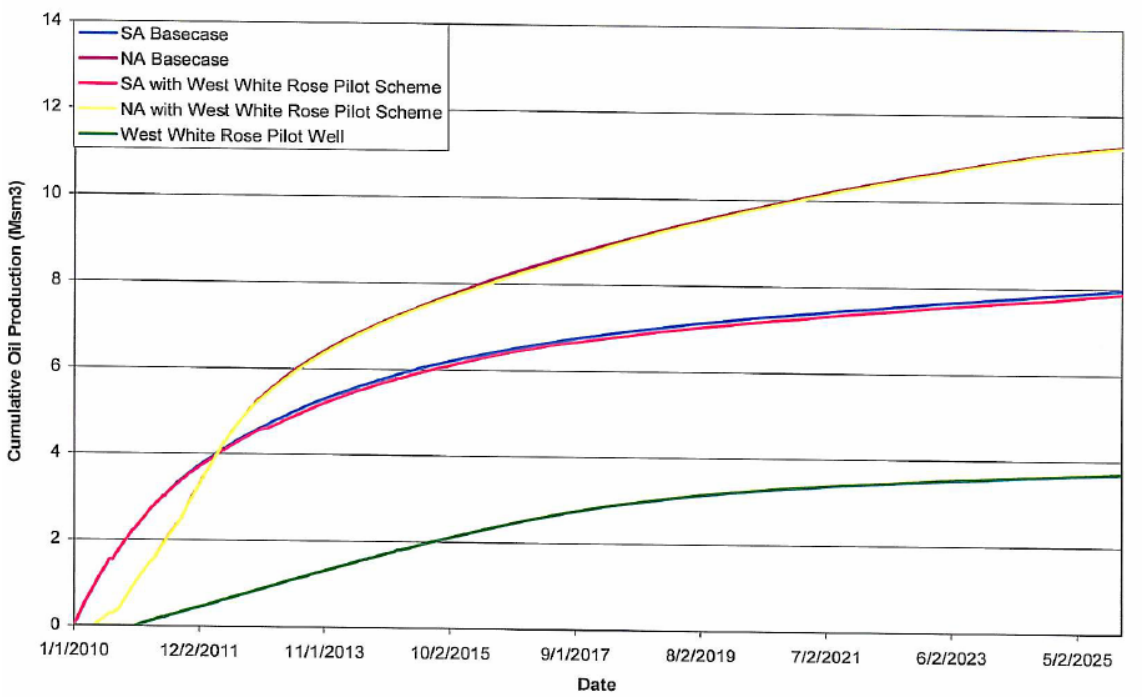


Figure 4.8.1 – Impact of West White Rose Pilot Scheme (Source: Husky)

4.8.2 Gas Management from Pilot Pair in Relation to Full White Rose development

The Proponent plans to re-inject produced gas from the pilot scheme into the Northern Drill Centre (NDC) for storage as is done with produced gas from South Avalon. A gas storage strategy was submitted by the Proponent in March, 2009. The cumulative volume of produced gas from the pilot scheme is expected to be within the remaining gas storage capacity.

A portion of the produced gas from the pilot scheme will also be used for fuel gas and flared in the same manner as South Avalon produced gas. An additional volume of flare gas will be issued to the Proponent for their annual flare gas consent volume prior to the start of pilot scheme production.

4.8.3 Water Injection Management for Pilot Pair in Relation to Full White Rose development

The water injection profiles from the West White Rose pilot scheme, White Rose and North Amethyst reservoir simulations were reviewed to determine the effect of the pilot pair on the water currently being injected by the Sea Rose FPSO. The following graph displays the simulated water injection rates for each development area, the combined water injection rate and the water injection capacity of the Sea Rose FPSO (44,000 m^3/d). As can be seen from the graph, the water injection rate for the WWR pilot project is low compared to the rates for the White Rose and North Amethyst. The total water injection from all three developments projects peaks at approximately 38,600 m^3/d in 2012. This peak is well below the water injection capacity of the Sea Rose FPSO, allowing further opportunities for development during the remainder of field life.(Figure 4.8.3.1)

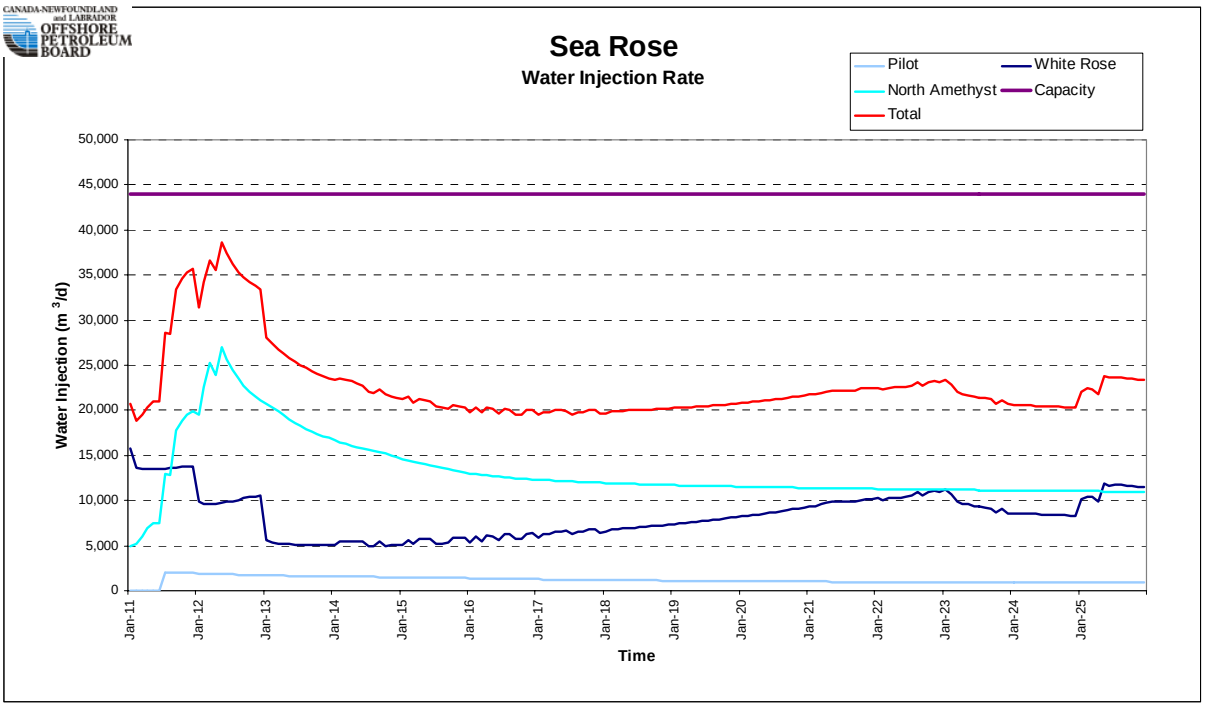


Figure 4.8.2 West White Rose Pilot Region Reservoir Pressure (Source: C-NLOPB)

Based on this review, the WWR pilot is not anticipated to have significant impact on the water injection capacity of the Sea Rose FPSO.

4.9 Commercialization of Pilot Pair Area

When there are multiple licenses with varying interest owners in a pool or field, it is important for proper development of a pool or field that all interest owners have due regard for sound engineering and economic principles and cooperate to prevent waste. This is typically accomplished through a unitization agreement. In the case of the West White Rose Pool, the Proponent advises that the interest holders in PL 1007 and SDL 1024 support the Application. However, it does not mention SDL 1025 in which Nalcor does not have a royalty share. Any commercial arrangement should address the interest of the royalty owners. These arrangements could affect the measurement requirements and may require amendment of the flow system and the flow calculation and allocation procedures approved by the Board's Chief Conservation Officer.

In conclusion, the Board's staff concurs with the proposed depletion scheme for the West White Rose pilot schemes. 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, as the licences may be subject to different royalty arrangements, the interests of the royalty owners must be considered as in the case of SDL 1025 where exploitation of the resource could occur from the pilot scheme. **Therefore, prior to permitting production from the West White Rose pilot project, the Board's staff advise that the commercial agreements be filed with the Board along with royalty owners' concurrence with the agreements.**

4.10 Conclusions and Recommendation

Staff have the following conclusions:

- Pressure data, fluid analysis and geological data confirm that the West White Rose pool is consistent with other pools in the White Rose Field. However, the West White Rose pool is significantly more geologically complex than the producing South Avalon pool. This complexity implicates numerous technical risks, including vertical barriers to fluid flow, fault seal, reservoir compartmentalization, reservoir connectivity and reservoir quality.
- Staff acknowledge the uncertainty associated with in-place volumetric estimates presented by the Proponent for the West White Rose Pool, and expect that technical information obtained from the pilot pair scheme will reduce this uncertainty. Staff note that reserve estimates were excluded from the Application as the pilot pair scheme objectives include constraining the recovery factors, which are essential for estimating the recoverable hydrocarbons. Detailed volumetric and reserve estimates for individual fault blocks and reservoir subdivisions will be required in the pilot pair final report and subsequent development plan application for full-scale West White Rose pool development.
- The proposed location for the pilot pair is within the highest quality reservoir encountered to date within the West White Rose Pool. The high reservoir quality will permit a better evaluation of faulting and barrier influences. Staff concur with placing the pilot pair in the region delineated by O-28Y well in the context of obtaining clear, indicative results to evaluate the development potential of the West White Rose pool.
- Staff concur with the sequence and objectives of the Proponent's pilot scheme. It is expected that results of the pilot pair will be the basis for a full depletion plan for the West White Rose area as outlined in the Proponent's Application.
- The Proponent's reservoir modelling and simulation are reasonable and appropriate within the context of a pilot scheme.

- Reservoir simulation indicates that the SeaRose FPSO facilities can adequately handle production from the proposed pilot well pair with minimal impact on South Avalon and North Amethyst production.

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

Condition 1:
Six months after first oil from the pilot scheme an interim report outlining the primary production results from the pilot producer must be submitted and accepted by the Board.

Condition 2:
No later than two years after first oil from the pilot scheme, the Proponent must provide a report, which is acceptable to the Board, on the analysis of the pilot pair results. This report will outline how the results relate to a better understanding of West White Rose pool in terms of recoverable reserve ranges and a depletion strategy.

Condition 3:
If reservoir performance and/or characteristics vary significantly from that predicted in the Proponent's Application and/or if it is determined that the pilot scheme is adversely affecting potential petroleum recovery in the West White Rose pool, the Board may reassess the merits of the pilot pair scheme.

Condition 4:
The Proponent must not alter the pilot scheme as outlined in the Application without Board approval.

Condition 5:

Prior to initiating production from the West White Rose Pilot Scheme, a unitization agreement among licence holders for the White Rose Significant Discovery Area shall be submitted to the satisfaction of the Chief Conservation Officer.

5.0 OPERATIONS AND SAFETY

The safety review of the Application focused on an assessment of the Proponent's plans to drill a producing well and a water injection well as a pilot scheme in the central drill center in order to obtain further information for evaluation of the potential development of the West White Rose pool.

The plan is to develop this area by using the existing central drill centre, tying in the production and water injection manifolds via sub sea flow lines and a sub sea stacked spool arrangement and drilling the pilot scheme wells utilizing a semi-submersible drilling installation. This is consistent with the approach approved in the original development plan. In this regard, the Proponent is not planning to use any unconventional technology.

The Proponent is planning to use an existing glory hole as the means of protecting the sub sea templates, wellheads, production trees and manifolds against scouring icebergs. This is an acceptable methodology for sub sea developments as approved in the original White Rose Development Plan. The Proponent designed the sub sea system in the existing central drill center with sufficient flexibility to allow for potential future development of additional wells for the West White Rose pool. This allows the West White Rose pilot scheme to be tied back to the Sea Rose FPSO via the central drill center. Potential future development of the West White Rose pool would require augmenting available capacity on the Sea Rose FPSO.

5.1. Drilling and Completions

Safety risks to personnel will arise during the various phases of development, including drilling and completions and subsea equipment installation programs. The drilling and

completions activities will be carried out using the Proponent's existing White Rose field processes and systems. In particular, drilling hazards and mitigative measures are covered by the Proponent's existing Quantitative Risk Analysis (QRA) and drilling contractor's Operational Integrity case. In addition, the final design of the drilling program of the pilot wells will be reviewed during the Approval to Drill a Well (ADW) process and the completion design and installation plan will be outlined and assessed in the Completion program.

5.2. Subsea Equipment Installation, Commissioning and Operation

The safety standards for the proposed installation activities are based on experience with similar previous programs. The production well for the proposed West White Rose pilot scheme will be drilled through an existing well slot and will tie into an existing production manifold. In order to achieve this, a stacked spool arrangement is proposed to accommodate this tie-in. As a result, the top of the stacked spool will be higher than the existing equipment in the central drill center with a reduced clearance of 1.4 meters instead of a clearance of 2.2 meters.

Given a reduced clearance with the stacked spool arrangement, there is potential for an iceberg to snag the spools. It was considered that the spool would not survive an iceberg impact resulting in major deformation of the spool. Husky conducted a study - *West Pilot Wells CW1/CP and Stacked Rigid Spool Study of Load Transfer under Iceberg Snag (WX-S-93-U-TN-00011-001)* - to determine the impact of the failure of the spool on other equipment in the glory hole.

The maximum load that the iceberg keel imparts on the spool pipe is limited by the crushing strength of the ice. The spool pipe transmits the load to the connecter. Although the yield strength of the connecter is less than that of the pipe, the connecter is much larger and therefore, the pipe will fail before the connector. Once the pipe fails, it

can no longer transmit any load to the connector and therefore, the connector will not fail when an iceberg snags the spool pipe.

The maximum load on the spool pipe due to iceberg impact was analyzed considering the loading in two orthogonal directions. The maximum load that the spool pipe imparts on the Christmas tree and the manifold is limited by the load capacity of the spool pipe. The Christmas tree and manifold were designed for fishing gear snag load which is greater than the load from the spool pipe.

Therefore, in the event that an iceberg snags the spool pipe, the integrity of the Christmas tree and manifold are not compromised.

Otherwise, the installation activities associated with the proposed West White Rose Pilot scheme do not raise any new safety concerns from the Staff's perspective particularly as the Proponent has demonstrated the ability to execute such programs successfully in the past.

5.3. Modifications to Installation

As the project moves into the detailed engineering phase, modifications will be made to the various control systems on board the Sea Rose FPSO, including an update to the Integrated Control and Safety System (ICSS) on topsides and a new master control station. The Proponent will use the existing management of change process for the modifications on the Sea Rose. Any modifications will require the involvement of the Certifying Authority in particular during the various design, installation and commissioning activities.

5.4. Safety Analysis

The Proponent will utilize existing systems and processes for assessing any identified risks related to the implementation of the West White Rose Pilot scheme. A Process Hazard Analysis (PHA) was conducted as part of the design process to examine the safety and operability aspects of the interconnection of the two wells to the manifold. This PHA did not identify any safety issues. The C-NLOPB will however, require the Proponent to address the simultaneous operations issues associated with installation activities and drilling and completions in the central drill center. Should there be further development of the West White Rose pool; a project safety assessment will be completed.

5.5. Existing Plans and Procedures

The Proponent's existing systems and processes for assessing risks of planned operations, modifications or changes will be used in relation to the implementation of the West White Rose pilot scheme. The Proponent's existing operations and maintenance policies and procedures, ice management plan, contingency plans, logistical support, communications, vessel surveillance and production safety protocols will also apply to the implementation of the West White Rose pilot scheme. These documents were effective for the development and operation of the previous White Rose and North Amethyst fields. The subsea and subsurface operating procedures however, will require an update to reflect the slight variation in stack spooled arrangement.

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. The Proponent should follow up with the C-NLOPB on the following matters as the project proceeds:

- When the project proceeds to the engineering design phase, the Proponent will keep 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 operational procedures must be made by the Proponent in accordance with its management of change process.

- As a matter of course, the Simultaneous Operations Risk assessment process to be completed to examine the risks associated with the West White Rose Pilot scheme and submitted to the C-NLOPB for review.

6.0 Protection of the Environment

The Board's staff reviewed the Proponent's Application to determine whether the White Rose Development Plan Amendment – West White Rose – Pilot Scheme raises any new environmental issues.

The additional development activities described in the Application were within the scope of project assessed in the White Rose Comprehensive Study Report, and will not require modification of the existing Environmental Protection Plans (EPPs) for Production and Drilling Operations at the White Rose project.

The Board's staff has concluded that the Application does not require additional environmental assessment pursuant to the Canadian Environmental Assessment Act and recommends that no environmentally related conditions be attached to the current approval.

7.0 Industrial Benefits

In the Application, the Proponent indicates that the White Rose Canada-Newfoundland and Labrador Benefits Plan and the regulatory requirements of Decision 2001.01 are applicable to the West White Rose Pilot Scheme. Consequently, staff has considered whether a Benefits Plan Amendment is required as well.

The capital cost of the Pilot Scheme is $250 million, consisting of drilling and completions ($130 million) and installation of subsea infrastructure ($120 million) for two wells. Drilling and completions will be carried out using existing contracts and services. Subsea infrastructure required for the Pilot scheme includes Christmas trees, wellhead equipment, rigid and stacked spools, gas lift jumpers, subsea control distribution equipment and gas lift distribution system. Some of this equipment is not manufactured in Canada. Items which can be fabricated in the Province and Canada are rigid spools and fabrication of subsea structures. The Proponent posted Expression of Interests for these items in 2009. Overall, Board staff is satisfied that the Proponent has well established procurement procedures in place that ensure local and Canadian suppliers are afforded opportunities to supply goods and services for the West White Rose Pilot Scheme.

Therefore, staff determined that the proposed pilot scheme will not require an amendment to the existing White Rose Benefits Plan (Decision 2001.01). However, if the Proponent decides to proceed with the full development of the West White Rose pool a Benefits Plan Amendment will be required.