bhpbilliton

MINERVA-4
DRILLING & COMPLETION PROGRAMME

Rev 0

September 2002

MINERVA DEVELOPMENT

PERMIT:VIC/L22

Controlled Document Nos.
Perth Drilling Team: PCD 0024
Minerva Project: 00MN-O84-0002

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Note:
Unless otherwise stated, the following abbreviations are adopted in this document:

mTVD RT = metres true vertical depth below Rotary Table
mTVD SS = metres true vertical depth below LAT
mMD = metres along-hole depth below Rotary Table

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1.0 WELL DATA

1.1 SUMMARY DATA SHEET

Well:	Minerva-4
Designation:	Development
Permit:	VIC/L22
Contract Operator:	BHP Billiton Petroleum Pty Ltd
Anticipated Spud Date:	December 2002
Rig:	Sedco 702
Rig Type:	Semi-submersible
Drilling Contractor:	Sedco Forex International Inc.
Water Depth:	60m L.A.T
RT above LAT	26m (assumed)
Surface Location:	AGD 84 Latitude: 38° 43' 12.702" S Longitude: 142° 57' 38.974" E UTM Zone 54S CM 141° East Easting: 670466 Northing: 5712433
Sub-Surface Location:	AGD 84 Latitude: 38° 43' 13.354" S Longitude: 142° 57' 38.992" E UTM Zone 54S CM 141° East Easting: 670466 Northing: 5712413
Target Depth:	1778mSS +/-45m
Rig Tolerance:	15m radius centred on the proposed well Location
Target Tolerance:	Refer to Section 1.8 Ellipse 150m x 80m centred on proposed sub-surface location
Primary Objective:	Minerva Formation
Total Well Days:	Drilling - 16.30 days Completion 14.33 days TOTAL 30.63 days

Total Depth:	1838mSS +/-45m Total depth is proposed to be 60m into the Minerva Formation Reservoir

1.2 EXECUTIVE SUMMARY

Foreword

BHP Billiton Petroleum Pty. Ltd is the operator for production license VIC/L22. Minerva-4 will be a vertical well drilled by the semi-submersible Sedco 702 MODU to target the Minerva Formation reservoir. Minerva-4 surface location is 514m SE of the Minerva-2A surface location, on the southern fault block of the Minerva Gas Field.

Objectives

Minerva-4 is a vertical development well designed to access the crest of the southern fault block of the Gas Minerva Field. The well will be drilled to approximately 60m beneath the Top Minerva Formation.

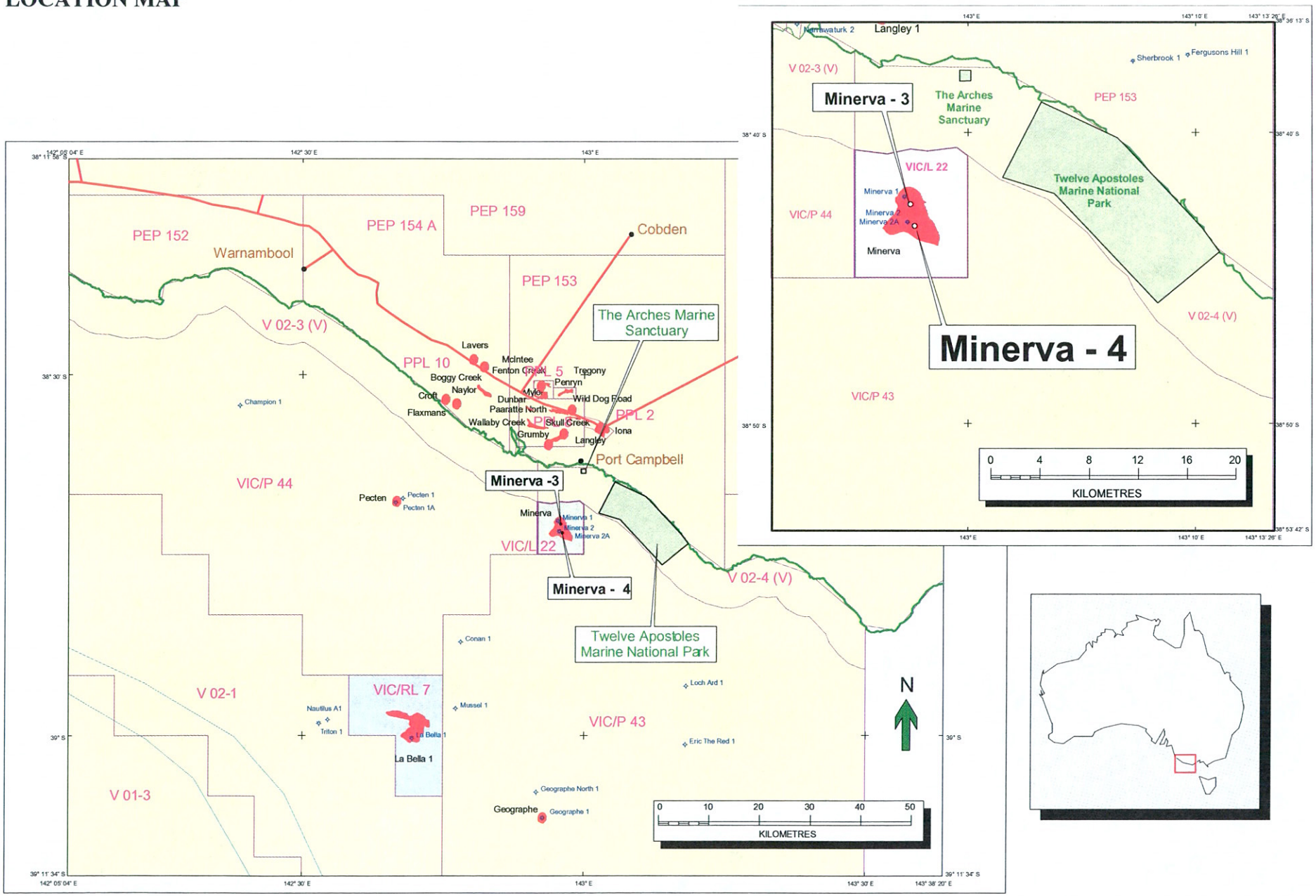
Completion/Testing

The well will be completed as a subsea gas producer. Four-inch expandable sand screens will be set across the Minerva Formation Reservoir and 7" production tubing will be run with a 9⅝" production packer. Clean-up flow testing will be conducted prior to the well being suspended pending commissioning of the Minerva Pipeline in 2003/2004.

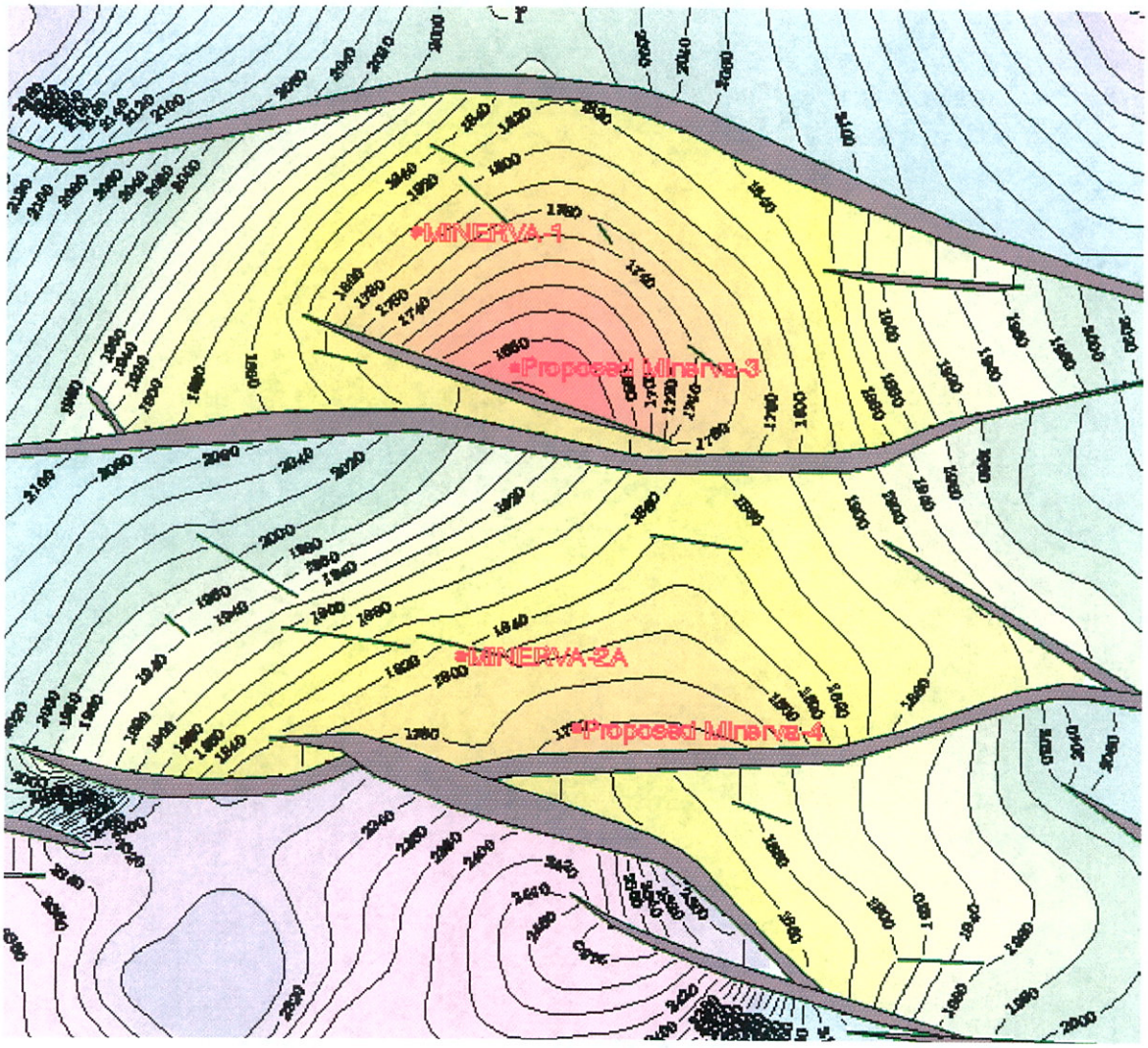
Notes:

- The Minerva-4 well is located approximately 10 kms due south of the Victorian Coastline, an area of environmental and cultural significance. The Twelve Apostles Marine National Park is 5kms to the north-east and The Arches Marine Sanctuary is 9kms to the north.
- A KCL/PHPA/Polymer Mud system will be used in the 12 ¼" hole section, with a mud weight of 1.20 sg to minimize hole problems from reactive clays.
- A NaCl/Polymer/$CaCO_3$ drill-in fluid will be used to drill the reservoir section.
- Wellbore fluid invasion will be minimized to reduce reservoir damage by the selection of properly sized bridging material.

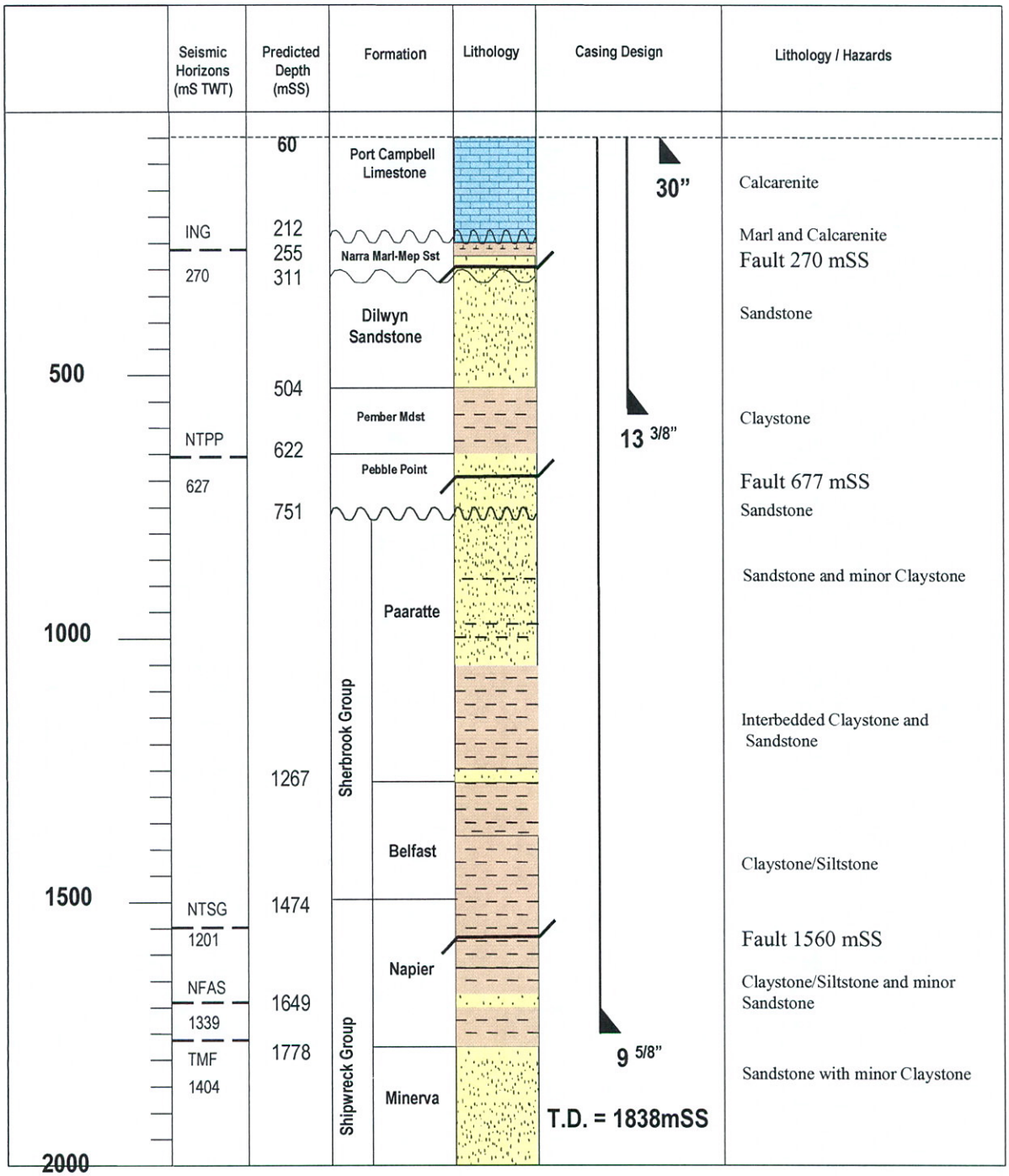
1.3 LOCATION MAP



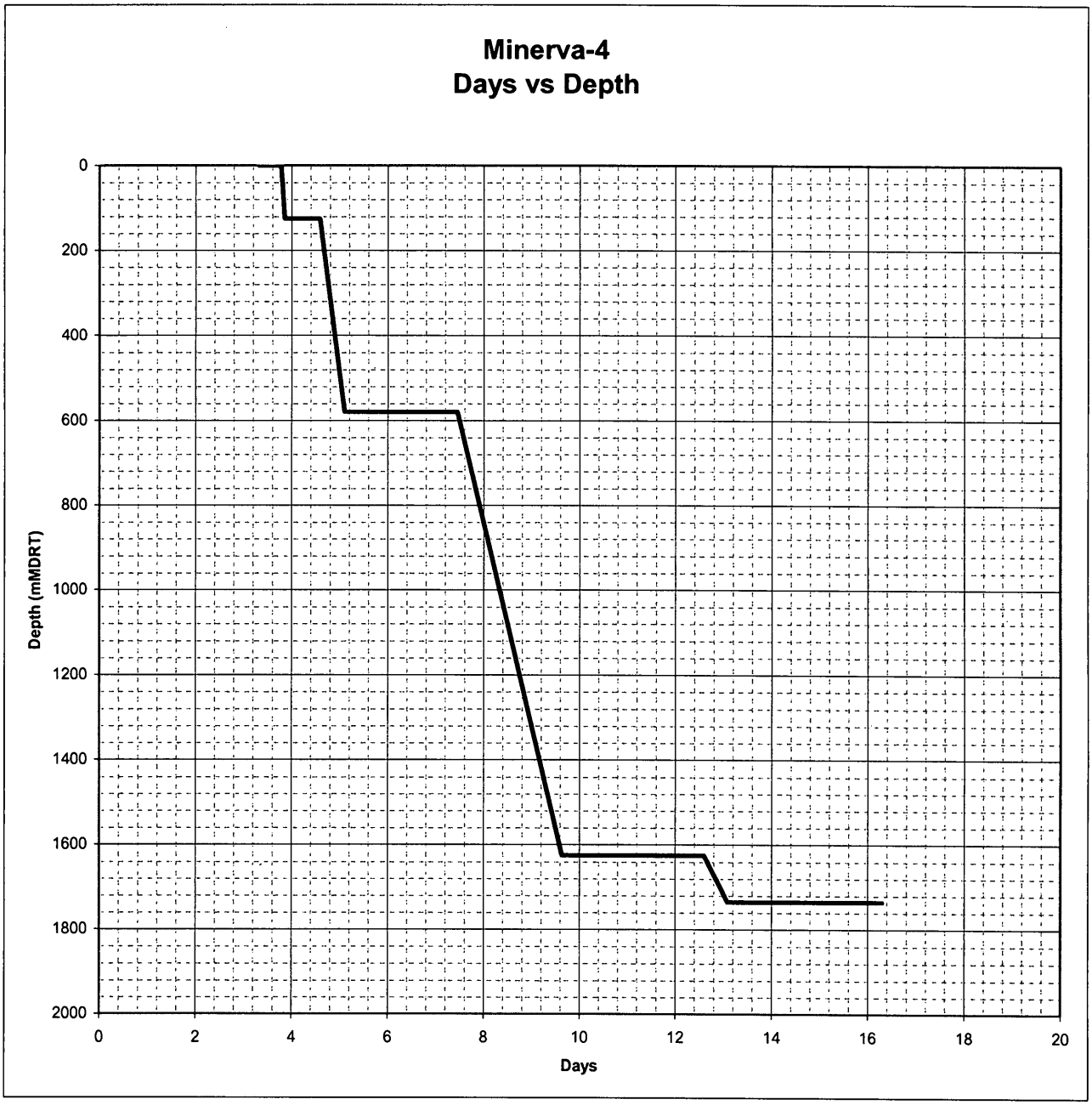
1.4 TOP MINERVA FORMATION DEPTH MAP – MAY 1995



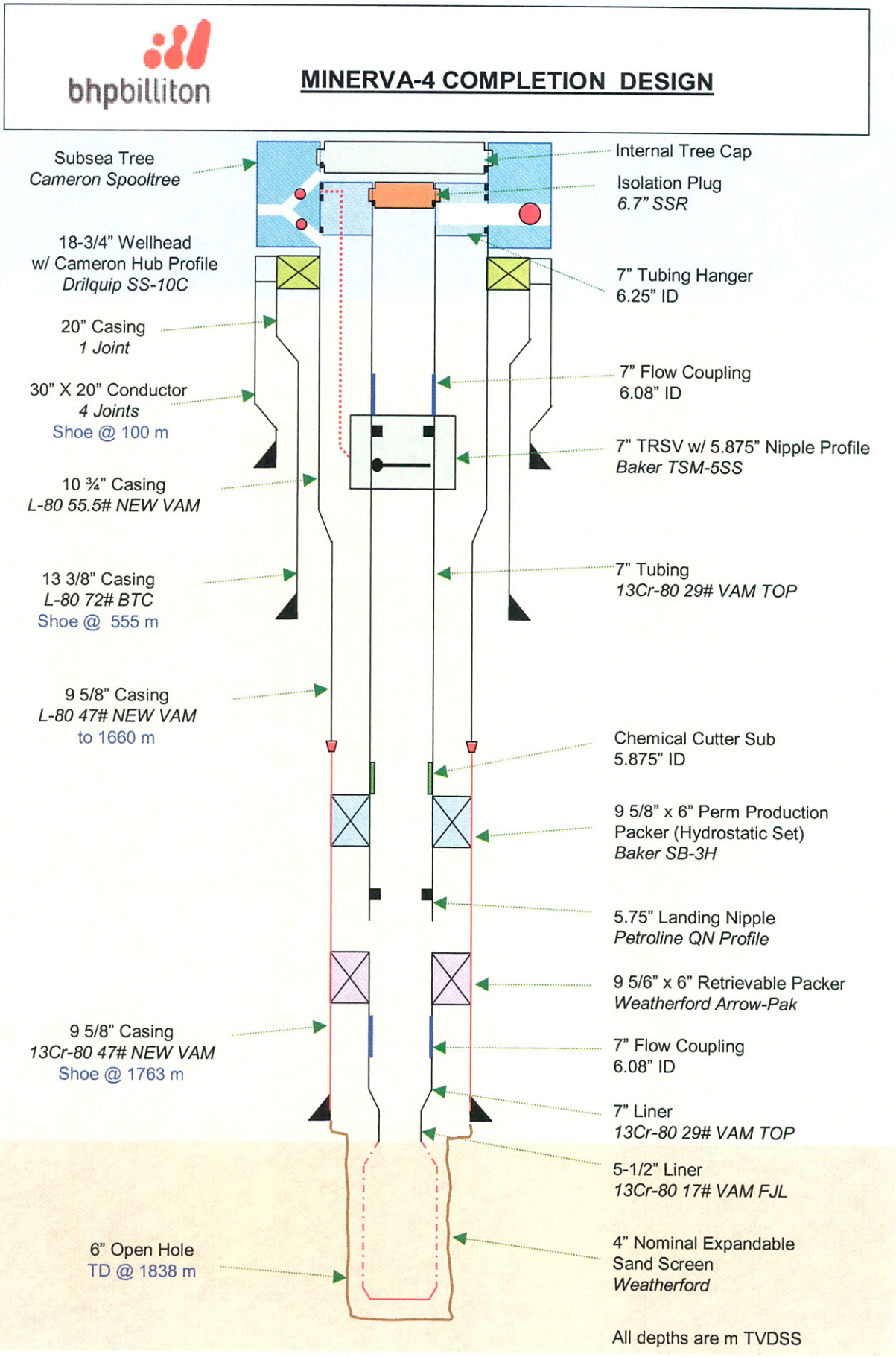
1.5 PREDICTED SECTION



1.6 TIME VERSUS DEPTH

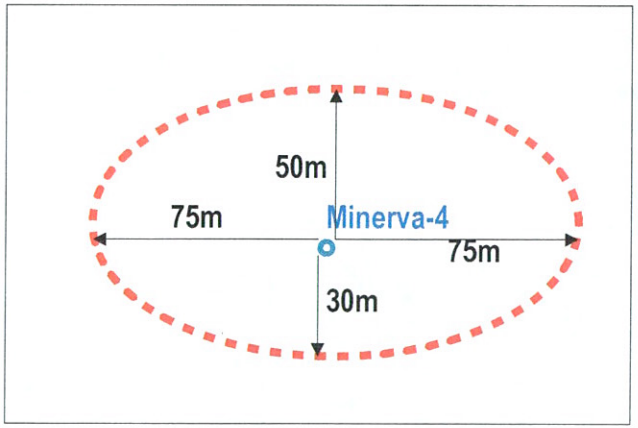


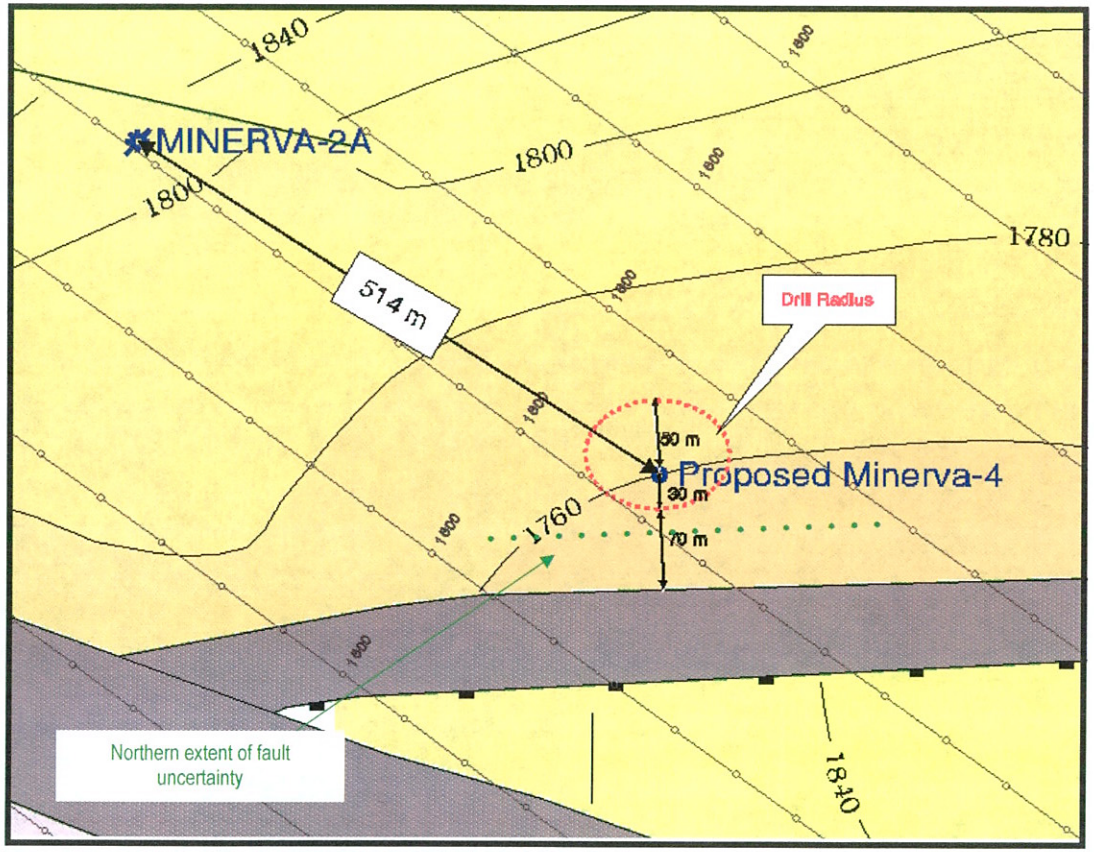
1.7 PROPOSED WELL COMPLETION SCHEMATIC



1.8 SUBSURFACE TARGET TOLERANCE

- Updip of Minerva-2 on the Minerva South Fault Block,
- 0.514 km to the SouthEast of Minerva-2,
- X = 670466 Y = 5712413
- Latitude 38 43' 13.35"
  Longitude 142 57' 38.99"E
- Inline 1533 Xline 1609
- >100 behind major fault





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2.0 GEOLOGY

2.1 INTRODUCTION

The Minerva-4 well is located in production license VIC/L22 in the offshore Otway Basin. The well is a crestal vertical development well designed to produce gas and condensate from the southern fault block of the Minerva Gas Field. The well is located 514m SE of the Minerva-2A surface location and is approximately 24m up dip at the Top Minerva Formation.

2.2 STRUCTURE

The Minerva Gas Field is composed of two E-W trending fault blocks that tilt down to the North. Each fault block is bounded by E-W trending normal faults at the Minerva Formation level with minor NW-SE trending faults also present. Fault blocks were formed by early Cretaceous extension however, structural closure has been enhanced by Early Cretaceous to Recent extension and inversion. Fault trends change from dominantly E-W within the Shipwreck Group to NW-SE in the Sherbrook and younger sediments.

The table below list the depth and uncertainty of seismically identified faults expected in Minerva-4.

Fault Depth mSS	Fault Throw
270 +/- 20m	5m down to NE
677 +/- 30m	17m down to NE
1560 +/- 100m	200m+ down to SW

No drilling fluid losses or gains, gas peaks or excess ditch cuttings were associated with any of these faults penetrated in Minerva-2A. No drilling fluid losses or gains, gas peaks or excess ditch cuttings are expected within Minerva-4. However the well will be carefully monitored wherever faults are expected.

There is a possibility for small scale (sub-seismic) faults encountered throughout the Sherbrook Group and Shipwreck Group sediments.

2.3 STRATIGRAPHY/RESERVOIR

Minerva-4 is predicted to intersect a sedimentary section ranging in age from Recent to Turonian (Early Cretaceous). The well is located in water depth of 60m (LAT). The stratigraphic section is similar to that intersected in Minerva-2A and Minerva-1. Conan-1 and Pecten-1A also provide information on the Port Campbell Limestone, Narrawaturk Marl, Mepunga Sandstone, Dilwyn Sandstone and Pember Mudstone Formations that were not sampled in Minerva-1 and 2A. The predicted section is presented in Section 1.5.

Port Campbell Limestone (Recent to Late Oligocene) 60mSS-212mSS

The Port Campbell Limestone consists of an upper light grey to white fine to medium grained fossiliferous calcarenite unit overlying a lower grey to green fossiliferous marl unit with minor calcarenites. Marls contain minor silty/argillaceous matrix and trace amounts of glauconite.

Narrawaturk Marl (Early Oligocene to Middle Eocene) 212mSS-255mSS

The Narrawaturk Marl consists of interbedded grey green to dark grey marls and minor white to off-white fine-grained fossiliferous calcarenites. Marls contain common calcisiltite, terrigenous silt and trace amounts of glauconite.

Mepunga Sandstone (Middle Eocene) 255mSS-311mSS

The Mepunga Sandstones consists of ferruginous to quartzose fine to coarse-grained sandstone which contains trace amounts of glauconite and siltstone. In Pecten-1A high resistivity reading through the sand and lack of hydrocarbon shows suggests fresh formation connate water.

Dilwyn Sandstone (Middle to Early Eocene) 311mSS-504mSS

The Dilwyn Sandstones consists of quartzose to rarely ferruginous fine to coarse grained sandstone with minor interbedded dark brown siltstone. In Pecten-1A sandstones had good inferred porosity, no shows and elevated resistivity measurements that suggest fresh formation connate water.

Pember Mudstone (Early Eocene to Late Paleocene) 504mSS-622mSS

The Pember Mudstone consists of medium to dark brown claystone that grades to slity-claystone throughout and becomes increasingly arenaceous with depth. Hard ferruginous to quartzose sandstones beds were encountered in Minerva-1 and Minerva-2A. A quartzose pebbly sandstone, with grains ranging from medium grained to pebble size was seen in Minerva-1 from 561-564mRkb that had siliceous and pyrite cement. Claystones are also carbonaceous in part, contain trace amounts of pyrite and glauconite.

Pebble Point (Early Paleocene) 622mSS-751mSS

The Pebble Point Sandstone consists of coarse to granule-sized sandstone that ranges in colour from clear to opaque, light green and red/orange brown. Sandstones contain trace dolomite cement, siliceous cement and argillaceous matrix in places. The basal Pebble Point consists of medium to dark grey/brown claystone, which is arenaceous in part. Sandstones have elevated resistivity reading indicating fresh connate formation water. Pebble Point Sandstone Formation outcrops onshore 10kms to the north of the Minerva Field.

Sherbrook Group (Late Cretaceous) 751mSS-1474mSS

The Sherbrook Group consists of the interbedded sandstones and claystone of the Paaratte Formation and lower claystones of the Belfast Formation.

Paaratte Formation (Late Cretaceous) 751mSS-1267mSS

The Paaratte Formation consists of interbedded sandstone and claystone at the top of the Sherbrook Group. Sandstones are light grey to clear and range from fine to coarse-grained. Hard quartz and calcite cemented layers are expected throughout Paaratte Formation sandstones which have sonic transit times ranging from 180-350 us/m. Claystones are medium to dark grey in colour and grade to arenaceous claystones and light brown to light browny/grey silty claystone.

Belfast Formation (Late Cretaceous) 1267mSS-1474mSS

The Belfast Mudstone consists of medium to dark grey/browny grey silty claystone to argillaceous siltstone.

Shipwreck Group (Late Cretaceous) 1474mSS-1838mSS)

The Shipwreck Group comprises, from youngest to oldest, the Napier, Minerva and La Bella Formations. The Napier Formation consists of claystone/siltstone with the Napier 'A' Sand located at approximately the middle of the Napier Formation. This sand contains gas which is believed to be in communication with the Minerva Formation Gas Reservoir. The Minerva Formation Gas Reservoir is located at the top of the Minerva Formation. The La Bella Formation was water bearing in Minerva-1/2A but will not be penetrated in Minerva-4.

Napier Formation (Late Cretaceous) 1474mSS-1778mSS

The Napier Formation consists of medium to dark grey/brown argillaceous siltstones and silty claystones, similar to sediments seen in the Belfast Mudstone, with thin interbedded sandstone(s). The interbedded sandstones belong to the Napier 'A' Sand and are described as clear to light grey fine to coarse-grained sands that range from loose to hard calcite/siliceous cemented sandstones. These sands have a distinctive coarsening upward GR profile grading to siltstone and ultimately argillaceous siltstones and claystones with depth.

The Top Napier A Sand is prognosed at 1649mSS in Minerva-4 and is expected to contain 3-5m of sands. The distance between the Top Napier A Sand and Top Minerva is prognosed at 129m. The total Napier Formation thickness varies in Minerva-1 and Minerva-2A from 342m to 246m. The variation in thickness is partly due to missing section from normal faults in Minerva-2A and stratigraphic thinning towards Minerva-2A. The Minerva-1 section however provides the most complete un-faulted section.

Napier Formations sediments were deposited in a lower shoreface to upper shoreface/delta front marine environment. The top Napier 'A' Sand is a prominent seismic reflector that is continuous across the field and pinches out to the south of the field.

Minerva Formation (Late Cretaceous) 1778mSS-1838mSS

The Minerva Formation is expected to consist of clear to light grey, very fine to granule size sandstone with minor interbedded medium to dark medium grey claystones/carbonaceous claystones. A total of 60m of Minerva Formation will be drilled in Minerva-4, which will penetrate the M1 and upper M2.1 reservoir units.

A carbonaceous claystone/coal layer at the top of the M1.2 Unit, the "M1.2 Shale", is prognosed 34m beneath the Top Minerva Formation and to be 2m thick. This unit is believed to have been deposited in a lacustrine/swamp environment and to be sealing across the field. It is planned to drill beneath this shale in order to optimally produce the reservoir. The M1.2 Shale is described in cuttings and core samples as a medium to dark brown/grey claystone to carbonaceous claystone/coal. Plant fragments were common, carbonaceous material, trace amounts of amber with rare fine to medium grained argillaceous sandstone interbeds. On neutron/density wireline logs the M1.2 Shale has a characteristic low density and high neutron reading, typically of carbonaceous/coal beds. It was seen in Minerva-1 from 1839-1842mRT and in Minerva-2A from 1863-1865mRT (Note: The M1.2 Shale was 34m beneath Top Minerva Formation in Minerva-2A).

2.4 WELL PROGNOSIS

The following table lists the Formation tops and uncertainties associated with these tops based on seismic interpretation and seismic velocity uncertainty.

Predicted Stratigraphy and Uncertainties

Formation/Group Horizon	Prognosed Depth		Uncertainty
	mSS	RT	
Seafloor	60	86	+/- 5m
Port Campbell Limestone	60	86	+/- 5m
Narrawaturk Marl	212	238	+/- 5m
Shallowest mapped closure – Intra Nirranda Seismic Horizon	255	281	+/- 7m
Mepunga Sandstone	255	281	+/- 7m
Dilwyn Sandstone	311	337	+/- 8m
Pember Mudstone	504	530	+/- 13m
Pebble Point Formation	622	648	+/- 15m
Paaratte Formation	751	777	+/- 19m
Belfast Formation	1267	1293	+/- 40m
Napier Formation	1474	1500	+/-40m
Napier Formation 'A' Sandstone	1649	1675	+/-40m
Minerva Formation	1778	1804	+/-45m
Total Depth	1838	1864	+/-45m

Assumed RT to LAT is 26m.

2.5 SHALLOW GAS

A shallow hazard drilling assessment was made for the Minerva-4 using the 3D seismic data covering the field and well data from Minerva-2A and 21 (See Minerva Project Document 00MN-R84-0010 – Minerva-4 Shallow Hazard Assessment Report). This study found:

- There are no sea floor abnormalities,
- There was no shallow gas intersected in adjacent wells and there is no evidence of any shallow gas hazards on the 3D seismic data running through the proposed Minerva-4 location. A 9⅞" shallow gas hole was drilled on Minerva-2 and Minerva-1 with no indications of shallow gas. First hydrocarbon gas was detected in the Paaratte Formation at 957mRT and 910mRT in Minerva-1 and Minerva-2A respectively.
- Despite the presence of structural closure from 255mSS, the proposed location appears in a safer, downdip location as compared to the Minerva-2A well,
- No evidence for connection to possible overpressures water sands exists,
- The well should intersect a very small (approx 5 ms throw) fault immediately beneath the Intra-Nirranda horizon (270mSS)
- Shallow faulting over the Minerva Field does not show any evidence of High Resolution Diagenetic Zones.

2.6 RESERVOIR HYDROCARBONS

The Minerva reservoir contains gas at a CGR of 6 bbl/MMscf with a GWC of 1915m TVDss. The gas gradient in the reservoir is 0.18 psi/m. The gas contains 1.9 mol% CO_2 and 1.0 mol% N_2. 0.4ppm H_2S was noted in the Minerva-1 DST.

2.7 TOTAL DEPTH

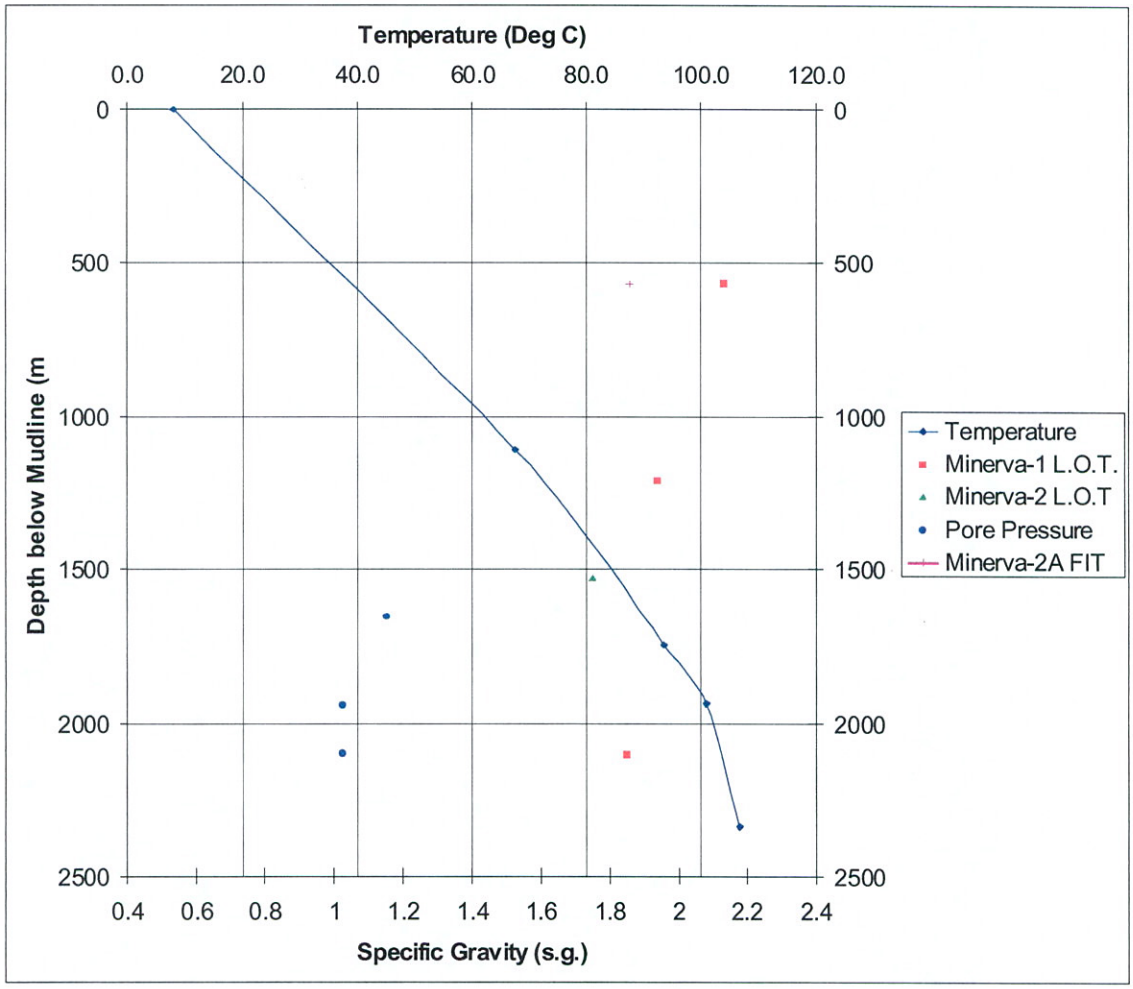
The well will be drilled to a TD of approximately 60m beneath the Top Minerva Formation. This will allow sufficient depth beneath the M1.2 Shale for optimum depletion of the reservoir. The M1.2 Shale is believed to be a field-wide sealing shale.

3.0 DRILLING & COMPLETION

3.1 CHRONOLOGY

OPERATION	ESTIMATED TIME (days)	CUMULATIVE TIME (days)
Run anchors	3.33	3.33
Rig-up to spud • Tag seabed	0.45	3.78
Drill 36in hole	0.08	3.86
POH • Run 30in • Make-up 16in BHA • RIH • Drill out	0.73	4.59
Drill 16in hole	0.51	5.10
POH to run 13-3/8in casing	0.24	5.34
Run 13-3/8in casing	0.52	5.86
Run BOPs and riser • Test BOPs • Make-up 12-1/4in BHA • Drill out	1.59	7.45
Drill 12-1/4in hole	2.19	9.64
Wiper trip • POH • Pull wear bushing	0.34	9.98
Run 9-5/8in casing	0.92	10.90
Test BOPs • Drill out with 8½" BHA • LOT	0.83	11.73
POH • Change BHA • RIH	0.88	12.61
Drill 6" hole to TD	0.47	13.08
Wiper trip • POH to log	0.44	13.52
Log	0.58	14.10
Wiper trip	0.48	14.58
Run 4in ESS liner • Expand ESS • POH	1.39	15.97
Set RPB plug in liner	0.33	16.30
Displace hole to seawater • Jet wellhead	0.62	16.92
Set storm packer • Pull riser and BOPs	1.11	18.03
Run Horizontal Subsea Tree	0.48	18.51
Run & Test BOPs • Pull storm packer	1.84	20.35
Perform clean out run • Displace hole to brine • POH	0.81	21.16
Run 7in completion • Displace tubing to underbalance cushion • Set packer	1.82	22.98
Recover RBP	0.44	23.42
Perform Clean-up flow	2.10	25.52
Leak Test TRSV valve • Set Tubing Hanger Plug	0.58	26.10
Pull landing string	0.31	26.41
Set and test tree cap	0.38	26.79
Pull BOPs	0.96	27.75
Run debris cap	0.10	27.85
Prepare to move	1.63	29.48
Pull anchors	1.15	30.63
Total		**30.63**

3.2 PRESSURE AND TEMPERATURE PROFILE



3.3 SITE SURVEY

The Minerva-4 well will be drilled 514m SE of the Minerva-2A surface location. There is no existing subsea infra-structure or pipelines in the vicinity. Two site surveys have been performed previously over the Minerva-4 proposed well location, the first in May 1992 covering an area 3km by 3km, followed by a larger survey covering an area of 5.4km by 4.5km in June 1993.

The seabed at this location is relatively flat, sloping gently to the south with a water depth of approximately 60m. The seabed features were investigated using a side scan sonar, with the seafloor characterised by large areas of unconsolidated, mobile, fine to medium grained carbonate sands. Elsewhere, there is evidence of mega-rippled coarse, shelly sands and gravels.

No problems of anchor slipping were reported on either of the Minerva exploration wells drilled to date. The Sedco 702 has Stevpris high holding capacity anchors and as such, holding capacity is not expected to be problematic on Minerva-4.

3.4 LOST CIRCULATION / HOLE PROBLEMS

No lost circulation problems have occurred in any of the previous Minerva wells. However, the Mepunga, Dilwyn and Pebble Point Formations are very porous and losses would be expected in these formations if excessive mud weights were used. Contingency LCM plans are in place to address the potential losses in these formations. The well is expected to encounter faults at 270mSS, 677mSS and 1560mSS. To minimise the risk of losses while drilling the reservoir section, the drill-in fluid will include bridging materials sized to bridge the pore throats. Testing of the bridging material will be performed on cores taken from Minerva-1.

The Minerva-2 well was lost while drilling a pilot hole, due to hole instability in the Pember mudstone. This problem was resolved for the re-spud, Minerva-2A, by spotting a KCL pill on bottom to stabilise the mudstone prior to pulling the bit. Tight hole was experienced in the Paaratte and Belfast formations of the Sherbrook Group in both Minerva-1 and 2A. Regionally, the Belfast mudstones can be over-pressured, as noted in Mussel-1, La Bella-1 and Triton-1. As the Minerva-4 well will be drilled at the crest of the structure, a higher mud weight will be used to provide an overbalance against the Napier gas sand. It is anticipated that this increased fluid density will help stabilisation of the Paaratte and Belfast clays. Selection of the optimum KCL concentration(s) in the mud system to be used for drilling the Pember, Belfast and Napier formations will be determined by performing fluid/rock compatibility testing.

Similarly, the drill-in fluid will be tested to select the optimal size distribution of bridging material to minimise formation damage.

3.5 FORMATION PRESSURE EVALUATION

The well is expected to have a normal pore pressure gradient until the Napier Gas Sand is intersected. RFTs taken in the Napier indicate that it is on the same gas gradient as the underlying main Minerva Formation reservoir. Pressure measurements of 2705 psia at 1635.8 mSS (1.16 SG) and 2711 psia at 1699.2 mSS (1.12 SG) were measured in Minerva-1 and Minerva-2A respectively.

The Minerva Formation reservoir contains gas at a pressure of 2747 psia at a datum of 1915 mSS with a gradient of 0.18 psi/m. The expected maximum pressure at the top of the reservoir is expected to be 2722 psia at this location.

The 12.25in hole section will be drilled with a 1.20SG KCL/PHPA/Polymer mud system. This system will be designed to inhibit the clays of the Pember, Belfast and Napier formations while providing sufficient overbalance against the Napier gas sand.

The reservoir will be drilled with 1.12SG drill-in fluid containing calcium carbonate as a bridging material, thereby providing 150psi overbalance to the predicted reservoir pressure.

3.6 FORMATION GASES

Background gas levels commonly build-up from negligible in the upper part of the Paaratte, increasing to between 0.1% and 1.0% at 957mRT and 910mRT in Minerva-1 and Minerva-2A respectively.

While drilling, neither H_2S nor CO_2 have been evident on any of the Minerva exploration wells. Operating policies will include H_2S detectors as part of the rig alarm system and H_2S monitoring at the rotary table, mud pits, and shale shakers via the mudlogging unit. A Garrett gas train will be used to monitor sulphides in the drilling mud. H_2S scavenger (zinc carbonate) will be onboard for direct addition to the mud system. Portable H_2S detectors and a number of 30 minute SCBA sets will also be available.

3.7 CASING PROGRAMME

Based on bathymetric data the water depth at Minerva-4 will be approximately 60m. The surface conductor will consist of the wellhead housing complete with 30" extension, two 30" intermediate joints, and a 30"/20" shoe joint with an expected shoe setting depth of 125mMD (100mTVDSS).

The 13⅜" casing shoe shall be set approximately 50mMD below the top of the Pember mudstones. The Pember formation is primarily composed of a silty claystone and providing a competent seat for the next hole section. The predicted fracture gradient at the 13⅜" casing shoe depth is expected to exceed 1.86SG EMW, thus providing sufficient kick tolerance to drill to the 9⅝" casing point.

The 9⅝" casing shoe has been programmed to be set towards the base of the Napier Formation, approximately 15m above the Minerva reservoir. The setting depth of the 9⅝"casing is programmed at approximately 1763mTVDSS. The actual setting depth will be based on MWD correlation of the Napier 'A' Gas Sand as observed in the offset wells, taking into account the relatively uniform isopach of the Napier Formation across the Field.

After drilling out the shoe in 8½" hole, a 6" hole will be drilled to TD in the Minerva Formation. TD will be determined by drilling 60m into the reservoir. A 4" expandable sand screen with a liner top packer will be set and the well prepared for running the subsea completion.

3.8 CASING DETAILS

	CASING				STRENGTH			SAFETY FACTORS		DESIGN ASSUMPTIONS		
Hole Size mm (in)	Casing Size mm (in)	Setting Depth (mTVDss)	Joint Type	Weight/Grade/Connections	Burst kPa (psi)	Collapse kPa (psi)	Tension kg (lbs)	Required	Design	Burst	Collapse	Tension
914 (36)	762 (30)	100	30in WH Housing plus extension and 30in Intermediate Jt 30in Intermediate Jt 30in x 20in Shoe Joint	637 kg/m (430 ppf) 1.5" WT, X-52, HD90 Box 459 kg/m (310 ppf) 1" WT, X-52, SF60 Pin x Box			Designed for Compressive Loading	NA	NA	-	-	-
406 (16)	340 (13.375)	555	18-3/4in WHH complete with 20in extension	508mm (20in) 1in WT X-52 Eztension	31,370 (4,550)	26,290 (3,900)	1,787,160 (3,940,000)	Burst 1.1 Collapse 1.0 Tension 1.4	3.66 7.40 7.62	Gas to surface from 13.375in LOT of 1.86SG	1.0SG loss zone in subsequent hole section balanced by 1.28SG mud column	Buoyed string weight plus shock load
			Remainder of string	340mm (13-3/8in) 107kg/m (72 ppf) N80 BTC	37,000 (5,380)	18,400 (2,670)	754,200 (1,662,000)	Burst 1.1 Collapse 1.0 Tension 1.4	4.33 6.74 3.21			
311 (12.25)	273 (10.75)	360	10-3/4in Hanger complete with 10-3/4in extension	273mm (10-3/4in) 83kg/m (55.5 ppf) L80 New Vam	44,470 (6,450)	27,720 (4,020)	578,780 (1,276,000)	Burst 1.1 Collapse 1.0 Tension 1.4	2.37 1.68 2.70	CITHP with tubing leak below hanger on 1.15SG packer fluid	Plugged perforations with gas to surface	Buoyed string weight while running casing plus shock load
	245 (9.625)	1763	Remainder of string	245mm (9-5/8in) 70 kg/m (47 ppf) L80 New Vam	47,400 (6,870)	32,760 (4,750)	483,050 (1,086,000)	Burst 1.1 Collapse 1.0 Tension 1.4	2.52 1.98 2.30			

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	CASING				STRENGTH			SAFETY FACTORS		DESIGN ASSUMPTIONS		
Hole Size mm (in)	Casing Size mm (in)	Setting Depth (mTVDss)	Joint Type	Weight/Grade/Connections	Burst kPa (psi)	Collapse kPa (psi)	Tension kg (lbs)	Required	Design	Burst	Collapse	Tension
216/152 (8.5 / 6)	140/102 (5.5/4)	1838	9-5/8in Retrievable Packer	178mm (7in) 43 kg/m (29ppf) L80 13Cr Vam Top pin down ESS deployment packer	34,500 (5,000)	34,500 (5,000)	NA	Liner will comprise Weatherford expandable sand screen technology.				
			Remainder of string	178mm (7in) 43 kg/m (29ppf) L80 13Cr Vam Top	63,300 (9,180)	48,400 (7,020)	307,100 (676,000)					
				140mm (5-1/2in) 25 kg/m (17ppf) L80 13Cr Vam FJL	53,400 (7,740)	43,400 (6,290)	124,500 (274,000)					
				102mm (4in) Expandable Sand Screen	NA	NA	NA					

3.9 CEMENTING PROGRAMME

	CASING		CEMENT						
Hole Size mm (in)	Size mm (in)	Setting Depth (mTVDss)	Type	Additives	Water m^3/mt (gps)	Weight SG (ppg)	Yield m^3/mt (cu.ft/sk)	Excess / TOC	NOTES
914 (36)	762 (30)	100	G TAIL	1.0% Calcium Chloride (BWOC)	0.464 (5.22)	1.90 (15.8)	0.784 (1.18)	200% Excess on gauge hole. TOC at seabed.	
406 (16)	340 (13.375)	555	G TAIL	NEAT	0.443 (5) Drill water	1.90 (15.8)	0.764 (1.15)	50% excess on gauge hole TOC 200m above shoe	• 1 joint shoe track. • Top/bottom plugs. • 2 centralisers per joint across shoe track and one per joint for 5 joints above shoe track. • PDC drillable plugs and float equipment. • Threadlock shoe track plus one joint above. • Shark bite insert for plug drill out.
			G LEAD	EXTENDED	1.112 (12.47) Sea water	1.50 (12.5)	1.475 (2.22)	50% excess on gauge hole TOC at seabed	
245 (12.25)	245 (9.625)	1763	TAIL	Class G + Gas check	0.396 (4.46) Drill water	1.90 (15.8)	TBA	15% Excess on gauge hole TOC 250m above 9⅝" shoe	• 2 joint shoe track. • Top/bottom plugs. • Centraliser programme TBA. • Threadlock shoe track plus one joint above.
			LEAD	Class G + extender	0.494 (5.56) Drill water	1.50 (12.5)	TBA	15% Excess on gauge hole TOC at 750m	

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3.10 DRILLING FLUIDS PROGRAMME

HOLE SIZE mm (in)	DEPTH (mTVDss)	WEIGHT (SG)	VISCOSITY (sec/lt)	YP ($lbs/100ft^2$)	FLUID LOSS (cc)	MUD TYPE	COMPOSITION / COMMENTS
914 (36)	ML – 100	1.03	100+ (sweeps)	50+ (sweeps)	n/a	Seawater / Hi-vis pills	Bentonite, soda ash, caustic soda, Guar gum (sweeps)
406 (16)	100-555	1.03	100+ (sweeps)	50+ (sweeps)	n/a	Seawater / Hi-vis pills	Bentonite, soda ash, caustic soda, Guar gum (sweeps). A weighted (1.15 SG) KCl pill will be spotted on bottom prior to POOH.
311 (12.25)	555-1763	1.20	50	20-30	API< 8 HTHP<18	KCl / PHPA / Polymer	KCl, Barite, Pac. Initial mud weight will be 1.15 SG, increasing to 1.20 SG prior to entering the Belfast formation. Fluid loss to be reduced to <5 prior to entering Belfast.
216 & 152 (8.5 & 6)	1763-TD	1.12	50	<20	API<5 HTHP <12	NaCl / Polymer / Calcium Carbonate	Brine with sized calcium carbonate as a bridging and weighting agent.

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3.11 PRESSURE TESTING SCHEDULE

	COMPONENT TEST PRESSURE kPa (psi)							
OPERATIONAL PHASE	CASING	PIPE RAMS	ANNULARS	SHEAR RAMS	1) MUD HOSE, STANDPIPE 2) TIW/GREY VALVE	IBOPs	CHOKE / KILL MANIFOLD	CHOKE / KILL LINES
Stump Test	-	3,450/34,500 (500/5,000)	3,450/24,000 (500/3,500)	3,450/34,500 (500/5,000)	3,450/34,500 (500/5,000)	3,450/34,500 (500/5,000)	3,450/34,500 (500/5,000)	
18.75in Wellhead/13.375in Casing Set	104kg/m (72ppf) N80							
Bump Plug	24,100 (3,500)	-	-	-	-	-	-	-
Running BOP Stack	-	-	-	-	-	-	-	1,380/24,100 (200/3,500)
Stack Landed	-	-	-	1,380/24,100 (200/3,500)	-	-	-	1,380/24,100 (200/3,500)
Periodic Testing (Fortnightly)	-	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)
9.625in Casing Set	70kg/m (47ppf) L-80							
Bump Plug	24,100 (3,500)	-	-	-	-	-	-	-
Pack-off Test	24,100 (3,500)	-	-	-	-	-	-	1,380/24,100 (200/3,500)
Prior to drill out	-	1,380/24,100 (200/3,500)	1,380/2,4100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)
Periodic Testing (Fortnightly)	-	1,380/24,100 (200/3,500)	1,380/2,4100 (200/3,500)	1,380/24,100 (200/3,500))	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)
9.625in x 7in ESS Deployment Packer Set	178mm (7in) x 102mm (4in) ESS Liner	-	-	-	-	-	-	-
After setting ESS deployment packer	24,100 (3,500)							
Xmas Tree Set	NA							
Stump Test (prior to running)	24,100 (3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)
Periodic Testing (Fortnightly)	-	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)	1,380/24,100 (200/3,500)
7in Production Tubing Set	13kg/m (29ppf) L-80 tubing							
Tubing after setting production packer	24,100 (3,500)	-	-	-	-	-	-	-
Production annulus / tubing hanger	24,100 (3,500)							

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3.12 KICK TOLERANCE SUMMARY

HOLE SIZE mm (in)	TD MTVDss	PREVIOUS CASING SIZE mm (in)	SHOE DEPTH (MTVDss)	LOT (SG)	MAX MUD WEIGHT (SG)	PORE PRESSURE (SG)	KICK TOLERANCE m^3 (bbl)	MINIMUM ACCEPTABLE KICK TOLERANCE m3 (bbl)
311 (12.25)	1763	340 (13.375)	555	1.86	1.20	1.14	>10.1 (63)	4.0 (25)
152 (6)	1838	244 (9.625)	1763	1.75	1.12	1.06	Can take gas back inside casing.	2.4 (15)

Assumptions/Notes

1. Minimum acceptable kick tolerances shown are in accordance with the BHPBP Well Design Standard.

2. All appropriate precautions as described in Table 4. 1 of the BHPBP Well Control Standard should be taken during drilling of the well.

3.13 SURVEYING

36in Hole: Anderdrift (MWD-inclination only)

16in Hole: Anderdrift (MWD-inclination only)

12.25in Hole: An MWD tool (with directional sensors) will be used.

6in Hole: An MWD tool (with directional sensors) will be used.

3.14 DIRECTIONAL DRILLING / ANTI-COLLISION

Minerva-4 is planned as a vertical well. The nearest offset well is the Minerva-2A exploration well, 514m to the Northwest, which has been temporarily suspended.

4.0 FORMATION EVALUATION

4.1 MUDLOGGING

Mudlogging and data engineering services will be provided by Baker Hughes Inteq.

Full mudlogging and drilling engineering services are to commence from spud. Sampling will commence from 13⅜" casing show and will continue to T.D. A digital copy (.PDF Format) of the mud log, drilling data log, pressure log and gas ratio log are required on a daily basis for the wellsite geologist to send to BHPB Petroleum Perth/Melbourne.

A final copy of the mudlog (1:500 scale), formation pressure log (1:1000), gas ratio log (1:500) and drilling data log (1:1000) will be provided in hard copy and digital copy at the end of the well as appendices in the final Mud Log Report

Data engineering services will include the monitoring of the following parameters:

Gas Parameters:

- FID total gas,
- FID chromatographic analysis,
- Report Background gas, Circulation Gas, Connection Gas and Trip gas,
- Continuous H_2S detection – ditch gas line, active mud pits and shakers,
- Report any H_2S associated with the above,
- Continuous CO_2 detection,
- Draeger portable detector for H_2S, CO_2 and $S0_2$

Drilling Parameters:

- Rate of penetration,
- Depth,
- Weight on Bit,
- Rotary and Bit RPM,
- Mud pit levels,
- Pump strokes,
- Mud pit levels,
- Pump Strokes,
- Calculation of Lag Time,
- Formation pressure analysis and prediction,
- Drill string torque and drag,
- Casing Shut In Pressure,
- Standpipe Pressure,
- Mud Density in/out,

4.2 DITCH CUTTINGS SAMPLING PROGRAMME

One set of unwashed (approximately 200 grams) and five sets of washed and air dried cuttings samples (approximately 150 grams) are to be collected every 10m from the 13⅜" casing shoe until 1600 mSS, approximately 50m above the expected top Napier Formation 'A' sandstone. From 1600 mSS, 5m samples are to be collected for the remainder of the 12¼" hole and entire 6" hole section. The Wellsite Geologist will review the sampling interval if drilling rate is too high or if hydrocarbons are encountered.

Junk sub, bit and stabiliser samples are to be collected where appropriate, described and collected for further analysis.

The amount of ditch cuttings shall be monitored by the mudloggers/wellsite geologist to ensure the hole is being cleaned adequately. Any changes in the amount of cuttings monitored at the surface should be reported to the BHPB Petroleum Drilling Supervisor. The presence and amount of abnormally shaped cuttings should be monitored whilst drilling, circulating, reaming and during any breaks in circulation whilst tripping into and out of the hole. Any changes in cuttings characteristics are to be reported to the BHPB Drilling Supervisor.

Clearly labelled sets of cuttings together with completed transmittal forms will be distributed at the conclusion of drilling as follows:

Distribution	Wet Cuttings	Washed/ Dried Cuttings
BHP Billiton Petroleum, Melbourne	1 x 200g (SET A)	1 x 150g (SET B)
Petrocraft Samples		1 x 150g (SET C)
Santos (BOL) Pty Ltd		1 x 150g (SET D)
DNRE, Melbourne		1 x 150g (SET E)
Geoscience Australia, Canberra		1 x 200g (Min 200g) (SET F)
TOTAL	1	5

Cuttings for BHPB Petroleum (Sets A & B) are to be sent to BHPB Petroleum Core Store Melbourne Attn: Diana Giordana (Address in Section 9) and at the conclusion of drilling. Petrocraft sample vials (Set C) should be sent to BHPB Petroleum Melbourne, Attention: Simon Horan.

Cuttings samples for Santos should be sent to the Santos Core Library in Adelaide Attn: Andy Pietsch (Address in Section 9). Cuttings for DNRE should be sent to the DNRE Core Library Melbourne Attn: Dee Ninis (Address in Section 9) and cuttings for Geoscience Australia should be sent to the Geoscience Australia Core and Cuttings Repository Canberra Attn: Eddie Resiak (Address Section 9).

The Wellsite Geologist is responsible for supervising all sample collection, labelling, packing, wellsite storage and shipping and must maintain an accurate transmittal record. It is the Wellsite Geologist's responsibility to ensure that drying temperatures for washed and dried cuttings samples do not exceed 25°C due to source rock analysis and mineralogy requirements. Accelerated drying of the cuttings samples must not occur.

4.3 MWD EVALUATION

The following measurements and survey shall be made.

Hole Section	Survey Type
12 ¼" hole	GR, Resistivity and Directional
6" hole:	GR, Resistivity, and Directional

A 1:500 copy of the GR/Resistivity log shall be sent to BHPB in both Melbourne & Perth each day plus a listing of all deviation surveys. Final 1:1000, 1:500 and 1:200 digital copies of logs (.PDF and PDS) shall be provided with the final MWD report. This report should be sent to the Operation Geologist BHPB Petroleum Melbourne.

4.4 WIRELINE LOGGING PROGRAMME

Open hole and cased hole wireline logging services will be provided by Schlumberger

Open hole Wireline Logs:

Hole Section	Survey Type
12 ¼" hole:	None
6" hole	1. PEX: MCFL-HGNS-LEHQT

A USIT tool for evaluation of the 9⅝" casing cementation shall be kept on the rig as a contingency.

A Log Quality Control Checklist Report should be completed for each logging suite. The log curves specified on this report should be transmitted to the Operation Geologist immediately that they have been finalized by the logging contractor in LAS Format and in PDS format.

At the completion of logging operation 1:200/1:500 scale log prints should be sent to BHPB Operations Geologist in Melbourne as well as a digital copy of these prints and all log data in DLIS and LAS format on a CD.

5.0 COMPLETION

5.1 INTRODUCTION

Minerva-4 will be completed as a vertical well with expandable sand screens (ESS) set inside the 6" hole drilled into the top of the reservoir section. The well design includes a horizontal Christmas tree, 7" 13Cr production tubing and a 7" tubing retrievable subsurface safety valve with a permanent packer set inside the 9⅝" casing.

A well clean-up flow will be conducted, fluid sampling and production logging carried out as required. The tubing hanger plug and tree cap will then be run, and the well will be suspended with subsurface safety valve and subsea tree valves closed, awaiting tie in of the flowline and control umbilical.

5.2 SUMMARY COMPLETION PROCEDURE

- Conduct wiper trip and condition hole for running ESS, if required. POH.
- Run 4" ESS, 5½" and 7" liner and 9⅝" retrievable packer on drillpipe
- Set 9⅝" retrievable packer and test
- POH with packer setting tool
- Run ACE expansion tool and expand 4" ESS.
- Run retrievable bridge plug on wireline, set in 5½" liner above ESS and pressure test
- RIH and displace drill-in fluid above retrievable bridge plug to seawater
- POH and jet wellhead and BOP
- Run 10¾" retrievable packer and storm valve, set packer below wellhead and test
- Pull BOP
- Run subsea tree on drillpipe and test
- Run and test BOP
- Pull storm packer
- Run clean-up string
- Pump clean-up pills. Displace well above retrievable bridge plug to filtered brine. POH.
- Pull bore protector from subsea tree
- Run 7" completion string
- Run 9⅝' landing string and land tubing hanger in subsea tree
- Lock down and test tubing hanger
- Circulate tubing to water based under-balanced fluid cushion
- Test subsurface safety valve
- Set 9⅝" production packer and test
- Pull retrievable bridge plug on wireline
- Flow well to clean-up drilling and completion fluids and shut in.
- Leak test subsurface safety valve
- Install tubing hanger plug on wireline and test
- Test subsea tree valves
- Pull 9⅝" landing string
- Jet bore of subsea tree above tubing hanger plug
- Run internal tree cap and test
- Pull BOP
- Run debris cap
- Work boats and pull anchors

6.0 ABANDONMENT

The well will be completed as a gas producer. There are no plans to abandon the well.

7.0 BASE

Perth will be the operations base. Portland will be the supply shore base with a one-way sailing time of approximately 7 hours. Crew changes will be made by helicopter from Essendon, Melbourne.

8.0 REPORTING REQUIREMENTS

Unless otherwise stated, all times referred to are Eastern Standard Time.

8.1 RIG

8.1.1 Drilling Reports

Daily Drilling Report covering previous midnight to midnight including an update to 0600hrs.

The drilling report shall be in metric units with oilfield units in parentheses. The drilling report shall carry the name of the OIM on board at the time.

Reports to be faxed to Perth to the Drilling Superintendent.

DIMS reports to be sent by e-mail to the Perth base.

8.1.2 Geological Reports/Mud Log/MWD Data

Daily Geological Report, Mud Log Reports, MWD Data covering previous 24 hour period from midnight to midnight from the time first cuttings returns are received at surface. Reports to be transmitted to Perth by 0700hrs (WST) to the Drilling Superintendent and Operations Geologist.

8.1.3 Register of Personnel

A Register of Personnel on board the drilling rig will be maintained and a daily statement will be transmitted ashore by facsimile giving the name and employer of each person on board. The statement will be transmitted at 1500hrs or after the departure of the last helicopter if later than 1500hrs, marked "Attention: Drilling Superintendent: cc. Air Logistics Co-ordinator".

8.1.4 Helicopter Manifest

The name of each person and employer will be transmitted to the Portland base and Perth offices for each crew change flight. This should be transmitted by 1600hrs on the day previous to the flight to Air Logistics Co-ordinator.

8.2 PERTH

8.2.1 Drilling Reports

The Management Summary of the Daily Drilling Report will be distributed via electronic mail to the distribution list.

8.2.2 Geological Reports/Mud Log/MWD Data

Reports and logs will be copied to the Drilling Superintendent. Distribution of the reports to the relevant parties will be via the Geological Operations.

9.0 ADDRESSES

BHP Billiton Petroleum Pty Ltd
Level 46, Central Park,
152-156 St Georges's Terrace
Perth WA 6000

Attn: Mr Ed Lintott
Drilling Superintendent
Ph: 08 9278 4611
Mb: 0419346550
Fax: 08 9447 4780
Email: Ed.Lintott@bhpbilliton.com

BHP Billiton Petroleum
600 Bourke Street,
MELBOURNE VIC 3000

Attn: Mr Simon Horan
Project Geologist/Operations Geologist
Ph: 03 9609 3577
Mb: 0407221962
Fax: 03 9652 6112
Email: Simon.Horan@bhpbilliton.com

BHP Billiton Petroleum Core Store,
c/- Kestrel Information Management (Australia),
578-590 Somerville Road,
SUNSHINE VIC. 3149

Attn: Diana Giordano
Core/Archive Supervisor
Ph: (03) 9311 3091
Mb: 0419136795
Fax:

Santos (BOL) Pty Ltd
Level 29, Santos House
91 King William Street
Adelaide, South Australia 5000

Attn: Mark Shimmield
Manager Asset Development, Southern Australia
Ph: 08 8224 7744
Mb: 0419880876
Fax: 08 82247520
Email: Mark.shimmield@santos.com.au

Attn: Andy Pietsch
Santos Core Library
C/O Ascot Transport
Francis Street
Gillman SA.5013
Mb: 0402080405

Department Natural Resources and Energy (VIC)
Level 7 250 Victoria Parade, East Melbourne 3002

Attn: Dr Kourosh Mehin
Manager Petroleum Resources
Ph: 03 9412 5082 wk
Ph: 03 9840 1079 Home
Fax: 03 9412 5156
Email: kourosh.mehin@nre.vic.gov.au

Attn: Bruce Armour
Petroleum Operations Inspector
Ph 03 9412 5065
Mb: 0417 398 821
Fax: 03 9412 5152
Email: bruce.armour@nre.vic.gov.au

Attn: Dee Ninis
Core Library Manager
DNRE Core Library
South Road (Off Sneydes Road)
Werribee VIC 3030

Geoscience Australia
Corner Jerrabomberra Avenue & Hindmarsh Drive
Symonston ACT 2609

Attn: Eddie Resiak
Core and Cuttings Repository
GEOSCIENCE AUSTRALIA
Corner Jerrabomberra Avenue & Hindmarsh Drive
Symonston ACT 2609

10.0 APPROVALS

Prepared by:

Senior Drilling Engineer/Senior Completions Engineer — Date 9/9/02

Project Geologist — Date 12/9/02

Approved by:

Drilling Engineering Supervisor/Completions Engineering Supervisor — Date 9/9/02

Drilling Superintendent — Date 11/9/02

Well Project Team Leader — Date 16/9/02

Management Approval by:

Drilling Manager — Date 11/09/02

Minerva Project Manager, BSAT — Date 16/9/02

Well Project Team

Well Project Team Leader	Graham Bunn
Project Geophysicist	Ric Jason
Drilling Superintendent	Ed Lintott
Drilling Engineering Supervisor	Alan Ferguson
Senior Drilling Engineer	Manual Sessink
Petrophysicist	Mark Locke
Project Geologist	Simon Horan
Reservoir Engineer	Rob Jellis
Completions Engineering Supervisor	Kevin Lay
Senior Completions Engineer	Victor Guatelli / Bob Bell
Process Engineer	Charles Sim

REFERENCES

1. VIC/L22: Minerva Gas Field Development Drilling Emergency Response Plan (00MN-N90-0005)
2. BHPB BSAT Emergency Response Plan
3. BHPB Drilling Management System, WWD 001
4. BHPB Drilling Process Manual (rev. 2) - Australia/Asia
5. BHPB Well Design Standard, WWD006
6. BHPB Well Control Standard, GCD005
7. BHPB Well Integrity Standard, GCD007
8. BHPB Drilling Hazard Assessment Guidelines, WWD004
9. Final Drilling Reports for Minerva-1 and 2a.
10. Minerva-4 Basis For Well Design
11. Minerva-4 Drilling Fluids Programme
12. Minerva-4 Cementing Programme
13. Minerva Well Completion Design Report
14. MODU Safety Case Bridging Document: VIC/L22 Minerva Gas Field Development Drilling (00MN-N90-0003)