Pipeline Crossing of Timor Trench

Review of

"Timor-Leste Gas Export Pipeline Feasibility Study"

Prepared for

The Ministry of Development and Environment

Timor-Leste

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1 Summary

The approximately 3000 m deep Timor Trench between the Sunrise gas field and Timor-Leste represents a significant challenge for pipeline installation. Woodside as operator for the field has conducted a Feasibility Study for a pipeline and LNG facility, concluding that a dual 18" pipeline system to Timor-Leste is technically feasible and would have an acceptable technical risk, but the cost would be very high. Also taking into account costs for the LNG plant, as well as business risks, a gas export system to Timor-Leste could not be supported.

The Pipeline Feasibility Study Report, prepared by INTEC as consultant to Woodside, and an over-arching report prepared by Woodside were issued in August 2004, followed by a presentation meeting in Dili 15.09.04 and a review meeting in Perth 28-29-10-04. INTEC and Woodside then issued addenda to their reports in November/December 2004, resulting in a 21 % cost estimate reduction for the pipeline, but still high compared to a pipeline to Darwin.

In the view of the Sunrise Joint Venturers, the Study has established that the Timor-Leste LNG export concept is not viable.

Lucon A/S has, through a contract with NPD, assisted the MDE of Timor-Leste with expert assistance in following the Pipeline Feasibility Study, including review of TOR, meetings with Woodside and INTEC, and review of documentation. Rev. 01 of the Review Report, issued 15.10.04, provided comments and observations to the INTEC and Woodside reports presented in August 2004. This rev. 02 of the Review Report also takes into account the addenda presented in December 2004.

The recommended 18" direct dual pipeline option appears, on the basis of the assumptions for the Study, reasonable for illustration of technical feasibility, cost and risk. However, further conceptual work should be performed before the final concept for a pipeline system to Timor-Leste is selected. A dedicated reconnaissance survey, which normally should have been performed prior to such a Feasibility Study, is strongly needed prior to any further conceptual work.

Based on the comments provided in Rev. 01 of the Review Report, Woodside has revised some of the most significant assumptions for the cost estimate, such as J-lay productivity, wall thickness distribution and rock dumping quantity, and thereby found reason to reduce the Offshore Pipeline cost estimate by 21 % from USD 91.6 mill to USD 724 mill. This reduction is, however, only half of what is required to reach a balanced estimate for a dual 18" pipeline system.

The single most important parameter in the cost estimate is the productivity of J-lay installation vessels. While Woodside in the addendum has increased the productivity from 0.78 km/day to 1.49 km/day, one of the considered vessels has a proven productivity exceeding 3 km/day including all downtime and other delays for a project with a larger pipe under similar circumstances. Woodside's arguments for not raising the productivity to the level proven in a similar project can not be supported, but is understood as a deliberate attempt to drive the total pipeline cost estimate to the highest possible level. Other cost items, such as wall thickness discrimination, route length allowance, Australian import duty, EPC management, are also based on cost driving assumptions.

Woodside has refused to consider an existing S-lay vessel in current and upgraded configurations, which may install pipelines across the Timor Trench at a considerably reduced cost.

The Table below shows the original and revised cost estimates as developed by Woodside, and four estimates based on alternative assumptions and conceptual solutions as developed in the Review Report.

Alternative	Cost (MUSD)
Dual 18" direct lines, J-lay, Feasibility Study	**916**
Dual 18" direct lines, J-lay, Feasibility Study Addendum	**724**
Dual 18" direct lines, J-lay, Alternative estimate	**503**
Single 24" => 18" => 24" direct line, J-lay	**441**
Triple 16" near direct lines, S-lay	**552**
Dual 18" direct lines, S-lay	**448**

All alternative estimates are significantly lower than the Feasibility Study and Addendum estimates, and show that widely different pipeline concepts all have a cost potential at the level of the Darwin option (566 MUSD) or lower.

In light of the information in the Addendum, that Australian manning rules may significantly reduce lay productivity, the Darwin estimate may be on the low side. Woodside has refused to provide details of this estimate.

Woodside have, through a significant reduction in the initial Feasibility Study estimate after TSDA comments, admitted that this estimate contained unreasonable cost driving elements. They are, however, unwilling to accept further reasonably justified cuts, and have introduced new cost driving elements in the Addendum estimate. They have refused to take information from a well recognized and reputable contractor seriously, and have further refused to consider installation methods in association with alternative pipeline concepts which could significantly reduce costs for the Timor-Leste option. Woodside can not be considered as a prudent operator in conducting the Timor-Leste Pipeline Feasibility Study.

2 Introduction

Development is being planned for Sunrise, a gas/condensate field in the Timor Sea with Woodside Petroleum as operator. The field is located in shallow water some 500 km North-West of Darwin in Australia. The distance from the Sunrise field to Timor-Leste is about 160 km. The gas is planned to be brought ashore in a pipeline to an LNG plant.

The approximately 3000 m deep Timor Trench on the Timor-Leste side of the field represents a significant challenge for pipeline installation. The operator and the joint venture partners have therefore primarily considered development concepts that include a pipeline to Darwin.

The Timor-Leste government has for a long time expressed a wish to also consider a pipeline to Timor Leste with the associated terminal and gas treatment facilities. Woodside agreed early in 2004 to carry out a Feasibility Study for a pipeline to Timor-Leste with associated LNG facilities.

The "Timor-Leste Pipeline and LNG Facility Feasibility Study", Reference 1, supported by the "Timor Leste Gas Export Pipeline Feasibility Study", "Timor-Leste LNG Development Conceptual Study" and "Sunrise Development - Timor-Leste LNG Feasibility Study", References 2, 3 and 4, was completed in August 2004. The Pipeline Feasibility Study was presented by Woodside to Timor Leste Government representatives in Dili on 15 September 2004.

Lucon A/S was in the spring of 2004 commissioned by the Norwegian Petroleum Directorate on behalf of the Ministry of Development and Environment, Timor-Leste to contribute to the qualification of a pipeline crossing of the Timor Trench. The work comprised expert assistance to MDE by Dr. ing. Sverre Lund in following the development of the Pipeline Feasibility Study, including review of terms of reference, meetings with Woodside and their consultant, review of interim results and final report, and presentation and discussion of results with government representatives.

In accordance with the contract with NPD, this report is prepared upon completion and presentation of the Feasibility Study. The report includes comments and observations to the Timor-Leste Pipeline Feasibility Study as presented in references 1 and 2, as well as conclusions and recommendations related to the Study.

Rev. 01 of the report was issued 15.10.04 and has subsequently been reviewed by Woodside and discussed in a meeting 28.10.04 in Perth. This has been followed by issue of Addendum to "Timor-Leste Pipeline and LNG Facility Feasibility Study", ref. 10, and to "Timor Leste Gas Export Pipeline Feasibility Study", ref. 11, and written responses to the specific comments to these reports, ref. 12.

This rev. 02 of the report is issued to reflect the additional information provided by Woodside in ref. 10, 11 and 12.

3 Main events

The main events during the course of the study were as follows:

- Terms of Reference Rev. 1 received 09.03 .04, comments sent 10.03.04
- Terms of Reference Rev. 2 received 19.04.04, comments sent 21.04.04
- Meeting with representatives for Timor-Leste in Stavanger 04.05.04
- Travel to Timor-Leste and Australia 01-12.06.04. Meetings in Dili 03-05.06. Participation in Seaaoc in Darwin 07-08.06. Meetings with Woodside 10.06.04 and with ConocoPhillips 11.06.04 in Perth.

- Based on the meeting 10.06.04, comments/suggestions to the Pipeline Feasibility Study were sent to Woodside 27.06.04.

- Travel to Australia and Timor-Leste 26.07-01.08.04. Meeting with Woodside and Intec in Perth 28.07.04, for presentation of preliminary results of the Pipeline Feasibility Study. Review of Pipeline Feasibility Study progress and preliminary results with Timor Leste Government staff in Dili 30.07.04.

- The Pipeline Feasibility Study Report was received 07.09.04. Preliminary comments were sent 09.09.04.

- Travel to Timor-Leste 12-18.09.04. Meeting with Woodside in Dili 15.09.04, presenting results and conclusions of the Pipeline Feasibility Study.

- Review Report Rev. 01 issued 15.10.04

- Meeting in Perth 28-29.10.04 with Woodside and Sunrise partners for discussions on the Timor-Leste Pipeline and LNG Facility Feasibility Study.

- The addenda to the Feasibility Study Report were issued by Woodside 30.11.04.

- Further comments and clarifications to the Feasibility Study Report were issued by Woodside 23.12.04.

- Review Report Rev. 02 issued 15.01 .05.

4 Terms of Reference for the Feasibility Study

The Terms of Reference (TOR) for the Feasibility Study were supplied by Woodside in two revisions, Reference 5 and 6. Comments to the pipeline part of TOR were provided to both revisions. Only a few of the comments to the first revision appeared to have been implemented in the second revision. The second revision of TOR, issued 19.04.04, is the last issue, and is attached to Reference 1, indicating that the comments to this revision were ignored (or did not reach Woodside).

The first revision left the impression of a rather superficial study, with a planned duration of 6 weeks and reporting in the form of a Technical Note. No reference was made to data and assumptions for the Pipeline Study.

Some editing had been done in the second revision. The LNG and Offshore Facility parts had been expanded, while the content of the Gas Export Pipeline part to a large extent was unchanged. The comments pointed to scarce seabed information in deep water, that the study therefore might be inconclusive, and that further work including a seabed survey may have to be undertaken before final conclusions can be made on Timor-Leste landing of the gas.

The QRA part of TOR predicted that risk mitigation may be required to provide equivalent risk to the Darwin option. The comment was made that risk mitigation would only be required if risks were unacceptable, but not to provide equivalent risk to the Darwin option if the risk for the Timor-Leste pipeline was acceptable.

The comments also pointed to the need for insight into studies and results for the Darwin alternative to ensure that comparisons were made on the same footings.

Rev. 2 of TOR stipulated 2-3 months duration and total a cost estimate of A $1.3 mill for the study, indicating a more comprehensive study than initially planned.

5 Technical Meetings with Woodside

Two technical meetings were arranged with Woodside in Perth during the course of the study, the first meeting 10.06.4 and the second meeting 28.07.04, References 7 and 8.

5.1 Meeting 10.06.04

The objective of the meeting was primarily to obtain insight into the premises for the Pipeline Feasibility Study performed by Intec.

The overall setting for the Sunrise Gas project and the three main development options were described:

1. Floating LNG, the concept is on a mature level after in depth studies.
2. Darwin LNG, less mature with ongoing studies on pipeline and LNG facilities.
3. Timor Leste LNG, the least mature option with ongoing pipeline and LNG - Feasibility Study.

The main assumptions and options for the Pipeline Feasibility Study were presented. The study was split in two stages. Some preliminary results from stage 1 in the form of an overall summary matrix for a wide range of alternatives were briefly presented. A screening and comparison of the alternatives would follow, with elimination of non- feasible and otherwise obviously less attractive alternatives.

Remaining alternatives would be detailed in stage 2, followed by a new screening for completion of the study by late August 2004.

The initial map studies indicated that direct crossings from Sunrise to Timor Leste would reach more than 3000 m, most probably 3300 m. The depth information appeared to be in conflict with information available to the Timor-Leste team, indicating that crossing depth might be limited to 2350 m. The map used by Woodside was provided.

The meeting lasted for two hours as planned by Woodside. No opportunity was given to go into the background for the results of stage 1 or other details.

After the meeting, on 27.06.04, some comments and suggestions were sent to Woodside, including proposals to consider a near direct route at maximum 2900 m according to the Woodside map, and the use of variable diameter, i.e. reduced diameter at the deepest part. The need for improved seabed information was pointed to.

5.2 Meeting 28.0 7.04

The meeting, with participation from Intec as consultant to Woodside as well as Woodside discipline specialists, comprised a review of preliminary results of the Pipeline Feasibility Study, with a three part split of the presentation:

1. Pipeline Design
2. Geohazards
3. Flow Assurance

In comparison to the first meeting, the second meeting lasted for a full day, with opportunity to discuss details.

Paper copies of the viewgraphs were made available, subsequently scanned and reprocessed in Dili, Reference 9. The viewgraphs were largely identical to the figures in the Feasibility Study Report.

Several direct and indirect routes to 3300 m and 2200 m depth respectively were presented, but no near direct route at 2900 m as suggested after the previous meeting. The indirect routes were not favoured due to much longer distances and higher geohazard risks.

Wall thickness design including 1.5 mm corrosion allowance appeared somewhat conservative. Resulting wall thicknesses were at or above current limitations for most pipe mills. Wall thicknesses for the largest depths can only be fabricated at a significant cost premium.

For installation, a J-lay vessel is required in deep water and a conventional S-lay vessel in shallow water. Ability to hold a water tilled pipe has been assumed for the deepwater installation, limiting the pipe diameter to 18” in 3300 m.

The various data sources for water depths and seabed topography were reviewed. All available maps have large uncertainties. A survey is required to confirm maximum depths along the Trough.

The review of geohazards was largely based on illustrations of topography in other areas, such as the Storegga slide off Mid-Norway. A qualitative assessment of geohazard risks was presented, including a comparison of risks for the Timor-Leste alternatives to the Darwin alternative. Woodside was requested to provide quantification of such risks, which may be acceptable even if they are higher than for a route to Darwin.

The dense phase option was not favoured, since this will require a minimum pressure of 300 bar to avoid two-phase flow. Some of the single phase high pressure cases result in rather high gas velocities at the downstream end, with corresponding low temperatures (frost) and possible erosion effects. Direct dual 18" pipelines are the preferred option, providing operational flexibility and being within the cap ability of two J-lay vessels for installation.

Some discussion of a near direct route at 2900 m and a concept with variable diameter will be included in the final report.

Cost estimates and risk assessment were not presented in the meeting.

Woodside indicated in the meeting that the Intec Pipeline Feasibility Study Report, as well as a Bechtel report for the Timor Leste LNG option and a Woodside top level report linking the pipeline and LNG reports, were planned for completion including partner review in August. The results and conclusions of the study were planned for presentation to Timor Leste representatives in Dili by the end of August.

6 Pipeline Feasibility Study

6.1 Study execution

6.1.1 Study premises

When seeing the results, the premises for the study appear to have been coloured by lack of incentives to demonstrate that the Timor-Leste alternative can be a realistic option:

- Uncertain seabed information has, as expected, resulted in significant cost additions and expressed risks associated with the uncertainties. Since seabed conditions were unknown, the Feasibility Study should "normally" have been preceded by a reconnaissance survey to establish a more firm base for the study.

- The Sunrise partnership has a stated objective to decide on a single development option by the end of 2004. It will not be prudent to base Sunrise development on a pipeline to Timor-Leste (which would be a "world scale" pipeline project, moving technology limits) without reference to a specific technical solution including a pipeline route with known seabed conditions. A desk-top study of the Timor-Leste option, without a reconnaissance survey to provide a reasonably firm engineering base, could in reality not allow a decision in favor of Timor-Leste, being in competition with a mature Darwin option.

- The TOR specifies direct (straight line, very deep) and indirect (very long, limited depth) routes. Limited efforts, and only at Timor-Leste request, were made to search for the optimum balance of distance and likely maximum depth through near direct routes or other novel concepts with a potential for cost reduction.

6.1.2 Timor-Leste influence

The Pipeline Feasibility Study Report, Rev. 0, is dated 10 August 2004. Rev. A of the report was issued 27.05-04 for internal Intec review. Rev. B was issued 24.06.04 for Client review. The report is rather comprehensive and must have taken at least 2 - 3 months to prepare. This indicates that the Feasibility Study was well underway at the time of submission of rev. 2 of the TOR 19.04.04. It was largely completed by Intec at the time of the first meeting 10.06.04, and was practically finished including partner review at the time of the second meeting 28.07.04.

Therefore, at all points of direct contact with Woodside during the study, actual progress was more advanced than the impression given, and the possibility to influence on the contents and results of the study has been minimal.

Rev. 01 of the Review Report pointed to some of the main assumptions behind the cost estimate being unrealistically conservative, contributing to a far too high cost estimate. This has to some extent been admitted by Woodside, who in the addendum to the Feasibility Study Report has doubled the J-lay productivity and considerably reduced the steel material quantity, and thereby found reason to reduce the Offshore Pipeline cost estimate by 21 % or USD 192 mill.

6.1.3 Form of comments

The over-arching report prepared by Woodside, Reference 1 and the Pipeline Feasibility Study Report by Intec, Reference 2, have been reviewed in some detail. Specific comments to the reports including the addenda, References 10 and 11, are presented in Appendix 2 and 3 respectively to this Review Report. Some general comments and observations are provided in the following sections.

6.2 Woodside over-arching report

The Objective of the Study was to establish the feasibility, cost, risks and potential risk mitigants associated with routing gas via a pipeline from the Sunrise offshore location to a proposed LNG site in Timor-Leste.

The Intec Feasibility Study Report, Reference 2, concludes that the study demonstrates that it is technically feasible to construct an export pipeline system across the Timor Trough from the Sunrise platform to Timor-Leste. The dual 18" pipeline option is the basis for this conclusion, and offers a balance of cost and risk. The Woodside report, Reference 1, express that the installation of a pipeline through this water depth is unproven, though theoretically feasible.

The Intec conclusion appears reasonable based on the assumptions in their report. The Woodside conclusion appears to dilute the clear conclusion on technical feasibility by Intec. Some doubt is introduced by the expression installation ... is unproven, though theoretically feasible. Presumably this expression is colored by the preference for another solution, and not representative for Woodside's approach to advances in technology. In fact, the lay vessel will hardly notice the difference between installation in 2200 m and 3300 m as long as the tension level is within the capability of the vessel.

The report emphasizes some of the most significant risk items and states that a pipeline to Timor-Leste carries significantly higher technical risk when compared to an onshore LNG development in Darwin (p. 4). This contradicts risk mitigating activities are included in the Timor-Leste option cost estimate (p. 11).Significant costs are included in the estimate to bring risks for the Timor Leste option down to the same level as for the Darwin option, in accordance with Terms of Reference for the Study. Risk analyses carried out by INTEC are pre risk mitigation. The risk situation post risk mitigation has not been analyzed, and no risk analyses are presented for the Darwin pipeline alternative. The risk comparison to the Darwin option therefore appears rather subjective.

The lack of maturity of the Timor-Leste option compared to the Darwin option is used as an argument against Timor-Leste. It is tempting to use such argument, but not “fair”. The least mature option is likely to carry higher risks and a more uncertain cost estimate, and therefore be much more difficult to select. The options should be matured to the same level to allow comparison on equal terms.

The report is attempting to demonstrate that the cost additions for the combined pipeline and LNG facilities at Timor-Leste would be so large in comparison to the Darwin option that it will not be worthwhile to pursue the Timor-Leste option any further. However, it should be taken into account that the revised Timor-Leste pipeline estimate, 724 mill USD, is most probably far on the high side, as further discussed below, with opportunities for cost reductions in the order of 200 mill USD, which would bring the pipeline cost down to the same level as the Darwin option. Such reduction appears possible within the current dual 18” direct route concept, and/or by optimizing near direct routes and other concepts, see Section 5.5.

6.3 Intec Feasibility Study Report

6.3.1 General

The report is comprehensive and in most areas thorough. The contents reflects strong adherence to the Terms of Reference provided by Woodside. The two stage approach, initially a screening of many alternatives and thereafter more in depth studies of a few selected options, appears sound.

The report contains many references to background material, falling in two groups, one consisting of detailed documentation etc. collected or developed as part of the work, the other being references of more general nature, such as conference papers, standards, public information etc. All documentation in the first group should be made available, however provision of specific documents has been refused by Woodside.

The recommended 18” direct dual pipeline option appears, on the basis of the assumptions for the Study, reasonable for illustration of technical feasibility cost and risk. However, the possibilities for other concepts with a potential of being competitive have not been fully explored. Further conceptual work should be performed before the final concept for a pipeline system to Timor-Leste is selected, preferably on the basis of the results of a dedicated reconnaissance survey.

6.3.2 Design requirements and statutory regulations

Apart from the lack of seabed information, the basis for the Study described in Chapter 3 appears largely sufficient at the current stage. The need for corrosion allowance of 1.5 mm is questioned. This allowance is specified by Woodside, and conveniently contributes to a wall thickness which slightly exceeds current mass production pipe mill capabilities.

Wave data for the area near the coast of Timor-Leste is provided, and it seems that this area enjoys a mild wave climate. The report elsewhere point to lack of wave information in the Timor Sea, and suggest for this reason the use of data which appears more representative for harsh areas such as the North Sea than for the Timor Sea. It is surprising that wave data for the Sunrise field is not referred to.

6.3.3 Route selection

The route options described in Chapter 4, being short, ultra deep direct routes or long, not so deep indirect routes, are as specified in the Terms of Reference. Both principal options are likely to attract high costs and maximum risks. Intec has apparently not been given the freedom to look for route alternatives which allow an improved compromise between length and depth, such as near direct routes limiting max water depth probably to 2900 m.

The only Timor Sea map presented in the Study Report is an old map with sketchy contour lines, indicating very long detours to obtain significant water depth reductions. Intec has used a much improved map provided by Woodside for the Study, with a single 3299 m depth sounding on the direct route. The map indicates that near direct routes may be limited to 2900 m. The map, with indication of 165 km direct and 195 km near direct routes, is shown in Appendix 1 to this Review Report.

In the addenda, References 10 and 11, the route length allowance has been increased from 5 % to 15 %, and the cost is now estimated for a route with 190 km length. The new indicative route option as developed by INTEC has been requested but has not been made available.

While it can be agreed that some allowance for route deviations is needed at the current stage, a 15 % allowance appears excessive for a direct route and should have been substantiated by a sketch. A length of 190 km is near the length for a near direct route, passing the Timor Trough some 40 - 50 km to the west of the direct route, avoiding the assumed deepest part of the Trough.

The landfall should be close to the terminal location (intuitively the terminal should be located on the south coast, offering better opportunities for alternative locations, and to avoid the onshore pipeline), but should also allow the shortest possible offshore pipeline and reasonable conditions for shore approach and landfall construction. In the Feasibility Study, one suitable location has been identified on the south coast, at Ponta de Lore, which is ideal for a direct route. However, for a near direct route, a landfall and terminal location somewhat further to the west is preferred.

6.3.4 Geohazards

The presentation of geohazards in Chapter 5 appears thorough, but is rather general, due to the lack of specific seabed information from the Timor Sea. Various types of geohazards are discussed, mostly supported by illustrations of slope failures in other areas. Some evidence of slope failures has been found on previous seismic profiles in the Timor Sea, probably caused by earthquakes.

Geohazard risks in terms of probability of ground accelerations exceeding 0.3 g have been compared between the direct route, the indirect route and the Darwin option. This comparison does not allow conclusions other than ranking of risks, since risk levels have not been quantified relative to acceptability for a pipeline.

According to the Study Report geohazards need to be related to the geological timeframe for the area, which is in the order of million years, and very long compared to the 25 years design life of the pipeline. Reference is made to other pipelines in seismic active areas. Geohazard risks for these lines were found acceptable.

Seismic profiles in the report indicate large areas in the Timor Sea with thick sediment layers, and also some evidence of slump scars. The sedimentation rate is very low. It must be assumed that the number/pattern of soil slides represent a fair indication of slide risk over a reasonable part of the period of stable sedimentation. The slides which have taken place are likely to be at locations where stability has been poor or near the centre of an earthquake. The information in the geohazard section of the report, showing thick sediment layers in sloping terrain, may be as much an evidence of a reasonably stable geotechnical situation in the area as the opposite.

Some seismic profiles indicate uneven seabed in connection with foldings and slides, however in most profiles seabed unevenness appear gentle with large “wavelengths” compared to “amplitudes”. Although the resolution is not the best, the profiles appear (when stretched to correct scale) to largely be able to accommodate a pipeline without significant spanning. Sediments are likely to be soft, and the rather heavy pipe is likely to penetrate during installation into the shoulders of possible spans created by e.g. slump scars or slump debris.

It appears likely that a pipeline route to Timor-Leste with acceptable geohazard risk can be found.

6.3.5 Flow assurance

Flow hydraulics have been analyzed for a large number of cases in Chapter 6. The analysis for the direct route is based on length of 175 1cm, which exceeds Option 1 route length by 10 km. Furthermore, the analysis are based on the inside diameter calculated as the nominal outside diameter minus the maximum wall thickness required in nearly the deepest water, while it is likely that wall thicknesses will be optimized according to the actual water depth and thereby result in an increased average ID. The increased length and reduced average ID contribute to some conservatism in the results for the direct route. It is likely that the results are representative for 190 - 200 km long near direct routes.

Based on the conclusion that 18” pipe is the maximum size which can be installed by current vessels in 3300 m, it has been suggested that a variable diameter single line is considered. Two such options were suggested to Woodside, an 18” **=>** 24” option and a 24” **=>** 18” **=>** 24” option, both with diameter transitions at the deepest point for 24” installation, at about 2400 m. The first option appears to require a too high upstream pressure. The second option can provide the required capacity with 300 bar inlet pressure, but is refused by Woodside based on unacceptable business risk. However, no quantification of business risks has been provided. A single line may result in a significant investment saving, and is attractive provided that further investigations of geohazards demonstrate that such risks are acceptable for a single line.

The lower limit of analyzed pipe sizes is 18”. However, triple 16” lines would give the required capacity, provide significant operational flexibility and add one or two lay vessels as candidates for installation, as further discussed below.

A brief discussion on system operability is included in Chapter 6.

6.3.6 Preliminary pipeline design

The preliminary pipeline design in Chapter 7 provides information on required wall thicknesses in various depths. This information is only partly used elsewhere in the report. The material cost estimate in the addendum, Reference 11, does to some extent take into account variations in wall thicknesses according to variations in depths, as requested by Timor Leste. However, flow hydraulics is based on the narrowest internal diameter.

There is a remaining potential for wall thickness optimization according to the variations in water depth, which in addition to saving in material costs would improve flow hydraulics, and allow increased lay productivity.

The assessments presented on pipeline stability in shallower waters and in the shore approach area, indicating all of concrete coating, drill/blast/excavation, rock cover and jetting to stabilize the pipe, are confusing. This is adjusted in the addendum, reference 11. The need for concrete weight coating is questioned. Rock dumping is also specified for stabilization. The submerged weight of the pipe is high due to the large wall thicknesses and should be sufficient to stabilize the pipe even in relatively shallow waters.

6.3.7 Fabrication mill capability

The largest wall thicknesses are slightly above the capability of most pipe mills, as discussed in Chapter 8. This is considered in the Study as one of the most significant project risks, which is mitigated by assuming special fabrication at triple cost.
It is likely that the wall thickness risk can be greatly reduced through further project development, by optimizing wall thickness design, elimination of corrosion allowance, possible reduction in maximum water depth, and through regular improvements in pipe mill capabilities.

6.3.8 Installation

Of the three vessels named in Chapter 9 as candidates for deep water installation, Balder and 57000 are considered capable of installing 18" pipe in 3300 m depth in their current configuration, possibly with the assistance of additional buoyancy in the deepest section. Buoyancy assistance is specified to hold, lower and recover the pipe in flooded (damaged) condition, however this requirement is challenged since most large diameter pipe in deep water has been installed without such capability. Both vessels have a limited shallow water capability, and mobilization of an additional vessel for shallow water installation would be required.

A productivity of 1.6 km/day, taking into account all weather downtime, but to be further reduced by 7 % to 1.5 km/day for mechanical downtime, has been assumed for the two vessels as basis for the revised cost estimate, Reference 11.

S7000 installed the deepwater parts of the twin 24" x 31.8 mm Blue Stream pipelines, totaling 710 km, in 8 months. This corresponds to an average productivity of 3 km/day, taking all downtime and reduced productivity in the start into account. The second Blue Stream line was installed with an average daily productivity exceeding 4 km/day, peaking at more than 5 km/day. Only those parts of the Timor-Leste pipeline which has a larger tension requirement or a larger wall thickness than Blue Stream should, in theory, be expected to see lower productivity than Blue Stream. This would apply only for depths larger than around 2900 m, or about 10 % of the total route. Productivities for Ormen Lange as discussed in References 10 and 11 are not relevant, since this pipe is much larger (32" x 35.3 mm) than Blue Stream, is in a weather exposed area, and with average productivity largely influenced by end effects due to very short length (2 x 20 km).

INTEC did in 2002 a study "East Timor Pipeline - Feasibility Study" for Oceanic Exploration, Reference 13. A route from Bayu-Undan to Suai is studied, and it is found that a 28" pipeline could be installed along this route, limited to 3000 m depth, with the 1-lay vessel Balder. For the cost estimate it is assumed that the 230 km long pipeline with wall thickness up to 45 mm could be installed in 77 days, corresponding to an average productivity of 3 km/day, at a dayrate of 500 000 USD/day. INTEC should explain why the productivity for the same vessel, installing the much smaller pipe of 18", is assumed to be 1.5 km/day or half the productivity assumed in the Oceanic study.

An average productivity of 1.5 km/day is therefore not to be believed, and no rational explanation has been provided. 3 km/d would represent a conservative estimate for the 18" Timor-Leste option, even if laying in the deepest section, with 10 % of the total length, should be slow due to the assumed added buoyancy for this section.

The third vessel named in the report, Solitaire, has not sufficient tension capacity for installation of 18" pipe in 3300 m, and was therefore ruled out in the Feasibility Study. However, the current vessel configuration may allow installation of 16" pipe to around 3000 m at rates exceeding 5 km/day. Solitaire can also lay the shallow water sections, and may prove very competitive for installation of triple direct or near direct 16" lines.

A fourth vessel, Deep Blue, has tension capabilities similar to Solitaire, and may also install 16" pipe to around 3000 m. However, the productivity of Deep Blue in the current configuration is limited for a long pipeline. Both Solitaire and Deep Blue have installed up to 18" pipelines to around 2000 m (Nakika/Shell and Mardi Gras/BP). Upgrading of capabilities is under consideration for both vessels.

Allseas has informed Timor-Leste that they recently have committed to install additional tension capacity on Solitaire, related to a contract from GulfTerra to install a pipeline of 24" O.D. with 34.3 mm wall thickness in 2500 m water depth in the Gulf of Mexico early 2006. This upgrade will allow Solitaire to install 18" pipe in 3300 in. Woodside have, however, refused to make further contact with Allseas, since they consider any information that Allseas would provide on their vessel upgrades would be speculative in nature.

The installation considerations in the Feasibility Study are limited to 3300 m and 2200 m depths. It was suggested to Woodside to consider installation in 2900 m depth, which appears likely for a near direct route, but no installation analyses were performed. The installation tension increases by about 40 % from 2900 m to 3300 m for the same pipe diameter. Therefore the maximum depth is of great significance for the maximum pipe size which can be installed. It appears that tension required to install 20" pipe in 2900 m would be similar to the tension for 18" pipe in 3300 m. The requirement to provide buoyancy assistance for 18" pipe can be removed in 2900 m.

6.3.9 Phase 1 concept study

The systematic of phase 1 and results in terms of options carried forward appear largely reasonable. None of the rejected cases should have been carried forward, while the decision to carry forward dense phase cases is questioned.

At the phase 1 initial screening stage, when the cases for consideration were selected, a wider selection of options should have been considered, in particular near direct routes at 2900 m and 16" pipe.

Participation by Timor-Leste at the screening stage would have been a great advantage.

6.3.10 Supplementary engineering considerations

The consideration in Chapter 11, to see whether other engineering aspects could have impact on the technical solutions, is relevant. The only significant issue found was repair contingency. This has been a common concern for all deepwater projects. Some few repair systems have been developed or are under development and are described.

A repair contingency is likely to be needed, and may preferably be based on joining one of the "clubs" having a system under development. Further studies should be done before a final decision is made on which system to base a repair contingency on.

6.3.11 Cost estimate

The basis for the cost estimate is presented in Chapter 12. The resulting estimate, also with a 21 % reduction according to the addendum, Reference 10, appears very high, even taking into account the particulars of the project in terms of ultra deep water and uncertain seabed conditions. The main reasons for a still high revised estimate are as follows:

- J-lay productivity is assumed at 1.6 km/day less 7% allowance for mechanical failure, effectively 1.5 km/day. One of the vessels has proven average productivity exceeding 4 km/day for a larger pipe in very deep water (24” Blue Stream, second line, at 2150 m). There is no reason why installation of 18” pipe should see a lower productivity in the Timor Sea, other than possibly for the short deepest section if the need for added buoyancy is confirmed. It is recommended that J-lay installation costs are reconsidered based on 3 km/day average productivity including allowances for weather and mechanical downtime.

- The large J-lay vessels are assumed not to be capable of installing the pipeline in shallow water at the Sunrise end. Additional mobilization of a conventional S-lay vessel has therefore been assumed.

    - The minimum depth at the Sunrise end is 150 - 160 m. This depth may be near the J-lay minimum depth for 18” pipe. The possibility for J-lay installation of the entire pipeline should therefore be further studied.

    - There are other lay vessels with capabilities for deep water which also can install shallow water pipe (Solitaire, Deep Blue). Pipe diameter or maximum water depth has then to be somewhat reduced. A concept allowing use of these vessels, such as triple 16” pipe, should be considered.

- Information from Allseas on recently committed upgrades of Solitaire suggests that this vessel will be able to install 18” pipeline in 3300 m depth at a much higher productivity than assumed by Woodside for the I-lay vessels. Mobilization costs may be reduced, and the use of an other vessel in shallow water will not be needed.

- There is a potential for further reduction in material costs:

    - Eliminate 1.5 mm corrosion allowance.

    - Use 4 - 5 different wall thicknesses along the pipe instead of three thicknesses, each suited to a specified depth range, e.g. < 1500 m, 1500 - 2000m, 2000 - 2500 m, 2500 - 3000m, >3000m.

    - Optimize wall thickness by tighter tolerances and stricter fabrication requirements as suggested in OS-F101.

    - Avoid special UOE fabrication of pipe by reduced requirement to wall thickness in the deepest water, finding a route with reduced water depth, await development in pipe mill capabilities.

- The two last items represent non-confirmed possibilities and will require further engineering.

- The pipe is assumed transported via Malaysia for coating. Most, if not all pipe will not require concrete coating. Some pipe mills have the capability of providing pipe with inside and outside corrosion coating in accordance with the specifications for the project. Avoiding pipe handling in Malaysia may represent a significant saving.

- Significant intervention costs (for strake installation, jetting, rock dumping) are included. Since these interventions have no engineering background they are considered as a contingency accounting for uncertain seabed topography and possibilities for free spanning pipe.

- Management costs appear high. There is a 15 % addition on all pipe lay cost for engineering, procurement and construction management (EPCm), being particularly high due to the high cost for J-lay installation. There is a further Woodside team management cost of 6.2 % on all Direct costs. Woodside have provided additional information in Reference 12, however the Contractor PM cost, 25.8 mill UDS, is still high in the revised estimate. This is twice the estimate for detailed design and follow-on engineering. Corresponding to 344 500 man-hours at 75 USD/hr, this can keep 100 men busy in two years. The very high PM addition to an already high cost for installation including lay vessel mobilization can not be supported. It appears from Reference 12, item 2.43, that a similar Contractor PM fee is not included in the Darwin estimate (only Operator PM fee included).

- Taking into account that some of the main uncertainties/risks are covered by specific cost elements in the estimate, a 20 % contingency on total Directs and Indirects appears high.

- 4.5 % on total Directs and Indirects for owners cost and 1 % for technical advisors fee also appear high. 6.2 % on Directs and 25.5 % on Directs and Indirects amount to more than 33 % addition on direct costs.

Since the cost estimate is compared to the estimate for the Darwin pipeline option, details of the Darwin estimate should also have been provided, however Woodside has refused to provide such information.

It is considered that there are opportunities for significant savings in the estimate through more detailed consideration of key estimating assumptions, further optimization of the current concept, and introduction of other, more cost effective concepts, see Section 5.5.

A summary pipeline project schedule is included in Chapter 12. The schedule is different from the overall project schedule presented by Woodside (Reference 1) in terms of start of activities, FED, construction and start-up. The 3.5 years total duration of the pipeline project falls comfortably within the much longer time to design and construct the LNG facilities. However, the schedule indicates pipeline activities start with linepipe prototype testing. It is recommended that the next activity on the Timor-Leste pipeline is a reconnaissance survey.

6.3.12 Risk analysis

The risk ranking in table 13-1 appears to be pre risk mitigation. Since the cost estimates contain significant costs for risk mitigation, this should have been reflected in the table, for instance by an additional column for post mitigation Risk Ranking. This would ease the comparison of risks to the Darwin option.

Also, the table as presented may leave a possibly unintended dramatic impression by the convention used to describe risks in the Risk Ranking column. It is as example not intuitively clear that a High risk for Water in line is acceptable.

Some of the risks will simply be removed by normal engineering, such as Heavy wall thickness pipe required, Excessive pipeline spans, and Installation vessel capability.

Some of the risk items are treated as independent, but are not. A costly Major repair may be the consequence of events in the table, such as External impact or Slope failure, but is in itself not a risk if events leading to repair also are risked.

The analysis including a risk workshop concluded that as long as best practices, as demonstrated by the application of current international codes and standards in design, should be applied ... the risk is regarded as ALARP. No unacceptable risk elements which can not be mitigated were identified. The need for a repair contingency is emphasized, and some few elements are identified for Quantitative Assessments.

6.3.13 Final option selection

The rationale behind selection of the dual 18” direct line for the purpose of establishing technical feasibility is accepted based on the assumptions for the Study. However, the conclusion that the 18” dual direct scenario is the only viable solution for the proposed Sunrise to Timor-Leste pipeline can not be supported.

Chapter 14 includes summary cost estimate tables, commented in Section 5.3.11 above.

A brief discussion is included on the near direct route with water depth limited to 2900 m, concluding that from an installation perspective there is no change. The required lay vessel tension will, however, be reduced by approximately 30 %, eliminating the need for additional buoyancy during installation, and allow one or possibly two additional vessels installing the line, with the potential of a significant further reduction in installation costs, on top of a material cost reduction.

6.4 Compliance with Terms of Reference

In addressing compliance with the Terms of Reference for the project, the over-arching report prepared by Woodside, Reference 1, as well as the Pipeline Feasibility Study Report, Reference 2, is considered.

6.4.1 Objective

The objective of the study is to establish the feasibility, cost, risks and potential risk mitigants associated with routing gas via a pipeline from the Sunrise offshore location to a proposed LNG site in Timor-Leste.

It is understood that the purpose is to use the results for comparison to the Darwin option and then decide on a single development option for Sunrise.

The technical feasibility of the pipeline has been established, as discussed above.

The Intec cost estimate, reduced from 916 mill USD to 724 mill USD in Reference 11, appears still excessive, taking into account worst case/most conservative assumptions wherever information is lacking and technical solutions could have been somewhat optimized, and includes in addition a significant contingency. The cost difference of 158 mill USD to the Darwin pipeline does not allow detailed comments, since the details of the Darwin solution are not known. However, as a general comment, it should be possible to find a technical solution and arrange installation in such a way that a Timor Leste pipeline system does not cost more than the Darwin pipeline.

The Woodside report lists the three highest ranked risks, and states that the risk mitigation activities are included in the Timor Leste option cost estimate. Presumably, the risk mitigation activities have therefore been designed to provide equivalent risk to the alternative Darwin OLNG option, as stated in the TOR. If so, the technical risk for the Timor Leste option should be on the same level as the Darwin option. This is in conflict with the general statement in the report that a development concept based on a pipeline from the Sunrise field to an onshore LNG plant in Timor-Leste ... carries a significantly higher technical risk, when compared to an onshore LNG development in Darwin.

The objective therefore appears satisfied wrt. feasibility. The cost estimate appears biased on the high side and not suited for direct comparison to other options. The risk conclusion appears ambiguous, but should be interpreted that risks associated with the Timor-Leste option are: acceptable.

6.4.2 Activities

<u>Pipeline Route Selection</u> should to a larger extent have taken into account near direct route options to optimize route lengths vs. maximum depth. INTEC/Woodside have in the Addenda assumed a significantly increased route length allowance, without substantiating the addition as requested by a sketch, but with a total length of 190 1cm, near the length for the indirect route of 195 km. The allowance exceeds what would represent a reasonable allowance for the direct route of 5 %, increasing the 165 km theoretical length to 173 km.

Qualitative Risk Assessment is done, however some dependent risk items are treated as independent. For some risk items, a higher risk is found than would intuitively be expected, indicating that a qualitative assessment may be subjective. Comparison analysis with other existing/planned pipelines is specified, but is not reported, other than some qualitative comparisons of geohazard risks for the Darwin option. Costs are apparently added to bring the risks down to the same level as for the Darwin pipeline.

Pipeline Size Selection is done satisfactorily. Variable diameter for the pipeline is considered in the addendum.

Material Selection is done satisfactorily.

Wall Thickness is done satisfactorily. 1.5 mm corrosion allowance can be removed for all wall thicknesses in accordance with North Sea practice for dry gas pipelines.

Stability Analysis appears premature, but the amount of intervention work has been reduced based on comments to rev. 0 of the Feasibility Study Report.

Installation Analysis appears satisfactory; however the criterion to have capacity to install a flooded pipe is challenged.

Protection Philosophy is not emphasized in the study, but is a minor item.

Shore Approach. Landfall and Rockdumping are based on a generic case. The cost estimate is reduced to a reasonable level in the addendum, Reference 11.

Pre-Commissioning Philosophy appears largely satisfactory.

Operating Philosophy is discussed in terms of System Operability and Repair Contingency.

Cost Estimate is done. The estimate is very high. Some major assumptions are challenged, in particular installation productivity and route length allowance. 3 % import duty to Australia on materials should be removed. In the estimate, references are made to KP values in the nearshore area which are confusing, but this is not of significance for the cost estimate.

Project Schedule is done. The schedule in the over-arching report prepared by Woodside, Reference 1, is different from the one in the Pipeline Feasibility Study Report, Reference 2.

6.5 Concept and cost considerations

The potential for cost reductions compared to the cost estimate provided in the addendum to the Feasibility Study report for the dual direct 18” lines is significant. This is illustrated by developing cost estimates for four alternatives:

- Dual direct 18” lines, 165 km each at 3300 m maximum depth, J-lay
- Single 24” **=>** 18” **=>** 24” direct line at 3300 m maximum depth, J-lay
- Triple near direct 16” lines, 195 km each at 2900 m maximum depth, S-lay
- Dual 18” direct lines, 165 km each at 3300 m maximum depth, S-lay

The estimates are provided in Appendix 4 to this Review Report, including a list of assumptions for each alternative. The estimates are provided in the same main format as the Feasibility Study estimate in Table 14-1.

The purpose is firstly to substantiate & realistic reduction in the cost estimate for the dual direct 18” option, and secondly to demonstrate that other conceptual solutions have a potential for a correspondingly low cost. This should provide more confidence in the cost reduction potential, and create interest in a continued pursuit for the “best” concept.

No technical basis has been developed other than the estimating assumptions, some weight estimates and some rough assessments of required lay tensions.

The estimating assumptions are based on the assumptions in the Feasibility Study and the Addendum, modified to take into account wall thickness optimization possibilities and realistic pipe laying productivities. Some other minor modifications are made to account for the characteristics of each alternative.

Total estimated costs are as follows:

Alternative	Cost (MUSD)
Dual 18" direct lines, J-lay, Feasibility Study	**916**
Dual 18" direct lines, J-lay, Feasibility Study Addendum	**724**
Dual 18" direct lines, J-lay, Alternative estimate	**503**
Single 24" => 18" => 24" direct line, J-lay	**441**
Triple 16" near direct lines, S-lay	**552**
Dual 18" direct lines, S-lay	**448**

All alternative estimates are significantly lower than the Feasibility Study estimate, including the Addendum estimate. The main reasons for the reductions are use of optimized material costs, realistic lay vessel productivities and the reduction in all percentage additions following the reduction in the total direct construction costs.

The estimates demonstrate that widely different pipeline concepts all have a cost potential at the level of the Darwin option (566 MUSD) or lower. In light of the information in the Addendum, that rules on manning vessels in Australian waters with local labour may significantly reduce lay productivity and contribute to machinery breakdowns, the Darwin estimate may be on the low side. Woodside has refused to provide details of this estimate.

The single line variable diameter option has the potential for a significant cost reduction compared to Darwin alternative, but has some challenges related to diameter variations in ultra deep waters.

The two last options assume the use of S-lay vessel Solitaire. The triple near direct line option can be done by Solitaire in the current configuration, has reduced risks associated with pipe fabrication limitations, avoids buoyancy assistance in the deepest part, and has improved operational flexibility. The last option is based on a decided upgrading of Solitaire for a 2006 installation contract in GoM, resulting in an estimate which also is significantly lower than the Darwin estimate.

7 Conclusions and recommendations

7.1 Conclusions

Based on the assumptions made for the Feasibility Study, it has been demonstrated that installation of a pipeline system for transportation of gas from Sunrise to Timor-Leste is technically feasible. The recommended technical solution comprising dual 18” direct pipelines to a maximum depth of 3300 m represents a significant extension of current pipe laying experience in terms of water-depth, but not so much principally once it is clarified that installation is within the capability of the lay vessel. The lay vessel does not notice water depth, only pipe tension.

The Study recommends that the dual 18” pipeline option is the preferred case for the potential Sunrise to Timor-Leste development. This recommendation is accepted for the purpose of establishing technical feasibility for the pipeline. However, further concept development and optimization studies are required before a final concept should be concluded, preceded by a reconnaissance survey.

The objective of the Feasibility Study as stated in the terms of reference is to establish the feasibility, cost, risks and potential risk mitigants associated with routing gas via a p4,eline from the Sunrise offshore location to a proposed LNG site in Timor-Leste. While feasibility is established and risks appear to be acceptable, costs have not been satisfactorily concluded. The revised estimated cost of 723 MUSD in the Addendum appears considerably overestimated. The main contributing factors to a high estimate are:

- Lack of obvious and simple wall thickness optimization which will significantly reduce pipe material costs.
- The assumed productivity for J-lay pipe installation is only a fraction of documented productivity for larger pipe under similar conditions.

- The route length allowance, increased from 5 % to 15 % in the addendum, is unnecessarily conservative for the direct route and has not been supported by a sketch.

In addition, due to lack of specific seabed information, the estimate is based on assumptions on important aspects such as maximum water depth, topography and geology. Costs are included to account for work required as a consequence of the seabed assumptions. Other conditions than assumed may significantly affect the cost.

"Normally", a Feasibility Study should have been preceded by a reconnaissance survey to secure a more specific data base for the study.

Some rough estimates for the dual 18" direct lines and two alternative concepts, with more realistic assumptions on pipe material costs and pipe laying productivity, are presented in Section 5.5. While any estimate on the current technical basis will have significant uncertainties, it appears likely that an optimized concept would cost in the region of 500 - 600 MTJSD, i.e. same order of magnitude as the Darwin option, with a possible upside to less than 500 MUSD, and not attract higher risks than the concept presented in the Feasibility Study report.

The lowest cost options are represented by a single pipeline, which according to current installation capabilities will need variable diameter along the route, and a dual pipeline installed by an upgraded S-lay vessel. Although variable diameter is established technology, application as suggested for an ultra deep pipeline will need thorough considerations of pigging technology.

It is of interest to note that a triple 16" pipe solution, which is within the current capability of an S-lay vessel, does not attract significantly more cost than the dual 18" J-lay option and is likely to represent a reduced risk.

It is important to note that technical challenges and risks are significantly reduced in 2900 m compared to 3300 m. Lay tension requirements are reduced by 30 %, allowing larger pipe to be installed or other vessels with reduced tension capacity to be used. Required wall thicknesses will be within pipe mill mass production capabilities and additional buoyancy during installation can be avoided.

Higher gas export pressure will result in some additional compression costs at the field, but as indicated in the last paragraph in Appendix 2 to this Review Report, reduced to 60 MUSD.

Woodside have, through a significant reduction in the initial cost estimate after TSDA comments, admitted that this estimate contained unreasonable cost driving elements. They are unwilling to accept further reasonably justified cuts, and have introduced new cost driving elements in the addendum estimate. They have refused to take information from a well recognized and reputable contractor as Allseas seriously, and have further refused to consider installation methods in association with alternative pipeline concepts which could significantly reduce costs for the Timor-Leste option.

Woodside can not be considered as a prudent operator in conducting the Timor-Leste Pipeline Feasibility Study.

7.2 Recommendations

The following recommendations are made:

- The comparison with the Darwin option should be based on a Sunrise to Timor-Leste pipeline cost in the range 500 - 600 MUSD. The cost difference to the Darwin pipeline is then insignificant.

- Insight into details of the Darwin pipeline cost estimate is required to verify cost differences.

- The cost estimate part of the Feasibility Study including Addendum should not be accepted for the reasons given in Section 6.1 above.

- Woodside should be requested to have the estimate verified by an independent body if they do not accept to reduce their estimate.

- Alternatively it should be considered to reject the entire Feasibility Study for the reason that the cost part of the objective has not been fulfilled.

- A decision to proceed with or to drop the Timor-Leste option at the current stage will presumably be mainly influenced by the cost difference between the Timor-Leste option and the Darwin option, which according to the above will be dominated by the differences on the LNG terminal.

- Should it be decided to proceed with the Timor-Leste option, then a reconnaissance survey should be performed as soon as possible. Further desk top studies without specific seabed information will not improve the decision base for the pipeline part.

- The survey should if possible be funded by the Sunrise partnership and performed by Woodside as operator as a normal part of Sunrise development.

- Following the survey, an extended Feasibility Study should be performed. The study should open for other concepts than the dual 18” direct lines, and ensure that the Timor-Leste option is brought to the same level of definition as the Darwin option.

- A final decision on the development concept for Sunrise should await completion of the extended Feasibility Study.

8 References

1. “Timor-Leste Pipeline and LNG Facility Feasibility Study”, Woodside, Doc. D0000RG5239, Rev 0, 20.08.04.

2. “Timor-Leste Gas Export Pipeline Feasibility Study”, Intec, Doc. 22014501-100- RPT-001, Rev 0, 10.08.04.

3. "Timor-Leste LNG Development Conceptual Study", ConocoPhillipsfBechtel, August 2004.

4. "Sunrise Development - Timor-Leste LNG Feasibility Study", ConocoPhillips, Rev. D, 17.August 2004

5. "SUNRISE DEVELOPMENT: Timor Leste Gas Export Pipeline Feasibility Study" and "TERMS OF REFERENCE, LNG Facility Feasibility Study for Timor Leste". Submitted 09.03.04.

6. "TERMS OF REFERENCE, Tinior Leste Pipeline and LNG Facility Feasibility Study". Submitted 19.04.04.

7. Report from meeting with Woodside 10.06.2004

8. Report from meeting with Woodside 28.07.2004

9. Viewgraphs from meeting with Woodside 28.07.04

10. "Timor-Leste Pipeline and LNG Facility Feasibility Study - Addendum", Woodside, Doc. D0000RG5239, Rev. 0, 01.12.2004.

11. "Timor-Leste Gas Export Pipeline Feasibility Study, Addendum to the Feasibility Study Report", Intec, Doc. 22014501-100-RPT-001, Rev 0, 17.11.2004.

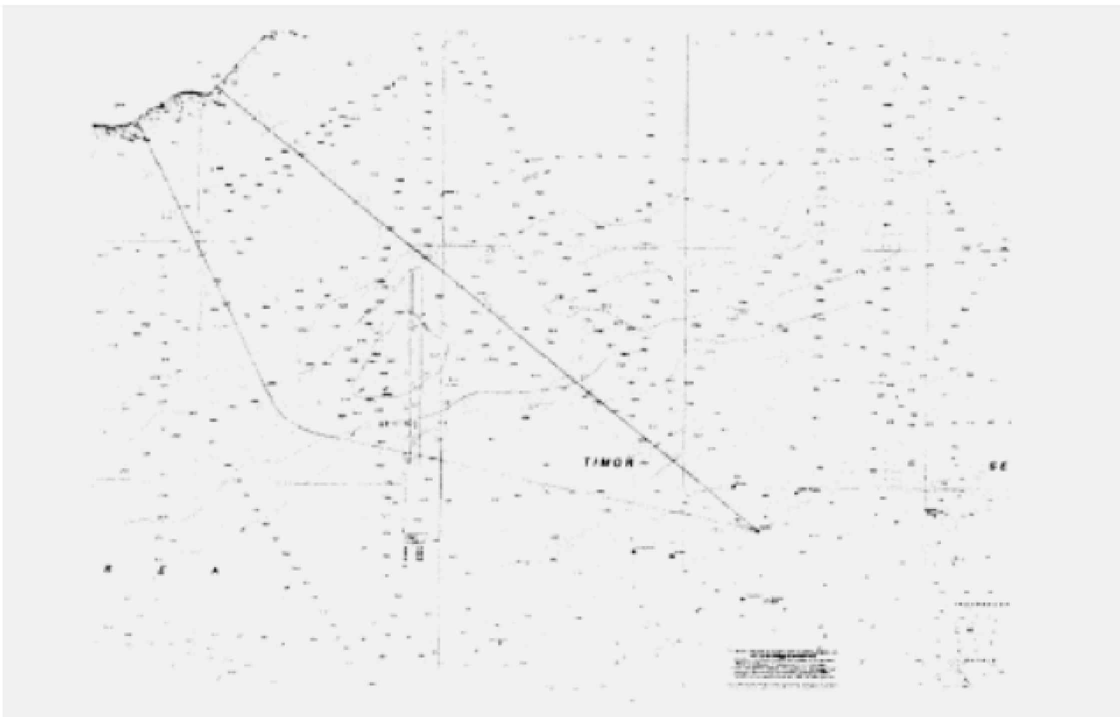
12. Letter ref. 1824016 from Woodside to Timor Sea Designated Authority on "Timor-Leste Pipeline and LNG Plant Feasibility Study", dated 23.12.2004.

13. "East Timor Pipeline - Feasibility Study" for Oceanic Exploration, INTEC Project no. P0063.01 Rev. A, June 2002.

Appendix 1

Timor Sea map

Direct route:	165 km length, 3300 m maximum depth
Indirect route:	195 km length, 2900 m maximum depth



Appendix 2

Specific Comments

to

Woodside Over-arching Report

Timor-Leste Pipeline and LNG Facility Feasibility Study

P. 4 "The findings from the feasibility study are that a development concept based on a pipeline from the Sunrise field to an onshore LNG plant in Timor-Leste ... carries significantly higher technical risk when compared to an onshore LNG development in Darwin", is in direct conflict with "The risk mitigating activities are included in the Timor-Leste option cost estimate". I.e. costs are included in the estimate to bring risks for the Timor Leste option down to the same level as for the Darwin option.

P. 4 "... buoyancy assistance is required for both vessels to handle the pipeline". This assumption is made to prevent overloading of the tensioning system in case of accidental flooding of the pipe, but appears not to be necessary. If flooding should take place, the additional weight is not coming instantly, and there is enough time to engage additional friction clamps to hold the pipe.

P. 8 "This step-out represents a significant technical challenge for installation of the pipeline, to the point where a single trunkline is not feasible because there are no existing laybarges capable of installing a large enough single trunkline". The possibility of installing a single pipeline with variable diameter, such as a 24" => 18" => 24", with diameter transitions at the maximum depth for 24", has not been fully explored.

P. 8 "The required wall thickness exceeds the limits of pipe mills for mass-produced UOE pipe". A corrosion allowance of 1.5 mm is included, but is in accordance with North Sea practice not required for a dry gas pipeline. Without this allowance the maximum wall thickness is very near the capabilities of pipe mills, and it is likely that pipe within few years can be mass-produced with the required thicknesses. A small reduction in maximum water depth will also bring the wall thickness within current capabilities.

P.9 "There is significantly higher seismic activity associated with the area north of Sunrise to Timor-Leste compared to the route to Darwin, which increases the overall risk of the Timor-Leste concept". It has not been documented that the higher seismic activity north of Sunrise leads to a corresponding higher risk for a pipeline to Timor-Leste. And if the risk should be higher, it may still be acceptable. Some credible risks may be higher for a Darwin pipeline, such as anchor dragging, dropped objects, military exercises, sabotage, which may contribute to an overall risk level which could be higher for the Darwin option than for the Timor-Leste option.

P.9 "... a sensitivity was conducted for the 2900 m depth, although the report identifies that the actual water depth is likely to be greater than 3000 m". The study concentrates on the direct straight line route, which passes a single depth sounding of 3299 m in an area which otherwise is indicated to have a maximum depth of 3000 m. Some 50 km to the west, the corresponding depth soundings do not reach 3000 m, with indications of about 2900 m as maximum depth. The question of likely water depth is therefore linked to the considered point of Timor Trench crossing. Reasonably short routes which might reduce maximum water depths have not been focused.

P. 9 "The study concludes that a water depth of 2900 m would allow the total pipeline to be fabricated with standard mass produced UOE pipe, resulting in some cost saving". In addition to materials saving, the additional buoyancy at the deepest section would not be required, and the main argument for very low installation productivity would disappear. A reduction in maximum water depth could also allow an increase in pipe diameter, with the possibility for a more cost-effective concept.

P. 11 "A dual pipeline solution would also be required for the dense phase option, and hence there was no benefit seen in pursuing a dense phase option". The main point in suggesting dense phase was to bring the condensate ashore through the gas pipeline in order to eliminate most condensate handling offshore. However, the type and quantity of condensate does not give the opportunity for dense phase transportation within reasonable pressures.

P. 11 "Heavy wall thickness pipe required - ... beyond the normal fabrication range of standard UOE mills. The proposed mitigation would be to perform prototype testing, and use tighter design tolerances (ie thinner walled pipe)". The mitigation implemented in the cost estimate is a hefty cost addition on all steel outside standard capabilities, based on a quotation from a specialized mill. Use of tighter tolerances would represent an attractive alternative.

P. 11 "Excessive bottom roughness could lead to freespans that in turn could result in buckling and pipe failure". This may be a risk if the pipe is lowered blindly into the sea. However, route optimization will always be an important part of design, and severe free spans can normally be avoided. Unavoidable severe spans can be predicted, and intervention measures planned at the design stage. This should therefore not be classified as a severe risk. (As long as seabed conditions are unknown, there could in theory (but at low probability) be a possibility of an unavoidable seabed feature, which would result in a span so long and high that it could not be corrected within reasonable efforts and cost. A survey followed by engineering is therefore strongly recommended before a Timor-Leste pipeline is selected as the single development option).

P. 13 "The pipeline and offshore facilities estimates are to an accuracy of +/-25% in line with standard WEL guidelines". Significant costs are included in the estimate to mitigate severe risks on an item by item basis, ref. section 3.2.3. Most risk items have a probability <0.1, while some have a probability > 0.1. A statistical approach to costing of total risk would lead to a smaller addition than the item by item addition. Therefore it appears more likely that the cost would be lower than the estimate than higher than the estimate.

P. 15 "The offshore pipeline cost associated with crossing the Timor Trench to Timor-Leste is in the order of US$350 million greater than the Darwin pipeline". Only the Timor-Leste pipeline estimate has been provided, while no details on technical solution, risks or estimate for the Darwin pipeline have been made available. Possible Darwin pipeline issues which might affect the cost difference can therefore not be commented.

P. 15 "Repair System. Higher geohazard than Darwin route and specialized repair system for 3300 m water depth". While in principle a specialized repair system is likely to be required for the Timor-Leste option, the probability of repair may not be lower for the shallow and therefore more exposed Darwin option, as implied by the text.

P. 20 "The pipeline also requires more definition for the Timor-Leste concept route than the Darwin route". The Level 1 schedule does not show any pipeline activity prior to June 2006, with BOD/FEED and Pipe Testing as the initial activities. The first route survey is planned from November 2006. However, a survey allowing a more precise definition of the Timor-Leste route is required at the earliest possible stage to determine maximum water depth and identify possible seabed features and conditions which may represent significant risks or costs. The Timor-Leste option can not be a realistic alternative to the Darwin option unless the definition of routes is on a corresponding level.

P. 22 "In addition, there is increased technical risk primarily associated with the installation of a pipeline in 3300 m water depth, ...". According to Section 3.2.3, "risk mitigation activities are included in the Timor-Leste option cost estimate", and according to the TOR for the Feasibility Study (Attachment 1) this is done "to provide equivalent risk to the alternative Darwin OLNG option". Therefore, either the risks are the same for both options, or a lower estimate should be provided for the Timor-Leste option, subtracting all risk mitigation costs due to deep water and uncertain seabed conditions.

P. 22 "A pipeline through this water depth is theoretically feasible but unproven, and installation of the line represents a significant technical challenge". The statement appears carefully designed to lead non-technical readers to understand that installation may need unproven technology and may meet practical difficulties, and is therefore not advisable. A less biased statement would be "A pipeline through this water depth is technically feasible, while installation of the line represents a significant technical challenge", which is consistent with the conclusion in the Intec Feasibility Study report.

P. 22 "... both vessels would require buoyancy assistance to allow installation". Ref. comment to P. 4 above.

P. 22 "The step-out in water depth therefore leads to significant risk and cost impact due to the installation and design challenges". Risks are mitigated by significant cost additions; see other comment to P. 22 above.

P. 23 Reference is made to "Timor-Leste Gas Export Pipeline Feasibility Study Report Rev B, 24 June 2004", wile Rev 0, 10 August 2004 was made available to Timor-Leste. The significance of this difference is not known.

Attachment 2. “The current reference case with a gas export pressure of 155 bara was used as basis for examining the incremental costs associated with various export pressures”. Incremental Cost graphs referring to both 155 bara and 169 bara export pressures are included. Attachment 3 indicates 170 bara export pressure for the Darwin option. 170 ban is also found as reference on p. 12 (“this is the intended export pressure for export to Darwin”) and p. 75 in the Intec report. For 169 bara reference pressure, the graph indicates 60 mill USD rather than 78 mill USD for additional compression to 255 bara, required for the Timor-Leste option, leading to an 18 mill USD reduction in the Timor-Leste option cost estimate.

Timor-Leste Pipeline and LNG Facility Feasibility Study - Addendum

P. 3. The original Timor-Leste Gas Export Pipeline Feasibility Study Report of August 2004 was based on the premise that Australian crewing of the barge would be a requirement This appears as a bad excuse for a deliberate attempt to raise the total cost estimate for a Timor-Leste pipeline beyond tolerable limits. The report (p. 112) simply states that They operate at relatively slow construction rates (approximately I km/day) and attract high day rates. The statement intends to demonstrate that this is the general productivity of J-lay vessels. There is no further discussion in the report on the background for the productivity, which is surprising in light of the significance of this item for the total cost estimate, and there is neither any qualification that a particularly low productivity was assumed because of Australian crewing.

P. 3. For example, friction clamps as used on Bluestream will not be used on Ormen Lange, and similarly are unlikely to be used on Timor Leste conditions, reducing the productivity compared to Bluestream. While the Ormen Lange pipe (32” x 35.3 mm) is much larger than Bluestream (24” x 31.8 mm), the Timor Leste pipe (18” x 23.6 - 33.3 mm) is much smaller than Bluestream. Apart from a short section at the deepest part of the crossing, the tension level for the Timor-Leste pipe will be less than for Bluestream. There is therefore no reason why the productivity for the Timor-Leste pipe, with possible exception for the deepest section, should be less than what was experienced for Bluestream.

P. 4. These routes show that a more realistic length allowance on the straight line distance is 15 %. Woodside have been requested to provide the indicative route options prepared by INTEC. However no such routes could be provided, and the allowance of 15 % therefore has no basis. The previous 5 % allowance is sufficiently conservative.

P. 5. The revised cost estimate of 723 MUSD, representing a cut of 21 % from the original estimate of 916 MUSD, is still far on the high side. The cut is almost the same as the target accuracy of the estimate (+/- 25 %). Such a reduction would never have been possible if the estimate had been made for the purpose of evaluating the pipeline as a real business opportunity, since in that case all unreasonable fat in the estimate would have been taken away at the outset. The opportunity for the cut, as well as the reluctance to accept further reasonably justified cuts, supports the impression that Woodside deliberately attempt to maintain a pipeline estimate beyond tolerable limits.

Appendix 3

Specific Comments

to

Intec Feasibility Study Report

Timor-Leste Gas Export Pipeline Feasibility Study

P. 2 “Though significantly less expensive than all other cases the 22” single direct pipeline attracted significant risk as it has no redundancy in the event of a geohazard event that could cause the line to be shut down”. No cost estimate or risk assessment is provided for the 22” single direct line. It has not been demonstrated that the geohazard risk will be unacceptable for a single direct line, while acceptable for a dual direct line. The main reasons for not recommending a single 22” line are installation difficulties and unattractive flow properties, as described elsewhere in the report.

P.2 “If the actual water depth were some 400 m shallower at 2900 m the use of standard mass produced UOE pipe can be used for all of the options considered eliminating the need for batch UOE pipe. This would represent an overall cost saving of approximately MUSD 30”. Firstly, it is likely that further project development will demonstrate that mass produced pipe can be used down to 3300 m, by removing 1.5 mm corrosion allowance, by further optimization of wall thickness design, and by the general development of pipe mill capabilities. The MUSD 30 is therefore a typical risk mitigation cost. Secondly, if maximum water depth could be limited to 2900 m, it is likely that the need for extra buoyancy to support the pipe if accidental flooding should Lake place, as assumed for the Study, can be avoided, which would result in a significant increase in installation productivity, and thereby a significant additional reduction in cost.

P. 3 “Facilities Cost: USD 78,325,000”. The details behind this cost estimate are not found in the report, and evaluation of Facilities Cost is according to Section 2.3 not within the scope of the document. The estimate appears to have been provided by Woodside, see Appendix 2 to the over-arching report: Figure 10-1 on p. 123 indicates about 60 mill USD.

P. 16 “Design Pressure - Pd - 187/390 barg”. An inside pressure equivalent to the hydrostatic pressure at the maximum depth (approx. 330 barg) will be required for dewatering and should be considered in selection of design pressure.

P. 16 “Incidental to Design Pressure Ratio - Yinc - - Ref 48 (Section 3 B305)”. DNV OS-F101 does not allow Yinc**<** 1.05.

P. 17 “Internal Corrosion Allowance - tcorr -1.5mm - Assumed”. Dry gas trunklines in the North Sea have zero corrosion allowance, and the general experience is that no internal corrosion will take place in a properly operated water dry, single phase gas transmission pipeline. Possible tendency to internal corrosion can be monitored by water dewpoint monitoring, corrosion probes and coupons, and inspection pigging. The 1.5 mm corrosion margin, corresponding to 5 % of the required steel tonnage, can safely be eliminated for the Timor-Leste pipeline. A 5 % reduction in steel quantity will represent a 6 mill USD material cost saving. The reduction in wall thickness may also allow competition between the mills for the deepest section, representing a further 22 mill USD saving, and a total material cost saving of 28 mill USD.

P. 20 “Figure 4-1. Sunrise Field to Timor-Leste Layout”. While this map, being the only Timor Sea map in the Study Report, is suited for general illustration of the route options, it is not representative for the best available depth information in the Timor Sea. Woodside have, in accordance with Appendix A to the study, supplied their considered best available data for the Study to Intec, including a more representative map. This map has been made available otherwise to Timor-Leste, see Appendix 1; however the map should have been included in the report.

P. 21 “Figure 4-2. Sunrise to Shore Direct Route (Option I and 2)”. The bathymetry profile, said in the text to represent Option 1, does not match any contoured map available to Timor Leste including the general arrangement drawing delivered by Woodside after the presentation 15.09.04. The profile has the deepest point at KP 88 and covers 175 km length, while the text say 165 km for Option 1. The alignment sheet made available to Timor Leste after the presentation 15.09.04 has 160 km length, with the deepest point at KP 68. Measurements on the map indicate162 km from Sunrise to the nearest point on Timor-Leste, as represented by Option 1. 165 km for Option 1 therefore appears as reasonable, accounting for small deviations from the straight line.

P. 23 “The following work is recommended to be undertaken prior to commencement of a detailed pipeline design phase”. The recommended bathymetric and geotechnical investigations need in principle to be performed prior to detailed design. However, prior to such detailed surveys, a regional reconnaissance survey is required to confirm maximum depths and the general bathymetry across the Timor Trench, also for near direct routes. Such a survey is essential to reduce current uncertainties on seabed conditions and geohazards, to reduce technical, cost and risk uncertainties for the Timor-Leste option by additional engineering studies, and to confirm that a suitable route without severe cost driving obstacles can be found. The survey should be performed prior to a decision on one single development option for Sunrise. .Awaiting further surveys for the Timor-Leste option until just before the detailed design phase, which according to the schedule p. 146 is directly following FID, can not be supported.

P. 26 “Furthermore, a single pipeline increasing in diameter towards the Timor-Leste coast was reviewed and found to offer no significant technical or financial advantage over the selected base case”. Two options were suggested to Woodside for a single line with varying diameter, an 18” **=>** 24” concept and a 24” **=>** 18” **=>** 24’ concept, both with diameter transitions at the deepest point for 24” installation, at 2200 - 2400 m. The first option appears to require a too high upstream pressure, while no conclusions have been provided for the second option. A single line may result in a significant investment saving, and further investigations of geohazards may prove that such risks would be acceptable for a single line.

P. 26 "... there is some uncertainty about the actual maximum water depth [Ref 53] ". The last item in the reference list is no. 52.

P. 29 "Survey records provide ample evidence of catastrophic, wide-reaching slope failures that few pipelines could survive". While a pipeline being hit by moving soil may not survive (depending on circumstances), evidence of a previous slope failure is not necessarily preventing a pipeline being laid through the general area or even through the traces of the slide. The probability and consequences associated with a new slide, being a measure of the risk to the pipeline, will be the key issue, not the fact that traces of old slides are found. Density of traces of slides on the seabed, related to the geological history for the area, may assist in establishing such risks.

P. 32 "Many ultra-deepwater pipelines that cross continental margins and descend from the continental shelf to abyssal depths must often transverse rough seabed topography, such as presented in Figure 5-4". Figure 5-4 is an illustration from a part of the Storegga slide off Norway as further described in Section 5.5.4, and is not typical for topography at the descent from continental margins.

P. 32 "One of the challenges with routing a pipeline through such terrain is the number and magnitude of freespans that often result [Figure 5-5]". Freespans as illustrated in Figure 5.5 are typical for a seabed with rock outcrops or an area of slide debris. No information is provided on actual seabed conditions, the cause of the illustrated freespans or whether corrective measures were undertaken. Figures 5-9 to 5-13 indicate thick sediment layers on the seabed in the deeper parts of Timor Sea. Some of the profiles indicate slide debris. Undisturbed seabed with thick sediment layers would normally not cause large free spans unless pockmarks are present.

P. 37 "The age of these slumps is however unknown at this time and therefore it is not possible to predict if these present a threat to a pipeline". The threat to a pipeline by such slumps on the seabed is not depending on theft age. However, a high density of recent slumps may indicate a seabed which is vulnerable to earthquakes causing new slides, which therefore may put a pipeline through the area at risk.

P. 37 "This is because an echo sounder in these water depths will have a footprint diameter in the hundreds of meters. This statement is related to the referenced surveys in the Timor Sea. A modern multi-beam echo sounder mounted on a surface vessel will have a footprint diameter of about 50 m in 3000 m of water.

P. 49 "This is because the seismic activity increases with proximity to the Timor Trough. The plot in Figure 5-22 does not support a peak in seismic activity in the Timor Trough, but an increase in activity when Timor-Leste is approached

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P. 50 "Figure 5-22. Hazard variation over prospective Sunrise export pipeline routes [Ref 31]". The graph is limited to a presentation of earth quake probabilities for 0.3 g ground acceleration. The resulting risks for a pipeline are not addressed and may well be acceptable for all options. A Darwin pipeline may be more exposed to other hazards, such as third party impact (dragged anchor, sunken ships, military exercise, sabotage), than the Timor-Leste options.

P. 50 "Therefore, before such a project can proceed it must be demonstrated that the probability of failure of such a pipeline in-service over its design life is within acceptable levels". This statement appears to be inconsistent with the general conclusion on p. 1:"... it is technically feasible to construct an export pipeline across the Timor Trough ...", with no reservation on geohazard risk, and: "This analysis identified the need to develop a repair system to allow the line to be re-commissioned in the event of a catastrophic geohazard event" indicating that the possible geohazard risks could be mitigated by a repair capability. However, the quote on p. 50 is strongly supported, i.e. the Timor-Leste pipeline alternative is currently not sufficiently mature to proceed with this alternative as the only option. A seabed survey is needed and the steps outlined on p. 50 can then be executed.

P.52 "It is important to realize that although there is a potential for extensive damage may be caused to a pipeline system as a result of seismic activity, such activity is often measured in terms of geological timeframe rather than over the pipeline system design life". The significance of this statement is emphasized. Geohazard risks have to be considered for the lifetime of the pipeline (25 years) relative to the geological timeframe for the Timor Sea (14 000 years for Australian shelf zone, otherwise order of magnitude million years).

P. 58 "... an extensive program of desktop studies and fieldwork (geophysical/geotechnical surveys) must be undertaken". It is suggested in the report that desktop studies including definition of data requirements and assessment of available regional data would be required before further surveys are undertaken. However, the results reported in the Feasibility Study represents what can realistically be achieved by desktop studies on the current data basis. It is strongly recommended that the next step in development of the Timor-Leste option is a regional seabed survey, i.e. step 4 on the recommended list, as described in some detail in Section 5.4.3 in the Feasibility Study report.

P. 72 "The export temperature was assumed to be 80°C". This is unusually high for a gas trunkline and may create a global buckling concern (also for the Darwin option).

P. 74 "Pipeline Configuration/Routes". For route length, reference is made to Section 4.2, which indicates that Option 1 is 165 km. The plots show that a route length of 175 km was assumed. All Option 1 cases are run with ID of the pipe assumed to correspond to the largest wall thickness for maximum 3300 m depth. OD is normally equal to the nominal diameter of the pipe, while ID varies according to variations in wall thickness. Table 7-1 on p. 102 indicates that significantly smaller wall thicknesses may be used for the majority of the route. As example, for 18" pipe at depths < 1500 m (50 % of route length), 21.7 mm wt. can be used, increasing the ID from 390 mm to 414 mm, or 12 % in cross section area. These assumptions lead to a significant conservatism in the flow analysis results for Option 1, to the extent that the results may be representative for a near direct route of 190 - 200 km length.

P. 100 "... a corrosion allowance of 1.5 mm has been assumed". In accordance with North Sea practice is a corrosion allowance not required for a dry gas pipeline.

P. 103 "Table 7-3 indicates that between Sunrise and Timor-Leste to a water depth of 200 m the pipeline will be stable with submerged weight alone". The description and results of stability analysis is unclear. According to Tables 3-3 and 3-4, the current and wave climate in the Timor Sea appear to be rather mild, and not consistent with the requirement for additional stabilization at depths less than 200 m (or 117 m?), taking into account the rather heavy pipe due to low D/t. The use of 15 m significant wave next to an area with 5.3 m 100 year significant wave needs explanation.

P. 105 "Table 7-5. Buckle Arrestor Requirements". The Mm Prop Buckle Depth (m) is presumably based on the minimum required wall thickness at the maximum depth. The Arrestor Thickness (mm) and Minimum Arrestor Length (mm) are presumably based on the maximum water depth.

P. 105 "The pipeline design pressure is assumed as 200 bar". If the onshore pipeline has a lower design pressure than the offshore pipeline, overpressure protection at the beach will be required.

P. 112 "This activity requires a specialist J-lay construction vessel such as Heerema Balder and Saipem 87000". There are currently two other vessels capable of installing pipe in ultra deep waters. These are Solitaire of Allseas and Deep Blue of Technip. Both vessels have installed pipe in depths down to 2300 m, and appear to have a nominal tension capacity for installation of up to 16" pipe in about 3000 m depth. The vessels are also suitable for shallow water installation as required for a Sunrise to Timor Leste pipeline.

P. 112 "They operate at relatively slow construction rates (approximately 1 km/day) and attract high day rates". 1 km/day represents a considerable underestimation of the performance of at least one of the two J-lay vessels. S7000 installed the deepwater parts of the twin 24' Blue Stream pipelines, totaling 710 km, in 8 months. This corresponds to an average productivity of 3 km/day, taking all downtime and reduced productivity in the start into account. Other sources refer to regular laying speed exceeding 4 km/day, peaking at more than 5 km/day. For 18" pipe with about the same wt (33.3 mm vs. 31.8 mm) the productivity should not be less. An average productivity of 3 km/d would therefore represent a conservative estimate, even if laying in the deepest section should be slow due to the assumed added buoyancy for this section.

P. 112 "A 4' generation S-lay barge such as Allseas Solitaire can install 20" pipe to water depths of approximately 1400 m". The tension required to install a 16" pipe in 2900 -3300 m is in the order of 450 - 500 t. According to Allseas homepages, Solitaire "is able to lay large diameter lines in unprecedented water depths, but is also able to lay small diameter pipelines economically". The vessel has a nominal tension capacity of 525 t. Illustrations show the stinger can be adjusted to a nearly vertical tip. Solitaire has installed 18" pipe to 1920 m in GoM for the Nakika project. Triple 16" lines will match the capacity requirements and may be within reach of Solitaire. Mobilization of a second vessel for shallow water will then not be required.

P. 114 "An ever present risk during J-lay operations is a possible buckle at the sag bend which could rupture the pipe and allow the catenary to fill with sea water". This is a risk also during S-lay operation, however, most large diameter/deepwater pipelines have been installed without a capability to hold, abandon and recover flooded pipe. Contact with DNV has revealed that the referred requirement in OS-F101, which strictly require capability to hold a flooded pipe and to recover a flooded pipe with the A/R winch, has been subject to many discussions, and they admit the requirement is not very practical. In some cases the requirement has been neglected, in other cases dispensation has been given. In general, recovery of a flooded pipe with one end on the seabed can be done by cutting the pipe at the other side of the damaged section, install a pig stopper/ pulleye / pullhead and A/R cable at the cut, pig the water out from the other end, and then recover the pipe. A capability to hold, lower and recover flooded pipe will not reduce the probability of a wet buckle, but may reduce extra costs once a buckle has occurred. Risks associated with wet buckles are usually covered by insurance.

P. 114 "... contingency spare pipe to a length of 5 % of total route length is included in the cost estimates". 5 % (8.25 km) appears as a reasonable number for a single pipe for Option 1, but no additional contingency is required for a dual pipe or the much longer indirect route options.

P. 116 "The purpose of this study was to determine the top tension for each combination of pipeline diameter, wall thickness and water depth whilst ensuring that the bending strain did not exceed 0.15 **%".** Inspecting OFFPIPE output in Appendix C, it appears that total strain is the limiting parameter, not bending strain. Taking into account total strain, not only bending strain in such water depths appears OK, but the computation of total strain is not clear, since it is not the sum of tensile strain and bending strain as given in the output tables.

P. 131 "18"DualDirect- 2_289_318 [1]. Operating pressure is 255 bar elsewhere, see Table 10-1. The design pressure is normally at, or just above, the maximum operating pressure, not 10 % above as indicated in the table. The maximum incidental pressure (which is the direct basis for wall thickness design) is normally 1.10 times the design pressure, while the factor may be reduced to 1.05, ref. OS-101.

P. 134 "... the compressor must deliver air, to drive the de-watering pig, at a pressure of 330 bar ...". When compressed to say 300 bar, the air will see a density which will help adding to the pressure at 3300 m depth. It is therefore expected that the required pressure at the compressors would be less than 300 bar.

P. 136 "When the repair involves large diameter pipelines in ultra-deep waters, as found on the proposed Sunrise to Timor-Leste development; the technical and operational difficulties become extreme". Repair in ultra deep waters would be very difficult, however since all repair in such depths will have to be performed by remotely operated equipment, repair would not be dramatically more difficult in 3300 m compared to 2200 m. For such depths equipment has been developed or is under development.

P. 142 "This can be achieved by using two sets of vertical spool connection systems to connect the replacement section". A I-lay vessel may pick up one of the pipe ends and lay the replacement pipe to the other pipe end for a single spool connection only.

P. 144 "... their productivity is assumed to be 1 km/day as a base case, [Ref 27]". 1 km/day represents a considerable underestimation of the performance of of Balder and S7000, ref. comment to p. 112 above. An average productivity of 3 km/d would represent a conservative estimate.

P. 146 "Prototype Testing". Is suggested as the initial activity. However such testing can wait until a survey has been done and it is confirmed that heavy wall pipe exceeding current experience is required.

P. 147 "Offshore Pipeline Installation J-lay". Some activities are confusing, such as Relocate to KP 18 and prepare for pipe pull and Pull pipeline from shore to KP 155. According to other descriptions there are no pipe pulls at KP 18, and the shore pull is already done when the I-lay vessel arrives.

P.146 "Route Selection Requirements and Pre-Survey". Most of the desktop studies can be skipped. The geophysical survey should be planned and performed before any other desktop activity. The survey needs completion prior to initiation of the FEED Study. The final route should preferably be selected prior to FID, which means that additional survey at ultra high resolution etc. should follow the initial survey as indicated in the schedule.

P. 150 "A typical wait on weather allowance of 15 % has been applied where required". The allowance has been applied for I-lay installation by one of the two big semi- submersible vessels on top of an already unrealistically low dayrate of 1 km/day, compared to previous experience exceeding 4 km/day for larger pipe. These vessels are hardly sensitive to any weather condition which normally can be expected in the Timor Sea.

P. 150 "The Project Management costs of the EPCm contractor are estimated and broken out as a separate sheet in the Phase 14 estimate". Project Management and contracting philosophies are not clear. The estimate includes both a significant cost for WEE PMT (6.2 % of Directs or 40 MUSD) and for EPCm (15 % of installation cost or 34.8 MUSD), in total 75 MUSD for Project Management. Is a separate EPCm contractor assumed, or is EPCm part of the main installation contract?

P. 151 "Inside diameter and wall thickness are derived from flow assurance and wall thickness (pressure containment) analysis respectively". The estimate for dual 18" lines in Appendix K is based on 30.0 mm wall thickness throughout, except for 20 km at the deepest point. This is not in accordance with the wall thickness distribution derived as part of preliminary pipeline design, ref. Table 7-1 and the alignment sheet handed out after the meeting in Dili 15.09.04.

P. 151 "The bare pipe is assumed transported by purpose built pipe carriers from Kuantan, Malaysia for coating". Coating at the pipe mill for all pipe not requiring concrete coating, thereby avoiding extra transport, harbour fees, etc., may represent an upside. Several mills offer capabilities to provide FBE and PP coatings.

P. 151 "An allowance of 5 % of the base pipeline length and cost has been assumed as spare pipe for welding and welder qualification, laybarge tensioner testing and overlength for buckle contingency and route detours". 5 % of route length should be sufficient as commented above to p. 114.

P. 156 “A jetting spread has been mobilized to lower the pipe at the shore approach”. There is a potential double/triple dip cost estimate for shore approach construction. On p. 154 “The shore approach excavation methodology assumes hard cemented material” which will require “marine drill and blast, backhoe dredge and tug and split hopper barge”. On p. 152 “preliminary engineering has determined that rock is required for protection in the shore approach; to stabilize the pipe in shallow water where concrete alone would exceed 100 mm”. Shore approach construction is likely not to require all of concrete coating, rock dumping, drill/blast and jetting. Drill/blast/excavate combined with rock dumping may represent a conservative assumption. Jetting as an alternative will represent an upside. Concrete coating should not be necessary in either case. The assumptions appear far from mature.

P. 158 “A layrate of 1.0 kin/day has been taken. An allowance of 7% of total duration and costs is assumed for mechanical downtime”. Consulting Appendix K, a 15 % allowance for weather has also been added, not mentioned in this part of the text. 1 km/day minus 22 %, i.e. 780 m/day, represents a considerable underestimation of the performance of Balder and S7000, ref. comment to p. 112 p. 144 and p. 150 above. An average productivity of 3 km/d taking into account all downtime would represent a conservative estimate.

P.160 “The total cost of purchasing a repair system and performing a repair is estimated to be in the region of MUSD 55”. According to the information in Section 12.16, the investment part of this cost is the 10 MUSD for purchase, development and testing, and 14.4 MUSD for spare pipe, i.e. in total 25 MUSD. The rest, 30 MUSD (or 25 MUSD?), is a possible future OPEX cost of performing a repair should a major damage to the pipe occur. The principle of adding 10 km of pipe suitable for installation in the deepest section as repair contingency appears sound, but appears not to have been implemented, since the detailed cost estimate in Appendix K is based on a 5 % cost addition for spare pipe.

P. 160 “Spare parts are excluded from this estimate apart from the spare line pipe required to perform a pipeline repair that requires replacement of up to 10 kin of line pipe”. The detailed cost estimate in Appendix K is based on a 5 % cost addition for spare pipe.

P. 162 “An estimate for the cost of relevant surveys and assessments is provided as follows”. The contents of “Route hydrographic and geohazard surveys” at 10 MUSD is not understood, and is considered not relevant in light of the other surveys and assessments. “Oceanographic measurements at port site” at 1 MUSD does not appear relevant for the pipeline. On top of the 23 MUSU total estimated survey cost, 4 MUSD for oceanographic survey is added as a separate item, see p. 168. A total of 27 MUSD is estimated for surveys and assessments, not taking into account pre-lay and post-lay survey costs included in the installation estimate. The survey estimate appears far on the high side and needs substantiation. 15 MUSD, still high, may be a more reasonable figure.

P. 163 “The risk analysis of the offshore pipeline has been performed in accordance with the requirements of DNV Standarc4 OS-Fl 01 “. The general DNV requirements are listed in Table 5-4 on p. St Otherwise, no documentation has been provided on such risk analysis.

P. 163 “The key risks identified by the risk workshop are summarized in Table 13-1”. The risk ranking in the table appears to be pre risk mitigation. The cost estimates in tables 14-1 to 14-3 contain significant costs for risk mitigation, which is not reflected in table 13-1.

P. 165 "An outcome of the risk analysis was that the consequence of many hazards occurring was skewed towards Major (in WEL terms) because of the cost of repair". Several risk items in Table 13-1, appear not to be independent, but are treated as independent items. Examples are slope instability, which can lead to excessive pipeline spans, which can necessitate a major repair; and water in line, which can lead to hydrate formation or internal corrosion and necessitate major repair.

P. 165 "Handover from J-lay to S-lay". The handover can be done by normal abandonment and recovery (A/R) procedures in the reasonably shallow and conventional water depth of 300 m. This risk is not referred to in Table 13-1, and should not be on the list of the few risks with a severity which requires further assessment at a quantitative level.

P. 168 "Therefore the indirect route can be excluded on the basis of unacceptable risk compared to the direct route". While it can be agreed that the geohazard risks for the indirect route are greater than for the direct route, it has not been demonstrated that those risks are unacceptable. Other factors leading to exclusion of the indirect route are higher costs and less favourable flow characteristics.

P. 168 "The detailed costing process described in Section 12 has been applied to the dual 18" case and the results are presented in Table 14-1 below". Some of the cost elements in the table and the following tables are probably provided by Woodside rather than being derived by Intec. This should have been made clear.

P. 169 "From an installation perspective there is no change as the lay rates for the f-lay vessels will be unchanged". Limiting the water depth to 2900 m, the use of additional buoyancy in the deepest section can be avoided, which will improve installation productivity in this part.

Timor-Leste Gas Export Pipeline Feasibility Study - Addendum

P. 1. The effect of the issues discussed is to reduce the cost estimate previously presented by some 18 %. The reduction from 916 to 724 MUSD is 21 %.

P. 1/2. The vessel superintendents and office staff of both companies confirmed that f-lay rates of 2 to 2.5 km/day were achievable. As TSDA has notec4 the Bluestream Project achieved a production of some 3 km/day. As presented, with a direct comparison to the average productivity for Bluestream, the companies' stated J-lay rates appear as expected minimum average productivities, taking into account all factors which could reduce the productivity from pea values.

P. 2. The Ormen Lange project is based on a significantly lower rate. The comparison to the assumed productivity for the much larger and shorter Ormen Lange pipe is not relevant. A similar comparison to Bluestream, being somewhat larger than the Timor Leste pipe, would have been relevant, but is cleverly avoided.

P. 2/3. The original Timor Leste Gas Export Pipeline Feasibility Study Report of August 2004 was based on the premise that Australian crewing of the barge would be a requirement. This is not credible. The report (p. 112) simply states that They operate at relatively slow construction rates (approximately 1 km/day) and attract high day rates. The statement is intended to demonstrate that this is the general productivity of 3-lay vessels. There is no further discussion in the report on the background for the productivity, which is surprising in light of the significance this single item has for the total cost estimate. There is neither any qualification in the report that a particularly low productivity was assumed because of Australian crewing.

P. 3 ….a 2 m significant wave height is exceeded 10 % of the time ... Apart from a graph showing wave height exceedance at Sunrise, Woodside has not been willing to supply relevant metocean documentation as requested, and in particular not ref. 36. The statement implies that 2 m significant is the limit for pipe handling. Weather downtime should then have been 10 %, not 15 % as stated on p. 4.

P. 3. There are technical issues that influence barge productivity in addition to welding rates. The explanation that follows on productivity for the much larger Ormen Lange pipe does not support the assumed substantially lower productivity for the Timor Leste pipeline than for Bluestream. Why can not friction clamps as used on Bluestream be used on the Timor-Leste pipeline to speed up productivity?

P. 3. A lay rate of 3 km/day is equivalent to a quad joint cycle time of 24 minutes. The normal Bluestream productivity exceeded 4 km/day peaking at 5 km/day, corresponding to a quad joint cycle time of 17 minutes and 14 minutes respectively, still leaving 7 minutes and 4 minutes respectively to operate tensioners and load pipe. 3 km/day was the average productivity over the entire project period, taking into account all kinds of delays and downtime, which were particularly significant for the first of the two pipelines.

P. 3. If we accept the contractors' view on base productivity (2 to 2.5 km/day), adjusted to take account of the above mentioned issues, ... It is very likely that the contractors' productivity information is the expected minimum average productivities, already taking into account all factors reducing productivities from peak values. The further adjustment done by INTEC/Woodside is therefore not accepted.

P. 4. Local factors 10 %. What is this? Is it a correction for Australian labor?

P. 4. The estimated barge productivity averaged over the pipeline length is 1.6 km/day. The actual average productivity used for cost estimating is 1.49 km/day, taking into account a 7 % mechanical breakdown factor. Discussion of this factor is avoided in the Addendum.

P. 4. In recognition of this commercial issue, a premium is attached to the cost of this material. This is a relatively minor change from the Feasibility Study report, included for all 30.0 mm wt. pipe. The relevance of operating with three different steel prices at such an early stage of a project, while not taking into account a further discrimination of wall thicknesses for further reduction of steel cost, as suggested in the previous comments, can only be explained by an intent to achieve a total cost estimate which is as high as possible and beyond tolerable limits.

P. 4. A 10 km length of this material has a weight of approximately 3500 tonne, yielding a cost of US$ 8.4 million. This clarification shows that repair system hardware cost excl. spare pipe is estimated to l0 MUSD. In the alternative estimates in Appendix 4, costs for 10 km spare pipe(s) are added at 850 USD/t.

P. 5. INTEC has prepared indicative route options based on avoidance of geohazards and the crossing of slopes orthogonal to contours. Sketches of these route options have been requested for understanding of the basis for increased route length allowance from 5 % to 15 %. Woodside has refused to provide such a sketch. Their argument that the Darwin option has a 20 % allowance on the direct route length is not relevant, since reefs and shallows prevent a direct route. A 5 % allowance is considered sufficient for the direct route, and the new 15 % route length allowance is considered as one of several contributions to achieve a total cost estimate which is as high as possible and beyond tolerable limits. The alternative estimates in Appendix 4 are based on 5 % route length allowance.

Cost estimate - Materials. Import Duty to Australia 3 %. The addition on most material costs for import duty to Australia is not relevant.

Appendix 4

Cost estimate assessments

1) Rev. 0 estimate vs. addendum estimate, dual 165 km 18” direct lines, J-lay

2) Dual 165 km 18” direct lines, J-lay

3) Single 165 km 24” => 18” => 24” direct line, J-lay

4) Triple 195 km 16” near direct lines, S-lay

5) Dual 165 km 18” direct lines, S-lay

Rev. 0 estimate vs. addendum estimate, dual 165 km 18” direct lines, J-lay

<u>Changes in addendum estimate:</u>

- J-lay vessel average productivity increased from 0.78 km/d to 1.49 km/d including allowance for weather and mechanical downtime
- Route length 165 km, length allowance increased from 5 % to 15 %, total route increased from 173 km to 190 km
- Two wall thicknesses in rev. 0, three thicknesses in addendum:
  - o 23.6mmforokmvs.l3Okm
  - o 30.0mm for 152.2 km vs. 50.6 km
  - o 33.3mm for 21km vs. 9.2 km
- Steel tonnage is reduced from 110 800 Te to 104 000 Te

- 10 km spare pipe for repair hardware, size is reduced from 24" to 18"
- Rock dumping cost is reduced
- Total survey cost is reduced

1) Rev. 0 estimate vs. addendum estimate, dual 165 km 18" direct lines, J-lay

Results:

Group	Description	Rev. 0 estimate MUSD		Addendum estimate MUSD	
Materials	Linepipe	127	**166**	112	**154**
	Other steel	2		2	
	PP and concrete coating	17		19	
	Transport and fees	7		8	
	Anodes	1		1	
	Rock supply + VIV strakes	6		6	
	Buckle arrestors	2		2	
	Supply base Timor-Leste	3		3	
	ESD valve	1		1	
Mob/demob	Mob/demob	56	**56**	56	**56**
Installation	Shore approach excavation	7	**369**	7	**246**
	Pipe pull	2		2	
	Shore pull	2		2	
	S-lay 2 x 40km	12		14	
	J-lay 2 x 123.4 km	242		152	
	Pipe haul	26		20	
	Rock dumping	42		22	
	EPCm	35		26	
	Tie-in to platform	1		1	
Pre-comm.	Pre-commissioning	5	**5**	5	**5**
Subtotal	Total directs construction		**596**		**461**
	Repair system		**23**		**18**
	Surveys		**27**		**22**
Subtotal Indirects	Total Directs		**646**		**501**
	Engineering Design	14	**84**	14	**75**
	Woodside PMT 6.2%	40		31	
	Construction Insurance	30		30	
Subtotal Additions	Total Directs and Indirects		**730**		**576**
	Contingency 20%	146	**186**	115	**147**
	Owners cost 4.5%	33		26	
	Technical Advisors Fee 1%	7		6	
Total	Total estimated cost, pipeline		**916**		**723**

2) Dual 165 km 18” direct lines, J-lay

<u>Assumptions:</u>

- J-lay vessel average productivity is 3 km/d including allowance for weather and mechanical downtime
- 1.5 mm corrosion allowance is eliminated
- 5 % route length allowance included, total route is 173 km
- Wall thicknesses are based on Table 7-1:

    - 20.2 mm wall thickness (21.7 - 1.5) shallower than 1500 m, for 85 km
    - 22.1 mm wall thickness (23.6 - 1.5) between 1500 and 2000 m, for 25 km
    - 25.6 mm wall thickness (27.1 -1.5) between 2000 and 2500 m, for 30 km
    - 29.4 mm wall thickness (30.9 - 1.5) between 2500 and 3000 m, for 23 km
    - 31.8 mm wall thickness (33.3 -1.5) deeper than 3000 m, for 10 km

- Steel tonnage is 86 155 Te
- Transport and fees is proportional to weight
- All pipe material is available at mass production unit cost 850 USD/Te
- 10 km spare pipe with 31.8 mm wall thickness is included as repair hardware
- Total survey cost is reduced from 19 + 3 MUSD to 15 MUSD
- EPCm management cost is 15% of pipeline laying cost

2) Dual 165 km 18” direct lines, J-lay

Results:

Group	Description	Addendum estimate MUSD		Addendum estimate MUSD	
Materials	Linepipe	112	**154**	73	**110**
	Other steel	2		2	
	PP and concrete coating	19		17	
	Transport and fees	8		5	
	Anodes	1		1	
	Rock supply + VIV strakes	6		6	
	Buckle arrestors	2		2	
	Supply base Timor-Leste	3		3	
	ESD valve	1		1	
Mob/demob	Mob/demob	56	**56**	56	**56**
Installation	Shore approach excavation	7	**246**	7	**137**
	Pipe pull	2		2	
	Shore pull	2		2	
	S-lay 2 x 40km	14		12	
	J-lay 2 x 123.4 km	152		70	
	Pipe haul	20		9	
	Rock dumping	22		22	
	EPCm	26		12	
	Tie-in to platform	1		1	
Pre-comm.	Pre-commissioning	5	**5**	5	**5**
Subtotal	Total directs construction		**461**		**308**
	Repair system		**18**		**13**
	Surveys		**22**		**15**
Subtotal Indirects	Total Directs		**501**		**336**
	Engineering Design	14	**75**	14	**65**
	Woodside PMT 6.2%	31		21	
	Construction Insurance	30		30	
Subtotal Additions	Total Directs and Indirects		**576**		**401**
	Contingency 20%	115	**147**	80	**102**
	Owners cost 4.5%	26		18	
	Technical Advisors Fee 1%	6		4	
Total	Total estimated cost, pipeline		**723**		**503**

3) Single 165 km 24” => 18” => 24” direct line, J-lay

<u>Assumptions:</u>

- J-lay vessel average productivity is 2.5 km/d including allowance for weather and mechanical downtime, changed from 3.0 km/day for dual 18” pipe due to larger pipe for most of the route and shorter total length
- 1.5 mm corrosion allowance is eliminated
- 5 % route length allowance is included, total route is 173 km
- 24” pipe for 146 km shallower than 2500 m
- 18” pipe for 27 km deeper than 2500 m
- Wall thicknesses are based on Table 7-1:
    - o 27.1 mm wall thickness (28.6 - 1.5) shallower than 1500 m, for 89 km 24”
    - o 29.4 mm wall thickness (30.9 - 1.5) between 1500 and 2000 m, for 26 km 24”
    - o 34.1 mm wall thickness (35:6 - 1.5) between 2000 and 2500 m, for 31 km 24”
    - o 29.4 mm wall thickness (30.9 - 1.5) between 2500 and 3000 m, for 16 km 18” o 31.8 mm wall thickness (33.3 -1.5) deeper than 3000 m, for 11km 18”
- Steel tonnage is 74 300 Te
- Transport and fees is proportional to weight
- All pipe material is available at mass production unit cost 850 USD/Te
- Shore approach construction reduced with 25 % due to single but larger pipe
- Rock dumping reduced with 25 % due to single but larger pipe
- Total survey cost is reduced from 19 + 3 MUSD to 15 MUSD
- 10 km 24” spare pipe with 34,1 mm wall thickness and 10 km 18” spare pipe with 31.8 mm wall thickness are included as repair hardware
- EPCm management cost is 15% of pipeline laying cost

3) Single 165 km 24” => 18” => 24” direct line, J-lay

		Addendum estimate		Alternative estimate	
		Dual 18" direct lines		Single 24" => 18" => 24" direct line	
Group	Description	MUSD	MUSD	MUSD	MUSD
Materials	Linepipe	112	**154**	59	**91**
	Other steel	2		2	
	PP and concrete coating	19		12	
	Transport and fees	8		6	
	Anodes	1		1	
	Rock supply + VIV strakes	6		5	
	Buckle arrestors	2		2	
	Supply base Timor-Leste	3		3	
	ESD valve	1		1	
Mob/demob	Mob/demob	56	**56**	56	**56**
Installation	Shore approach excavation	7	**246**	4	**105**
	Pipe pull	2		2	
	Shore pull	2		2	
	S-lay 2 x 40km	14		8	
	J-lay 2 x 123.4 km	152		56	
	Pipe haul	20		5	
	Rock dumping	22		17	
	EPCm	26		10	
	Tie-in to platform	1		1	
Pre-comm.	Pre-commissioning	5	**5**	5	**5**
Subtotal	Total directs construction		**461**		**257**
	Repair system		**18**		**17**
	Surveys		**22**		**15**
Subtotal Indirects	Total Directs		**501**		**289**
	Engineering Design	14	**75**	14	**62**
	Woodside PMT 6.2%	31		18	
	Construction Insurance	30		30	
Subtotal Additions	Total Directs and Indirects		**576**		**351**
	Contingency 20%	115	**147**	70	**90**
	Owners cost 4.5%	26		16	
	Technical Advisors Fee 1%	6		4	
Total	Total estimated cost, pipeline		**723**		**441**

4) Triple 195 km 16" near direct lines, S-lay

Assumptions:

- Three lines are installed, all lines are 205 km incl. 5 % route length allowance
- Maximum water depth is 2900 m.
- S-lay vessel Solitaire is assumed for all installation with average productivity 5 km/d including allowance for weather and mechanical downtime, ref Section 9.1.
- Mobilization fee is assumed the same as for J-lay vessels
- Day rate is assumed at 0.7 MUSD/day
- No mobilization of a second lay-vessel is required
- 1.5 mm corrosion allowance is eliminated
- Wall thicknesses are scaled from 18" pipe (same D/t):
    - 18.0 mm wall thickness shallower than 1500 m, for 105 km
    - 19.6 mm wall thickness between 1500 and 2000 m, for 53 km
    - 22.8 mm wall thickness between 2000 and 2500 m, for 26 km
    - 25.4 mm wall thickness between 2500 and 2900 m, for 21 km
- Steel tonnage is 115 930 Te.
- Transport and fees is proportional to weight
- Coating cost assumed proportional to pipe surface area, increased with 56%
- All pipe material is available at.mass production unit cost 850 USD/Te
- Shore approach construction increased with 50 % due to third pipe
- Rock dumping increased with 25 % due to third but smaller pipes
- 10 km spare pipe with 25.4 mm wall thickness is included as repair hardware
- Total survey cost is reduced from 19 + 3 MUSD to 15 MUSD
- EPCm management cost is included in mobilization fee
- Construction insurance reduced to 25 MUSD due to shallower water/reduced risk

4) Triple 195 km 16” near direct lines, S-lay

		Addendum estimate		Alternative estimate	
		Dual 18" direct lines		Single 24" => 18" => 24" direct line	
Group	Description	MUSD	MUSD	MUSD	MUSD
Materials	Linepipe	112	**154**	99	**152**
	Other steel	2		2	
	PP and concrete coating	19		26	
	Transport and fees	8		9	
	Anodes	1		1	
	Rock supply + VIV strakes	6		8	
	Buckle arrestors	2		3	
	Supply base Timor-Leste	3		3	
	ESD valve	1		1	
Mob/demob	Mob/demob	56	**56**	49	**49**
Installation	Shore approach excavation	7	**246**	10	**145**
	Pipe pull	2		3	
	Shore pull	2		3	
	S-lay 2 x 40km	14		86	
	J-lay 2 x 123.4 km	152		0	
	Pipe haul	20		11	
	Rock dumping	22		28	
	EPCm	26		0	
	Tie-in to platform	1		2	
Pre-comm.	Pre-commissioning	5	**5**	7	**7**
Subtotal	Total directs construction		**461**		**351**
	Repair system		**18**		**12**
	Surveys		**22**		**15**
Subtotal Indirects	Total Directs		**501**		**378**
	Engineering Design	14	**75**	14	**62**
	Woodside PMT 6.2%	31		23	
	Construction Insurance	30		25	
Subtotal Additions	Total Directs and Indirects		**576**		**440**
	Contingency 20%	115	**147**	88	**112**
	Owners cost 4.5%	26		20	
	Technical Advisors Fee 1%	6		4	
Total	Total estimated cost, pipeline		**723**		**552**

5) Dual 165 km 18” direct lines, S-lay

Assumptions:

- Solitaire average productivity is 4 km/d including allowance for weather and mechanical downtime
- Mobilization fee is assumed the same as for J-lay vessels
- Day rate is assumed at 0.7 MUSD/day
- No mobilization of a second lay-vessel is required
- 1.5 mm corrosion allowance is eliminated
- Wall thicknesses are based on Table 7-1:
  - o 20.2mm wall thickness (21.7 - 1.5) shallower than 1500 m, for 85 km
  - o 22.1 mm wall thickness .(23.6 - 1.5) between 1500 and 2000 m, for 25 km
  - o 25.6 mm wall thickness (27.1 -1.5) between 2000 and 2500 m, for 30km
  - o 29.4mm wall thickness (30.9 -1.5) between 2500 and 3000 m, for 23 km
  - o 31.8 mm wall thickness (33.3 -1.5) deeper than 3000 m, for 10 km
- 5 % route length allowance included, total route is 173 km
- Steel tonnage is 86 155 Te
- Transport and fees is proportional to weight
- All pipe material is available at mass production unit cost 850 USD/Te
- 10 kin 18” spare pipe with 31.8 mm wall thickness is included as repair hardware
- Total survey cost is reduced from 19 **+** 3 MUSD to 15 MUSD
- EPCm management cost is included in mobilization fee

5) Dual 165 km 18” direct lines, S-lay

Results:

Group	Description	Addendum estimate MUSD		Addendum estimate MUSD	
Materials	Linepipe	112	**154**	73	**110**
	Other steel	2		2	
	PP and concrete coating	19		17	
	Transport and fees	8		5	
	Anodes	1		1	
	Rock supply + VIV strakes	6		6	
	Buckle arrestors	2		2	
	Supply base Timor-Leste	3		3	
	ESD valve	1		1	
Mob/demob	Mob/demob	56	**56**	49	**49**
Installation	Shore approach excavation	7	**246**	7	**103**
	Pipe pull	2		2	
	Shore pull	2		2	
	S-lay 2 x 40km	14		60	
	J-lay 2 x 123.4 km	152		0	
	Pipe haul	20		9	
	Rock dumping	22		22	
	EPCm	26		0	
	Tie-in to platform	1		1	
Pre-comm.	Pre-commissioning	5	**5**	5	**5**
Subtotal	Total directs construction		**461**		**267**
	Repair system		**18**		**13**
	Surveys		**22**		**15**
Subtotal Indirects	Total Directs		**501**		**295**
	Engineering Design	14	**75**	14	**62**
	Woodside PMT 6.2%	31		18	
	Construction Insurance	30		30	
Subtotal Additions	Total Directs and Indirects		**576**		**357**
	Contingency 20%	115	**147**	71	**91**
	Owners cost 4.5%	26		16	
	Technical Advisors Fee 1%	6		4	
Total	Total estimated cost, pipeline		**723**		**488**