

## **Section 1: Thunderbolt 1 Drilling Program**



**Great South Land**  
Minerals Limited

Great South Land Minerals Limited ABN 54 068 650 386

# **DRILLING PROGRAM**

## **Thunderbolt 1**

**(17 1/2" surface hole (air drilled by mineral rig), 13 3/8" surface casing, 12 1/4" intermediate hole, 9 5/8" intermediate casing, 8 1/2" production hole, 7" production casing)**

**2008.**

## APPROVALS

Prepared By Wesley

D. New Drilling Manager

12/9/08.

Date \_\_\_\_\_

Reviewed By 

12/9/08

Date

Approved By                     *C. S. S.*                    

12/9/08

Date

## List of Revisions

Revision Number	Revision Date	Revised Section	Revision Details	Revised By
1	10/09/08	All	First release	DN

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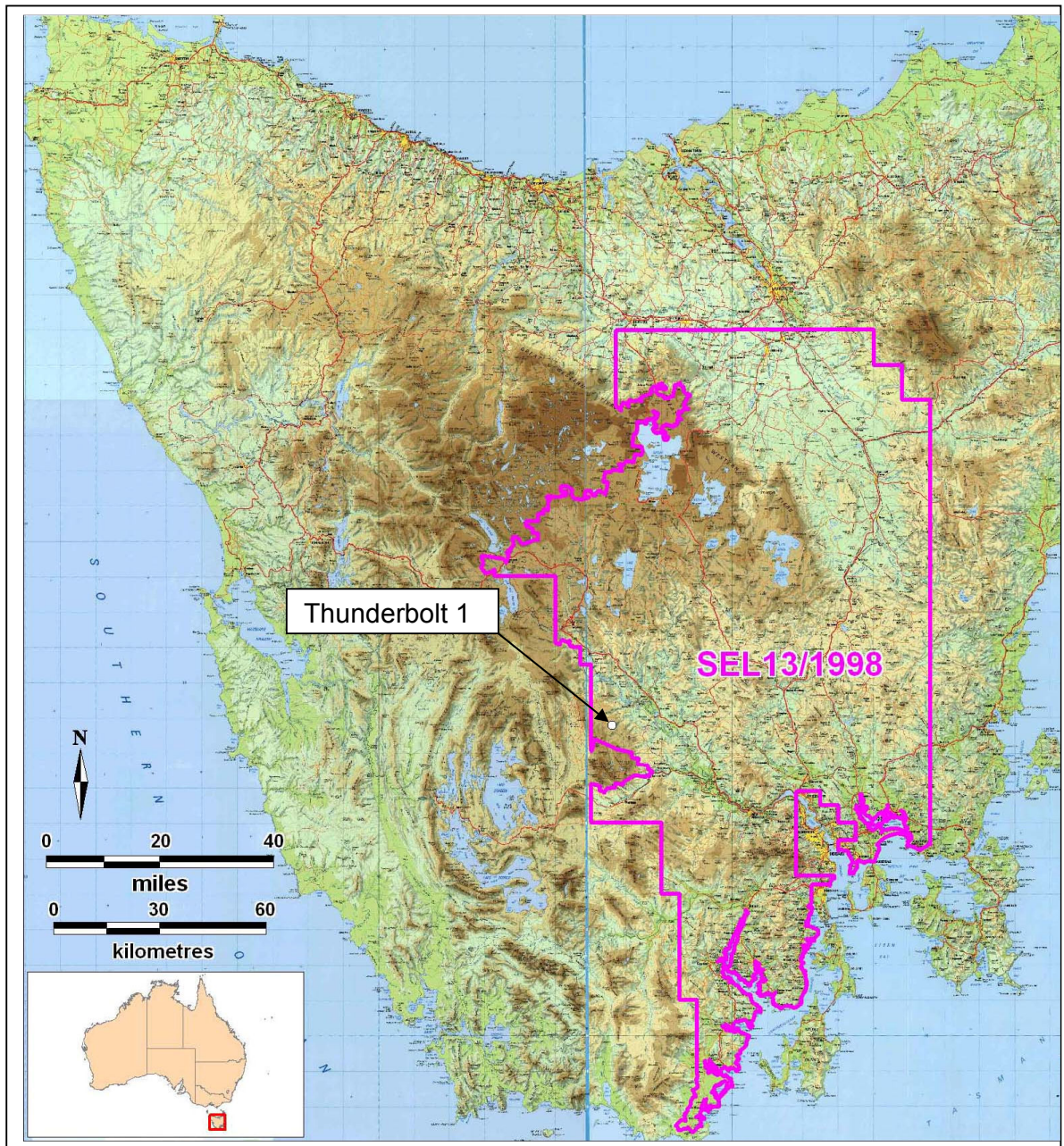
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## 1. GENERAL DRILLING PROCEDURES

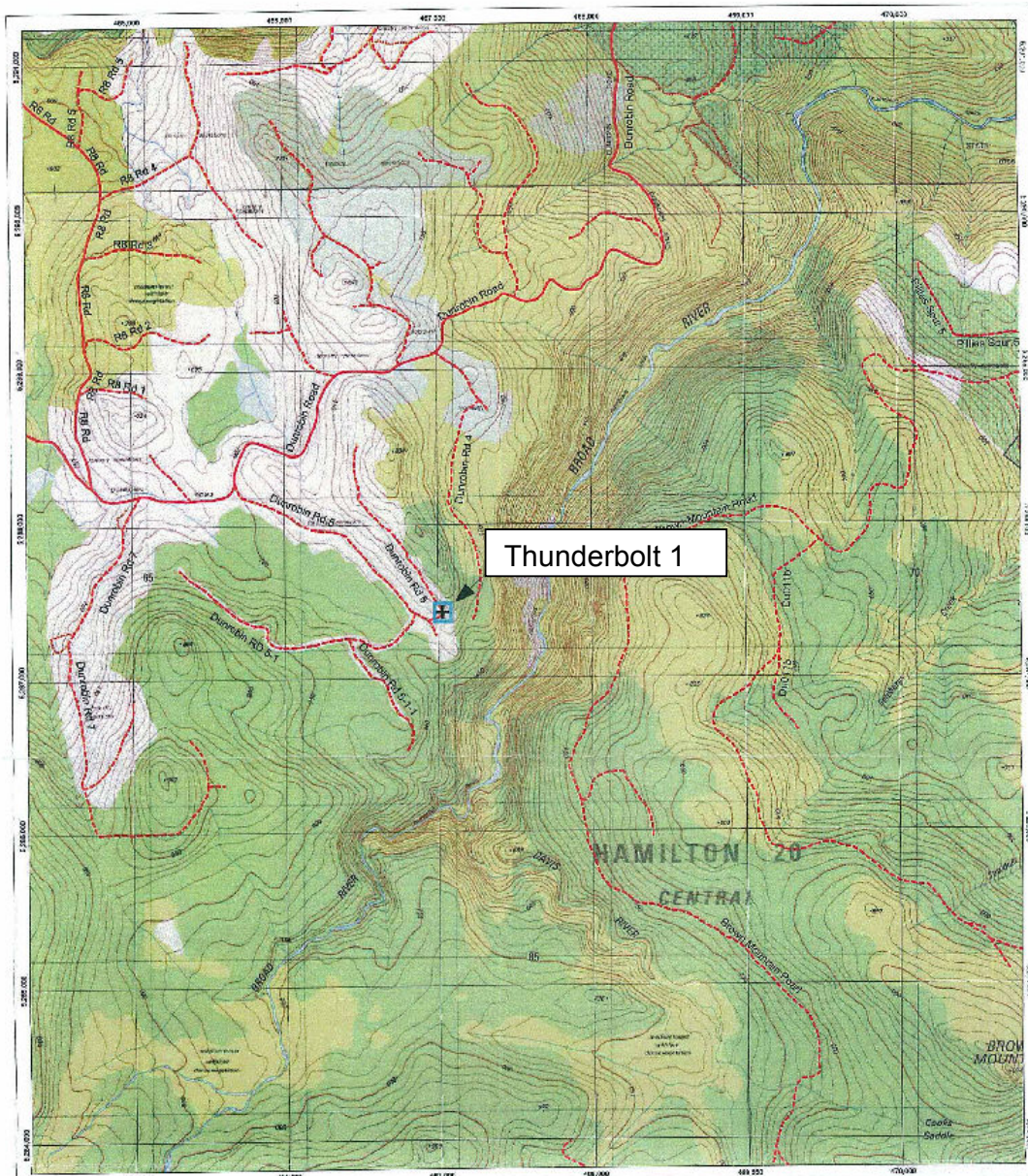
### Well Data Summary

Well Name	Thunderbolt 1
Block	SEL 13-98
Location	Tasmania Basin
Grid Location Co-ordinates – (AGA 66 Zone 55)	Easting 466,844 mE Northing 5,287,200mN
Well Type	Oil / Gas Exploration
Ground Level (above sea level)	730m (Preliminary)
Total Depth (BRT)	2600m
RT Hunt Rig 3 (above ground level)	5.0m
Drilling Rig	Rig #3
Mineral Rig Drilling Contractor	Gerald Spaulding / DR24
Oil Rig Drilling Contractor / Rig	Hunt Energy / Rig 3
Well Objectives	Evaluation of the hydrocarbon bearing potential Thunderbolt structure.
17-1/2" Hole / 13 3/8" Surface Casing	350m (drilled by mineral rig) / 347m (run by oil rig)
12 1/4" Hole / 9 5/8" Intermediate Casing	1800m / 1797m (Oil Rig)
8 1/2" Hole / 7" Production Casing	2600m / 2597m (if required) (Oil rig)
Water Source	Local source

## LOCATION MAPS







Thunderbolt 1

diff text DPW 25K Topo Map Image

- + RP033 Diff Site
- Significant all weather 2 lane feeder road
- Single lane all weather minor road
- Single lane minor road

NOTE: Coordinates on this map are based on GDA04.

For copyright, this is the register and control of DPW.

THIS IS A DIGITAL COPY OF THE ORIGINAL MAP.

LOCATION MAP

4431	4831	4831
4430	4830	4830
4429	4829	4829
4428	4828	4828
4427	4827	4827
4426	4826	4826

GSLM drill site location



Plot identifier: \_\_\_\_\_ Prepared by: bco  
Date: Thursday, 31 July 2008 Pages: 1 of 1

Scale 1:25,000  
2 km



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## **1.1 Introduction**

Thunderbolt 1 will be one of the first hydrocarbon exploration wells drilled in Tasmania and consequently a very conservative approach has been used in this program. The actual drilling program may have to be amended depending on events during the drilling of the well. Where possible any such changes should be discussed with the drilling manager prior to being implemented. Expect the unexpected!

Safety is of prime importance to GSLM and all appropriate safety systems (Work permits, JSA's, management systems, safety meetings etc) must be used to ensure the well is drilled as safely as possible.

All primary and secondary well control equipment must be operational at all times.

GSLM will conduct all their operations in accordance with the SEO and Environmental Management Plan and will make every effort to minimize the environmental impact of the well. The lease size should be kept as small as practical and all equipment kept within the cleared area. All spills, no matter how small will be cleaned up immediately and recorded in the spill register. As soon as practical after completion of the well the lease will be restored to the conditions required by MRT and the landowner.

The procedures described in this program are based on good oil field practice and will allow the well to be drilled with the minimum risk to personnel, the environment and equipment.

This drilling program should be used as part of the Drilling Plan which includes the Drilling Operations Manual, the Environmental Plan and the Drilling Montage.

## **1.2 General Operating Guideline**

All operating procedures and engineering design contained in this program are intended to be within the stated requirements of the Mineral Resources Development Act 1995 (as amended), the Mineral Exploration Code of Practice, Schedule C For On-Shore Exploration For Petroleum, Coal Seam Gas or Geothermal Substances, the Statement of Environmental Objectives, the Drilling Operations Manual and the Environmental Management Plan. A copy of these documents shall be available in the Drilling Supervisor's office.

The 17 ½" surface hole will be pre-drilled to approximately 350m within the Dolerite by a Spaulding's mineral rig. Offset well data and regional studies indicate that there is a very low probability of encountering hydrocarbons (no hydrocarbons have been recorded from any mineral or water well in the area) so this section of hole will be treated as a non-hydrocarbon section. Geological studies also suggest that the basal Dolerite is unlikely to be fractured and it is therefore considered highly unlikely that gas could flow from the underlying Triassic into the surface hole.

While Spaulding's mineral drilling rig is on location the senior driller will be responsible for ensuring that Spaulding's SOP's are followed and that the drilling is carried out to the standard specified in this program.



Once the Hunt Rig moves onto location the drilling Supervisor shall be responsible for ensuring that the procedural guidelines are implemented to the standard specified in this program and in the Drilling Operations Manual.

Changes to the procedures in this program will only be made after consultation with the Drilling Manager.

The maximum depth for this well will be 2800m (regardless of lithology) as this is the maximum capacity of the rig with 4 ½" drillpipe.

### **1.3 Safety**

The safety of all personnel, equipment and the environment is of prime concern to GSLM. All operations must be undertaken in a safe manner and must comply with all the relevant company and legislative requirements. No job is so important that safety standards need to be compromised and all personnel have the right to halt any operation they feel is unsafe. All personnel on the rig have an obligation to ensure that the correct safety procedures are in place and that they are correctly followed (e.g. Permit to Work, JSA, safety meetings, Hazop). All personnel must also be trained and qualified for the job they are doing.

### **1.4 Environmental Procedures.**

It is GSLM's intent to drill Thunderbolt in such a way as to minimize the risk of environmental damage. Environmental policies are given in GSLM's Statement of Environmental Objectives and environmental procedures are given in the Environmental Management Plan for this well. Prior to operations commencing on the Thunderbolt location the following surveys will be carried out:

- Special Value Assessment
- Acoustic Survey
- Hydrogeological Report
- European Heritage
- Aboriginal Cultural Heritage

The results of these surveys and any recommendations made will be incorporated into the Environmental Management Plan as part of the Drilling Plan.

The key points of the Environmental Management Plan are as follows:

- The Mineral Resources Tasmania Mineral Exploration Code of Practice (Edition 4 – March 1999) will be used as a minimum standard for road and lease construction and rehabilitation activities
- The drilling sump will be lined to prevent possible shallow groundwater contamination.
- Sewerage and grey water will be contained on site in approved septic tanks. At the end of the well the contents of the tank will be transported to an appropriate facility and disposed of. The tanks will be removed and the hole filled in.
- The drill cuttings will be buried on site in the sump.
- Drilling fluids will be non-toxic and will comply with good oil field practice.
- Casing strings will be engineered to minimize the risk of blowouts and consequential escape of hydrocarbons.

- Blow out preventers will be installed, tested and operational at all times when drilling below the surface casing.
- All annular spaces between hole and casing will be cemented to provide zonal isolation for any aquifers.
- Primary well control will be maintained by using sufficient mud weight to overbalance expected formation pressures.
- If the well is abandoned all aquifers of different salinities in the open hole section will be isolated by cement plugs to prevent possible crossflow between them.
- If the well is plugged and abandoned the lease and access road will be restored to the conditions set down in the landowners agreement.
- If the well is suspended pending later completion as a producing well the lease will be fenced and a separate EMP prepared to cover completion and production activities.
- At the end of the well the fluid in the sump will be transported to an approved waste facility or otherwise disposed of in an approved manner.

## 1.5 Chain of Command

GSLM Management team shall set general drilling policies and shall review and approve the drilling plan. All suggestions or instructions regarding drilling operations from the management team shall be given to the drilling manager who will review them before passing them on the GSLM drilling supervisor on the rig. **The GSLM drilling manager is the only person who can issue instructions to the drilling supervisor.**

The drilling supervisor shall issue operational instructions to third party personnel, the Hunt Toolpusher and drillers. **The GSLM drilling supervisor is the only GSLM representative who can issue instructions to the Hunt toolpusher, drillers or rig crew.**

The Hunt toolpusher and/or driller will then pass on instructions from the GSLM drilling supervisor to the rest of the drilling crew.

Third party and GSLM personnel on the rig will discuss all operational requirements that may affect safety or the drilling operation with the GSLM drilling supervisor who will issue the appropriate instructions.

## 1.6 Well Control Equipment & Procedures

Based on regional geological studies and data from water and mineral wells drilled in the area the risk of encountering hydrocarbons in the 17 1/2" hole section is considered very low and BOP's will not be run while drilling this section.

Because the expected maximum surface pressure for this well is over 3000 psi a 5000 psi rated, 13 5/8" BOP stack will be used on this well. This will ensure the rated pressure of the BOP's will not be exceeded if abnormal formation pressure is encountered.

BOP's will be installed, tested and operational at all times when drilling below the 13 3/8" casing shoe. If the BOP's fail to test or are found to be faulty drilling operations

must be immediately suspended and can not resume until the BOP's are tested and fully operational.

Wells shall be shut in using the hard shut in technique. The preferred method for killing the well is the "Wait and Weight" method. Refer to the Drilling Operations Manual for detailed procedures.

All primary kick detection alarms (return flow, pit volumes, gas etc) will be set and functional prior to drilling out of the 13 3/8" surface casing and shall remain operational at all times after this. If any indications of a kick are noted then the well should be shut in immediately, shut in pressures monitored and the drilling supervisor and toolpusher notified.

All well control equipment should be function tested daily after drilling out of the 13 3/8" surface casing, except the pipe rams which should be functioned on each trip out of the hole.

## **1.7 Drills and Safety Procedures**

### **BOP EQUIPMENT, DRILLS AND TESTING**

BOP drills shall be conducted with each crew, periodically, to ensure proficiency with the procedures for shutting in wells.

A kill drill shall be conducted prior to drilling out a new string of casing.

BOPs shall be pressure tested every 14 days after installation and initial testing.

Pipe rams and annular preventers shall be operated on a daily basis with blind rams being operated on each trip out of the hole. Manual closing controls are to be checked daily. This should be alternated between the Main Control Manifold, and the remote stations.

### **TRIPPING**

The trip tank shall be used at all times during tripping out, while tripping in after hydrocarbons have been encountered and while pipe is out of the hole. An accurate record of hole fill volumes shall be maintained during tripping, logging and casing running operations. Any anomalies should be immediately flow checked.

### **FLOW CHECKS**

If there is any indication that the well may be flowing then a flow check shall be conducted immediately. Flow checks shall also be conducted prior to commencing a trip out of the hole, when the bit is at the shoe, prior to pulling the BHA through the BOP stack and if the well fails to take the calculated volume of fluid.

All significant drilling breaks, return flow abnormalities or unexplained pit volume variations shall be immediately flow checked. If in doubt – flow check.

## SAFETY MEETINGS

A pre-spud safety meeting shall be conducted to ensure that all personnel are aware of the well objectives, local community issues, heritage issues, operating guidelines, environmental sensitivities of the location and reporting arrangements for this well. Minutes must be taken from this meeting. Representatives from the local community may also be invited.

Well control safety meetings shall be held prior to spud, as well as prior to drilling out each string of casing.

Pre-job safety meetings shall be held prior to conducting any non-routine or critical operations

Emergency engine shut down equipment shall be tested and operated weekly on all engines.

Safety drills shall be held periodically at the discretion of the Operator's Representative.

Pre tour safety meetings should be held, reviewing the next 12 hours operations, and the Drilling Contractor's job safety assessment and work permit procedures should be followed.

### **1.8 Leak Off Tests**

A 'leak-off test' or 'formation integrity test' will be conducted in the open hole after drilling 3 meters of new hole below the 13 3/8" and 9 5/8" casing shoes. The purpose of the test is to determine the competence of the formation below the shoe and the competence of the primary cement job around the shoe.

#### **The following is the recommended leak-off test procedure:**

1. Drill out cement plus 3 meters of new formation using mud from the previous section.
2. Circulate clean to a balanced mud weight.  
Note: The fluid in the hole should be a mud, and not a fluid with no, or only dissolved, solids.
3. Pull the bit back into casing shoe.
4. Make sure the hole is filled up and close the BOP (Annular) around the drill pipe.
5. Rig up the test pump to the drill pipe or annulus. Use a pressure gauge of appropriate range mounted at the pump unit manifold.
6. Slowly pump mud until pressures begin to increase. Volume pumped will start from this point.

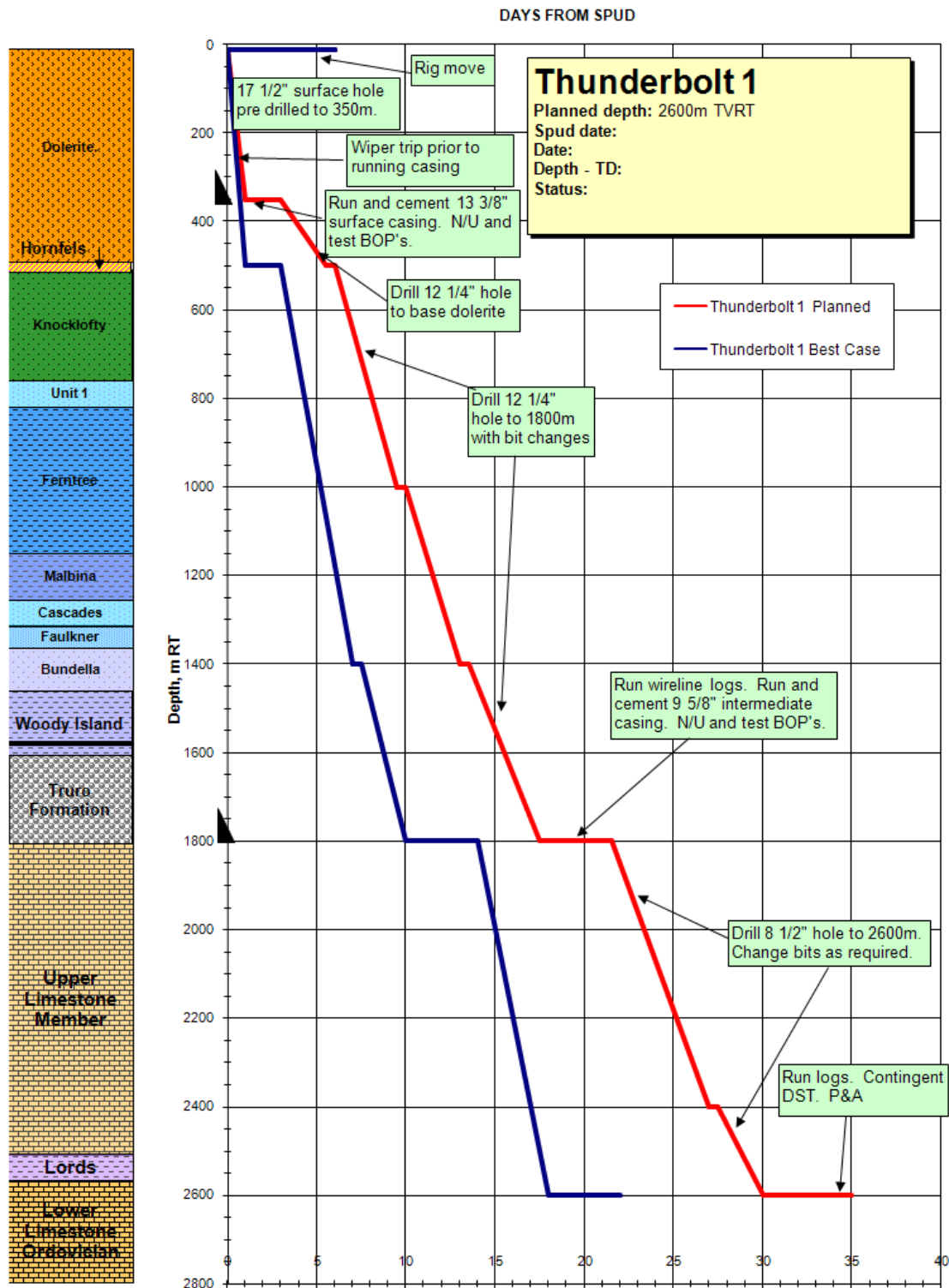


7. Pump 0.25 bbl and wait for 2 minutes or the time required for the pressure to stabilise in case this takes longer.
8. Record the volume pumped, and the bleed back stabilised pressure.
9. Repeat items 6 & 7, plot pressures versus cumulative mud volume for each pumped volume increment.
10. Continue procedure until the final stabilised pressure after the waiting time, deviates from the expected pressure based on the plot. Keep well closed in to verify that a constant pressure has indeed been obtained.
11. Bleed off pressure and establish volume of mud lost to the formation.  
Note: If there is a solid float valve in the drill string, bleed off at the choke line, and not at the pump unit. If the float is ported then bleed off at the pump unit, and monitor the annulus pressure to ensure it is bled off before opening the Annular Preventer
12. Open the BOP (Annular) and resume drilling operations.
13. Record maximum stabilized pressure, TV depth and equivalent mud weight of this test on the next 'Daily Drilling Report' and the 'IADC' report.

For Thunderbolt1 the following 'Leak Off Test' values have been used to determine the kick tolerance:

<b>Casing Shoe</b>	<b>Hole Size</b>	<b>Vertical Depth</b>	<b>Leak off test (ppg)</b>	<b>Kick Tolerance</b>
13 3/8	17 1/2	350 m	13.2 ppg EMW	30.9 bbls
9 5/8"	8 1/2"	1800 m	10.4 ppg EMW	32.3 bbls

## 1.9 Time vs Depth Curve.



## **2. DETAILED DRILLING PROCEDURES**

The following procedures give a detailed outline of the operations sequence.

### **2.1 Construct Location**

1. The landowner must be notified at least 14 days prior to any earthworks commencing. He should also be consulted regarding the lease building process to ensure any issues he may have can be resolved.
2. The location will be scouted, pegged, surveyed and constructed to accommodate Hunt Rig 3.
3. The lease will be constructed by a competent earthworks contractor who has local experience. The sump shall be lined.
4. Once constructed the lease will be fenced.
5. The rig will be moved to the location on a day rate move basis.
6. A representative sample of the cementing water should be forwarded for analysis, as soon as possible.
7. The turkey's nest shall be filled prior to spud.
8. The drilling contractor will be responsible for ensuring potable water is supplied to the rig camp.

### **2.2 Move Rig. Set Conductor and pre drill 17 ½" hole.**

The logistics coordinator, ITAC, will coordinate the rig move from Bellevue to Thunderbolt. Prior to the rig move commencing ITAC will prepare a Traffic Management Plan which will address the following:

- Requirements for escorting oversize loads
- Obtaining all required permits.
- Scouting the route and checking for low slung power lines
- Confirming that the chosen route is suitable for the loads being carried
- Liaising with Forestry Tasmania and Gunns regarding trucking movements.
- Liaising with local police.

Geophysical data indicates that the dolerite in this area is 500m thick and due to the very low rates of penetration that would be expected if this hole section was drilled conventionally (using an oil drilling rig) it has been decided to set the conductor and air drill the 17 ½" hole as deep as possible with a mineral rig. Geological supervision will be provided to monitor the lithology and terminate the drilling if it appears to be getting close to the base of the dolerite (this will be indicated by the presence of Hornsfels in the cuttings). If requested by Mineral Resources Tasmania a mudlogging will also be onsite to monitor gas readings.

Regional studies and data from mineral and water wells drilled in the area indicate that there is a very low probability of encountering hydrocarbons while drilling the dolerite, and consequently this section of hole will be drilled as a mineral hole with a mineral drilling rig and without BOP's.

The 20" conductor will be set at 20m or into the top of the dolerite to isolate any shallow aquifers that may be present. In the Thunderbolt location the dolerite is expected to be no more than 10m below surface and the 20" conductor will either be set into the top of the consolidated dolerite. The 20" conductor will be grouted in place if required. Once the 17 1/2" hole has been air drilled the hole will be displaced with mud and the mineral rig moved off location pending the arrival of the drilling rig.

The conditions set out in the Environmental Management Plan referred to elsewhere in this program also apply to the operations of the mineral rig. During drilling of this hole section the SOP's developed by Spaulding's for this rig will be used in all operations to ensure this hole section is safely drilled..

The following procedure will be used to pre-drill the 17 1/2" surface hole.

NOTE Due to a lack of deep hole exploration in the area, the following should be used as a guide only as a varied number of unknowns may hinder the mineral rig in reaching target depth.

The rig provided by Spaulding's will be the Foremost Dual Rotary 24. This rig is a truck mounted rig with on-board air compressor, and will be floated to site. Drilling will be conducted using high pressure Down-the-hole hammers, with support of three other high pressure compressors to facilitate in reaching target depth.

0 – bedrock:	8" steel conductor pipe
Bedrock - target depth (300 – 400m):	8" test hole grouting all major aquifers at the company discretion as encountered.
Opening of Test hole First Pass 12":	0 - bedrock: 20" conductor pipe  Bedrock to target depth: 12" diameter'
Opening of Test hole Second Pass 1	Bedrock to total depth: 17 1/2"

If drilling conditions are favorable the 12" pass may be omitted and the hole opened directly to 17 1/2".



### **2.3 Move Drilling Rig to Location - Rig Up**

1. The rig move will not start until the Traffic Management Plan is in place and approved.
2. Rig rate operations will normally cover the following:
  - Move on to location.
  - Rig up.
  - Install the rat hole and mouse hole (if not previously installed)
  - N/U riser/bell nipple and flowline etc.
  - Inspect rig.

Rig Move rate operations end and 'Day Rate' operations commence, when the bit goes through the R/T to start the clean out trip.

3. The conductor will be preset before the rig arrives on location.
4. The drilling contractor will cut the conductor above the cellar base, to suit the length of his riser/bell nipple. The bell nipple and flowline will be installed, and the drilling contractor will weld a nipple/ball valve in the conductor, below the bell nipple connection, to drain the bell nipple etc. A cellar pump should also be installed.
5. During rigging up operations an independent inspector will inspect the rig to determine it is "Fit for Purpose". Where practical items identified as critical should be fixed prior to spudding. If a critical item can not be fixed prior to spud then a risk assessment must be undertaken and procedures put in place to ensure operations can safely continue. If sufficient safeguards can not be put in place to ensure the safety of the operation then drilling will not commence until the item is fixed.
6. The Drilling Supervisor will inspect and accept rig and equipment prior to spud. The rig 'on hire' commences when these operations are complete, and the bit is made up and run through the rotary table ready to spud.

### **2.4 Clean out 17 1/2" Hole / Run 13 3/8" Casing. (Spud – Approx 350m)**

#### **2.4.1 General Notes:**

1. The 17 1/2" surface hole will be drilled to either the top of the Hornsfells or the capacity of the mineral rig (at approximately 350m)
2. The 13 3/8" casing will be cemented back to surface.
3. If required a top-up cement job will be carried out on the surface casing, in order to provide sufficient structural support for the BOP.
4. The mud system to be used to clean out the well will be gel based spud mud with additions of 2-3% KCl as required. Circulate HiVis pills as required to clean the hole.

7. The bradenhead will be a slip on weld type and will be welded to the 13 3/8" BTC surface casing using a certified pressure welder and following the manufactures recommended procedure.
8. Ensure coupling on last joint of casing is backed off slightly prior to cementing so that it will back out with the landing joint.
9. Casing threads should be visually inspected and cleaned. The casing should be drifted with the API drift size, which is 12 inches in length. Note: Thread cleaning should be carried out with water **not** diesel.
10. The 13 3/8" BTC x 13 5/8" bradenhead should be checked for size and damage to the threads at the spud stage. Confirm all the requisite studs, nuts, ring gaskets, side outlet valves and fittings are all ready for assembly.

#### **2.4.2 17 1/2" Hole Cleanout**

1. Pick up the bit, bit-sub a slick 6 1/2" BHA (with jars) as per Section 6.0.
2. Pick up drill pipe and RIH to TD. Wash last 4 singles to bottom.
3. Circulate the hole clean and circulate Hi Vis pill if required.
4. Run survey, POOH to 150m and run survey. POOH.

#### **2.4.3 13 3/8" Casing Sequence**

1. Hold pre job safety meeting. Rig up to run 13 3/8" casing. Make up shoe and a two joint shoe track with float on top of second joint. Check operation of the floats, removing auto fill-ups. Thread lock the shoe track.
2. Ensure circulating swedge and hose are on the rig floor before starting to run the casing.
3. Run casing to setting depth, partially fill every joint and completely fill every 5 joints and install centraliser's as per running list.
4. **Ensure that the circulating swedge thread is appropriate for the casing being run.** Make up circulating swedge to last joint but only circulate down if tight hole noted.
5. Make up circulating swedge and circulate the landing joint down. Measure in to the required setting depth. Continue to circulate and reciprocate casing until shakers are clean, gas returns to background levels and a minimum of two annular volumes.
6. Condition the mud suitable for cementing.
7. **Soft break casing collar on the last joint**, so that it can be backed out with the landing joint prior to installation of the Bradenhead.

8. Pump 40 bbl water 'Spacer' as per Section 10.
9. Hold pre job safety meeting. Rig up cementing contractor. Make up 13 3/8" cement head. Put bottom plug into casing and install top plug into cement head. Pump 5 bbls water and pressure test lines to 3000 psi for 5 minutes.  
**Note:** Make up cement head adaptor to a joint of casing prior to running the casing to ensure compatibility.
10. Mix and pump lead and tail cement slurries according to cement program. Three samples of the lead slurry and three samples of the tail slurry should be collected. The slurry densities should be checked (use a pressurized mud balance if possible).
11. It is the responsibility of the cementing contractor and the drilling supervisor to ensure that both the top and bottom plugs are installed and released correctly.
12. Pump 5 bbls water behind to flush lines, release top plug and displace with 5 bbls of water. Displace cement. Bump plug to 500 psi above final circulating pressure and hold for 5 minutes. If floats holding pressure test casing to required pressure for 10 min. Release pressure and record flow back. Do not displace more than 100% of theoretical casing volume plus 50% of the shoe track volume.  
  
If the floats do not hold, then pump back the volume of mud bled off, pressure up to the differential pressure of annulus to pipe, and WOC. If cement returns are observed during the job then divert to the sump.
13. **Regardless of cement returns a top up job will be run.** Run a 1" stinger 12m into the annulus circulate clean, and perform a top-up cement job with approximately 50 sx class A cement and CaCl<sub>2</sub> to provide accelerated structural support for the BOP.

## 2.5 Nipple Up Casing Head and BOP

1. Drain and flush riser, open turn-buckles and raise conductor. Flush the riser clean to visually ensure correct placement of the casing collar.
2. Wait on cement a minimum of 4 hours from top up job or until surface cement samples are firm enough to support string weight. Slack off string and back out the casing collar. Ensure collar on bottom of landing joint backs out on landing joint. Rig down all casing running equipment.
3. Empty and clean mud tanks while WOC. Keep sufficient old mud in pill tank to drill shoe track.
4. Pump out and clean up cellar area and prepare bradenhead while WOC. Ensure the casing is open at surface during WOC.
5. Install 13 5/8" 5000 psi x 13 3/8" bradenhead and weld onto the 13 3/8" casing as per the manufactures recommended procedure.
6. Nipple up BOP stack and drilling spool. Note: The BOP ram configuration should be 4 1/2" pipe rams over blind/shear rams.

7. Run the BOP test plug, and pressure test BOP stack, mud standpipe manifold, choke manifold and ancillary well control equipment.
8. Run the cup tester, close pipe rams and test the bradenhead/casing connection as outlined in Section 11.
9. Pull cup tester, **run wear bushing**.

## **2.6 Drill 12 1/4" Intermediate Hole / Run 9 5/8" Casing. (350m – 1800m)**

### **2.6.1 General Notes:**

1. The 9-5/8" casing will be cemented back to 150m inside the 13 3/8" casing shoe..
2. A KCL Polymer mud system will be used to drill this section of hole. Keep the mud weight as low as possible and adhere to the mud program. Circulate HiVis pills as required to clean the hole.
3. The 9 5/8" casing will be landed inside the 11" x 5k casing spool.
4. Casing threads should be visually inspected and cleaned. The casing should be drifted with the API drift size, which is 12 inches in length with a diameter of 8.765 inches.

Note: Thread cleaning should be carried out with water **not** diesel.

5. Section TD will be determined by the lithology. The aim is to set the intermediate casing in a competent formation near the base of the Truro Formation. This will allow the Permian and Triassic formations to be isolated before penetrating the Limestone formations below.
6. The mudlogging unit will monitor H<sub>2</sub>S at the shakers, cellar and rig floor. Drilling can not continue if any H<sub>2</sub>S sensor is not working. A CO<sub>2</sub> detector will also be run by the mudlogging unit.

### **2.6.2 12 1/4" Hole Drilling Sequence.**

- 1) After nipping up and testing the BOP's pick up the bit, bit-sub, crossover sub and kelly to spud then continue picking up the 12-1/4" semi packed BHA as per Section 6.0
- 2) Drill out the shoe track using mud.
- 3) Clean out rat hole and drill 3m of new hole.
- 4) Perform Leak-off test.
- 5) Run Totco surveys approximately every 100m. This can be increased to every 150m if deviation remains low.



- 6) There is a potential reservoir immediately below the dolerite/Hornfels so ensure all kick detection systems are operating while drilling this hole section.
- 7) Ream each connection to minimize any deviation and to clean up the hole.
- 8) Change bits as required. PDC bit will be the preferred bit through this section.
- 9) Make wiper trips as hole conditions dictate. As a guide do not exceed 36 hours drilling between wiper trips.
- 10) Circulate the hole clean prior to all trips, and for at least 10 minutes prior to running any other surveys.
- 11) Using the 9-5/8" casing tally, determine the actual casing setting depth. Drill the 12-1/4" hole to fit the casing tally with no more than 3m of rathole. Ensure that the casing string is properly spaced out to have a casing collar at the required well-head level.
- 12) Use barite not drill solids for weighting up. Increase mud weight to 9.1 - 9.3ppg for hole stability if required when approaching section TD.
- 13) At section TD, circulate HiVis pill and circulate hole clean, drop survey, POOH to surface. RIH to bottom, circulate HiVis pill and circulate hole clean, condition mud, POOH and lay down 8" drill collars.
- 14) Run wireline logs. A full logging suite will be run, Sonic, resistivity, GR, caliper, neutron density. One gun of sidewall cores will also be run.
- 15) Run Drill Stem Tests (contingent on shows and wireline log interpretation). Any significant mudlog show or wireline log anomaly may be tested by post logging inflate straddle test.

### **2.6.3 9-5/8" Casing Sequence**

- 1) Rig up to run 9-5/8" casing. Hold pre job safety meeting. Make up shoe and a two joint shoe track with float on top of second joint. Check operation of the floats, removing auto fill-ups. Thread lock the shoe track.
- 2) Ensure circulating swedge and hose are on the rig floor before starting to run the casing.
- 3) Run casing to setting depth, partially fill every joint and completely fill every 5 joints and install centraliser's as per running list.
- 4) Ensure that the circulating swedge thread is appropriate for the casing being run. Make up circulating swedge to last joint but only circulate down if tight hole noted.
- 5) Make up circulating swedge and circulate the landing joint down. Measure in to the required setting depth. Continue to circulate and reciprocate casing until

shakers are clean, gas returns to background levels and a minimum of two annular volumes.

- 6) Condition the mud suitable for cementing (YP 12-14 max). Circulate at equivalent annular velocity used when drilling 12-1/4" hole.
- 7) Pump 40 bbl water 'Spacer' as per Section 10.
- 8) Hold pre job safety meeting. Rig up cementing contractor. Make up 9-5/8" cement head. Put bottom plug into casing and install top plug into cement head. Pump 5 bbls water and pressure test lines to 3000 psi for 5 minutes.  
Make up cement head adaptor to a joint of casing prior to running the casing to ensure compatibility.
- 9) Mix and pump lead and tail cement slurries according to cement program. Three samples of the lead slurry and three samples of the tail slurry should be collected. The slurry densities should be checked (use a pressurized mud balance if possible).
- 10) It is the responsibility of the cementing contractor and the drilling supervisor to ensure that both the top and bottom plugs are installed and released correctly.
- 11) Pump 5 bbls water behind to flush lines, release top plug and displace with 5 bbls of water. Displace cement. Bump plug to 500 psi above final circulating pressure and hold for 5 minutes. If floats holding pressure test casing to required pressure for 10 min. Release pressure and record flow back. Do not displace more than 100% of theoretical casing volume plus 50% of the shoe track volume.
- 12) If the floats do not hold, then pump back the volume of mud bled off, pressure up to the differential pressure of annulus to pipe, and WOC. If cement returns are observed during the job then divert to the sump.
- 13) Wait on cement a minimum of 4 hours or until surface cement samples are firm enough to support string weight.
- 14) Set casing slips and cut casing.
- 15) Nipple up the drilling spool and 13-5/8" BOP stack.
- 16) Run the BOP test plug, and pressure test BOP stack, mud standpipe manifold, choke manifold and ancillary well control equipment.
- 17) Run the cup tester, close pipe rams and test the bradenhead/casing connection as outlined in Section 11.
- 18) Pull cup tester, **run wear bushing**.

## **2.7 Drill 8 1/2" Hole / Run 7" Casing**

### **2.7.1 General Notes:**

1. Maintain mud weights as required to keep well overbalanced by at least 150 psi.
2. Flow check all significant drilling breaks and ensure all primary kick detection systems are calibrated and working.
3. Change bits if required. The bit program shown below is for guidance only, actual bit selection will depend on the lithologies penetrated.
4. Maintain the drilled solids as low as practical at all times by fully utilizing all available solids control equipment. Dump and dilute if required.
5. 7" production casing will be run in the 8 1/2" hole if the well is to be used for later production.
6. On receipt of the casing, it should be laid out, numbered and strapped (including pup and marker joints). The threads should be cleaned and visually inspected, and all joints drifted to the API size.  
**Note:** Threads must not be cleaned with diesel, use high pressure water instead
7. The casing slip & seal assembly, "C" section, and suspension valve, should be checked. Confirm all the requisite studs, nuts, ring gaskets, side outlet valves and fittings are all ready for assembly. Ensure there is a small hydraulic hand pump (with fittings) to pressure test the casing hanger and adapter. (See Wellhead Manual).
8. The surveying procedure for this section will be Totco survey at 100m intervals, to TD. If deviation remains low the survey frequency may be increased to 150m. A survey should be taken at TD prior to POOH.
9. If production casing is run then the turkeys nest liner should be left in place so that the turkeys nest can be used during the completion and production phase of the well. If the well is to be abandoned then the liner should be removed.
10. All pore pressure indicators should be closely monitored while drilling and any anomalies reported.
11. This section will TD once sufficient Lower Limestone Member has been penetrated to allow evaluation of its hydrocarbon potential.

### **2.7.2 8 1/2" Hole Drilling Sequence (1800m – 2600m):**

1. The maximum depth for this well will be 2800m (regardless of lithology) as this is the maximum depth the rig can safely drill to with 4 1/2" drillpipe in 8 1/2" hole. The toolpusher, drillers and drilling supervisor must know the limits of the rig and must ensure these are not exceeded. If the hole becomes unstable and significant overpull is recorded then the well may be terminated early. If there are any

concerns regarding the capacity of the rig operations must be suspended pending clarification from both Hunt and GSLM management.

2. Make up a new packed 8-1/2" BHA and RIH to top of cement.
3. If the plug did not bump, pressure test the casing prior to drilling out the shoe track.
4. Drill out the shoe track and 3m of new hole. Circulate clean to a balanced mud weight.
5. Perform Leak Off Test as outlined in Section 2.5.
6. Drill 8 1/2" hole, optimising ROP once top stabiliser is below the shoe.
7. Make wiper trips as hole conditions dictate. As a guide do not exceed 36 hours drilling. Circulate the hole clean prior to all surveys and trips.
8. Run surveys every +/- 100m, to TD. A survey should be taken at TD prior to POOH
9. Drill ahead changing bits as required. Bit selection will be decided after discussion with the drilling manager and will be dependant on the drilled lithologies and observed bit wear. PDC bits will be the preferred bit through this section.
10. Drilling parameters should be kept constant as much as possible through the potential reservoir sections.
11. At TD circulate hole clean and condition mud if required. Make a wiper trip back to old hole and POOH (strap out) to run wireline logs.
12. Run Electric Logs as advised by wellsite geologist. A full suite of logs will be run (sonic, GR, resistivity, neutron density, caliper, SP, CST)
13. Depending on log evaluation DST's may be run. If post logging DST's are run a wiper trip may be required.
14. Circulate hole clean. POOH and make up test tools as required.
15. Run DST, POOH and lay down test tools.

### **2.7.3 7" Casing Sequence (if required):**

1. Make up a rock bit (no jets) on slick BHA. RIH, circulate hole clean and condition mud if required. POOH laying out drill pipe and drill collars. Pull wear bushing.
2. Lay out kelly and swivel.

3. Rig up to run 7" Casing. (change pipe rams to 7" and pressure test bonnet seals). Ensure the circulating head (7" BTC pin x 2" weco half union) is on the drill floor prior to the 7" going below the 9 5/8" casing shoe..
4. Make up float collar one joint above the float shoe. Check operation of floats. Threadlock the shoe track.
5. Run casing to setting depth, filling every 5 joints. Install centralisers as per section 9.
6. Circulate at least the last joint of casing down.
7. Ensure that there are no collars between the rig floor and the setting profile. Continue to circulate until shakers are clean, gas returns to background, and a minimum of two hole volumes. Condition the mud suitable for cementing (YP: 12 - 14 max). Circulate at equivalent annular velocity used while drilling. Ensure that all fluid (mud or spacer) remaining in the annulus above the top of cement contains 2000 ppm biocide, do not add corrosion inhibitor to avoid damage to formation.
8. Use rig pumps to pump SAPP spacer.
9. Rig up Halliburton. Make up 7" cement head with plugs installed. Drop bottom plug and pump 5bbls water to ensure plug release. Pressure test lines to 3,500 psi for 5 minutes. Pump remainder of spacer.  
**Note:** Ensure that a 'Side Manifold' is used with the Cement Head, and that there is a connection to enable the surface lines to be flushed.
10. Mix and pump the lead and tail cement slurries, according to Section 10. It is the responsibility of the Halliburton cementer and drilling supervisor to ensure that both the top and bottom plugs are installed and released correctly.
11. Flush any cement from the surface lines, to ensure that there will be no cement left inside the casing on top of the top plug. Release the top plug and displace cement with 5 bbls 'Spacer' followed by inhibited brine at a minimum of 6 bpm. Do not displace more than 100% of theoretical casing volume plus 50% of the shoe track volume. If the floats do not hold, then pump back the volume of mud bled off, pressure up to the differential pressure of annulus to pipe, and WOC.
12. Bump plug to 500 psi above final circulating pressure and hold for 5 minutes. Slowly pressure up and test casing for 10 minutes. Release pressure and record flow back.
13. WOC to set for a minimum of 4 hours. After WOC for two hours every second nut can be removed from bottom BOP flange.
14. Run the slip and seal assembly and slack off casing. Lift BOP's and check slips are engaged properly. Rough cut casing and lay out landing joint. Remove BOP's and make final cut on casing 4 1/2" above the top of the bradenhead flange.

15. Nipple up "C" section with X-bushings installed. The X-bushings should be energized and the "C" section and connection pressure tested to 2000 psi. (Use Wood group if possible).

16. Dump and clean pits. Release rig.

#### 2.7.4 Abandonment (if required)

If production Casing is not run, the well will be abandoned with cement plugs and the wellhead removed. Any formations containing hydrocarbons must be isolated, as must formations of different water salinities. Formation salinities will be determined from wireline logs and any water recovered from Drill Stem Tests. Table 2.6.4 below is an indicative abandonment program only and will be modified based on actual formations drilled and log derived formation salinities.

Note 1: The surface casing will be cemented back to surface and the intermediate casing will be cemented back to inside the surface casing so all formations above the intermediate shoe will be isolated from each other.

Note 2: The shoe plug should be pressure tested to 200 psi above leak-off pressure.

Plug	Formation	Age	Top	Bottom	Interval
1	Lower Limestone Mbr	Ordovician	2525m	2575m	50m
2	Shoe Plug	Ordovician / Casing	1760m	1825m	65m
4	Surface plug	Inside casing	0m	15m	15m

Table 2.6.4: Indicative Abandonment Program.

The following is the general guideline for setting abandonment plugs.

1. Make up mule shoe, 150m of 2 7/8" tubing stinger on 4 1/2" DP (if the 2 7/8" stinger is not available use 4 1/2" DP). RIH to the first plug setting depth. Circulate one hole volume.
2. If a tubing stinger is available this will have the following features:
  - a) The shoe of the bottom joint should be cut and welded to form a closed end bull nose.
  - b) Plate centraliser ribs should be welded near the bottom to ensure stand off, and to ease RIH.
  - c) The bottom joint should have 4 circulating slots cut between 1 and 2 meters above the shoe.
3. Pump spacers and set balanced cement plugs as per the abandonment program.
4. Wireline logs will be used to confirm all depths.
5. All cement plugs (other than surface plug) will be not less than 45m in length. The top of each cement plug is recommended to be 25m above the top of the formation it is covering. Cement volumes shall be calculated on caliper volumes plus 10% excess. If caliper log data not available use theoretical volume plus 20% excess.

6. Ensure there is a minimum of 100m of fresh water spacer, balanced in front and behind cement plugs to ensure separation from the chlorides in the KCl mud.
7. Pick up above each plug and circulate clean. Pull back to 10 - 30m below the next plug. Spot a 10 - 20m hiviis pill if required. Pull back 10 - 30m to the next plug setting depth.
8. Before setting the cement plug across the 9-5/8" casing shoe ensure mud left inside the casing contains 2000 ppm biocide / corrosion inhibitor.
9. Pressure test the 9 5/8" shoe plug to 200 psi above the LOT pressure.
10. POOH and lay down excess drill pipe.
11. RIH to 30mRT, with 2-7/8" stinger. Circ and spot a 10m HiVis pill (YP=50). Pull back to 15m, and set the surface cement plug from 15m back to the wellhead. (Monitor returns at the wellhead side outlet to ensure no cement into the BOP). POOH to wellhead, circ to clean BOP etc. Lay down 2-7/8" stinger.
12. Pull wear bushing. Nipple down BOPs and back out the bradenhead. Weld on cover plate. Install well identification plate.
13. Release the rig. From this point all operations are covered by the Rig Move rate.
14. The turkeys nest should be emptied to the sump and the liner removed as part of the lease clean up (if the well is cased and suspended do not remove turkeys nest liner).

## 2.8 DRILL WATER SOURCE

Drill water for Thunderbolt1 will be from a nearby freshwater source. The wellsite mud engineer must check the water before making up any mud, and report the following:

Chlorides	(mg/l)
Calcium	(mg/l)
Magnesium	(mg/l)
pH	
Bicarbonates	(mg/l HCO)
Carbonates	(mg/l CO)

## 2.9 Directional Plan & Wellbore Surveying

### 2.9.1. General Notes:

No specific target tolerance is given for this well. A nominal target of 100m radius will be assumed.

Survey intervals will normally be 100m but this may be increased to 150m intervals if inclinations remain low.

A GPIT directional survey may be run as part of the wireline logging program

### 2.9.3 Survey Program

#### 20" Conductor.

The 20" conductor will not be surveyed.

#### 17 1/2" Hole

The 17 1/2" hole will be surveyed on the clean out trip prior to running the 13 3/8" casing at TD and at 150m

#### 12 1/4" Hole

The 12 1/4" hole will be surveyed, whilst drilling.  
Surveys will be taken at 100m or 150m intervals and at TD.

#### 8 1/2" Hole

The 8 1/2" hole will be surveyed, whilst drilling with.  
Surveys will be taken at 100m or 150m intervals and at TD.  
A GPIT survey may be run as part of the wireline logging program.

### 2.10 Formation Pressure

#### 2.10.1 Expected Pressure

Based on regional data and information from mineral wells a normal pore pressure gradient of 8.6 ppg EMW has been assumed for this well. This would give a maximum surface pressure of 2876 psi (assuming gas to surface from 2600m). The well has been designed to allow a 30 bbl gas kick to be shut in and circulated out without fracturing the formation at the shoe from a depth of 2800m.

It should be noted that very little drilling has been done in Tasmania and **higher than expect formation pressures could be encountered at any depth**. The drilling and casing program will be adjusted as required to ensure that safety margins are not exceeded if higher than expected formation pressures are encountered.

- NOTE: 5000 psi BOP's and wellhead equipment will be used on this well to ensure sufficient safety margin.

Fracture gradients are not known for this area but based on the expected lithology they are estimated to be significantly higher than the values required for a 30 bbl kick tolerance. Formation integrity tests will be run after drilling out both the surface and intermediate casings to confirm this.

#### 2.10.2: Well Control Procedures

Primary well control will be maintained by keeping the mud weight high enough to give a minimum 150 psi overbalance at all times. Mud weights will be no less than 9.0 ppg while drilling the intermediate and production holes.



During drilling operations the well will be monitored at all times for indications of increasing formation pressure. The parameters that will be monitored will include:

- Background Gas. An increasing trend in background gas may indicate increasing formation pressure.
- Connection Gas. The occurrence of connection gas indicates formation pressure is very close to mud hydrostatic.
- Hole conditions.
- Cavings. The presence of large splintery (propeller shaped) cavings is often an indication of increasing formation pressure.
- Rate of Penetration. An increase in the rate of penetration over a significant interval while the drilling parameters remain constant may indicate increasing formation pressure.
- Mud properties. Changes in mud salinities may indicate minor influx of formation fluids.
- Drilling parameters.

If there are indications that the formation pressure is increasing then the mud weight may be increased. If possible this should be discussed with the Drilling Manager first.

Drilling operations shall be carried out in such a way as to minimize the size of any influx of formation fluids and the following equipment and procedures shall be used to ensure this.

- The trip tank shall be used and a trip sheet filled out for all trips out of the hole. The trip tank may also be required for trips in the hole below any permeable reservoirs.
- All significant drilling breaks will be flow checked.
- Pit volumes, total gas and return flow will be calibrated and operational at all times while drilling below the surface casing shoe. If any of these items fail then drilling should be stopped until the equipment is repaired.
- When tripping out of the hole 5min flow checks shall be made after 5 stands, 10 stands, casing shoe and top of BOP's.
- Well control drills will be carried out to ensure all crew are proficient in these procedures.
- The hole shall be kept full of mud at all times.

If there is any indication that the well may be flowing then the well should be shut in and monitored for pressure. **If in doubt shut in.**

### **2.10.3: Well Control Equipment**

After the surface casing has been set the 13 3/8" 5k BOP's will be nipped up and tested. The BOP's will then be function tested every day and pressure tested every 14 days and will be controllable from both the Koomy unit and the drill floor. The rig will also be equipped with an accumulator unit which (with pumps inoperative) must be able to:

- Close all BOP functions
- Open al BOP functions
- Close the annular

- Open the HCR valve.

## **2.11 Housekeeping**

The following procedures will be in place to ensure the drilling of Thunderbolt is undertaken safely and has the minimum impact on the environment.

- Any material removed when building the lease will be stockpiled on the location. When the lease is restored the stockpiled material will be returned to the lease.
- Once the lease is built the location will be fenced and the drilling operation will remain within the fenced area.
- The sump will be lined with a plastic liner to prevent the drilling fluid contaminating the groundwater.
- Once the well is finished any fluids in the sump will be transferred to a recognized waste area.
- All sewerage will be collected in designated buried tanks. The contents of these tanks will be transferred to the appropriate waste disposal facility at the end of the well.
- All rubbish will be collected into rubbish skips and removed from location.
- All spills will be cleaned up immediately and recorded in the Spill Register.
- Drainage ditches will be dug round the rig to ensure any waste material flows into the sump.
- On abandoned wells, as soon as practical after the rig moves the lease will be restored as required by the Environmental Management Plan.
- The rig will be kept tidy and all unused equipment correctly stored.

### **3. DRILLING FLUID**

The following notes are for general guideline only. A detailed drilling fluids programme will be produced for this well.

The make up water should be checked as soon as possible, as it may have an effect on the initial mud formulations.

The 17 1/2" hole section will be air drilled and no mud program is required for this section. Prior to the mineral rig moving from the location the well will be displaced to mud to prevent any water influx while the drilling rig moves onto location.

A Gel/KCl mud will be used on the cleanout trip prior to running casing.

The 12 1/4" and 8 1/2" hole sections should be drilled with a 2% KCl-Polymer system with hi-vis sweeps if required. PHPA may also be added if required to help encapsulate any hydrating clays that may be encountered. Mud weights through both these sections should be maintained at a MINIMUM of 9.0 ppg but should be increased immediately if there is any indication of increasing formation pressure.

Barite or KCl should be used for all slugs prior to trips. KCl should be used in preference to barite but if several trips are made in quick succession barite may have to be used to prevent increasing the KCl concentration too much. Barite should be used for weighting up if required.

The drilled solids should be maintained as low as practical (to minimize formation damage) by using the finest practical shaker screens and dumping / diluting if required.

While drilling the 12 1/4" and 8 1/2" hole sections any significant downhole mud losses should be treated immediately by circulating a LCM pill. If losses persist then a LCM pill should be spotted over the loss zone and allowed to soak.

Ensure that the corrosion control programme is followed. Particular attention should be paid to maintaining alkalinities in the programmed range.

Bactericide should be added to the mud to prevent the build up of bacteria that can rapidly degrade the polymers. Care should be taken when adding the bactericide to ensure it is not added too fast as this can affect the muddlogging H<sub>2</sub>S detectors causing erroneous alarms.

#### 4. BIT AND HYDRAULICS

The bit program below is preliminary only and will be amended as required by actual drilling conditions. Sufficient backup bits will be on location to allow considerable variation to the program.

##### DRILL BITS AND HYDRAULICS SUMMARY

Bit Size	17 1/2	17 1/2"	12 1/4"	12 1/4"	12 1/4"	8 1/2"	8 1/2"
Type	1.1.7	5.3.7	5 blade	6 Blade	6 Blade	5 blade	5.3.7
Designation	Tooth	Insert	PDC	PDC	PDC	PDC	Insert
Depth In	350	350	500	1000	1400	1800	2400
Depth Out	350	500	1000	1400	1800	2400	2600
Distance	0	150	500	400	400	600	200
ROP (m/hr)	Cleanout	2	9	5	4	10	5
RPM	120	50	70-120	40-70	40-70	70-120	40/70
WOB (klb)	0-2	35-50	5-30	10-35	30-50	10-25	25-45
BHA Type	Slick	Slick	Semi-packed	Semi-packed	Semi-packed	Packed	Packed
Motor	No	No	Yes (?)	Yes (?)	Yes (?)	6 1/2"	6 1/2"
Nozzles	3x26	3x26	5 x 18	5 x 18	3 x 18	5 x 12	3 x 12
Pump gpm	750	750	600	600	600	350	350

In the 17 1/2" hole section, a flow rate of 700 - 750 gpm will be used to ensure efficient cavings removal.

In the 12 1/4" hole section flow rates of 650 – 500 gpm will be used to maintain good hole cleaning and to help optimize ROP.

When drilling the 8 1/2" hole flow rates of 400 - 300 gpm shall be used to maintain good hole cleaning and optimize bit hydraulics.

The actual hydraulics should be calculated and adjusted on the rig site.

##### Bit Numbering Convention.

Bits should be numbered sequentially and each run should be uniquely identified. If a bit is run in the hole it should be called NB#? (e.g. NB#5) if it is a new bit and RRB#? (e.g. RRB#5) if it has been run on a previous well. In both cases the bit number will be the next in sequence (e.g. if for bits have been run then the next bit will be either NB#5 or RRB#5). For each subsequent run the bit is called a re-run bit and given a run number (e.g. RRB#5.1). Note the bit number is still the same as that used on the first run, it is only the run number that changes.

**5. BOTTOM HOLE ASSEMBLIES (Indicative only, actual BHA will be determined on location)**

Bit Run No:	1	2	3	4
Bit IADC	117	All	All	All
Bit Size	17 1/2"	12 1/4"	8 1/2"	8 1/2"
BHA				
Type / Component	Slick	Semi packed	Packed motor	Packed
NBS & Float		12 1/4" NBS	8 1/2" NBS	8 1/2" NBS
DC	16 x 6 1/4" DC	1 x 8" DC or 8" mud motor	1 x 6 1/4" Mud motor	1 x 6 1/4" Pony DC
Stabiliser		12 1/4" SS	8 1/2" SS	8 1/2" SS
DC		2 x 8"	1 x 6 1/4"	1 x 6 1/4"
Stabiliser			8 1/2" SS	8 1/2" SS
DC		21 x 6 1/4"	21 x 6 1/4"	21 x 6 1/4"
Drilling Jar	6 1/2"	6 1/2"	6 1/2"	6 1/2"
DC	2 x 6 1/4" DC	2 x 6 1/4"	2 x 6 1/4"	2 x 6 1/4"
HWDP	6 x 4 1/2"	6 x 4 1/2"	6 x 4 1/2"	6 x 4 1/2"

**NOTES**

1. Use 12 1/2" string stabilisers
2. If the 8 1/2" NBS is not available replace with a NBRR.
3. First 8 1/2" stabiliser / reamer should be in gauge to 1/16" undergauge.
4. Top 8 1/2" stabiliser should be no more than 1/8" undergauge when run in the hole.
5. Discuss with the drilling manager any change to the drilling jar position in the string.
6. A Totco ring should be positioned in the 17 1/2", 12 1/4" and 8 1/2" BHA's.
7. Maximum WOB shall be limited to 90% of the available buoyed weight below the drilling jars. Check this at time of making up the BHA.
8. Run non-ported float and Totco ring in both 12 1/4" and 8 1/2" hole BHA's.

## **6. WELLHEAD DETAILS**

All wellhead equipment will be 5000 psi.

The well will utilize the following wellhead equipment:

1. Wellhead:  
Wood Group Pressure Control, Type WG 22, 13 5/8" 5k x 13 3/8" BTC"
2. "B" section:  
13 5/8" 5k x 11", 3k , Wood Group Pressure Control, Type WG
3. "C" section:  
11" 3k x 7 1/16", 3k , Wood Group Pressure Control, Type WG TCM-X  
Bottom connection : 13", RX-53 Flange.  
Top connection : 7 1/16", 5000 psi RX-45 Flange.
4. Blind Flange  
7 1/16" 5000psi x 1/2" NPT with needle valve and pressure gauge

Refer to the Wellhead Equipment Manual for equipment and procedural details.

A Wood Group engineer is available and can be called to the rig if required.

## 7. CASING DESIGN

### 7.1 Casing Design Criteria

#### **Burst:**

Surface Casing	1) Leak off pressure at the shoe with a gas gradient to surface. 2) Assumes a casing test pressure of 2800 psi with mud on the inside of the casing and water on the outside of the casing.
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Production Casing	Internal load equal to a leak or failure in the top of the string during production and the casing evacuated. The mud behind the casing is assumed to have deteriorated. Formation still at virgin pressure and production fluid is gas.
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Burst Safety Factor	1.1
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<b>Collapse:</b>	Internal load equal to complete evacuation External load equal to mud hydrostatic
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Collapse Safety Factor	1.0
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#### **Tension:**

Tension Running	Equal to un-buoyed weight
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Tension Press Test	Equal to buoyed weight plus pressure test axial load
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Tension Safety Factor	1.6
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### 7.2. Casing Specifications

The following casing sizes will be run (Note Casing of higher grade or weight may be used instead of the casing listed below:

Casing String	Surface	Intermediate	Production	Production	Production
Hole size (in)	17 1/2	12 1/4	8 ½	8 ½	8 ½
Casing size (in)	13 3/8	9-5/8	7	7	7
Top Depth	<b>0</b>	<b>0</b>	<b>0</b>	<b>300</b>	<b>2040</b>
Bottom Depth	<b>350</b>	<b>1800</b>	<b>300</b>	<b>2040</b>	<b>2600</b>
Grade	K55	K55	K55	K55	K55
Weight (lb./ft)	54.5	36	26	23	26
Connection	BTC	BTC	BTC	BTC	BTC
Nominal Wall (in)	0.760	0.352	0.362	0.317	0.362
Inside diameter (in)	12.615	8.921	6.276	6.366	6.276
Drift Diameter (in)	12.459	8.765	6.151	6.241	6.151
Capacity (bbl/ft)	0.1545	0.0773	0.0382	0.0394	0.0382
Coupling OD (in)	14.375	10.625	7.656	7.656	7.656
Make up	To base of triangle	To base of triangle	To base of triangle	To base of triangle	To base of triangle
Float Equip	Halliburton	Halliburton			Halliburton
Float Shoe*	Non Rotating	Non Rotating			Standard
Float Collar*	Non Rotating	Non Rotating			Standard
Shoe Track Length	2 joint	2 joint			1 joint
Threadlock	Shoe Track	Shoe Track			Shoe Track
Plugs	PDC drillable	PDC drillable			Standard

- Use Halliburton tables for any field calculations.
- 7" casing will only be run if required
- Safety factors will be recalculated using actual depths prior to running casing.

## Casing Safety Factors

### CASING DESIGN

Size (in.)	Grade	Wn (lbm/ft)	Depth (ft)	Length (psi)	SAFETY FACTORS					
					Collapse	Burst	Tension			Biaxial
							Running	Cementing	Pressure	
7	K55	26	0		N/A	1.68	1.67	2.22	1.68	N/A
		26	1000	1000	9.05	1.66	1.87	2.58	1.88	7.39
7	K55	23	1000		6.83	1.46	1.61	2.27	1.64	5.57
		23	6700	5700	1.02	1.37	3.81	12.17	4.00	0.97
7	K55	26	6700		1.35	1.57	3.34	13.80	4.65	1.28
		26	8530	1830	1.06	1.55	5.42		9.95	1.06
7										

### 7.3. Marker Joints

A marker joint for perforating and production logging control shall be positioned 15m above each potential pay zone separated by more than 75m. The marker joints will be 3m (10ft) in length and will be of the same weight and grade as the casing string in which it is being run.



## **8.0 CENTRALISER PROGRAMME**

### **13 3/8" Casing** (Bow Spring Type):

- 1 on the middle of the first and second joints (across stop collars)
- 1 on the coupling of the third joint
- 1 on the first coupling below base cellar

### **9-5/8" Casing** (Bow Spring Type):

- 1 on the middle of the first and second joints (across stop collars)
- 1 on the coupling of the third joint
- 1 over each coupling from 15m above to 15m below any pay zones
- 1 on the first, third and fifth coupling above the 13 3/8" casing shoe.

### **7" Casing** (Bow Spring Type):

- 1 3m above the float shoe
- 1 3m above the float collar
- 1 on the next 2 couplings
- 1 over each coupling from 15m above to 15m below any pay zones
- 1 over the first third and fifth couplings above the 9 5/8" shoe

## 9. CEMENTING

*Note: For all slurries listed below, the following cementing information should be given to the cementing contractor, with a request to confirm the recipes required to give the listed properties.*

### 9.1 General Notes:

1. A detailed Cementing Program will be provided by the cementing contractor for each cement job.
2. As soon as possible after equipment arrives on location check that the cement head crossovers will make up to the relevant casing.
3. Prior to all casing cement jobs, ensure that the cement unit has a working and calibrated chart recorder, and that the Compupac system is functioning. After the job Halliburton will provide a job log including annotated Compupac log.
4. **Ensure correct cement head has been sent to rig (threads match).**
5. Cement coverage is shown in the table below.

	Lead Slurry	Tail Slurry	Top up
<b>Conductor</b>	Conductor base back to cellar floor.		
<b>Surface Casing</b>	120m above shoe to Surface.	Shoe to 120m above shoe.	12m below cellar to surface.
<b>Intermediate Casing</b>	Either 120m above shoe or 65m above hydro-carbons to 150m above 13 3/8" shoe	Shoe to either 120m above shoe or 65m above hydrocarbons	Not required
<b>Production Casing</b>	Either 120m above shoe or 65m above hydro-carbons to 150m above 9 5/8" shoe	Shoe to either 120m above shoe or 65m above hydrocarbons	Not Required.

### 9.2 Conductor

The 20" conductor is to be installed at a minimum depth of 10m below the cellar base. This will be grouted in place if required.

### 9.3 13 3/8" SURFACE CASING

Notes:

- 1 Cement contractor will perform slurry pilot tests using the selected source water.
- 2 NF5 Defoamer should be used when mixing all slurries.
- 3 The 13 3/8" casing will be cemented to surface in a single stage, using a lead and tail slurry.
- 4 Cement volumes should be calculated at the rig and then confirmed with the Drilling Manager in advance of the job.
- 5 Ensure 2 plugs are used in the cement head.
- 6 When circulating after landing casing, reduce the YP to a maximum of 14.
- 7 Reciprocate casing during cementing and displacing.
- 8 Displace cement with mud using cement unit or rig pumps. Use rig pumps to bump plug and pressure test casing.

#### **9.4 9-5/8" INTERMEDIATE Casing**

Notes:

- 1 Cementing contractor will perform slurry pilot tests using the selected source water.
- 2 NF5 Defoamer should be used when mixing all slurries.
- 3 The 9-5/8" casing will be cemented to 120m inside the 13 3/8" casing shoe in a single stage, using a lead and tail slurry.
- 4 Cement volumes should be calculated at the rig, then confirmed with the Drilling Manager, in advance of the job.
- 5 Ensure 2 plugs are used in the cement head.
- 6 When circulating after landing casing, reduce the YP to a maximum of 14.
- 7 Reciprocate casing during cementing and displacing.
- 8 Displace cement with mud using cement unit or rig pumps. Use cement unit pumps to bump plug and pressure test casing.

#### **9.5 7" Production Casing**

Notes:

1. Cementing contractor will perform slurry pilot tests using the selected source water.
2. Defoamer should be used when mixing all slurries.
3. Allow for dead volume in tanks when calculating mixwater and chemical requirements.
4. The production casing will be cemented back to 150 m inside the 9 5/8" surface casing in a single stage, using a lead and tail slurry.
5. Cement volumes should be calculated at the rig, then confirmed with the Drilling Manager in advance of the job.
6. Ensure plugs are correctly loaded.
7. Pump the spacer and flush before releasing the bottom plug.
8. When circulating after landing casing, reduce the mud YP to a maximum of 14.
9. Prior to the job Cementing contractor will furnish a job simulation to the wellsite.
10. Reciprocate casing as far as possible during cementing and displacing.
11. Use cement unit or rig pumps to displace cement but bump plugs with cement unit.

Spacer / Flush: Pump the following sequence:

- a. Rig to pump 30 bbls SAPP / drill water (8 ppb SAPP) flush
- b. Halliburton to pump 10 bbls Water Spacer
- c. Pressure test surface lines and equipment to 3500 psi.
- d. Halliburton to pump 10 bbls water spacer

## 10. PRESSURE TESTING SCHEDULE

1. After installation of the BOP's, the pipe rams, choke and kill line valves, choke manifold, mud standpipe manifold, and kelly valves are to be tested to 3100 which is the maximum possible surface pressure assuming gas to surface from 2800m. The annular preventer is also to be tested to 1500 psi. This can be done with a Test Plug or a Cup Type Tester.
2. Blind rams shall only be tested against a Test Plug, after backing out the drill pipe.
3. Casing Head is designed to accommodate the maximum surface pressure, assuming gas to surface from TD). The casing head test should be carried out using 13 3/8" Cup Type Tester, against the 4 1/2" pipe rams, at the initial BOP test phase.
4. All tests are to include a low pressure test prior to testing to the high pressure.
5. Test pressures shall be held for 5 minutes for low and 10 minutes for high pressure tests.
7. If the BOPs are tested with a test plug the wellhead connection, and the Casing Head side outlet valves must be pressure tested separately with a cup tester.
8. BOPs shall be tested prior to drilling out each casing string and then every 14 days (first operationally suitable opportunity thereafter), with a Test Plug. (not the Blind Rams)
9. The accumulator unit shall be tested prior to drilling out the casing on which the BOP's are first installed. The tests required are:
  - a) The accumulator bottles shall be precharged to 1200 psi (with Nitrogen).
  - b) Accumulator recharging pumps (air and electric) should be set to 'start' at approx 2,600 psi, and 'stop' at approx 2,800 psi.
10. An accumulator performance test is required to be carried out to determine if there is sufficient accumulator storage volume available. The procedure for this test is as follows:
  - Switch off all accumulator recharging pumps (air and electric).
  - The accumulator fully charged pressure should be approx 2,800 psi.
  - Close and Open each of the BOP functions.
  - There should still be approx 1,400 psi (i.e. 200 psi above precharge) of accumulator pressure available.
  - Refer to the 'Drilling Operations Manual' for details.

Note: If this test does not confirm satisfactory volume is available then the Drilling Manager must be informed

Great South Land Minerals Limited				DRILLING PROGRAM					THUNDERBOLT -1 (SEL 13-98)								
Great South Land Minerals Limited ABN 54 068 650 386				Well Type: Wildcat Exploration Well Rig: Hunt Rig 3					Northing: 5,287,200 mN (AGD 66, Hunt Energy Rig #3 KB = 5m) Easting: 466,844 mE (AMG Zone 55) Ground Elevation = 730 m								
Mt MD (RT)	Potential Targets	LITHO-LOGY	P A	WELL SCHEMATIC	CASING/ WELLHEAD	CEMENTATION	DRILLING FLUID	EVALUATION	WELL DATA	PROVISIONAL BIT PROGRAM	BHA Data	FLOW RATE	GENERAL COMMENTS				
225		Dolerite	17 1/2"		SURFACE CASING 13 3/8" csg 0 - 350m (approx) 56lb/ft K55 BTC (Not confirmed) Two joint shoe track. Air drill surface hole as deep as possible or until Hornsfels unit	SURFACE CASING Lead to surface: 30% excess, Wt 11.8 ppg, liquid additives Tail to 120m above shoe: 30% excess. Wt 15.8 ppg. Displace with mud	SURFACE HOLE Air drill to approx 350m Displace with mud prior to moving mineral rig off location Use Gel spud mud to clean out hole prior to running casing.	SURFACE HOLE <u>Not logged</u>	20" Conductor set 10-15m below cellar floor. in top of the Dolerite	10m - 350m NB #1 17 1/2" Hamer bit	Air drilling BHA	AIR DRILL	<b>This will be one of the first oil/gas exploration well drilled onshore Tasmania and thefore all personnel must be alert for possible problems at all times.</b>  Pit volumes MUST be closely monitored and any anomilies flow checked. Gas detectors MUST be operational during ALL drilling and circulating				
450		Knocklofty Fomation	12 1/4" Hole		INTERMEDIATE CASING 0m - 1800m 9 5/8" 36# K55 BTC Make up casing to the triangle. Two joint shoe track. 12 1/4" 36# K55 BTC marker joints to be run no more than 15m above pay zones more than 75m apart. Set casing shoe in basal Truro Fomation at approximatly 1800m.	INTERMEDIATE HOLE Lead from 120m above shoe or 65m above hydrocarbons to 150m inside 13 3/8 casing shoe. Wt 11.8 ppg, liquid additives Tail to 120m above shoe or 65m above any hydrocarbons. Wt 15.6 ppg, liquid additives Cement excess 10% over caliper or 20% over theoretical if caliper not available Do not over displace any job by more than half the shoe track volume Displace cement with mud Cementing contractor will provide detailed cement program prior to job.	INTERMEDIATE HOLE 3-4% KCl-Polymer Mud weight 8.8 ppg 9.0 ppg PV ALAP, YP > 10lbs/sqft API Fluid loss < 7cc's pH 8.5 - 9, PHPA may be added if required Mud properties should be adjusted as indicated by hole condition Any down hole losses should be treated with LCM's as required via periodical sweeps or direct additions. Reuse sump water where Pit volumes must be closely monitored at all times and any anomalies flow checked See mud program for more detail.	INTERMEDIATE HOLE <u>Mudlogging - Samples</u> every 3 meters or less frequently if required due to fast ROP. Wireline Logs: Run 1: BHC-DLL-MSFL-GR-Cal-SP FDC-CNL Run 2: CST  <u>Drill Stem Tests</u> Post logging, inflate straddle DST's will be run to evaluate shows	INTERMEDIATE HOLE Test BOP's to 2000 psi Perform LOT Totco surveys every 100m.  Min LOT for 30bbl Kick Tolerance = 13.9ppg EMW Expected press. (ppg): Pr grad of 8.6 ppg EMW. expected. Max surf pr = 1993 psi (assumes GTS from 1800m)	350m - 500m Slick Bit, 3x8DC, 20x6 1/2DC	500m - 1800m Semi Packed Bit, 12 1/4" NBS, 8" Mud motor 12 1/4" Stabiliser 2 x 8" DC's 18 x 6 1/2" DC's 6 3/4" Drilling Jars 2 x 6 1/2" DC's 6 x HWDP	350m - 1800m 500 - 650 gpm	<b>Crew competency</b>  All personnel working for GSLM must be competent, qualified and trained in their job. No person should undertake any job/task for which they are not trained.				
675																	
900																	
1125																	
1350																	
1575		Unit 1								Base Dolerite - 1000m NB#3 12 1/4" PDC Bit 5 blade 16mm cutters 5 x 18 jets			<b>Rig "Fit for Purpose"</b>  The rig shall be inspected by a third party inspector and signed off as being fit for purpose PRIOR TO SPUD.  Planned and preventative maintainece systems will be used to ensure the rig remains fit for purpose for the duration of the program. If the rig is deemed at any time to not be in a safe condition operations will be suspended until the problem is resolved.  The rig will be inspected by a third party inspector every 6 months after operations commence  The drilling contractors operating procedures and systems will also be inspected.				
1800		Ferntree								1000m - 1400m NB#3 12 1/4" PDC Bit 6 blade 16mm cutters 5 x 18 jets							
		Malbina								1400m - 1800m NB#5 12 1/4" PDC bit 6 blade 16/13mm cutters 5 x 18 jets							
		Cascades															
		Faulkner															
		Bundella											<b>Drilling Summary</b>  Obtain regulatory approvals Build lease and access roads Rig up mineral rig and air drill 17 1/2" hole to capacity of rig or base Dolerite Move mineral rig off location Move drilling rig to location and rig up Run and cement 13 3/8" surface casing N/U and test BOP's. M/U new BHA. RIH Drill 3m of new hole and perform LOT. Drill 12 1/4" hole to base Truro Fm at approximately 1800m Run wireline logs & DST's Run and cement 9 5/8" casing to 1800m Nipple up and test BOP's RIH and drill 3m new formation Run LOT Drill 8 1/2" hole to TD at approx 2600m. Run wireline logs. Run DST's (contingent on shows) If no hydrocarbons plug and abandon If hydrocarbons present run and cement 7" production casing Nipple down BOP's Release rig.				
		Woody Island - Tasmanite Oil Shale															
		Truro Formation															
2025		Upper Limestone Member	8 1/2" Hole		PRODUCTION CASING 7" 23# and 26# K55 BTC 0m - 300 m 7" 26# K55 BTC 300m - 2040m 7" 23# K55 BTC 2040m - 2600m 7" 26# K55 BTC Single joint shoe track. 7" 26# K55 BTC marker joints to be run 15m above any pay zones	PRODUCTION CASING Lead from 120m above shoe or 65m above hydrocarbons to 150m inside 13 3/8 casing shoe. Wt 11.8 ppg, liquid additives Tail to 120m above shoe or 65m above any hydrocarbons. Wt 15.6 ppg, liquid additives Cement excess 10% over caliper or 20% over theoretical if caliper not available Displace cement with kill weight brine containing Biocite and corrosion inhibitor Cementing contractor will provide detailed cement program prior to job.	PRODUCTION HOLE 3-4% KCl-Polymer Mud weight 8.8 ppg 9.0 ppg PV ALAP, YP > 10lbs/sqft API Fluid loss < 7cc's pH 8.5 - 9, Mud properties should be adjusted as indicated by hole condition Reuse sump water Pit volumes must be closely monitored at all times and any anomalies flow checked Pit volumes must be closely monitored at all times and any anomalies flow checked See mud program for more detail.	PRODUCTION HOLE <u>Mudlogging - Samples</u> every 3 meters or less frequently if required due to fast ROP. Wireline Logs: Run 1: BHC-DLL-MSFL-GR-Cal-SP FDC-CNL Run 2: CST <u>Drill Stem Tests</u> Post logging, inflate straddle DST's will be run to evaluate shows	Install wear bushings Performe LOT Min LOT for 30bbl Kick Tolerance = 10.4ppg EMW <u>Expected press. (ppg):</u> Pr grad of 8.6 ppg EMW. expected. Max surf pr = 2876 psi (assumes GTS from 2600m) Temp Gradient 2° f/100ft	1800m - 2400m NB #6 8 1/2" PDC Bit 5 blades 16mm cutters with 5 x 12 jets	1800m - 2600m Packed BHA Bit, 8 1/2" NBR 6 1/2" Mud motor, 8 1/2" String Stabiliser 1 x 6 1/2" DC 8 1/2" String Stabiliser 20 x 6 1/2" DC's 6 3/4" Jars 2 x 6 1/2" DC's 6 x HWDP The serial numbers and drilling hours for all jars, stabiliser and near bit stabilisers/reamers should be recorded on the daily drilling report.	1800m - TD 300 - 400 gpm					
2250																	
2475																	
2610																	
TARGETS:			<b>SAFETY</b>  No job is so important that safety needs to be compromised. All available tools (pre-job safety meetings, JSA's, Work Permits e.t.c.) should all be used to ensure a safe operation. It is more important to do the job safely than it is to do it quickly and no job should be rushed. All personnel MUST be trained in EVERY job they do. Any person has the right to suspend any operation they feel is unsafe. The drilling rig and ALL equipment must be "Fit for Purpose".  Plan your work and work safely					WELL OBJECTIVES: Evaluate the hydrocarbon potential of the Thunderbolt structure WATER SOURCE: Drillwater, mixwater, cementing water - local dam Potable water - Town water DRILLING HAZARDS: Overpressured formations. Stuck pipe due to sticky formation. Lost circulation in shallow sands. H2S. Slow drilling. Differential sticking. Unexpected formations Prepared by: Duncan New Checked by: Clive Burrett Date: 9th September 2008					Contingent Bits 1 x 12 1/4" IADC 117 1 x 12 1/4" IADC 417 2 x 12 1/4" IADC 517 1 x 8 1/2" IADC 117 1 x 8 1/2" IADC 437 2 x 8 1/2" IADC 517 2 x 8 1/2" IADC 537 2 x 8 1/2" IADC 637 2 x PDC bits  Max WOB = 85% of buoyed weight below jars.  A non-ported float and Totco ring must be run in all hole sections  Stabilisers and NBS should be changed out when 1/8" undergauge				
P & A PLUGS								Flow rates should be sufficient to give good hole cleaning and low enough to reduce hole washout.					Rig Move: 6 days Clean out surface hole 1.0 d Surface casing. BOP's: 2.0 d Intermediate hole: 15.5 days Evaluate 12 1/4" hole: 2.0 day 9 5/8" casing and BOP's: 2 d Drill 8 1/2" hole: 9.5 days Evaluation: 3 days P&A or C&S 2.0 days Total=37.0 d (excluding move)				
Min plug length is 45 m Pressure test 9 5/8" shoe plug.																	