white rose

WHITE ROSE OILFIELD

PROJECT DESCRIPTION

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Husky Oil

EXECUTIVE SUMMARY

Husky Oil Operations Limited (Husky Oil), as the Operator, with joint-venturer Petro-Canada, is proposing to develop the White Rose oilfield, located in the Jeanne d'Arc Basin. White Rose is one of five Significant Discovery Areas operated by Husky Oil in the Newfoundland offshore. Husky Oil has a first oil target in the 2003-2004 timeframe. By submitting this document to the Canada-Newfoundland Offshore Petroleum Board (C-NOPB), Husky Oil and its joint-venturer Petro-Canada initiate the federal environmental assessment process under the *Canadian Environmental Assessment Act* (CEAA) and the Development Application (DA) review process under the *Atlantic Accord Implementation Act*.

Husky Oil and its joint-venturer Petro-Canada have taken an approach to developing the field based on the following principles:

- maximizing returns to shareholders in a socially-responsible way, including demonstrating a high regard for safety and environmental stewardship;
- building on lessons learned from the Hibernia and Terra Nova developments;
- focusing on the specific differences of the proposed White Rose oilfield development;
- initiating early and ongoing communication with regulatory authorities to ensure project planning considers all regulatory requirements;
- conducting a thorough public consultation program, ensuring stakeholders receive early information on the project and have an opportunity to provide meaningful input into project planning; and
- involving the supply community early in the process.

White Rose is located approximately 350 km east of the Island of Newfoundland on the eastern edge of the Jeanne d'Arc Basin. The South White Rose oil pool covers approximately 40 km^2, with an estimated 40 10^6m^3 (million cubic metres) of recoverable oil, which makes the White Rose oilfield development significantly smaller than the previous two oil and gas developments on the Grand Banks (Hibernia and Terra Nova developments). Considerations related to the development of potential small ancillary oil pools in the area will be discussed in the DA. Considerations relating to the evaluation of gas resources in the White Rose area will also be outlined in the DA.

Husky Oil and its joint-venturer have initiated several studies to detail the development of the White Rose oilfield. Development of an initial reservoir depletion plan is ongoing and expected to be outlined by May 2000. Further work to refine the plan will be ongoing. Based on work to date, the South White Rose oil pool will require 10 to 14 production wells. To maximize oil production, reservoir pressure will be maintained by injecting water into an additional six to eight strategically placed wells. It is also planned to inject surplus produced gas into the reservoir for gas conservation and to assist in pressure maintenance. The process facilities will be custom-designed to process the reservoir fluids from the White Rose oilfield. The facilities will have a 20-year design life, and will comply with all statutory safety and environmental requirements.

In November 1999, Husky Oil initiated a concept selection study to identify the potential alternatives for developing the White Rose oilfield. Husky Oil has analyzed eight production concepts, which were further analyzed with respect to construction time, capital costs, concept maturity, concept deliverability, and risk and Canada-Newfoundland Benefits considerations. The concept selection study concludes that the preferred production system for the White Rose oilfield development is a steel floating production, storage and offloading (FPSO) facility similar to that selected for the Terra Nova Development.

A typical subsea solution for the floating production facility consists of templates, manifolds, flowlines, umbilicals and risers. The main method of iceberg scour protection will be dredged glory holes, with the possibility of using a caisson system at strategic locations to optimize field layout.

Construction of the floating platform will be separated into two major components; the FPSO hull and the topsides equipment modules. The operation of the White Rose oilfield development will be managed by Husky Oil as operator of the field from Husky Oil's office in St. John's, employing both company and third-party expertise. At the end of the production life of the White Rose oilfield, the operator will decommission and abandon the site according to C-NOPB requirements and *Newfoundland Offshore Area Production and Conservation Regulations*. The FPSO facility will be removed from the White Rose oilfield. Subsea infrastructure will be removed and the wells will be plugged and abandoned.

In creating the framework for developing the White Rose oilfield, Husky Oil has documented specific *Canada-Newfoundland Benefits Guidelines* which recognize Newfoundland and Labrador as one of the principal beneficiaries from the development of oil and gas resources off its shores. Accordingly, full and fair opportunity for residents of Newfoundland and Labrador to participate in the development on a competitive basis will be provided.

Husky Oil recognizes the importance of informing all stakeholders about the project and the value of the input that they provide. The Company is committed to involving all stakeholders in preparing the DA for the proposed White Rose oilfield development, and has initiated a formal consultation program, including focus groups, community public information sessions, and meetings with regulators. Issues raised during consultation activities will be addressed by Husky Oil.

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1 INTRODUCTION

Husky Oil Operations Limited (Husky Oil), as the Operator and in a joint-venture with Petro-Canada, is proposing to develop the White Rose oilfield, located in the Jeanne d'Arc Basin. The White Rose oilfield development is the result of exploration drilling carried out by Husky Oil in the Jeanne d'Arc Basin since 1982. The focus of the proposed development, the South White Rose oil pool, contains an estimated 40 million cubic metres (250 million barrels) of recoverable oil. The project will be the third offshore oil development for Newfoundland and Labrador, following the Hibernia and Terra Nova developments.

This project description presents a summary of the proposed White Rose oilfield development and related information. It describes the components of the proposed project as currently planned. Considerations related to any possible gas development in the northern White Rose area, for which development is not currently proposed, will be outlined. Project details will be refined as information becomes available from ongoing engineering and design studies. By submitting this document to the Canada-Newfoundland Offshore Petroleum Board (C-NOPB), Husky Oil and its joint-venturer Petro-Canada initiate the federal environmental assessment process under the *Canadian Environmental Assessment Act* (CEAA) and the Development Application (DA) process under the *Atlantic Accord Implementation Act*. Husky Oil is committed to carrying out an environmental assessment that fulfils CEAA requirements and preparing a comprehensive DA for the C-NOPB.

1.1 The Proponent

Husky Oil Operations Limited is a Canadian-based, privately held, integrated oil and gas company with headquarters in Calgary, Alberta. The company's operations include the exploration for and development of crude oil and natural gas, as well as the production, purchase, transportation and marketing of crude oil, natural gas, natural gas liquids (NGLs), sulphur and petroleum coke, and the upgrading and refining of crude oil and marketing of refined petroleum products, including gasoline, alternative fuels and asphalt. Husky Oil Operations Limited is a wholly owned subsidiary of Husky Oil Limited.

In January 1998, Husky Oil opened an office in St. John's, Newfoundland. This office manages ongoing exploration and development activities on the Grand Banks and other East Coast business interests. Contact persons for the purposes of the DA and related environmental assessment are:

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East Coast Operations Manager

Mr. Donald Sutherland
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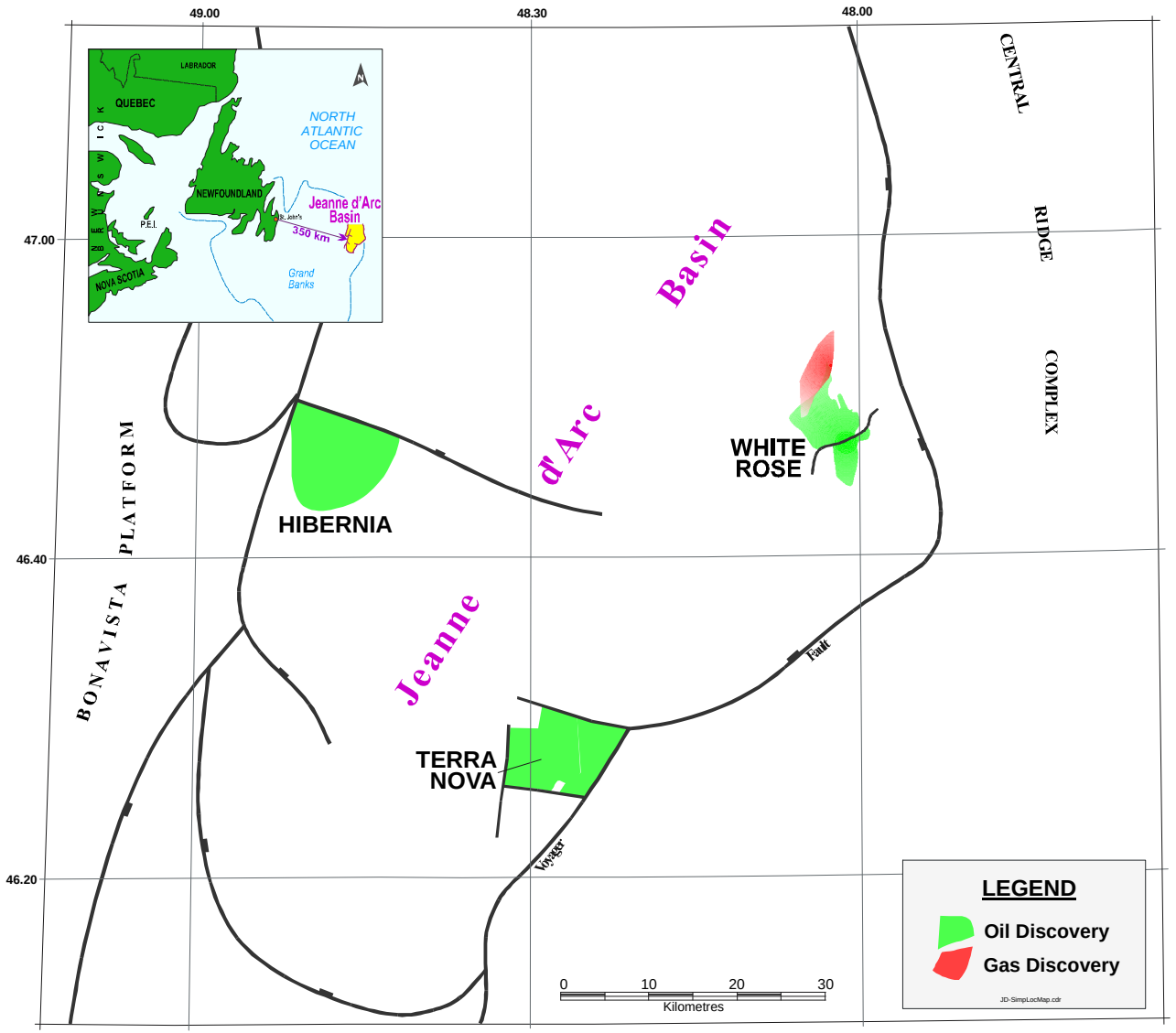
1.2 Project Location

White Rose is located approximately 350 km east of the Island of Newfoundland on the eastern edge of the Jeanne d'Arc Basin (Figure 1.2-1). Husky Oil's land holdings (Significant Discovery Areas and Licenses) in the Jeanne d'Arc Basin are indicated in Figure 1.2-2. The current land holdings are the result of significant investment and an extensive exploration program initiated in 1982 and a series of inter-company and land sale acquisitions over the past 18 years.



Source: Husky Oil

FIGURE 1.2-1

JEANNE d'ARC BASIN

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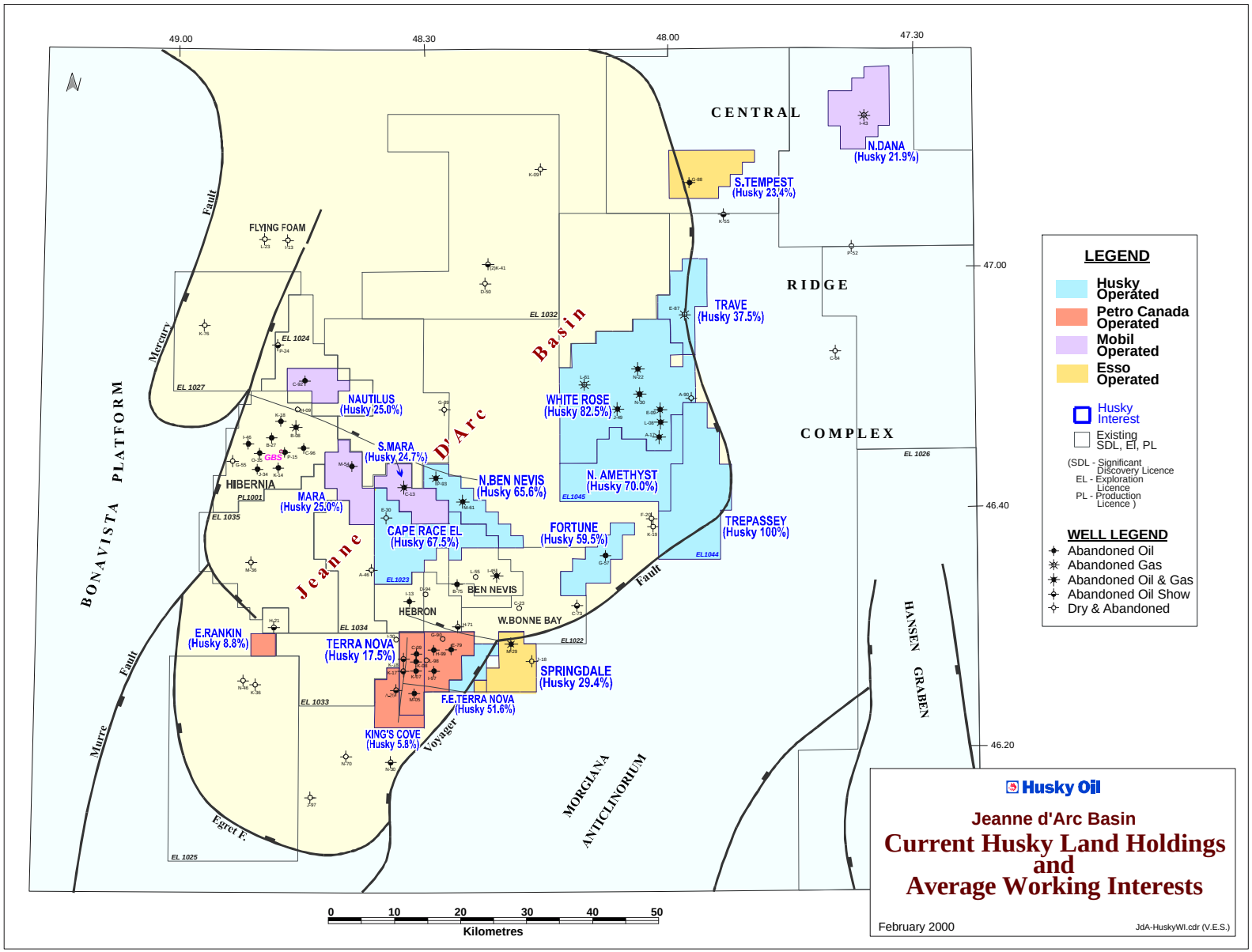

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FIGURE 1.2-2

CURRENT HUSKY LAND HOLDINGS AND AVERAGE WORKING INTERESTS IN THE JEANNE d'ARC BASIN

1.3 White Rose Significant Discovery Area

The White Rose Significant Discovery Area consists of both oil and gas fields or pools, including the South White Rose oil pool and the North White Rose gas pool. The South White Rose oil pool covers approximately 40 km**5**, with an estimated 40 10^6m**;** (million cubic metres) of recoverable oil.

Within the northern and western areas of the White Rose Significant Discovery Area, there is the potential for a number of smaller ancillary oil pools to be in place. Current estimates of potential recoverable oil reserves from these smaller pools is in the range of 10 to 20 10^6m**;** (60 to 125 mmbls from the combined J-49 and N-22 pools). If additional evaluation of these resources determines that economically recoverable reserves exist, it is the proponent's intention to ultimately tie these pools into the White Rose oilfield development infrastructure. Potential reserves, steps planned to obtain additional needed information, factors leading to future development and possible timing for development of these ancillary oil pools will be outlined in the DA.

The White Rose oilfield contains medium-weight crude oil at approximately 30° API. It has a relatively high pour point and wax content. Basic reservoir data are presented in Table 1.3-1.

Table 1.3-1 Basic South White Rose Oil Pool Reservoir Data

Reservoir Characteristic	Data
Reservoir Depth (gas/oil contact) (mSS)	2,875
Oil Water Contact (mSS)	3,000
Initial Reservoir Pressure (kPa)	29,420
Reservoir Temperature (°C)	110

mSS – metres subsea

With an estimated 40 10^6m**;** of recoverable oil reserves, the proposed White Rose oilfield development is significantly smaller than the previous two oil and gas developments on the Grand Banks. The approach to developing the field is based on the following principles:

- maximizing returns to shareholders in a socially responsible way, including demonstrating a high regard for safety and environmental stewardship;
- building on lessons learned from the Hibernia and Terra Nova developments;
- focusing on the specific differences of the proposed White Rose oilfield development;
- initiating early and ongoing communication with regulatory authorities to ensure project planning considers all regulatory requirements;

- conducting a thorough public consultation program, ensuring stakeholders receive early information on the project and have an opportunity to provide meaningful input into project planning; and

- involving the supply community early in the process, recognizing Newfoundland and Labrador as one of the principal beneficiaries of oil development off its shores.

Drilling to date in the North White Rose gas pool has proven approximately 350 billion cubic feet of natural gas to be in place. Early estimates are that potential natural gas resource from North White Rose could be approximately 2.0 trillion cubic feet. However, even these optimistic estimates are significantly less than the total gas reserves required to support regional development of threshold natural gas export volumes.

The proven amount of gas at North White Rose will therefore have to increase significantly through further drilling success to support a regional gas development project.

Husky and its joint-venturer Petro-Canada are following up on the evaluation of the oil and gas discovery drilled in 1999 at North White Rose. If sufficient gas reserves are proven in White Rose and other areas in the future, a depletion plan and facility design for field development would need to be prepared, along with designs for transportation systems to take the product market.

Husky is not seeking development approval for natural gas but, as required in the C-NOPB DA Guidelines (C-NOPB 1988), the DA will discuss the proponents' approach to this resource, including potential reserves, factors leading to future development, as well as timing and steps planned to obtain additional information regarding the pool.

If commercial viability of the North White Rose gas pool is determined, the proponents would seek approval to develop this resource, either through amendment to the proposed DA or through submission of a separate DA. In both cases, further public consultation, and a full assessment of benefits and environmental and socio-economic issues would be required at that time.

Technical evaluation indicates that the development and transportation of the South White Rose and future ancillary oil pools will not have a negative impact on future development of nearby gas pools.

2 ENVIRONMENTAL SETTING

The Grand Banks ecosystem is a complex and dynamic system that has been subject to a number of human-induced and environmental changes over the past 15 years. The collapse of several fish populations (for example, Northern cod) led to the closing of most major ground fisheries in the early 1990s and a shift in harvesting effort to lesser-fished species such as shrimp, crab, scallops and clams. Changes in water mass characteristics, such as temperature and salinity, were also observed between 1985 and 1995 (Petro-Canada 1996). In 1997, the Grand Banks became an oil-producing region. Currently, there is one producing oilfield (Hibernia) on the Grand Banks and a second (Terra Nova) soon to begin production.

2.1 Physical Environment

The Newfoundland Grand Banks are one of the harshest environmental operating areas in the world. The physical environment (wind, waves, currents) of the Jeanne d'Arc Basin is described in Table 2.1-1. Air and water temperature minimums and maximums are provided in Table 2.1-2, as are the flying weather visibilities. Icing and iceberg criteria are outlined in Table 2.1-3.

Table 2.1-1 Physical Environment Data for the Jeanne d'Arc Basin

Parameter[1]	Unit	Return Period		
		1-year	10-year	100-year
Wind				
One Hour Mean	m/s	33.4	38.6	43.7
One Minute Mean	m/s	38.6	42.2	46.3
Wave				
Significant Wave Height	m	11.0	14.0	17.5
Spectral Peak Period Range	s	12.9 – 16.6	14.2 – 18.3	15.7 – 20.2
Maximum Wave Height	m	20.9	30.4	30.4
Associated Period Range	s	11.5 – 17.6	14.1 – 21.3	14.1 – 21.3
Current				
Near Surface (10 m)	m/s	0.75	0.80	1.00
Mid Depth (25 m)	m/s	0.60	0.76	0.95
Mid Depth (75 m)	m/s	0.30	0.60	0.75
Near Bottom (100 m)	m/s	0.15	0.32	0.65
Maximum Astronomical Tide Range	m	1.04	1.04	1.04
Maximum Tide Above MSL	m	0.53	0.53	0.53
Minimum Tide Below MSL	m	0.51	0.51	0.51
Storm Surge Above MSL	m	0.50	0.61	
Storm Surge Below MSL	m	0.54	0.66	0.79
Tsunami Level Above MSL	m	negl.[2]	0.10	1.20
Tsunami Current	m/s	negl.[2]	negl.[2]	negl.[2]

[1] Combined loads and directionality:

i) Peak Conditions

a) Extreme wind and wave conditions tend to occur at the same time, within about a three-hour timeframe.

b) Extreme wind and wave criteria are considered as acting with a 15º separation.

c) Extreme current speeds tend to lag behind peak wind and wave conditions by a few hours. Near surface currents (at a depth of 10 m) tend to be of approximately 70% of their maximum values at the time of the peak wind and waves, and be rotated clockwise by 40º and 110º from the wind vector.

d) Mid-depth and near-bottom currents show maximum speeds that are almost equal at the time of extreme winds and waves, and at the time of maximum surface speeds.

ii) Off Peak Conditions

a) Off peak wind speeds and wave heights, when at about 80% of their maximum value, have an average angular separation of 37º and waves tend to be rotated clockwise from the wind vector.

b) Winds and waves are more frequently not aligned than they are co-linear.

[2] Negligible

NOTE: These represent averages of current data (including extremes). The figures that will be used for design purposes will be agreed upon with C-NOPB and the certifying agency.

Source: after Husky Oil 1998.

Table 2.1-2 Ambient Conditions

Parameter	Value	
	Maximum	**Minimum**
Air Temperature (ºC)	26.5	-17.3
Water Temperature (Surface) (ºC)	15.4	-1.7
Water Temperature (Seabed) (ºC)	3.0	-1.7
Flying Visibility <1 km, Ceiling < 100m	26.4 to 55.1 % of time (April – August)	10.2 to 22.9 % of time (September – March)

Table 2.1-3 Icing and Iceberg Criteria

Theoretical Superstructure Icing Accumulation on 5 cm Cylinder	**10-Year Return**	**100-Year Return**
Glaze and Rime Icing (mm)	72	169
Spray Icing (mm)	316	514
Icebergs Sightings	**Mean**	**Maximum**
One Degree Grid	67	268
Mass (t)	220,000	--
Speed (km/h)	0.77	9.8
Sea Ice Occurrence	**Mean Concentration**	**Average Number of Weeks**
Within 25 km	54 to 57 % coverage	2.3 to 2.6

2.2 Marine Environment

The main wildlife components of the marine ecosystem on the Grand Banks are plankton, benthos, fish, seabirds and waterfowl, and marine mammals. Plankton (plant and animal organisms that drift with ocean currents) are the basis of the ocean food chain. These serve as a food source for seabirds and waterfowl, fish, baleen whales and other predators.

The most biologically productive part of the marine environment on the Grand Banks is the top 50 m of the water column. Here, phytoplankton convert water and carbon dioxide into organic matter with the help of sunlight. This process produces the plankton biomass that forms the base of the food web (Petro-Canada 1996).

Benthos, marine plants and animals that live on or near the ocean bottom, are also an important food source of many fish species. Benthic species include commercially-important species such as lobster (*Homerus americanus*), shrimp, scallop and crab, as well as various types of algae and invertebrates such as polychaete worms, molluscs and crustaceans (Petro-Canada 1996).

Like plankton and benthos, fish are an important component of the marine ecosystem. They are food for both other marine species and predators. Fish on the Grand Banks are also an important food source for

humans. Common fish species on the Grand Banks include pelagic species, such as capelin (*Mallotus villosus*), Atlantic mackerel (*Scomber scombrus*) and tuna (*Thunnus* sp.), and demersal species such as skate (*Raja* sp.), flounder (Order Pleuronectiformes) and cod (Family Gadidae) (Petro-Canada 1996).

Marine birds and mammals are important predators on the Grand Banks, feeding on plankton, benthos and fish. They are also prey for larger marine mammals and fish. Marine bird species found on the Grand Banks include dovekies (*Alle alle*), murres (*Uria* sp.), puffins (*Fratercula arctica*), razorbills (*Alca torda*), black guillemots (*Cepphus grylle*), shearwaters (*Puffinus* sp.), gannets (*Sula bassanus*), fulmars (*Fulmarus glacialis*), storm-petrels (*Oceanites oceanicus*), phalaropes (*Phalaropus* sp.), gulls (*Larus* spp.), kittiwakes (*Rissa tridactyla*), terns (*Sterna* sp.), jaegars (*Stercorarius* sp.) and skuas (*Catharacta skua*). Marine mammals found on the Grand Banks include whales, dolphins, porpoises and seals. Common whales are humpback (*Megaptera novaeanliae*), minke (*Balaenoptera acutorostrata*), blue (*B. musculus*), fin (*B. physalus*), sei (*B. borealis*), pilot (*Globicephala melaena*), sperm (*Physeter catadon*), killer (*Orcinus orca*) and northern bottlenosed (*Hyperoodon ampullatus*) (Petro-Canada 1996; Wiese and Montevecchi 1999).

The water depth at the southern part of the White Rose area ranges from 115 to 130 m, with a seabed slope of approximately 0.05 m over 100 m (Nortech Jacques Whitford 1997). Both sea ice and icebergs occur on the Grand Banks, with iceberg severity off Newfoundland largely determined by regional sea ice conditions (Marko et al. 1994 in Petro-Canada 1996). Icing and iceberg data relevant to the White Rose area are provided in Table 2.1-3.

2.3 Substrate

Substrate type and characteristics in the White Rose area are based on data collected from glory holes constructed for subsea well protection at the Terra Nova site (C-CORE 1999), and site-specific surveys conducted for Husky Oil's drilling programs in the White Rose area. This information is summarized in Table 2.3-1.

Table 2.3-1 Substrate Profiles and Description

Substrate Stratigraphy	Profile Name and Description			
	Terra Nova Glory Holes			White Rose Site Surveys (Husky Oil, May, 1997, March 1999)
	0-90 Glory Hole (BIO & Seabed Exploration, April 1996)	1998 SW Glory Hole (Seacore)	Terra Nova Project Summary	
Sand	0 to 1.5 m loose sand with small stones	0-1.6 m[1] sand or sand and gravel and cobbles	0-2 m sand and sand and gravel	0 to 3 m fine/ medium sand, relatively hard packed
Clay or Hard Pan	1.5 to 2.3 m variable thickness, grey-green well-cemented, "shelly" mudstone (southwest); dark grey, stiff massive mud (north)		2 to 4 m hard pan	
Sand and Gravel (and Cobbles)			4-5.5 m sand, gravel and cobbles/boulder; Friction Angle=44°, Cohesion = 0 kPa	2 to 10 m coarse sand and gravel
Layered Clay and Sand with Cobbles/ Boulders	2.3 to 8.0 m fine grained sand with clay matrix, numerous stones (good initial strength)		5.5 to 9.5 m layered clay and sand with cobbles/boulders; Friction Angle=42°, Cohesion = up to 28 kPa	
Clay with Cobbles	8.0 to 9.8 m stiff grey/green clay		9.5 to 16.5 m clay with cobbles and boulders high to low plasticity	10 to 700 m claystone

[1] No data below 1.6 m

3 EXPLORATION AND INDICATED RESOURCES

3.1 Exploration History and Status

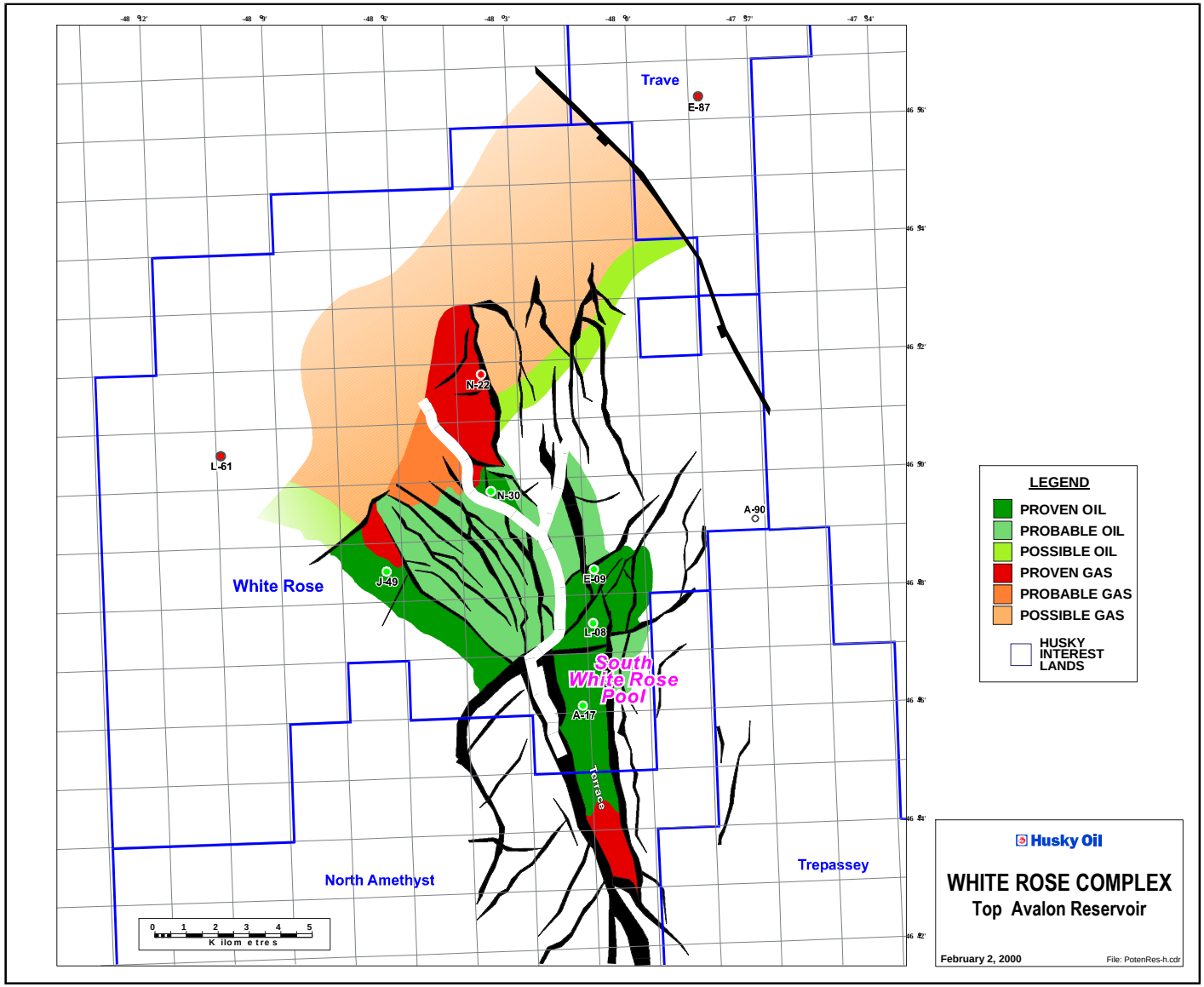
White Rose is one of five Significant Discovery Areas operated by Husky Oil in the Newfoundland offshore (Figure 1.2-2). The first three wells drilled on the White Rose Significant Discovery Area, White Rose N-22, J-49 and L-61, were drilled between 1984 and 1986 (Figure 3.1-1). Results of these wells were encouraging, as oil and gas were encountered in all wells. Based on these results, the White Rose E-09 well was drilled in 1987-1988. This well was drilled into a separate structural culmination on the southern flank of the complex. It was the first well drilled in the South White Rose oil pool and encountered over 90 m of net oil pay, indicating the potential for commercial development.

In 1999, two additional delineation wells were drilled into the South White Rose oil pool, White Rose L-08 and A-17. These wells confirmed the extent and quality of the reservoir encountered by the E-09 well.

A third well, White Rose N-30, was also drilled in 1999. It was drilled into the northern part of White Rose, downdip from the N-22 well. Results from this well helped to determine the extent of the hydrocarbon pool first encountered by the N-22 well and provide data on the northern limit of the South White Rose oil pool. The three wells drilled into the South White Rose oil pool, together with detailed interpretation of 3-D seismic data, have established reserves of approximately 40 $10^6 m^3$ of recoverable oil for the field. The results of the three South White Rose wells drilled are summarized in Table 3.1-1.

Table 3.1-1 Summary of South White Rose Wells

Well	E-09	L-08	A-17
Net Oil Pay (m)	94	107	92
Water Depth (m)	124	121	118
Latitude	46E 48’26.24” N	46E 47’30.70” N	46E 46’07.463” N
Longitude	48E 01’22.65” W	48E 01’20.22” W	48E 01’40.918” W
Status	Suspended Oil & Gas	Suspended Oil & Gas	Suspended Oil & Gas



Source: Husky Oil

FIGURE 3.1-1

WHITE ROSE FIELD

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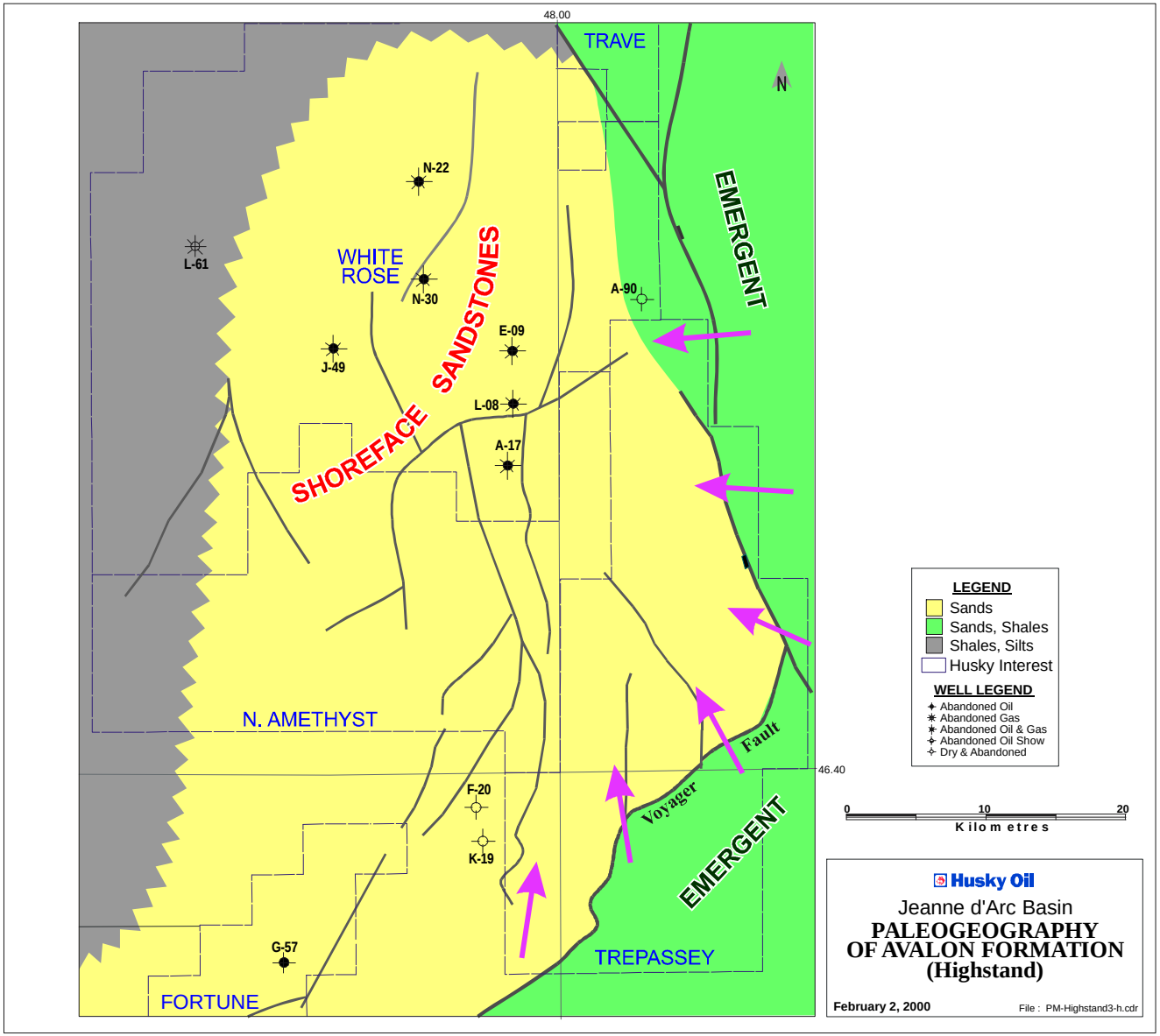
3.2 Regional Geology

The oil reservoir discovered at White Rose is Avalon Formation sandstones. These sandstones were deposited during the early Cretaceous as shoreface sands along a north-south trending shoreline roughly paralleling the eastern margin of the Jeanne d'Arc Basin. The origin of these sands was the erosion of outcropping Hibernia Formation sandstones from highlands to the east and southeast of White Rose (Figure 3.2-1). The depositional setting for the Avalon Formation was such that a massive (greater than 300 m thick), clean, well sorted, fine grained, polycyclic sandstone was laid down over a broad area.

The Avalon Formation reservoir was later structured and broken by faults during tectonic and salt movement episodes in the late Cretaceous. This resulted in the Avalon Formation in the White Rose area being broken into separate fault blocks and structural culminations.

During the Tertiary Period, oil source rock of the Jurassic Egret Formation was buried deeply enough to mature and expel hydrocarbons. These hydrocarbons migrated up the faults and pooled in structural culminations and fault block traps within the Avalon Formation.



Source: Husky Oil

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FIGURE 3.2-1

JEANNE d'ARC BASIN

PALEOGEOGRAPHY OF AVALON FORMATION (HIGHSTAND)

4 PLANNING AND ENVIRONMENTAL MANAGEMENT

4.1 Project Need and Justification

Husky Oil is one of the leading operators and interest holders in the Canadian East Coast offshore oil industry. The company holds an approximate 32% net working interest in the Significant Discovery Licence areas in the Jeanne d'Arc Basin. Husky Oil's joint-venturer, Petro-Canada, is the Operator of the Terra Nova oilfield and also holds substantial interests in the Newfoundland offshore region. The Jeanne d'Arc sedimentary basin is recognized as the principal oil-producing basin off the east coast of North America. It is a significant business area for Husky Oil and a key to the company's continued growth. Husky Oil, in a joint-venture with Petro-Canada, proposes to develop an economically significant oil discovery in the White Rose Significant Discovery Area, as outlined in Section 1.3. The two parties strongly believe that this project will meet market demands for oil and generate considerable economic benefits for the local and provincial economies of Newfoundland and Labrador, as well as a reasonable financial return for Husky Oil and its joint-venturer Petro-Canada.

The joint-venture parties recognize Newfoundland and Labrador as one of the principal beneficiaries of oil and gas resources off its shores. In this regard, the development will increase training and employment opportunities for people of the province. It will also contribute to the growth in petroleum industry infrastructure and business opportunities arising from the increased demand for goods and services. This will ultimately attract new investment to the province, contributing to the sustained growth of the provincial and Canadian economies. From Husky Oil's perspective, the proposed development will also satisfy its goal to acquire, find and develop substantial oil reserves. This will have a major impact on the company's overall growth and be in keeping with its mission statement: "to maximize returns to its shareholders in a socially responsible way".

4.2 Project Management

The joint-venture parties and their average interests in the White Rose Significant Discovery Areas are:

- Husky Oil 82.5%
- Petro-Canada 17.5%

The White Rose oilfield development will be managed from Husky Oil's office in St. John's, Newfoundland, with support being provided as required by the company's head office as well as oil industry service providers in Newfoundland.

The project will be staffed with the necessary skills and at a level appropriate for the nature and scale of the development activity taking place. While the nature and level of activity at the St. John's office will vary, overall activities will include:

- management of project development and production operations;
- environmental and socio-economic studies for the environmental impact statement and DA;
- project engineering;
- procurement;
- geoscientific analysis;
- reservoir engineering;
- drilling operations;
- logistics; and
- development-related communications.

Husky Oil will select and work with the major contractors to form an integrated project team that will be located in St. John's. This team will manage the following activities: engineering, project coordination, procurement, fabrication, construction, installation, commissioning and operations.

4.3 Canada-Newfoundland Benefits

In creating the framework for developing the White Rose oilfield, Husky Oil has documented specific *Canada-Newfoundland Benefits Guidelines* which recognize Newfoundland and Labrador as one of the principal beneficiaries from oil and gas resources off its shores. The project beliefs and guiding principles are:

- significant skill and industrial capabilities and growth potential exist within Newfoundland and Labrador and Canada;
- transfer of technology reduces long term operating costs and provides cost-effective support services for current programs and future projects;
- a full and fair opportunity for local firms and individuals to participate in development on a competitive basis must be provided;
- first consideration for the delivery of competitive goods and services shall be provided to Newfoundland and Labrador suppliers; and
- competitiveness of local firms is essential for sustained growth within the province.

To ensure that local and Canadian suppliers have full and fair opportunities to competitively provide goods and services for the project, Husky Oil will maintain its current open communication with industry associations. As well, a number of strategies will be used (such as early dissemination of information on scopes of work required, maintaining a local presence of engineering, project management and procurement personnel) and Husky will, where competitive and feasible, appropriately

size tasks and project work components or packages to fit capabilities of Newfoundland and Labrador and Canadian companies. In addition, practical technology transfer and research and development initiatives related to project activities will be undertaken by Husky Oil and suppliers. Specific initiatives to be undertaken will be described in the Canada-Newfoundland Benefits Plan.

In keeping with its Guidelines, Husky Oil has been and will continue to strive to be a leader in its approach to maximizing Canada-Newfoundland opportunities. Within the project framework by proactively supporting the local and national supply community on a competitive basis and providing employment opportunities to residents of Newfoundland and Labrador, Husky Oil believes that it will not only fulfill its commitment to maximize benefits to the people of Newfoundland and Labrador but will also optimize its development and operating costs.

4.4 Schedule

The planned schedule for developing the White Rose oilfield is shown in Figure 4.4-1. The schedule for preparing the DA and regulatory review is shown in Figure 4.4-2.

WHITE ROSE OILFIELD DEVELOPMENT PROJECT SCHEDULE

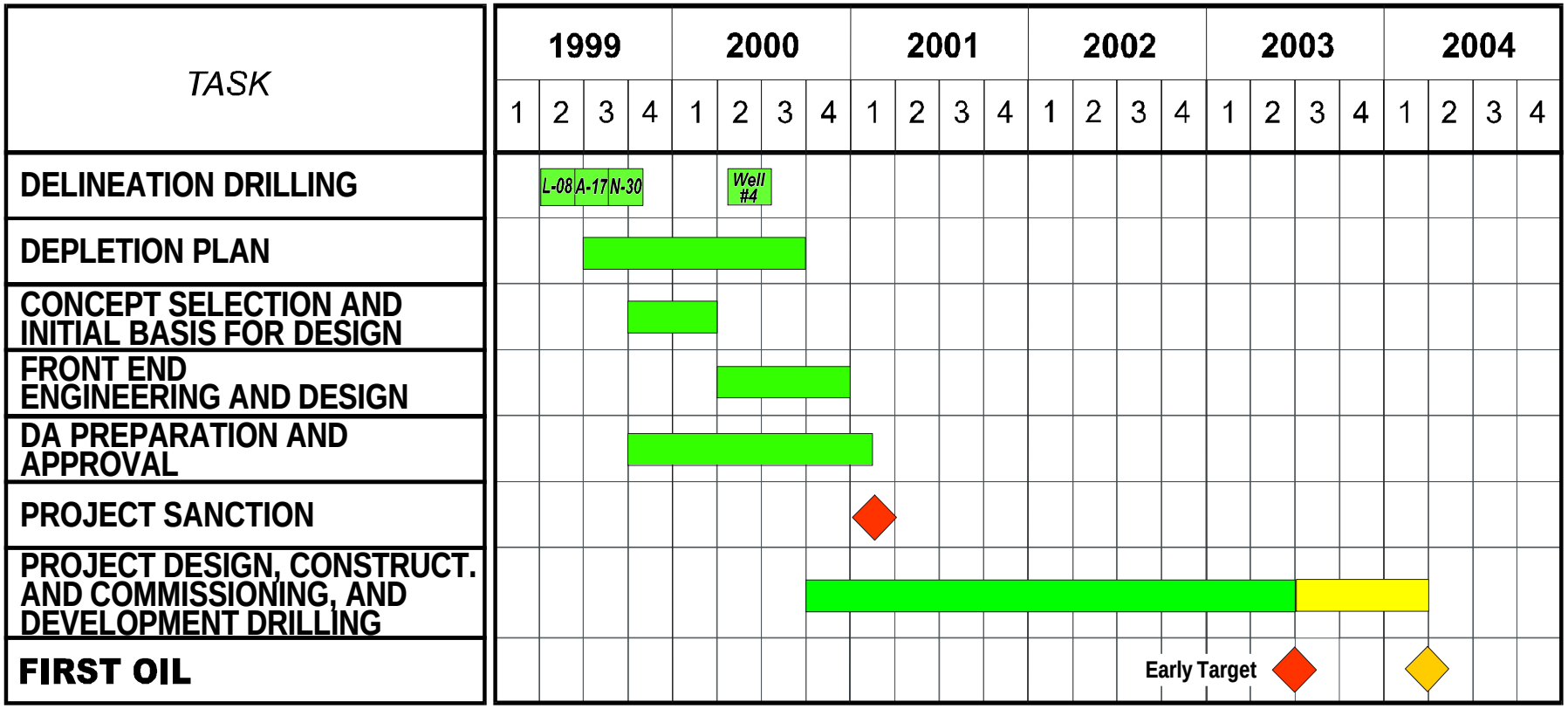

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FIGURE 4.4-1

WHITE ROSE OILFIELD DEVELOPMENT
PROJECT SCHEDULE

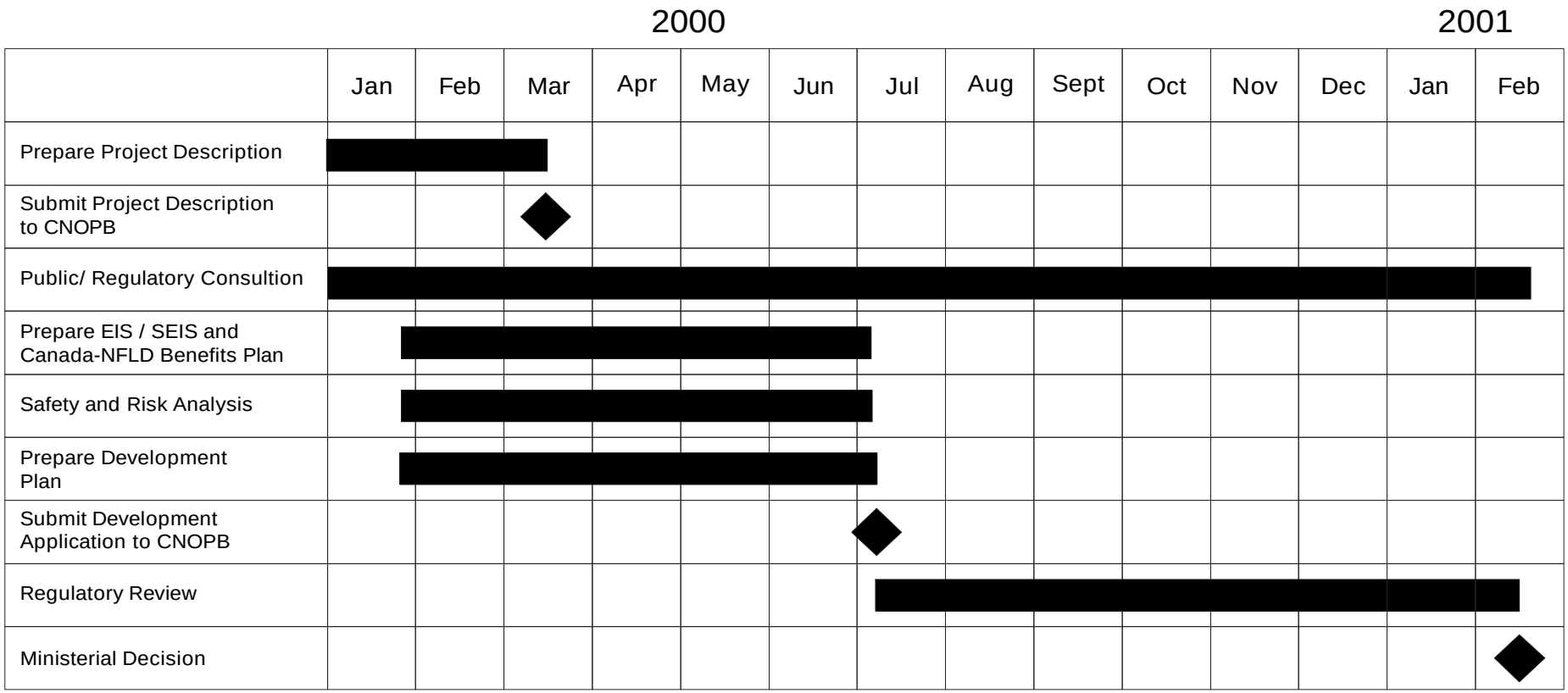

FIGURE 4.4-2

SCHEDULE FOR DEVELOPMENT APPLICATION
PREPARATION AND REVIEW

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4.5 Regulatory Framework

Plans for offshore oil development projects in Newfoundland and Labrador must be approved by the C-NOPB. Companies proposing such projects must prepare and submit a Development Application (DA) to the C-NOPB. This DA initiates action under the *Atlantic Accord Implementation Act* and the *Canadian Environmental Assessment Act* (CEAA). The C-NOPB is the lead agency (Responsible Authority (RA)) under CEAA for offshore oil projects and within Newfoundland and Labrador jurisdiction. Other federal authorities for offshore oil projects include Natural Resources Canada, Environment Canada, Transport Canada and Department of Fisheries and Oceans (DFO).

The White Rose oilfield development must address the C-NOPB's guidelines for preparing a DA (C-NOPB 1988), as well as the environmental assessment requirements outlined in CEAA. Based on Hibernia and Terra Nova precedents, fish habitat alteration, disruption and destruction (HADD), as defined by Section 35(2) of the *Fisheries Act*, may result from constructing glory holes for the project. This may require an authorization from DFO. Issuing an authorization for HADD is a decision on the *Law List Regulations* pursuant to CEAA. Therefore, DFO may choose to be an RA under CEAA for the proposed White Rose oilfield development.

Trenching subsea lines and excavating glory holes with seabed spoil deposition may require an Ocean Dumping Permit, under the *Canadian Environmental Protection Act* (CEPA), from Environment Canada. This permit is also a decision on the *Law List Regulations.* Therefore, Environment Canada may also be an RA for the environmental assessment.

4.6 Loss Control Management

Husky Oil maintains a strong commitment to health, safety and environmental stewardship. Leadership, responsibility, accountability and improvement are the principles and values underlying this commitment. The company conducts its business activities with a progressive approach, and is committed to monitoring and improving its performance. Central to its commitment to stewardship is the company's Loss Control Management (LCM) system.

The LCM system is reviewed on a periodic basis to ensure adherence to company policy and is responsive to public policy issues. In addition, health, safety and environmental (HS&E) audits are conducted at all major facilities on a scheduled basis. By tracking performance indicators, such as emissions, spills, waste volumes and public complaints, the company is in a position to review its performance, compare performance with that of its peers and take appropriate action where necessary.

Over the more than 60 years it has operated in Canada and elsewhere, Husky Oil has received many HS&E awards. Furthermore, in periodic reviews with regulators, the company has received recognition for its commitment and innovative approach to HS&E protection and performance. Recently, Husky Oil won two federal government awards for Climate Change Leadership. In 1999, it was selected as a

"Gold Champion Level Reporter" by the Voluntary Challenge and Registry for reducing greenhouse gas emissions.

Husky Oil is committed to using the same corporate philosophy and approach that it uses elsewhere for its proposed White Rose oilfield development. A site-specific LCM system and environmental protection plans will be developed for the White Rose oilfield development. Environmental protection plans will be prepared for each project phase including construction, operation and decommissioning. Plans for ice management and contingency plans for emergency events are already in place for delineation drilling and will be modified as necessary for development-related activities.

Husky Oil will comply with all pertinent federal and provincial legislation and, at a minimum, achieve all standards for offshore oil production. Environmental compliance monitoring (ECM) will be conducted. An environmental effects monitoring (EEM) program will be established for the project; this will commence with a planned baseline survey of the White Rose site in the summer of 2000.

4.7 Public Consultation

Husky Oil recognizes the importance of informing all stakeholders about the project and the value of the input that they provide. The company is committed to involving all stakeholders in providing input into preparation of the DA for the proposed White Rose oilfield development and has initiated a formal consultation program. The main components of the public consultation program are summarized below:

- Through its St. John's office, Husky Oil has established an ongoing relationship with the supply community, government and other stakeholders in Newfoundland and Labrador.

- During the fourth-quarter of 1999, over 30 meetings were held with government, the supply community and other stakeholders to discuss the company's ongoing plans and preliminary progress for White Rose.

- Key informant workshops will be held in early March in Clarenville, Marystown and St. John's. These workshops will involve invited participants from a range of government, community, industry, fishery and environmental groups.

- Public information sessions will be held in mid to late March in Clarenville, Marystown, Arnold's Cove and St. John's. These sessions will be open to the general public and will be advertised in the local media, prior to the event.

- Ongoing consultation will be held with key regulatory agencies to discuss issues and Husky Oil's approach to DA preparation.

- A second set of public information sessions will be held in June 2000. These sessions will also be open to the general public and allow opportunity for review of the draft DA documents.

- A toll-free telephone number, and project-specific e-mail address and web site will be maintained to improve access to the project team and project information.

- Members of the project team will be available on request to meet with federal, provincial and municipal government representatives, community and environmental organizations, industry and business groups, school groups, media and others.

- Public inquiries and issues raised will be documented, tracked and dealt with.

5 THE PROPOSED PROJECT

5.1 Project Features

Important aspects of the proposed White Rose oilfield development are:

- field size is approximately 10 km long and 4 km wide;
- estimated project life span is 12 to 14 years, with facilities designed for a 20-year life span;
- estimated 40 10^6m**;** (250 mmbls) of oil recovered over project life, with the potential to add an additional 10 to 20 10^6m**;** (60 to 125 mmbls) recoverable oil reserves from nearby ancillary oil pools in future if they are proven to be commercially viable;
- reservoir pressure maintenance using waterflooding;
- gas conservation;
- protection of wellheads from scour will be ensured using two to four glory holes (25 m by 25 to 65 m in size, all with an approximate 3:1 slope), with the potential to add an additional one to two glory holes to develop nearby ancillary oil pools in future if they are proven to be commercially viable. Spoils from construction of glory holes will be deposited on the seabed;
- 18 to 25 wells, including production and water and gas injection wells, with the potential to add additional production and injection wells to develop nearby ancillary oil pools in future if they are proven to be commercially viable;
- vertical and horizontal or deviated wells; and
- trenched subsea pipelines for transportation of oil from the wellhead to the production facility.

5.2 Development Scenario

5.2.1 Depletion Strategy

Development of an initial reservoir depletion plan is ongoing and expected to be outlined by May 2000. Further work to refine the reservoir depletion plan is ongoing. Based on work to date, the South White Rose oil pool will likely require 10 to 14 production wells. To maximize oil production, reservoir pressure will be maintained by injecting water into an additional six to eight strategically placed wells. It is also planned to inject surplus produced gas into the reservoir for gas conservation and to assist in pressure maintenance.

Current planning anticipates that four to six production wells, one to three water injection wells and one gas injection well will be drilled and tied in for first-oil production. Drilling would continue over a two to four-year period after first-oil until the reservoir is fully developed. Ongoing reservoir management may require further production optimization wells in the pool over the life of the project.

It is anticipated that gas lift will be the artificial lift method used to optimize oil production later in the life of the field. Provisions for gas lift equipment will be included in the initial completion design of the wells.

5.2.2 Reservoir Fluids

Reservoir fluid characteristics are provided in Table 5.2-1.

Table 5.2-1 Reservoir Fluid Data

Gas to Oil Ratio (m^3/m^3)	120 – 150
Bubble Point (kPa)	29,400
Reservoir Fluid Viscosity (mPa.s)	0.5 – 0.75
Wax Appearance Temperature (°C)	40 – 70
Pour Point (°C) [based on Well L-08]	18

5.3 Process Requirements

5.3.1 General

The production facilities will be custom-designed to process the reservoir fluids from the White Rose oilfield and to meet environmental operating conditions on the Grand Banks. The facilities will have a 20-year life span, and comply with all statutory safety and environmental requirements.

5.3.2 Production Design Conditions

Production design conditions are summarized in Table 5.3-1.

Table 5.3-1 Production Design Conditions

Production Parameter	Design Criteria
Maximum Shut-In Wellhead Pressure (kPa)	28,000
Flowing Wellhead Pressure (kPa)	3,000 – 6,000
Flowing Wellhead Temperature (°C)	50 –80
Peak Oil Production (m^3/d)	12,000 – 18,000
Peak Produced Water (m^3/d)	15,000 – 30,000
Peak Produced Gas ($10^6 m^3/d$)	4 – 7

5.3.3 Crude Export Quality

Crude oil will be processed to meet typical tanker export specifications:

- Reid Vapour Pressure (RVP) 83 kPa maximum
- Base Sediment and Water (BS&W) 0.5% (vol) maximum
- Salt 0.06 kg/m³
- Sulphur 0.5% wt

5.3.4 Gas Treatment

A portion of the associated gas from the reservoir will be treated, compressed and used for fuel and lift gas. There will be no flaring of produced gas other than for specific operational or maintenance requirements. Surplus gas will be re-injected for reservoir pressure maintenance and conservation.

5.3.5 Water Treatment

Seawater will be treated and injected into the reservoir for pressure maintenance. Any produced water will be treated and disposed of according to applicable legislation and guidelines.

5.3.6 Well Testing

Production wells will be tested with a test separator or a multi-phase meter. Typical design values for the test separator are:

- Oil 3,600 m³/d
- Gas 470 10^3m³/d
- Water Max of 90% (vol) water cut assumed

5.3.7 Chemical Injection Requirements

The following chemicals may be required for operations:

- methanol;
- corrosion inhibitor;
- demulsifier;
- wax inhibitor;
- scale inhibitor;

- oxygen scavenger;
- anti-foam; and
- biocide.

Chemical injection requirements will be determined during the design phase and adjusted based on actual production performance.

5.4 Production Systems

In November 1999, Husky Oil initiated a concept selection study to identify the potential alternatives for developing the White Rose oilfield. The eight production concepts analyzed were:

- steel floating, production, storage, offloading (FPSO) facility;
- concrete FPSO facility;
- steel floating, production, drilling, storage, offloading (FPDSO) 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); and
- concrete barrier wall with floating production unit (FPU).

The disconnectable concrete TLP, concrete barrier wall with FPU and steel FPDSO were not carried forward because they either did not meet Husky Oil's technical requirements or were prototypes with no operating history in harsh-environment offshore locations.

The remaining five options (steel FPSO facility, concrete FPSO facility, steel semi-submersible facility with and without integrated storage, concrete semi-submersible facility and concrete GBS) were further analyzed with respect to construction time, capital costs, concept maturity, concept deliverability and risk considerations. Further evaluation was carried out on the options meriting additional consideration, including the FPSO, steel semi submersible (without integral storage) and GBS.

The concept selection study concludes that the preferred production system for the White Rose oilfield development is a steel FPSO facility similar to that selected for the Terra Nova Development. Husky Oil is undertaking additional analysis of this system to assess fully its technical and economic aspects as well as environmental effects (as required by CEAA) and operational safety. In addition, Husky Oil will continue to evaluate the viability of the steel semi-submersible facility (without integral storage) in relation to the impact of any changes in field production rates identified during the finalization of the reservoir depletion plan.

The DA will contain a description of the technically and economically feasible systems considered, along with a discussion of the technical, cost, schedule, operational and safety factors leading to selection of the proposed system. Benefits considerations and environmental and socio-economic alternatives of the viable options will also be addressed.

Steel FPSO facilities have been in use since 1976, when the first one was installed on the Castellon oilfield, offshore Spain. Today, there are about 60 FPSO structures in operation or under construction in the world. Canada's first FPSO facility will be on production on the Terra Nova oilfield in 2001.

The FPSO facility will be similar in design to the Terra Nova FPSO facility but with a lower throughput design capacity. For purposes of illustration, a typical North Sea steel FPSO facility is shown in Figure 5.4-1. Deck space requirements for the topsides process plant will result in a vessel with approximately 700,000 to 850,000 bbls of storage capacity. This will provide storage for approximately eight to ten days of oil production if producing 75,000 to 100,000 BOPD. It is currently estimated that a shuttle tanker will be required every five to six days at peak periods.

The FPSO will contain a turret and emergency shutdown systems which allows the FPSO to disconnect and move off location to address operational or emergency situations.

The average time to construct and install an FPSO facility of this size is more than two years. While it has not been decided where the various components would be constructed, there are several major shipyards in the world with the capacity to build the vessel hull. There are both Canadian and international fabrication yards with the capacity to build topside facilities. There are four major suppliers in the world that build turrets for offshore oil production.

FIGURE 5.4-1

TYPICAL NORTH SEA STEEL FPSO FACILITY

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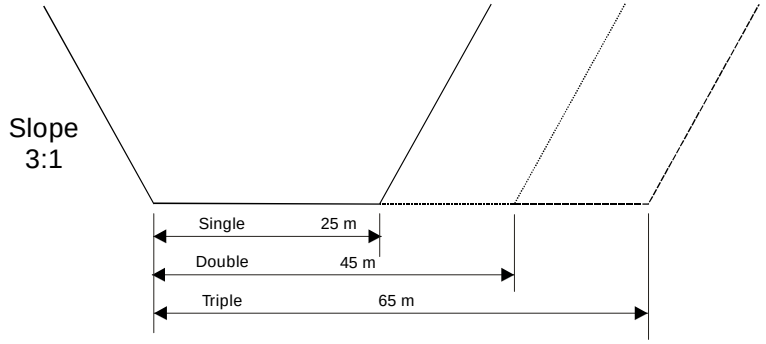
5.5 Subsea Installations

A typical subsea solution for floating production facilities consists of templates, manifolds, flowlines, umbilicals and risers. Projects on the Grand Banks also include some form of iceberg scour protection for their subsea installations. For the White Rose oilfield development, the main method of iceberg scour protection will be glory holes (see Figure 5.5-1 for a typical glory hole profile), with the possibility of using a caisson system at strategic locations to optimize field layout. At present, a field layout has not been finalized. However, it is anticipated that two or three drill centres located in glory holes will be required to access the oil reserves in the South White Rose oil pool.

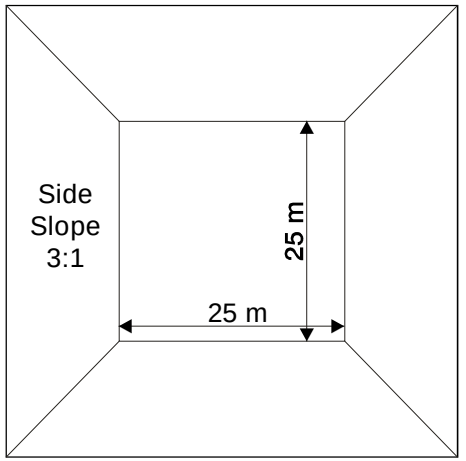
5.5.1 Factors Affecting the Subsea Facilities Layout

Key factors affecting the final layout of the subsea facilities are:

- an optimum reservoir depletion strategy that dictates the choice of:
  - deviated or vertical well design; and
  - location and orientation of horizontal wells;
- well construction limitations;
- well testing requirements;
- potential wax formation in subsea facilities;
- concurrent drilling, workover and tanker offloading operations; and
- use of template or cluster wells and manifolds.



Profile for Single.
Double, Triple
Glory Holes



Plan View for a Single
Glory Hole

FIGURE 5.5-1

TYPICAL GLORY HOLE PROFILE AND PLAN VIEW

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5.5.2 Typical Option for Subsea Facilities Layout

The preliminary subsea layout for the White Rose oilfield development can be described as follows:

- two to three drill centres in a north-south alignment to allow complete access to the South White Rose oil pool;
- gas injection, water injection and oil production capabilities required at all drill centres;
- a possible one to three additional well centres, depending on depletion plan requirements for the area, and well trajectory design considerations;
- templates used to minimize glory hole size;
- templates are single service, either production/gas lift or water or gas injection;
- flexible flowlines used for all intrafield lines and risers;
- well testing carried out via a dedicated test line;
- round-trip pigging facilities for wax removal; and
- conventional electro-hydraulic control systems.

A potential subsea layout for two drill centres is shown in Figure 5.5-2.

The preliminary subsea layout is based on using field-proven equipment. Fluid properties of the South White Rose oil pool do not indicate any challenges that have not already been overcome in previous projects with the technology that is currently available.

The initial subsea system is designed to mitigate the effect of well placement. This will be accomplished by having production and water and gas injection capabilities at all drill centres. However, this increases the number of risers necessary for the project and, subsequently, the turret complexity. The final determination on the number of drill centres and fluid handling requirements at each drill centre will be made during the front end engineering and design (FEED) stage.

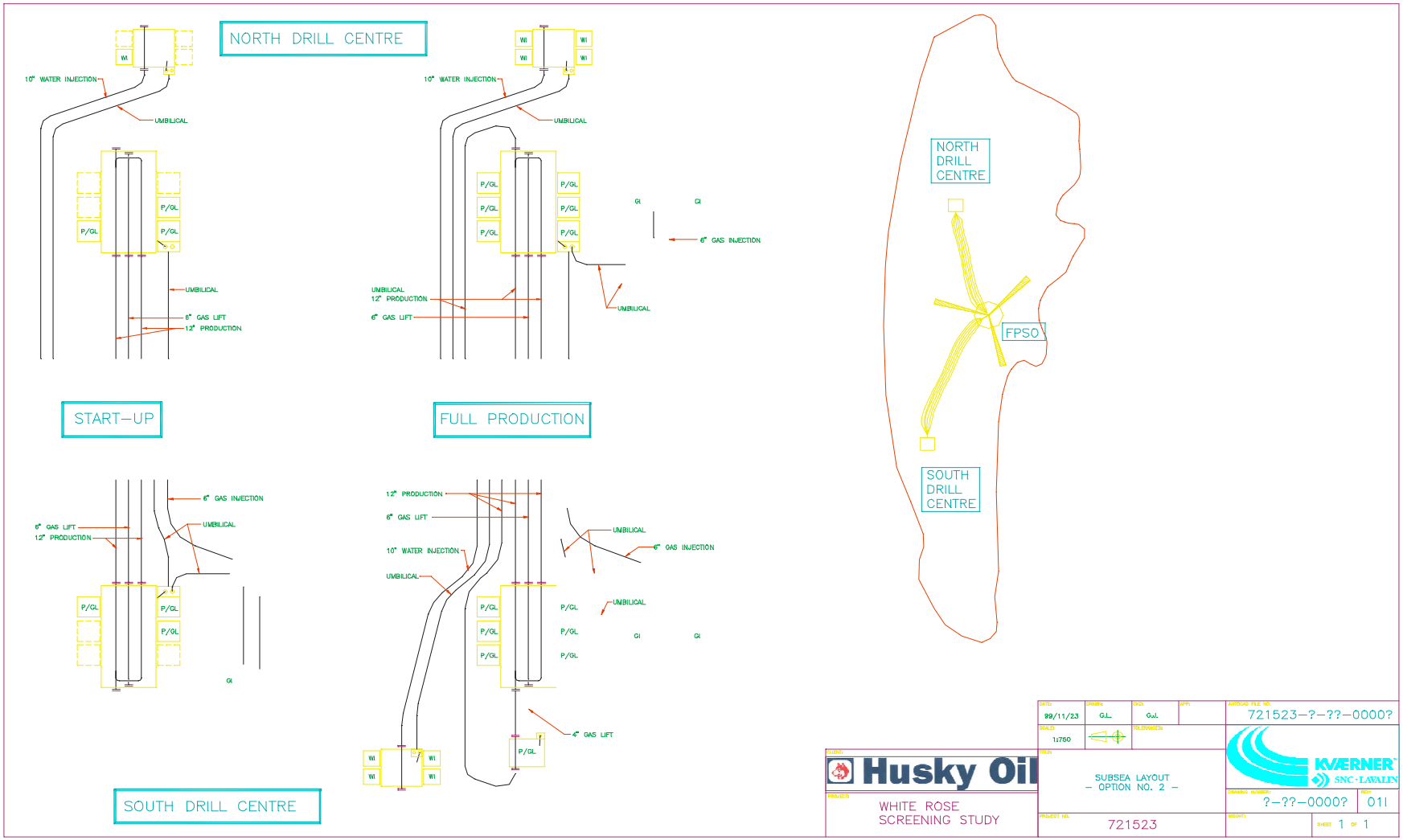

FIGURE 5.5-2

TYPICAL SUBSEA INSTALLATION FOR A TWO DRILL-CENTRE SCENARIO

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Areas of further investigation with respect to subsea design and layout include:

- alternatives to flexible flowlines (rigid pipe, bundles);
- use of cluster manifolds in place of templates;
- use of subsea manifolds to reduce the number of risers;
- alternatives for seabed protection;
- alternatives for well testing (multiphase metering);
- downhole/subsea processing;
- alternate strategies for wax control;
- well profile/trajectory design;
- well completion techniques; and
- well productivity and injectivity.

6 PROJECT PHASES

6.1 Construction and Installation

Construction of the floating platform will be separated into two major components; the FPSO hull and the topsides equipment modules.

To meet a first oil target of the third quarter of 2003, Husky Oil must:

- with its joint-venturer Petro-Canada, sanction the project by December 2000;
- begin construction of the glory holes by May 2001;
- begin drilling in the summer of 2001 using a mobile offshore drill unit (MODU) (wells will be suspended until production begins);
- trench the subsea lines through the summer of 2001 and 2002; and
- construct the floating production facility beginning in 2001.

6.2 Operations and Maintenance

6.2.1 Organization

The operation of the White Rose field will be managed by Husky Oil as operator of the field, employing both company resources and third-party services. The onshore organization will typically consist of approximately 50 personnel reporting to operations management. This group will include engineering, technical, loss control, logistics, financial and administrative personnel. An existing marine base and warehouse facility will be used to handle supply vessel and material movements.

The offshore production organization will typically consist of approximately 100 personnel, half of whom will be on the floating production facility, with the other half on rotational shore leave. The offshore group will include management, production and maintenance technicians, as well as marine, logistics, loss control and medical personnel. The manager on the floating production facility will have prime responsibility for coordinating all field activities, including emergency response, simultaneous production operations, tanker loading and drilling operations.

Drilling and workover operations will be conducted in the field using a MODU. The offshore complement on a MODU typically consists of approximately 90 to 100 personnel in drilling and marine roles. Each MODU will have a designated manager responsible for offshore operations on that facility.

Personnel will be transported to and from the field by helicopter. A standby vessel will be in place at all times and the floating production facility will have the capability to leave the location under its own power in the event of an emergency.

6.2.2 Operating and Maintenance Procedures

Husky Oil's operating and maintenance procedures include:

- Maintenance Procedures – A phase-specific, operations-integrity plan detailing maintenance and inspection procedures will be implemented. Operating parameters will ensure all systems and equipment do not exceed design specifications or environmental limits. Maintenance programs will ensure the safe operation and optimum reliability of equipment.

- Production and Marine Procedures – A phase-specific integrity plan detailing the procedures associated with production and marine supply activities, including environmental concerns, mitigation procedures and roles, responsibilities and authority will be implemented.

- Ice Management Plan and Procedures – Husky Oil has an existing ice management plan and procedures, which involve cooperation with the other operators on the Grand Banks (Hibernia and Terra Nova).

- Loss Control Management – Husky Oil follows the corporate-wide HS&E Management System, which has been modified using recognized international protocols (for example, International Safety Management (ISM) Code) to incorporate working in the offshore environment.

- Emergency Procedures – Husky Oil has an existing emergency response plan that will be modified to include production operations.

- Facility-Specific Alert and Emergency Response Procedures - Vessel-specific contingency plans incorporating procedures necessary during operation and maintenance will be implemented.

- Environmental Protection and Monitoring Procedures – Both environmental effects monitoring (EEM) and environmental compliance monitoring (ECM) will be conducted. Environmental protection plan requirements such as effluent treatment will be incorporated into design considerations.

6.2.3 Logistics

Husky Oil will ensure the following logistics services are provided to support the operation of the White Rose oilfield development, with a view to enhance existing suppliers and infrastructure in preference to construction of new facilities:

- onshore supply base and storage;
- support vessels;

- material and consumable procurement and movement;
- personnel movement by helicopter; and
- diving requirements.

6.2.4 Communications

Primary and backup communications systems will be in place to ensure reliable contact between project facilities, vessels, aircraft and shore facilities on a 24-hour basis.

6.2.5 Contingency Plans

Husky Oil has an existing contingency plan for drilling and other exploration activities which includes ice management, oil spill response and emergency response. The plan currently addresses:

- emergency response organization and training;
- vessel surveillance and collision avoidance;
- operations safety;
- personal injury or death;
- fire or explosion;
- vessel collision and structural impairment;
- hydrocarbon and chemical spills;
- loss of ballast control or vessel stability;
- heavy weather;
- loss of well control;
- loss of vessels or helicopters/fixed-wing aircraft; and
- diving emergencies.

These plans will be expanded to reflect production and operational concerns (for example, subsea pipelines).

6.3 Decommissioning and Abandonment

At the end of the production life of the White Rose oilfield development, the operator will decommission and abandon the site according to C-NOPB requirements and *Newfoundland Offshore Area Production and Conservation Regulations*. The floating production facility will be removed from the oilfield. Subsea infrastructure will be removed and the wells will be plugged and abandoned.

7 PRELIMINARY ISSUE ANALYSIS

Based on previous DAs (Hibernia and Terra Nova), the DA guidelines (C-NOPB 1988) and review of existing project information, a preliminary list of valued environmental components (VECs) have been identified for the proposed White Rose oilfield development. These are:

- Employment and Business;
- Infrastructure and Services;
- Commercial Fisheries;
- Fish and Fish Habitat;
- Seabirds; and
- Marine Mammals.

This preliminary VEC list will be discussed during the scoping process, which will include:

- individual stakeholder meetings;
- key informant workshops; and
- public information sessions.

This scoping process will take place before providing a draft DA for internal review. A second round of technical scoping and consultation sessions will be conducted before submitting the final DA to the C-NOPB.

The list of possible issues will be frequently refined in consultation with regulatory agencies and other stakeholders. Issues will be monitored on a regular basis and incorporated into the DA.

Possible issues that have emerged during discussions with regulators and other stakeholders (from the approximately 30 meetings Husky Oil has already held with various stakeholder groups) pertaining to the White Rose oilfield development include:

- changing nature of the fishery;
- traditional fishing activity;
- long term effects on the commercial fishery;
- seabed importance to crab, scallops and shrimp;
- fishing vessel traffic;
- marine mammals, in particular, changes in migration patterns of seals and whales;
- fish tainting;
- gas flaring (greenhouse gases);
- fish habitat destruction and compensation;
- seabirds;

- cumulative effects;
- disposal of drill cuttings;
- disposal of produced water;
- Canada-Newfoundland benefits;
- safety;
- public consultation; and
- oil spills.

Issues raised during future consultation activities will be addressed in the appropriate sections of Husky Oil's DA.

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9 GLOSSARY

Word	Definition
Abandonment	The decommissioning of facilities, including the plugging of wells, and removal of offshore structures following exhaustion of reserves
Astronomical Tides	The alternate rise and fall of the surface of oceans, seas and the bays, rivers, etc., connected with them, caused by the gravitational attraction of the sun and moon
Avalon Formation	A particular rock deposit that formed approximately 110 million years ago in the **Cretaceous** period. It is the source rock of the White Rose South oil pool
Benthos	Marine plants and animals that live on or near the ocean bottom
Borehole	The hole in the earth made by the drill; the uncased drill hole from the surface to the bottom of the well
Bundle	A group of pipes tied together
Caisson	A large-diameter pipe that houses and protects a **wellhead** located below the sea floor
Cluster Manifolds	A set of pipes and valves which handle the collection and distribution of fluids for **cluster wells**
Cluster Wells	Individual wells grouped around a fluid or gas gathering or distribution point
Complex	A large geological structural feature composed of several smaller structural features. In this case the complex refers to the White Rose salt dome and adjacent collapse features, including many individual fault blocks
Cretaceous	A period of Geologic time from approximately 130 to 65 million years ago. Dinosaurs and other reptiles thrived in the early Cretaceous but by the end of this period, dinosaurs and many of the reptiles had become extinct
Delineation Wells	Wells drilled after the initial exploration well to give a better understanding of the extent and performance of the reservoir
Demersal Species	Animals [adults] living on or near the sea floor
Deviated Wells	Wells that begin in a vertical direction, from a central surface location and then turn at an angle to reach specific targets in the reservoir
Downdip	A direction towards a lower elevation from a given point on a structure or surface
Drill Centre	A central sea-floor location for a group of wells having different target locations in the reservoir
Fault Block Traps	A hydrocarbon trap created by differential movement along geologic faults that fragments the reservoir into one of several structural compartments
Flowlines	Pipelines used to move fluids from one location such as a well to a gathering centre
Glaze	A smooth, slippery coating of thin ice
Glory Hole	Large excavations into the seafloor, where **wellheads** and other equipment can be located to protect them from damage from icebergs
Hard Pan	A dense, tight layer of "soil" often found within a few metres of the sea floor
Jurassic	A period of Geologic time from approximately 180 to 45 million years ago. Older plant groups continued to decline and newer forms continued to spread, dinosaurs were growing in size and becoming specialized for varied ways of life, and marsupial mammals and the first birds appeared
MSL	Mean Sea Level – the mean surface water level determined by averaging heights at all stages of the tide over a 19-year period. Mean sea level is usually determined from hourly height readings measured from a fixed, predetermined reference level
Manifolds	A piece of equipment where the fluids from several **flowlines** or wells are received and combined
Multiphase Metering	Meters that can distinguish and measure mixed fluids such as gas, water and oil
Net Oil Pay	The remaining pay thickness in an oil zone after zones of low porosity, shale, and high water saturation have been discounted
Pelagic Species	Animals which live within the water column
Pigging	Passing an object (the "pig") through a pipe to clean scale and other residue from the inside of the pipe, in much the same way as a pipecleaner is used to clean a pipe
Plankton	Plant (phytoplankton) and animal (zooplankton) organisms that drift with ocean currents
Resource	An initial volume of oil and gas that is estimated to be contained in a reservoir
Rime	An accumulation of granular ice tufts on the windward sides of exposed objects that is formed from supercooled fog or cloud and built out directly against the wind

Word	Definition
Riser	A **flowline** for transmission of fluids or gas from the seabed to the surface production facility or to a tanker-loading platform
Round-Trip Pigging	The process of **pigging** a line and returning the pig to its starting point by means of a pipeline loop
Significant Discovery Areas	The area deemed to be evaluated by an exploration well drilled on an Exploration License that has encountered and tested significant hydrocarbons. Lands within a Significant Discovery Area continue to be held by the exploration company after the Exploration License has expired
Significant Discovery Licenses	The document of title by which lands are held within a **Significant Discovery Area**. Ownership of a Significant Discovery License must be homogeneous, therefore, there may be several Significant Discovery Licenses comprising a **Significant Discovery Area** if ownership of the **Significant Discovery Area** is complicated
Structural Culmination	The highest point of a structural feature
Template	A design pattern with built-in guides for equipment and structures to ensure their usefulness
Tertiary	A period of Geologic time from approximately 65 to 2.5 million years ago. The earliest large mammals, grasses and hominids appeared during this period. It is also the period during which most of today's high mountain ranges were formed.
Throughput	The amount, usually volume, that can be processed through a piece of equipment or facility, usually expressed on a daily basis
Topside Facilities	All the oil and gas separation, treatment and production equipment and related equipment such as compressors, flares and accommodations located on top of an offshore facility
Tsunami	A very long period wave generated by an underwater earthquake, landslide or volcanic eruption [also known as a tidal wave or seismic sea wave]
Tree	a) An arrangement of valves placed on top of a well to control flow from the well b) An arrangement of valves and fittings attached to the tubing head to control flow and provide access to the tubing string [also referred to a an Xmas (Christmas) tree]
Turret	A low, tower-like structure capable of revolving horizontally within the hull of a floating offshore facility and connected to a number of mooring lines and **risers**. It allows the ship to rotate with the weather while maintaining a fixed mooring system
Umbilical	A conduit or group of conduits that provide communications, control and power from a surface facility to another facility on the sea floor
Wellbore	The hole drilled by the drill bit
Well Completion	The final sealing-off of a drilled well from the **borehole** with valving, safety and flow-control devices, following final cementing and perforation of the casing at the production zone and removal of the drilling apparatus from the **borehole**
Wellhead	The equipment installed at the surface of the **wellbore** used to support the casing strings and upon which the **tree** is installed; it controls the rate of flow of liquid and gas from the well
Well Workover	A program of work performed on an existing well; may involve re-evaluating the production formation, clearing sand from producing zone, jet lifting, replacing downhole equipment, deepening the well, acidizing or fracturing, or improving the drive mechanism

Note: Bolded words within a definition are themselves defined.