# APLNG PIPELINE PROJECT

# Looping and Expansion Desktop Review

Revision 3

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# CONTENTS

# 1 EXECUTIVE SUMMARY

APLNG propose to develop a coal seam gas (CSG) to liquefied natural gas (LNG) project in Queensland. As part of this project APLNG is proposing to build a gas pipeline to supply their LNG plant. APLNG propose to install a pipeline to ensure it has sufficient capacity to transport the gas for their LNG plant.

APLNG is applying to the National Competition Council for a 15 year no coverage determination. As part of the documentation required to be submitted to the regulator, APLNG needs to include a cost assessment for expanding the pipeline. This review provides the cost assessment.

The scope of work for the review was to conduct a desktop study to determine the indicative percentage change in construction costs for a scenario where the pipeline is duplicated along its total length using an identical pipeline. In addition to this the Study is to provide: commentary on incremental partial looping sections; additional cost to pre-invest in a pipeline with an MAOP of 15.3 MPag; and an evaluation of costs associated with the development of a stand-alone independent pipeline in the same corridor as the APLNG line.

OSD has attempted to quantify the incremental costs for construction associated with the looping of an existing pipeline. OSD has assessed the pipeline route and addressed issues specific to this route in this review, however it should be noted that this is a high level desk top review and not a detailed bottom up estimate comparing the various scenarios.

The assessment shows that looping the pipeline length of 349 km, which excludes the Narrows Marine Crossing and Curtis Island portion of the pipeline, would result in an increase in present day construction costs a minimum of 17% above that of the APLNG pipeline. Several additional cost issues, which are outside the scope of this Study, have the potential to increase this percentage.

The costs for partial looping have not been defined, rather a narrative has been provided to describe the potential cost variations that would occur for the various potential looping options that have been provided by APLNG.

An additional present day pipeline cost increase in the vicinity of $69 Million, in addition to potential costs outside the scope if this Study, is necessary for a pipeline with an operating pressure of 15.3 MPag compared to the current APLNG optimised pipeline design pressure of 13.5 MPag. This additional pipeline construction cost increase provides only marginal pipeline flow rate increases and would also require additional compression facilities near the gas fields.

The stand alone pipeline option, in the same pipeline corridor as the APLNG pipeline, would result in an increase in present day construction costs in the order of 7% above that of the APLNG pipeline.

# 2 INTRODUCTION

Australia Pacific LNG Limited (APLNG) is a joint venture between Origin Energy Limited and ConocoPhillips Australia Pacific LNG Pty Ltd. APLNG proposed to develop a coal seam gas (CSG) to liquefied natural gas (LNG) project in Queensland. As part of this project APLNG is proposing to build a gas pipeline from the Coal Seam Gas (CSG) production area located in the vicinity of the town of Wandoan to Curtis Island in Gladstone, to supply their LNG plant.

APLNG propose to install a pipeline to ensure it has sufficient capacity to transport 1560 TJ per day of coal seam gas from their Surat Basin coal seam gas fields to their two train Curtis Island LNG plant. The Pipeline also has been designed to operate fully compressed so that it can provide gas for APLNG Curtis Island LNG Plant expansion to 4 trains by addition of intermediate booster compressors. The proposed pipeline has a nominal diameter of 1050 mm and a design pressure of 13.5 MPag.

APLNG is applying to the National Competition Council for a 15 year no coverage determination. As part of the documentation required to be submitted to the regulator, APLNG needs to include a cost assessment for expanding the pipeline. This cost assessment is to be substantiated by an external credible independent pipeline expert. OSD Pipelines has been selected by APLNG as this expert and this Study forms the assessment.

OSD has not been supplied with APLNG’s total cost or cost breakdown for the export pipeline.

The following documentation was provided by APLNG for this review:

- Route maps;
- Preliminary alignment sheets;
- Pipeline schematic, including location of mainline valves and scraper stations;
- Relevant flow assurance information;
- Pipeline design basis;
- ROW configuration and construction drawing.

This review covers only the DN1050 pipeline from the start at KP0 to the mainline valve at KP349, it excludes the section of pipeline associated with the

Narrows Marine Crossing and Curtis Island. Refer to Appendix A for the pipeline route map.

# 3 SCOPE OF WORK

The scope of work for the review was to conduct a desktop study to determine the indicative percentage change in construction costs for the APLNG Pipeline in a scenario where the pipeline, at some indeterminate time after completion of the initial construction, is duplicated along its total length using an identical pipeline. This shall include desk top review of the following:

- Identify all typical components making up the construction costs of the pipeline
- Identify which of the above components would change in cost in the scenario where the pipeline is looped
- Identify the range of costs variations for these components in the scenario where the pipeline is looped
- Identify other factors which could influence the range of costs
- As a result of the above, provide a percentage range for the change in construction costs for the APLNG Pipeline where the original pipeline is looped along it total length.

In addition to the above the Study is to provide:

- Commentary on incremental capacity increases including partial looping sections
- Anticipated additional capital cost to pre-invest in a pipeline with an Maximum Allowable Operating Pressure (MAOP) of the ANSI Class 900 limit of 15.3 MPag over the base case of an MAOP of 13.5 MPag
- An evaluation of costs associated with the development of a standalone independent pipeline within the same corridor as the APLNG pipeline. This corridor is assumed as not being "over populated" with other pipelines making the construction of a standalone pipeline reasonably straight forward.

Prior to covering the specific items in the scope of work, the Study provides an overview of the proposed APLNG Pipeline and the route along which the pipeline will be constructed. This is provided as background information that is relevant to the review.

# 4 DESCRIPTION OF THE EXPORT PIPELINE

## 4.1 ROUTE

The route of the proposed export pipeline reviewed for this Study is included in Appendix A.

## 4.2 END POINTS AND FACILITIES

As detailed by APLNG, the pipeline reviewed in this Study has the following facilities;

| KP | Facility | Comments |
|---|---|---|
| KP0 | Launcher, Isolation Valve, connection for future compression | Endpoint of Reedy Creek and Condabri Laterals, proposed future booster compression facility |
| KP90 | Mainline Valve 1 | |
| KP170 | Launcher-Receiver, Isolation valve, connections for future compression | Proposed location of future booster compression facility |
| KP249 | Mainline Valve 2 | |
| KP328 | Mainline Valve 3 | MLV for zoning requirement T1,I |
| KP349 | Mainline Valve 4, Branch valve | Start of the narrows crossing area |

## 4.3 DIAMETER, COATING AND DEPTH OF COVER

The pipeline is to be DN1050 diameter. The wall thickness ranges from 18.68mm to 25.4mm. The pipe is to be manufactured to American Petroleum Institute Specification 5L in Grade X70. The external coating is to be dual layer Fusion Bonded Epoxy and the pipe shall be internally coated to improve flow efficiency.

The pipeline has a proposed MAOP of 13.5 MPag.

The buried pipeline depth of cover shall be as detailed below:

| Description | Location class | Depth of cover [mm] |
|---|---|---|
| Rural Pastoral | R1, R2 | 750 |
| Residential | T1, T2 | 900 |
| Agricultural | | 900 |
| Blade / Deep Ploughing | | 1,200 |
| Designated Roads Easements | | 1,200 |
| Watercourse (submerged) | | 1500-2000 |
| Railway (bottom of ballast) | T1, CIC | 2000 |
| Gladstone State Development Area | T1, CIC | 1,200 |
| | T1 | 900 |

## 4.4 EASEMENT

The typical construction Right Of Way (ROW) shall be 40m wide, except where required to satisfy localised specific circumstances (i.e. sensitive areas), in which case the typical width will be reduced to 34m. Post construction, the pipeline permanent easement will be 30m wide.

Two fibre optic cables are proposed to be installed parallel to the pipeline with one at approximately 3m to the right side when looking in the direction of flow, the other at approximately 8m to the left side when looking in the direction of flow.

From the data provided by APLNG, the DN1050 pipeline is assumed to generally be offset from the right side of the easement when looking in the direction of flow.

# 5 DESKTOP REVIEW OF ROUTE

### 5.1.1 Terrain Review

A terrain report has not been available to OSD for the purpose of this desk top review, the information available regarding the route has been based solely on

OSD's knowledge of the general easement area. This can be broken down into four possible types of terrain:

- Alluvial plains – characterised by very low slope gradients, with clayey top soils overlying silty sands and gravels. Expected to be found for approximately 20% of the selected route. These conditions are suitable for pipeline looping construction using a 40m working width
- Undulating terrain – terrain with minor relief, underlain by clayey soils and intermixed clays, sands, and gravels. Expected to be found for approximately 30% of the selected route. These conditions are suitable for pipeline looping construction using a 40m working width
- Low lying hills – characterized by increasing slope gradients, and underlain by thinner clayey and rocky soils with areas of shallow rock. Expected to be found for approximately 40% of the selected route
- Moderately rugged hills – terrain with low to moderate relief, underlain by thin clayey soils, clayey gravels, and rock. Expected to be found for approximately 10% of the selected route.

In Low Lying Hills and Moderately Rugged Hills, the original pipeline construction will be undertaken in areas with both minor and major side slopes. This is undertaken using cut/fill earthworks over the 40m wide easement width. Subsequent pipeline looping would prove to be difficult, as additional working width would not be readily available. However, construction of a standalone pipeline within several kilometres of the APLNG Pipeline through these areas appears to be the optimal design provided the necessary construction Right Of Way (ROW) width is obtained during the approvals phase.

This implies generally that, for any of the expansion options selected, approximately 50% of the APLNG easement route will be through terrain that is relatively straightforward for construction, assuming that a suitable easement is obtained.

### 5.1.2 Land Use

It is understood that the last approximately 80km of the pipeline leading into Gladstone is in the process of being zoned a Queensland State Government Corridor. This is proposed as a 200m wide pipeline corridor, to suit all intended pipelines and potentially other infrastructure and includes both the section referred to as the Common Infrastructure Corridor, and the area referred to as the Gladstone State Development Area.

The timing of the looping, relative to the existing pipelines at time of looping construction, will have a bearing on the increased difficulty of construction. Dependent on the alignment of pipelines within this corridor, it may require special construction techniques at substantial incremental costs to loop the pipeline in this section. It has been assumed that the additional easement width required could be obtained for the purpose of looping the APLNG Pipeline.

### 5.1.3 Callide Range

Approximately 32km of the route is through the Callide Ranges, with granite boulders in the area.

To construct through the Callide Range area with a loop pipeline it is anticipated that traditional methods of blasting to clear rock will not be able to be used due to the proximity of the existing pipeline and the potential existence of third party pipelines, and that controlled blasting techniques are expected to be required. This retains some risks with side slopes stability and controlling blast falls.

In this area other alternative means of construction may be required, including rock hammers and rock saws at increased construction costs.

### 5.1.4 Government Common Infrastructure Corridor

The section of the route commencing within the Calliope Ranges, and ending at the Gladstone State Development Area, shall be via the shared infrastructure corridor allocated by the Queensland Government. This is proposed as a 200m wide corridor, stretching for approximately 44km.

Therefore regardless of the expansion option selected, the easement accessible through the Common Infrastructure Corridor is fixed. Thus with looping of the pipeline, the looping will be required to remain within the allocated APLNG 50m corridor. It assumed that whilst the 50m easement has been fixed, the location of each pipeline within the easement is not defined by the Government.

### 5.1.5 Reroutes

For a total loop of the pipeline, it is anticipated that up to 50 reroutes or variations from the original pipeline route will be required due to environmental, cultural heritage, or physical obstacles. It is assumed that this number is linearly applicable to partial looping. It can be anticipated that each of the re-routes will add additional length to the pipeline. This is further discussed below.

# 6 DUPLICATED PIPELINE

This section details the scenario where the pipeline is duplicated along its total length using an identical pipeline in the same easement.

Looping of pipelines is a common mechanism for increasing throughput capacity of pipeline systems transporting gas or other products for multiple shippers to multiple users. Instances of pipeline looping for pipelines connecting Owners Gas Fields and Gas Processing plants, especially an LNG plant are far less common. In Australia, gas pipelines are typically not designed with intent for looping, and subsequently the development process for these pipeline projects does not address future looping.

Looping part or all of a pipeline system requires particular attention to the integrity of the existing pipeline and infrastructure. This generally adds costs above “typical” construction costs for a pipeline system.

The proposed permanent 30 metre wide easement would not permit another larger diameter pipeline to be installed in the existing easement, due to the configuration of the pipeline and a fibre optic cable laid in parallel. For efficient pipeline construction an additional 40 metre temporary working width, which included a 30 metre easement, would be required for the looped pipeline immediately adjacent the APLNG Pipeline where site conditions are suitable. Where site conditions are not suitable the easement would need to be located at a distance remote from the original pipeline.

## 6.1 TYPICAL CONSTRUCTION COST COMPONENTS

The typical components making up the construction costs of the pipeline include the following:

- ❑ Mobilisation of equipment and personnel to site
- ❑ Clear and grade ROW working width and stockpile the topsoil
- ❑ String individual pipe joints along ROW
- ❑ Excavate trench and stockpile the sub-soil
- ❑ Weld individual pipes into continuous lengths
- ❑ Non-destructively test the welded joints
- ❑ Apply field joint coating to cover the weld margins
- ❑ Install suitable padding material in the bottom of the trench (where required)
- ❑ Lower the welded pipe into the trench
- ❑ Install suitable shading material over the pipe (where required)
- ❑ Complete backfilling the trench using the sub-soil
- ❑ Respread the topsoil over the ROW and restore contours
- ❑ Perform a hydrostatic pressure test to confirm the integrity of the pipeline

- Demobilisation of equipment and personnel.

In addition to the above, when constructing a pipeline in close proximity to an existing operational pipeline it is necessary to accurately identify the location of the existing pipeline and to install temporary markers or fences to ensure that the integrity of the existing pipeline is not threatened by any construction activities.

## 6.2 CONSTRUCTION COST COMPONENT CHANGES

Some of the typical construction cost components will vary between the initial pipeline construction and the duplication or looping. These are discussed below.

### 6.2.1 Marking Existing Pipeline

It is necessary to provide a clearly visible indication of the location of the existing pipeline to ensure that construction activities for the duplication do not encroach on to the operating high pressure pipeline. Installing this will be an additional cost which is not required for the initial construction.

For the purpose of estimating, where potholing is required for looping scenarios it is assumed to be undertaken every 200m at a unit cost of $1000, equivalent to $5,000 per km, giving an overall cost increase of $1.8 Million.

### 6.2.2 Trenching and Blasting - Callide Ranges

It is believed that approximately 32km of the route will transverse area where blasting may be the most economical method of trenching through rock. Due to the proximity of the existing pipeline, extra construction costs will be incurred due to having to undertake controlled blasting, or utilise rock hammer excavation. An estimate of $200 per metre length has been allowed for this activity, giving an overall cost increase of $6.4 Million. Where only partial traversing occurs, it is assumed to be on a pro rata basis.

### 6.2.3 Special Crossings

It is estimated that approximately 100 major or intermediate crossings and 150 minor crossings will be undertaken.

Due to the nature of water course and other features crossings, it is typical to encounter difficulties in remaining parallel to an existing pipeline, to undertake an optimal crossing.

It is estimated that 25% of the major crossings will require additional work or special construction procedures to enable efficient pipeline crossings.

An estimate of $0.5 Million per crossing has been assumed to cover increase in construction difficulties. This represents $12.5 Million for the full looping project. Assuming these special crossings are evenly spread along the entire pipeline route, this cost estimate can be applied on a pro rata basis for partial looping options.

## 6.3 RANGE OF COST VARIATIONS

The construction cost element changes are identified as:

- Marking existing pipeline= $1.8 Million
- Additional trenching = $6.4 Million
- Special crossings = $12.5 Million.

This equates to a minimum expected base increase of $20.7 Million. To this needs to be added the other factors identified below.

## 6.4 OTHER FACTORS

Other factors which will influence the cost of the duplication include:

### 6.4.1 Extra Working Width

A temporary extra working width of 40m has been assumed for the looping options. A budget estimate to rent this land to cover compensation for loss of farming use, with its associated approvals, easement identification, preparation of drawings, etc. is $ 2.2 Million for the full looping option.

This cost is applicable to the 100% looping option and on a pro rata basis for the partial looping options.

### 6.4.2 Additional Earthworks

The existing pipeline route has, in particular locations, been selected to minimise the earthworks required where the route traverses hilly and/or undulating country. Constructing a parallel pipeline in the same easement will necessitate the clearing and grading of additional working width; this is expected to require much greater excavation into side slopes than the original pipeline together with subsequent greater restoration costs.

In the Callide Hills, the original pipeline construction will involve land levelling using cut and fill techniques. With the construction of the looping pipeline it may not be possible to secure additional working areas, next to the existing pipeline, as the area will either be up against a cut or working over fill.

Accordingly the looping pipeline construction in rugged areas with significant side slopes will involve construction within the original 40m easement. This will involve reduced access and working over spoil, with reduced construction efficiency.

It has been assumed that approximately 50% of the 32km through the Callide Ranges will have this reduced construction efficiency.

It is estimated that a $1 Million per km would apply due to reduced construction efficiency, which will be applicable to all expansion scenarios that traverse the Callide Ranges. For example, where the expansion traverses the length of the Callide Ranges, assuming that 50% of the length of side slopes represent 16km, this incremental cost represents $16 Million.

As a standalone line will have the option of selecting a different route through these ranges, it is assumed that route selection will be undertaken to minimise any negative effects to pipeline construction. Thus the stand alone pipeline will not be within the same limited easement through these difficult areas, and the additional costs associated with working in the constrained easement will not be applicable.

### 6.4.3 Route Changes

It is very probable that the initial pipeline easement contains areas where geological, topographical, environmental or cultural heritage concerns will prohibit the construction of a parallel pipeline immediately adjacent the APLNG Pipeline easement. Where this occurs it will be necessary to relocate the duplicate pipeline remote from the existing APLNG easement and this relocation is likely to increase the length of the duplicate pipeline relative to the original pipeline.

Without a full knowledge of all the factors affecting the existing easement it is impossible to quantify any length increase accurately. OSD suggest that for the purpose of estimation a total increase in pipeline length of 10 km over the total 349 km, or 2.8%, be considered. For the purpose of this Study, this would add an estimated $3.5 Million per kilometre for total costs, equating to $35 Million. Total costs have been used as the basis for the re-routing, as this would only be completed if this was more economical than staying on the same alignment. This process is typical when assessing re-routing a pipeline.

This is applicable to the 100% looping option, and to be applied pro rata for the partial looping options.

The stand alone pipeline is assumed to be located in the same corridor as the APLNG pipeline, therefore it is expected that re-routing away from the corridor will be necessary in difficult terrain locations. OSD suggest that for the purpose of estimation a total increase in pipeline length of 5km over the total 349 km be considered. For the purpose of this Study, this would add an estimated $3.5 Million per kilometre for total costs, equating to $17.5 Million. The length of re-routing is less than for the looped pipeline as the stand alone pipeline will have some flexibility on routing as it is in the same corridor but not directly adjacent to the APLNG pipeline.

### 6.4.4 Environmental and Cultural Heritage

The original pipeline was given approval on the basis of the completion of an environmental and Cultural Heritage studies.

If a significant variation in the pipeline route is undertaken, a new environmental review process will be required to be undertaken. It is anticipated that both pipeline looping and a standalone pipeline will require a cultural heritage review. The costs of these activities have not been evaluated.

### 6.4.5 Operations Costs

During the construction phase of a duplicated pipeline, representatives from APLNG Pipeline Operating Group will be required at site full time to issue work permits and carry out duties to ensure compliance with the Operating and Safety Plans and licence conditions of the APLNG Pipeline.

Whilst OSD has no information of APLNG Pipeline operating procedures, for the purpose of this Study only it is estimated that a minimum of four APLNG Pipeline Operating Representatives on site at any time will be required at site over an 18 month period. This equates to a two crews of four, to provide coverage while the construction crews are operating. Present day estimated costs of $250,000 per annum for a Operations Representative, which includes items such as salary, vehicle, tools and overheads. In addition it is estimated that another $500,000 per annum is required in additional Operations costs which covers supervision and management coordination. The total estimated cost is in the order of $4 Million provided the looping contractor provides full attendances and facilities.

APLNG Pipelines Operations Group may have other technical impacts associated with the design, engineering, construction and commissioning of the duplicated pipeline immediately adjacent the APLNG Pipeline easement but these impacts are outside the scope of this study.

### 6.4.6 Safe Working Practices

Due to construction activities occurring in proximity to the existing APLNG pipeline and other high pressure gas systems, construction contractors and pipeline owner will require additional safe working practices to be developed. The nature and cost impact of these practices are hard to quantify and OSD has not made a provision for these costs at this time.

### 6.4.7 Risk Assessments

Risk assessments are undertaken as part of the Pipeline Licence conditions and the nominated Australian Standards for Pipelines. The outcomes of the risk assessment process can impose additional design, construction and operation constraints and limitations on a pipeline project. Without a looping risk assessment it is not possible at this stage to quantify any specific incremental costs that may be identified by such a risk assessment.

### 6.4.8 Looping Project Insurance

Due to duplicated pipeline construction activities occurring in close proximity to the existing APLNG Pipeline, both the construction contractor and the pipeline owner will need to take out specific additional insurance associated with the risk of damage to the existing APLNG Pipeline, which has the potential to impact both the LNG Plant and the Gas Fields operation. The cost and details of the insurance for looping are outside scope of this Study.

## 6.5 TOTAL CONSTRUCTION COST CHANGES

### 6.5.1 Base Estimate Assumption

Using the OSD pipeline construction costing data base, it is anticipated that pipeline construction for Class 600 pipelines will be $24,000/inch/km in 2009 dollars. This has been escalated by 5% to account for increases in negotiated labour rates, bringing the total to $25,200 per inch km. Then it is necessary to increase the cost again to allow for the difference between Class 600 and Class 900 pipelines: the cost of a Class 900 pipeline will be greater for all the activities which are influenced by the weight of pipe handled (stringing, lifting, lowering in) and the wall thickness (welding) as well as increased costs for valves, flanges and fittings. It is estimated that this will increase the overall construction costs by 25%, bringing the base construction cost for a Class 900 pipeline to $31,500 per inch km.

For the DN1050 pipeline under consideration, this equates to an assumed base present day construction cost of $1.323 Million per km for the purpose of this study only. The APLNG Project may be using costs different to this estimate since OSD has no information on Project specific items such as pipeline approval conditions, land and existing project site infrastructure impacts, third party commitments, construction plans for wet season impacts, and other indirect overhead costs. It also assumes that all coated line pipe and permanent materials are provided free issue to the construction contractor at Owners stockpiles along the ROW.

### 6.5.2 Total Expected Cost Variation

The total expected cost increase for total APLNG Pipeline looping consists of:

- Initial cost variations = $20.7 Million
- Extra working width = $2.2 Million
- Additional earthworks = $16 Million
- Route changes = $35 Million
- APLNG Pipeline Operating Representatives= $4 Million.

This results in a expected present day cost increase for construction in the order of $78 Million for the fully looped configuration. Assuming a base present day rate of $1.323 million per km for construction for the initial pipeline this represents a present day increase in construction cost to complete the looped pipeline a minimum of 17%.

Other issues have been identified in the preceding discussion have the potential to increase the cost of construction; however the analysis of this is outside of the scope of this Study.

# 7 PARTIAL LOOPING

## 7.1 ADDITIONAL CONSTRUCTION COSTS: PARTIAL LOOPING

When the construction is undertaken in multiple isolated sections there will be additional costs related to the reduction in working efficiency, when compared to build a new pipeline.

Looping connection points to the APLNG Pipeline are ideally completed at locations where existing connections are possible, such as stations and mainline valves. It is recognised that this is not always possible and that a direct connection to the pipeline may be required. This direct connection is achieved by a process called hot tapping. The APLNG Pipeline is designed for a pressure that may make hot tapping of the pipeline difficult and to complete the hot tapping connection may be restricted to periods where the pipeline operating conditions allow this work to occur. Detailed analysis of this is outside the scope of this study, however it is noted that completing of a hot tapping operation is likely to have additional cost or schedule impacts on completion of looping.

No consideration has been given to any costs required for compression to achieve a maximum gas flow for a given configuration of looping.

### 7.1.1 Mobilisation

If the entire pipeline is duplicated in a single operation, the cost of mobilisation and demobilisation will not change. If the pipeline duplication occurs in multiple separate stages then a mobilisation/demobilisation cost will apply to each stage as personnel and equipment have to be moved unproductively between stages.

The estimates of construction costs assume that the same size of spread is mobilised for both the complete looping and the partial looping. On this basis the mobilisation/demobilisation costs will be the same for both partial and complete looping but the impact on total construction cost will be inversely proportional to the total length of loop being constructed, resulting in a higher cost per kilometre of pipeline constructed for the shorter loop sections.

### 7.1.2 Hydrostatic Testing

When pressure testing a long, large volume pipeline it is usual to move the test water between sections in order to minimise water usage. If the duplication occurs in multiple separate stages this will not be possible and a significantly greater volume of water will be required for the testing, together with the need to find a separate source of water (and disposal site for the contaminated water after the test) for each stage. This will increase the cost of the pipeline hydrostatic testing per kilometre of pipeline.

## 7.2 PARTIAL LOOPING SECTIONS

The partial looping will be selected in line with the Pipeline Capacity Modelling report provided by APLNG, 299-R-01.doc provided to OSD on 28th September 2010. This Study has identified the following partial looping options. The partial looping sections are labelled PLO for this Study.

### 7.2.1 PLO1 - Loop from kP0 - 50 and kP 170 - 220

This scenario involves a total of 100km of looping constructed within the existing easement. A review of the route using topographic maps and Google earth imagery indicates that the basic construction is unlikely to involve additional difficulties when compared with the original construction.

Overall construction cost per km will increase over the initial installation due to:

- The need to mark the existing pipeline,
- The requirement to move all the construction plant and equipment 120km between the two sections,
- The requirement to locate and obtain permits for two separate sources of water for hydrotesting,
- The need to either set up two construction camps or to lose productive time in travelling from a single camp to two separated work sites,
- The greater impact of mobilisation/demobilisation costs on the cost/km,
- The addition of two connections to the existing APLNG Pipeline and associated valves, facilities and control systems.

### 7.2.2 PLO2 - Loop from kP0 - 100 and kP 170 - 220

This scenario involves a total of 150km of looping constructed within the existing easement. A review of the route using topographic maps and Google earth imagery indicates that the basic construction may involve additional difficulties when compared with the original construction in the area between KP90 and KP105 where the route appears to be through densely wooded and hilly terrain.

Overall construction cost per km will increase over the initial installation due to:

- The need to mark the existing pipeline,
- The requirement to move all the construction plant and equipment 70km between the two sections,
- The requirement to locate and obtain permits for two separate sources of water for hydrotesting,
- The need to either set up two construction camps or to lose productive time in travelling from a single camp to two separated work sites,
- The requirement to clear additional woodland between KP90 and KP105,
- The greater impact of mobilisation/demobilisation costs on the cost/km,
- The addition of two connections to the existing APLNG Pipeline and associated valves, facilities and control systems.

### 7.2.3 PLO3 - Loop from kP0 - 270

This scenario involves a total of 270km of looping constructed within the existing easement. A review of the route using topographic maps and Google earth imagery indicates that the basic construction may involve additional difficulties when compared with the original construction in the area between KP90 and KP105 where the route appears to be through densely wooded and hilly terrain, and also between KP255 and KP270 where the pipeline route appears to follow the Dawson Highway and other roads through the Callide ranges: it appears very likely that the available working width in this area is restricted by the roads to the left and the steep hills to the right, looking in direction of flow.

Overall construction cost per km will increase over the initial installation due to:

- The need to mark the existing pipeline, and
- The need to constrain construction into a narrow ROW,
- The addition of one connection to the existing APLNG Pipeline and associated valves, facilities and control systems.

### 7.2.4 PLO4 - Loop from kP0 - 320

This scenario involves a total of 320km of looping constructed within the existing easement. A review of the route using topographic maps and Google earth imagery indicates that the basic construction may involve additional difficulties when compared with the original construction in the area between KP90 and KP105 where the route appears to be through densely wooded and hilly terrain, and also between KP255 and KP270 where the pipeline route appears to follow the Dawson Highway and other roads through the Callide ranges: it appears very likely that the available working width in this area is restricted by the roads to the left and the steep hills to the right, looking in direction of flow.

Overall construction cost per km will increase over the initial installation due to:

- The need to mark the existing pipeline, and
- The need to constrain construction into a narrow ROW.

### 7.2.5 PLO5 - Loop from kP0 - 50, kP 90 - 140 and kP 170 - 220

This scenario involves a total of 150km of looping constructed within the existing easement. A review of the route using topographic maps and Google earth imagery indicates that the basic construction may involve additional difficulties when compared with the original construction in the area between KP90 and KP105 where the route appears to be through densely wooded and hilly terrain.

Overall construction cost per km will increase over the initial installation due to:

- The need to mark the existing pipeline,
- The requirement to float all the construction plant and equipment in two separate stages of 40km and 30km respectively

- The requirement to locate and obtain permits for three separate sources of water for hydrotesting
- The need to either set up two construction camps or to lose productive time in travelling from a single camp to three separated work sites.(Note: because of the smaller ratio between the length of looping and the gaps between sections, this impact will be less than in PLO1 & PLO2)
- The greater imact of mobilisation/demobilisation costs on the cost/km
- The addition of three connections to the existing APLNG Pipeline and associated valves, facilities and control systems.

### 7.2.6 PLO6 - Loop from kP0 - 50, kP 90 - 140, kP 170 - 220 and kP 249 - 269

This scenario involves a total of 170km of looping constructed within the existing easement. A review of the route using topographic maps and Google earth imagery indicates that the basic construction may involve additional difficulties when compared with the original construction in the area between KP90 and KP105 where the route appears to be through densely wooded and hilly terrain, and also between KP255 and KP269 where the pipeline route appears to follow the Dawson Highway and other roads through the Callide ranges: it appears very likely that the available working width in this area is restricted by the roads to the left and the steep hills to the right, looking in direction of flow.

Overall construction cost per km will increase over the initial installation due to:

- The need to mark the existing pipeline,
- The requirement to float all the construction plant and equipment in three separate stages of 40km, 30km and 29km respectively,
- The requirement to locate and obtain permits for four separate sources of water for hydrotesting,
- The addition of four connections to the existing APLNG Pipeline and associated valves, facilities and control systems.

# 8 INCREASE PIPELINE MAOP

The option of increasing the MAOP limit on the APLNG will allow for additional capacity within the line, with a significantly lower capital cost than either looping or installation of a standalone pipeline. Whilst there are benefits to utilising this option, there is the major limitation of the relatively small increase in delivery capacity of the pipeline. OSD estimates that an increase in the MAOP from 13.5MPag to 15.3MPag will increase the maximum capacity of the pipeline by 12.5%

The increase in cost to pre-invest in a pipeline with an MAOP of 15.3MPag over the base case of 13.5MPag is driven by material costs for the additional thickness on linepipe to account for the higher pressure, together will increased construction costs due to the increased total weight of pipe to be installed. There are other cost increases; however these are insignificant when compared to the materials costs.

For the increased MAOP, OSD has calculated a required standard wall thickness of 21.12mm. For the option of increased pipeline MAOP, the steel cost has been calculated in terms of the difference between required standard wall thicknesses for the 13.5MPag and 15.3MPag MAOPs. These have been determined as 18.68mm and 21.12mm respectively. The increase in wall thickness adds 63kg to each metre of pipe, or approximately 22,000 tonnes to the total weight of pipe required. At $1780 per tonne this will increase the total pipe cost by $39 Million or 13%. Additionally a 13% weight increase may be expected to raise the construction cost by around 6%. This equates to a construction cost increase in the range of $30 Million based on base cost assumptions in this Study, and an overall additional $69 Million

In addition the increase in pipeline pressure it would be necessary to add additional compression at the start of the pipeline to provide additional capacity to transport gas. No consideration has been given to any potential impact this may have on the operation of the APLNG Curtis Island LNG Plant, the analysis of this is outside the scope of this Study.

# 9 STAND ALONE PIPELINE

The stand alone pipeline is assumed to be within the same corridor as the APLNG pipeline, with the corridor not being “over populated” with other pipelines. Being a new pipeline, it will require starting the Project from the approval stage, requiring a new pipeline licence, cultural heritage, and environmental approvals.

The cost estimate for this option assumes that the start and end points of the new pipeline are the same as those on used in this Study for the scope of the APLNG Pipeline reviewed, and also that the location of any facilities, stations, and mainline valves mirror the APLNG pipeline.

The cost increase over the initial APLNG pipeline is based on the cost analysis in Section 6 of this report, the cost increases for the stand alone pipeline are summarised below.

- ❑ Marking existing pipeline – Not applicable, as pipeline is assumed to have sufficient separation from the initial APLNG pipeline not to require centreline marking. The use of cadastre data from the initial APLNG pipeline by the stand alone pipeline construction survey is assumed to be sufficient

- Trenching and blasting in the Callide Ranges - $6.4 million. Costs assumed to be equally applicable to the stand alone pipeline and the looped pipeline.
- Special crossings = $6.25 million. Costs assumed as half of the looped pipeline cost increase due to greater separation from the initial APLNG pipeline
- Extra working width – No additional costs above the initial APLNG pipeline
- Additional earthworks – Not applicable, as alignment options within the corridor is anticipated to result in the same quantities as the initial APLNG pipeline
- Route changes = $17.5 million, as covered in Section 6.4.3
- Environmental and Cultural Heritage - No additional costs above the initial APLNG pipeline
- Operating Costs - $1 million. This is estimated based on a significant reduction in resources from APLNG operations as compared to the looped pipeline. The work required by APLNG operations would be for designated construction equipment access crossings and any ad hoc crossings for the stand alone pipeline.

This results in a total present day increase in construction costs above that of the initial APLNG pipeline of $31.2 million. This equates to a percentage cost increase over the initial APLNG pipeline of approximately 7%.

# 10 ASSUMPTIONS

This review is based on a defined set of assumptions; the costs presented in this Study must be read in conjunction with the assumptions as these have a material impact when making a comparison of the results in this Study with costs from reports developed by the APLNG project, other similar projects or any other pipeline project.

Key assumptions used in this Study are as follows:

- There is no allowance of project specific risks in the cost rates. Project specific risks include items such as foreign exchange variation, labour wage escalation outside of relevant wage agreements;
- No allowance for costs beyond what is known from recently constructed projects from the regulatory process, this includes items such as pipeline

licence requirements, environmental approval requirements and land access conditions;

- All costs are in Australian Dollars;
- All costs are present day costs;
- All costs exclude Goods and Services Tax (GST);
- Cost for uncoated line pipe delivered to site Pipe stockpiles, $1,780 per metric tonne;
- Estimates include allowances for Facilities including; Main Line Valves, and Scraper stations;
- No compression or metering has been included in any costs.

# 11 CONCLUSION

OSD has attempted to quantify the incremental costs for construction associated with the looping of an existing pipeline. OSD has assessed the pipeline route and addressed issues specific to this route in this review, however it should be noted that this is a high level review and not a detailed bottom up estimate comparing the various scenarios.

With the available data, OSD believes the accuracy of all estimates in this Study is in the range ±35%.

Our assessment shows that looping the pipeline length of 349 km, which excludes the Narrows Marine Crossing and Curtis Island section of the pipeline, would result in an increase in construction costs a minimum of 17% above that of the APLNG pipeline.

This Study is designed to provide an estimate of the overall cost changes for the purpose of assessing cost variation from a base pipeline cost estimate to achieve increased capacity.

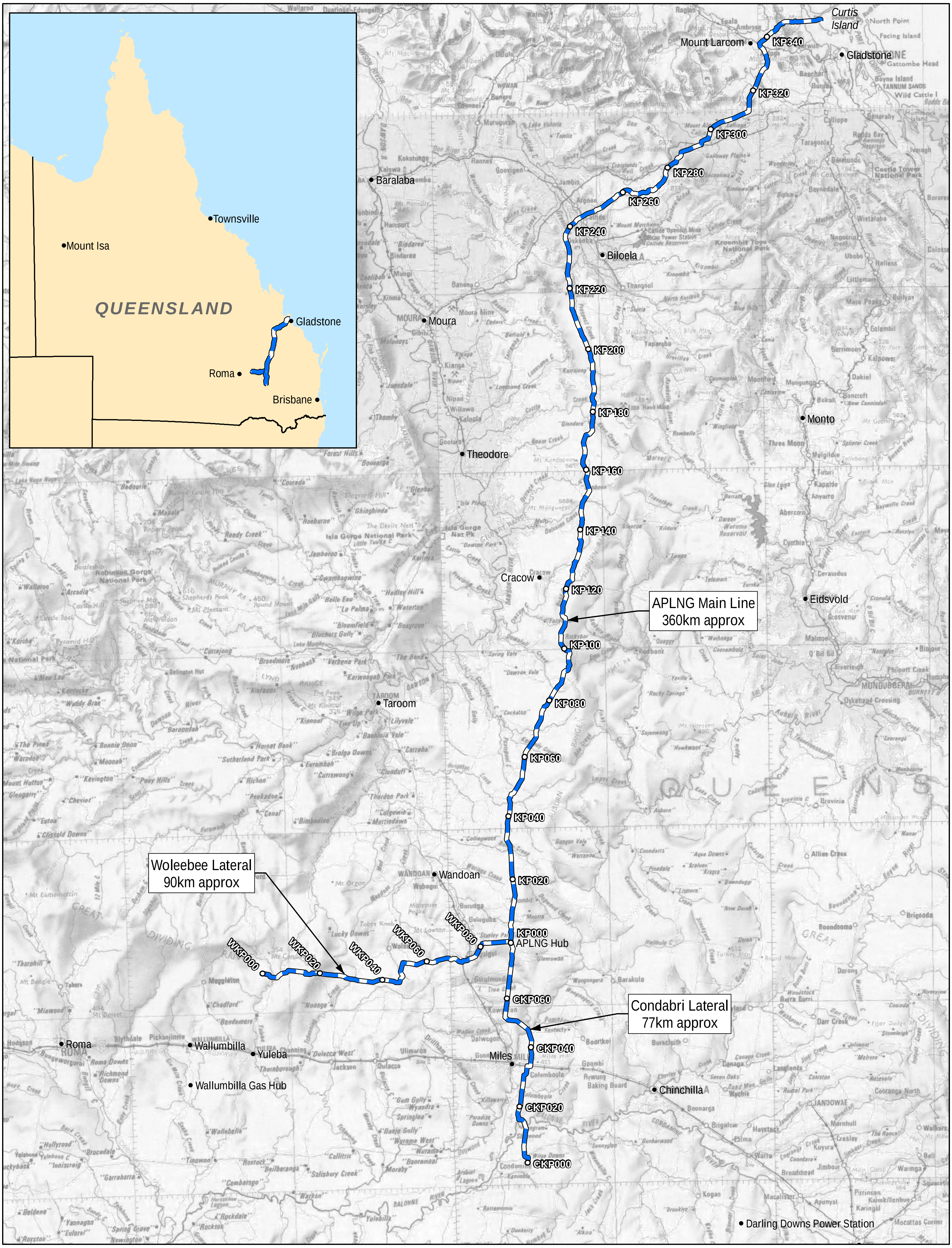
The costs for partial looping have not been defined, rather a narrative has been provided to describe the potential cost variations that would occur for the various potential looping options that have been provided by APLNG.

For the increased pipeline MAOP option to utilise the maximum MAOP allowable for Class 900 valves and flanges, this is expected to increase pipeline costs in the vicinity of $69 Million, in addition to potential costs outside the scope of this Study. It is noted that the OSD estimated capacity increase would be in the order of 12.5% for this option, as opposed to 100% capacity increases for the fully looped option and the stand alone option.

The stand alone pipeline option is assumed to be in the same pipeline corridor as the APLNG pipeline, and that this corridor is assumed as not being “over populated” with other pipelines making the construction of a standalone pipeline reasonably straight forward. Based on this assumption, the increase in present day construction costs above that of the initial APLNG pipeline is estimated at $31.2 million. This equates to a percentage cost increase over the initial APLNG pipeline of approximately 7%.

# APPENDIX A

## APLNG PIPELINE ROUTE MAP




NOTES
Base data: Geodata V3, Geoscience Australia

LEGEND
20km Kilometre Post
Main APLNG Pipeline System (Option 3H - 04/03/2010)

0 10 20 30 40
Kilometres
Datum: GDA94
Projection: MGA94 Zone 56

DISCLAIMER
In preparing this map, Origin Energy have endeavoured to ensure that the data and information are as accurate and reliable as possible. However Origin Energy cannot accept liability for any decisions or actions of whatever kind or nature based on this study. Origin Energy expressly disclaims any loss or damage that may arise therefrom.

WKSP C:\Data\APLNG\Workspaces\APLNG_A3_Main_Pipeline_Overview.mxd

AUSTRALIA PACIFIC LNG
Origin energy

PROJECT AUSTRALIA PACIFIC LNG
TITLE MAIN APLNG PIPELINE SYSTEM TOPOGRAPHIC OVERVIEW

| DRAWN | DATE | CHECKED | APPROVED | MAP DOC ID |
|---|---|---|---|---|
| DBJ | 29/04/2010 | | | GIS00394 |

Layout: A3 Portrait