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Atmospheric issues : Eastern Gas Pipeline : draft environmental impact statement (Commonwealth), environmental impact statement (New South Wales), environmental effects statement (Victoria)

NSW DEPT PRIMARY INDUSTRIES
AB020180

Eastern Gas Pipeline

Draft Environmental Impact Statement
(Commonwealth)

Environmental Impact Statement
(New South Wales)

Environment Effects Statement
(Victoria)

Background Paper

BHP

Westcoast Energy

No. 3

Atmospheric Issues

AGC Woodward Clyde Pty Ltd

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF PLATES

1.0 INTRODUCTION

BHP Petroleum Pty Ltd and Westcoast Energy Australia Pty Ltd commissioned AGC Woodward-Clyde Pty Ltd (Woodward-Clyde) to undertake a study of atmospheric issues associated with the construction and operation of a natural gas pipeline, the Eastern Gas Pipeline Project (EGPP), from Longford in Victoria through to Wilton in New South Wales. The broad objectives of this study included:

1. Identification of atmospheric issues associated with any gaseous emissions from compressor stations, terminals or emergency release points along the route;

2. Assess air quality issues, in particular:
   - dust generation during construction and advise amelioration measures;
   - gaseous emissions from turbines at the proposed compressor stations; and

3. Evaluate the potential impacts of the project on greenhouse gas emissions and ozone depletion. This evaluation will include the consideration of both positive and negative impacts.

2.0 PROJECT DESCRIPTION

2.1 GENERAL

The EGPP is proposed to be constructed from Longford in Victoria to Wilton in New South Wales (702.5 km). The pipeline will service industries located in Sydney as well as a further 65,000 people along the route. The proposed route is illustrated in Figure 1 and is to run from Longford through Bairnsdale, Orbost, Bombala, Cooma, Queanbeyan, Nowra, Port Kembla to Wilton. It is proposed that the pipeline will reach maximum capacity 9 years after commissioning.

2.2 OPERATIONAL COMPONENTS OF THE PIPELINE

The pipeline will be a buried steel pipeline designed and constructed in accordance with Australian Standard AS2885, Pipelines - Gas and Liquefied Petroleum, and the Victorian and NSW Pipelines Regulations and Pipeline Act. The installation of modern piping materials means that leakages of natural gas will be virtually eliminated.

The above ground facilities which will be required at intervals along the pipeline route include:

- compressor stations;
- meter stations;
- sales taps;
- mainline valves;
- scraper traps;
- cathodic protection system; and
- control and communications systems.

Figure 2 is a schematic illustration of the proposed pipeline and above ground services. The following provides a more detailed description of these facilities and indicates any potential atmospheric issues which may be associated with their operation.

2.2.1 Compressor Stations

The initial proposed capacity of the pipeline will only require one compressor station which will be located at Longford, adjacent to the existing Esso Gas Plant (refer Figure 3). This station will initially consist of two gas turbine compressors, being upgraded to three compressors within five years from commissioning of the pipeline.

The Longford compressor station will be located in a metal shed on approximately 15 hectares of land with 10 to 12 hectares of the land acting as a buffer zone. The compressor station will comprise of modern 4 to 5 MW gas fuelled turbines fitted with dry low NO_x combustors and a gas filter to remove particulates. Exact details of the compressors have not been confirmed at this stage.

Two other compressor stations are proposed along the route, one near Cann River and the other near Michelago. The Cann River compressor station will be constructed about five years after the commissioning of the pipeline and consist of two compressors. The Michelago compressor station will be constructed within 7 years after the commissioning of the pipeline and consist of one compressor.

The operation of the compressor stations has the potential to emit oxides of nitrogen (NO_x), carbon monoxide (CO) and unburnt hydrocarbons (HC). These emissions will be continuously vented to the atmosphere via an exhaust stack. The impact of the operation of the compressor stations has been evaluated further in Section 5.3.

2.2.2 Meter Stations

Two main meter stations will be located at Longford and Wilton. In addition, metering stations will be located at each of the 17 sales taps where gas volumes leave the main transmission pipeline and are transferred to local gas reticulation systems or individual customers.

2.2.3 Sales Taps

Sales taps have been proposed at various locations along the length of the pipeline. These taps will be available for future use of the gas by communities along the length of the pipeline. The sales taps and the associated meter stations do not vent or combust any gas, hence there will be no atmospheric issues associated with the sales taps or meter stations.

2.2.4 Mainline Valves

Mainline valves are proposed to be located at 15 to 35 kilometre intervals along the pipeline. These valves will automatically detect any pressure drops in the system and shut off a section of the pipeline to limit gas escape in the event of a pipeline incident. The valves can also be operated manually from the Gas Control Centre.

2.2.5 Scraper Barrels

Scraper barrels along the route will permit inspection and cleaning devices to be inserted into the pipeline to remove impurities and/or detect damage or metal loss within the pipe. Scraper barrels will be constructed at each of the compressor stations and at some stand alone locations along the route. BHP Petroleum have indicated that these will only be required to be operated once every ten years.

There is the potential for gas to be emitted to the atmosphere from accidental releases or maintenance of the mainline valves and scraper barrels. These releases are discussed further in Section 5.2.

2.2.6 Protection, Control and Communication Systems

The operation of the pipeline requires dedicated communications facilities. This may include satellite facilities, existing telephone systems, microwave towers or VHF facilities.

The pipeline will be protected from corrosion by an internal epoxy coat and an external coat of FBE overlaid with high density polyethylene. A cathodic protection system will also be incorporated to protect areas where the protective coating is damaged or defective. The cathodic protection points will be located at fence lines or at existing access points.

There will be no gas releases or combustion associated with these systems and hence, no atmospheric issues arise from the operation of these systems.

2.3 CONSTRUCTION OF THE PIPELINE

The pipeline will be constructed by three construction teams over three different lengths (spreads). These spreads are marked on the schematic diagram of the pipeline shown in Figure 2. Each spread will progress at an average of 3.5 kilometres per day. The main activities which will be undertaken on each spread include:

- clearing of vegetation;
- grading;
- drilling and blasting of large areas of rock which cannot be ripped during the grading process or dug to a sufficient depth to allow specified cover of the pipe;
- a ditch will be dug by a ditcher or excavator for the pipe to lie in;
- laying (stringing) the pipes in preparation for welding;
- bending of pipes will be done using a hydraulic bending machine;
- pipes will be welded three times;
- the pipe coating will be checked and repaired if necessary, welds will be coated with FBE and then heat shrink will be placed over the top;
- the pipeline will be lowered into the ditch onto soil and padding and the ditch will be back-filled;

- mainline valves, scraper barrels and meter stations will be installed;
- cleaning up and rehabilitation of the area; and
- testing of the pipeline.

These activities are illustrated in Figure 4.

During this construction phase there is the potential for adverse atmospheric impacts from dust generated on the surrounding environment. In particular, there is the potential for dust impacts in the vicinity of inhabited dwellings. The potential for adverse atmospheric impacts in remote or isolated areas is negligible. This is discussed in more detail in Section 4.

3.0 EXISTING AIR ENVIRONMENT

3.1 METEOROLOGY AND CLIMATOLOGY ALONG PROPOSED PIPELINE ROUTE

The climate and meteorology along the proposed pipeline route has been compiled and detailed in the report "Climate and Meteorology, Eastern Gas Pipeline Project" (Envirometer, 1995). The general conclusions of this report are as follows:

- Air temperatures higher than 45°C and lower than -10°C have occurred along the pipeline route, with regular exposure to sub-zero temperatures during winter in higher areas;
- there is the possibility of thunderstorm activity along the route which peaks between November and March;
- average rainfall varies significantly along the pipeline route; and
- there is a good spread of wind speeds and wind directions at the locations examined along the pipeline route.

3.2 GENERAL DESCRIPTION ALONG THE PIPELINE ROUTE

The proposed route of the gas pipeline is mainly through rural areas and state forests of Victoria and New South Wales. The route of the pipeline crosses a range of different terrain features and meteorological conditions.

3.2.1 Victoria

The Victorian Environment Protection Authority (VEPA) has undertaken detailed air studies in the Latrobe Valley and Melbourne Pollution Control Regions. In addition, these areas are routinely monitored by the VEPA for levels of ozone (O_3), nitrogen dioxide (NO_2) and carbon monoxide (CO). The air quality of the Latrobe Valley is applicable only to the Longford area and this is discussed in further detail in Section 3.3. Other areas where the gas pipeline is proposed in Victoria are rural areas and state forests, which are likely to have ambient levels of O_3, NO_2, and CO significantly lower than levels measured in the city areas, and well below the ambient air criteria noted in Section 5.

Plates 1 to 4 show the area around Longford and typical terrain in Victoria along the pipeline corridor up to the NSW border.

3.2.2 New South Wales

The New South Wales Environmental Protection Authority (NSW EPA) routinely monitors air quality in NSW. Data are collected from the Sydney, Newcastle and Wollongong areas and published every quarter by the NSW EPA. The data collected from regional areas in Wollongong are the most applicable in representing the existing air quality toward the end of the proposed pipeline in Spread III from Nowra to Wilton. This region comprises the greatest area of urban and industrial development along the route. Monitoring data for Albion Park for the first quarter of 1994 indicates that all levels of O_3, NO_2 and CO were below the ambient air criteria for New South Wales noted in Section 5.

Most of the other regions along the proposed pipeline route are in rural areas or state forests where it is expected that the ambient air quality is good and pollutant levels lower than that measured near the industrial area of Wollongong.

Plates 4 to 6 show the typical terrain in NSW from the border with Victoria to Berry along the pipeline corridor.

3.3 LONGFORD COMPRESSOR STATION SITE

Longford is located near Sale in Victoria (refer to Figure 1). The area is located within the Latrobe Valley Air Pollution Control Region. This area has been extensively reviewed as part of the Latrobe Valley Air Shed Study and is included in the general ongoing air quality monitoring program undertaken by the VEPA. The Latrobe Valley Air Monitoring program shows that despite power generation and other heavy industrial activities in the Valley, the air quality is generally considered superior to that in the

Melbourne Metropolitan area (Streeton J.A., 1990). Experimental evidence also indicates that on occasion, the Latrobe Valley environment is influenced by the plume from Melbourne, and this can cause significant levels of ozone, originating in Melbourne, to be measured in the Latrobe Valley (Bell, 1989).

Close to the location where the proposed compressor station is to be located at Longford, the area is largely rural with flat and open terrain (refer Plates 1 and 2). The closest industry is an adjacent gas generation plant operated by ESSO (refer to Figure 3).

The nearest residences to the Gas Plant are rural dwellings located more than 2 km from the plant located mainly to the west and north (refer Figure 3). No information on the emissions from the Gas Plant and the ambient air quality in the vicinity of the Gas Plant were available for this report. A site inspection of the area around the plant was conducted on the 14 June 1995. During this inspection, weak hydrocarbon odours were detected within a kilometre downwind of the plant.

4.0 POTENTIAL ATMOSPHERIC IMPACTS - CONSTRUCTION

4.1 AMBIENT AIR GUIDELINES

The most likely atmospheric impact from the construction of the pipeline and compressor stations will be the generation of dust. The Victorian Environment Protection Authority (VEPA) has not set an ambient air guideline for dust. The only a criteria the State Environment Protection Policy (The Air Environment) has set is for visibility-reducing particulates. This is a measure based on aesthetic considerations.

The New South Wales Environmental Protection Authority (NSW EPA) has adopted the National Health and Medical Research Council (NHMRC) Guidelines as objectives for air quality, supplemented by World Health Organisation (WHO) Long Term Goals and United States Environmental Protection Agency (US EPA) Air Quality Standards for total suspended particulates and particulate matter. In addition the NSW EPA has adopted a standard on deposited matter.

The NHMRC and ANZECC have published National Air Quality Objectives for Australia. These standards include a national standard for total suspended particulates. This standard as well and those adopted by the NSW EPA are listed in Table 4.1

TABLE 4.1 AMBIENT AIR GUIDELINES FOR PARTICULATES

POLLUTANT	NSW STANDARD	NATIONAL STANDARD
Suspended matter	40 $\mu g/m^3$ (annual mean of 24-hour values)	
Total suspended particulates	90 $\mu g/m^3$ (annual mean)	90 $\mu g/m^3$ (annual mean)
Particulate matter < 10 µm	50 $\mu g/m^3$ (annual mean) 150 $\mu g/m^3$ (24 hour maximum)	
Deposited matter	Maximum increment of 2 g/m^2/month (annual average) Maximum total of 4 g/m^2/month (annual average)	

4.2 PIPELINE CORRIDOR

A general description of the construction phase of the project has been presented in Section 2. Details of the construction program have been provided by BHP Petroleum. The pipeline will be constructed in 3 spreads.

- Spread I from Longford to the New South Wales border (0 km to 264.5 km)
- Spread II from the New South Wales border to Hillview (264.5 km to 534 km)
- Spread III from Hillview to Wilton (534 km to 702.5 km).

The proposed construction process aims to have each of the three spreads constructed during the same period of time with the disturbance over the whole spread limited to approximately 4 to 6 months. This period of disturbance is presently proposed for November 1996 to April 1997. The impact of these construction activities will be limited to a short period of time at any particular location.

The report "Climate and Meteorology, Eastern Gas Pipeline Project" (Enviromet, 1995) provided a summary of the implications of climate and meteorology for construction of the pipeline. With respect to the potential generation of dust, dry weather, high temperatures and high evaporation will result in the greatest potential for the generation of dust during the construction of the pipeline. Strong winds will result in the potential for wind erosion from the surfaces exposed and disturbed during the construction phase. The following observations of the meteorological conditions in the three regions have been extracted from the above report.

During the period from November to March, the rainfall in the Gippsland region (Spread I) is generally lower than average. In the Southern Tablelands (Spread II), the highest average rainfall occurs during the summer months. The Illawarra region (Spread III) experiences its driest period in spring (up to November) with higher than average rainfall expected in the summer and autumn months. All three regions have a higher than average likelihood of experiencing intense daily rainfall.

Extreme maximum temperatures can exceed 40°C in all months between November and March in Gipsland (Spread I) and Illawarra (Spread III), and in January and February in the Southern Tablelands (Spread II). Temperatures exceeding 30°C can occur on 10 to 15 days in each month in this period in all regions along the pipeline.

Windroses of the winds in the three regions (presented in the Climate and Meteorology report) indicate a good spread of wind speed and direction during the months of construction. There is the likelihood of all three regions experiencing strong winds during this period which will increase the potential for wind erosion from the surface of the exposed ground.

These observations of the rainfall patterns and temperature conditions indicate that during the proposed construction period, there is a greater potential for the generation of dust in Spread I due to the low rainfall and high temperatures in the region. There is also a reasonably high potential for the generation of dust in Spread II and Spread III if there is a dry spring and summer in 1996/1997. The high temperatures in these regions will ensure that evaporation rates will be high, enabling the surface to dry out very quickly.

Table 4.2 summarises the meteorological conditions in each spread during the months of November to April, as well as the resultant potential for dust generation during the construction phase.

TABLE 4.2 SUMMARY OF METEOROLOGICAL CONDITIONS DURING CONSTRUCTION PERIOD

Spread	Rainfall	Temperature	Winds	Potential for Dust Generation and Erosion
Spread I	Low	High	Low to High	High potential for dust generation and erosion during periods of high winds
Spread II	High	High	Low to High	Moderate potential of dust generation and erosion during periods of strong winds
Spread III	High	High	Low to High	Moderate potential of dust generation and erosion during periods of strong winds

The potential impact of dust generation during construction will be limited to those areas where the pipeline corridor is in close proximity to residential rural dwellings and other sensitive receptors, particularly urban areas. The generation of dust in remote or rural areas will have a negligible impact.

The spread with the area of greatest urban development is Spread III where the pipeline corridor runs through urban areas in the Illawarra region from Nowra to Wilton. Application of management measures (discussed in Section 7) will ensure that impacts are negligable.

4.3 COMPRESSOR STATION SITES

The compressor station at Longford will be constructed by June 1997 with foundation and building work expected in the months of December 1996 to March 1997. Data on the meteorological conditions at Longford during these months (Enviromet, 1995) indicates that January and February tend to be drier months of the year (although there is not very much variability between months) with high temperatures (maximum exceeding 40°C) and high evaporation. These meteorological conditions would tend to indicate that there is the potential for dust generation during the construction period from December to March.

The nearest residences to the proposed compressor station site (indicted in Figure 3) are more than two kilometres from the site. Dust generated during the proposed construction interval is likely to have a negligible effect on these residences given the distance between the site and the residences and the duration of the construction activity. However, the potential for dust generation will need to be monitored and ameliorative measures (as discussed in Section 7) implemented if required.

The remaining two compressor stations proposed along the route of the pipeline corridor are planned for construction within five to ten years following commissioning of the pipeline. Again, there will be a greater potential for dust to be generated during the construction of these compressor stations should they be constructed during warm to hot and dry conditions. However, the potential for adverse impacts is likely to be negligible given the proposed remote locations of these compressor stations, as they will be constructed away from residential dwellings and urban areas.

The occurrence of high winds during the construction period may result in the generation of dust via wind erosion of the exposed surfaces.

5.0 POTENTIAL ATMOSPHERIC IMPACTS - PIPELINE OPERATION

5.1 GUIDELINES

5.1.1 Ambient Air Guidelines

Ambient air guidelines which are relevant to the emissions from the operation of the pipeline are carbon monoxide (CO) and oxides of nitrogen (NO_x).

The Victorian Environment Protection Authority (VEPA) administers the air quality guidelines set out in the Environment Protection Act 1970. The ambient air guidelines and emission standards are contained in the State Environment Protection Policy (The Air Environment) under Section 16 of the Act.

The New South Wales Environmental Protection Authority (NSW EPA), formerly the State Pollution Control Commission (SPCC), adopted the National Health and Medical Research Council (NHMRC) Guidelines as objectives for air quality, supplemented by World Health Organisation (WHO) Long Term Goals and United States Environmental Protection Agency (US EPA) Air Quality Standards. These air quality standards have been determined in the light of current international knowledge on the adverse effects of air pollutants on health (NSW EPA, 1994).

The NHMRC and ANZECC have published National Air Quality Objectives for Australia. These objectives as well as the ambient air guidelines for Victoria and New South Wales are presented in Table 5.1 below.

TABLE 5.1 AMBIENT AIR QUALITY CRITERIA

Pollutant	National	Victoria	New South Wales
Carbon monoxide			
1-hour average		acceptable level = 38 mg/m^3	109 mg/m^3 (15-minute maximum)
		detrimental level = 75 mg/m^3	31 mg/m^3 (1-hour maximum)
8-hour average	10 mg/m^3	acceptable level = 12 mg/m^3	11 mg/m^3 (8-hour maximum)
		detrimental level = 25 mg/m^3	
Nitrogen Dioxide[1]			
1-hour average	320 μg/m^3	acceptable level = 307 μg/m^3	328 μg/m^3 (1-hour maximum)
		detrimental level = 512 μg/m^3	
24-hour average		acceptable level = 123 μg/m^3	
		detrimental level = 308 μg/m^3	
annual average			102 μg/m^3

Note:

1. There is no criteria for oxides of nitrogen, however the conservative approach is to assume all oxides of nitrogen are nitrogen dioxide.

5.1.2 Emission Standards

In addition to ambient air guidelines discussed above, emission standards for new stationary facilities have been set or adopted on a national level and in Victoria and New South Wales.

The VEPA has set out emissions standards for CO and NO_x under the Environment Protection Act 1970. Emissions from all new facilities in NSW are subject to emission limits set out in the Clean Air Act 1961. National emission standards for air pollutants have been set out by the NHMRC (1986). The emission standards set by each of these bodies are listed in Table 5.2

TABLE 5.2 EMISSION STANDARDS

Pollutant	National	Victoria	New South Wales
Carbon monoxide	1.0 g/m^3	2.5 g/m^3	No standard set
Oxides of nitrogen	0.09 g/m^3 (see note 1)	0.09 g/m^3 (see note 2)	2.5 g/m^3 (see note 3)

Note:

1 - Emission standard for oxides of nitrogen for gas turbines rates at less than 10 MW. Nitrogen oxides calculated as NO_2 at 15% oxygen reference level.

2 - Emission standard for oxides of nitrogen for gas turbines rated at less than 30 MW. Nitrogen oxides calculated as NO_2 at 15% oxygen reference level.

3 - Oxides of nitrogen expressed as NO_2. New installations may be required to adhere to tighter license requirements (typically 0.5 to 1.0 g/m^3)

The VEPA has indicated that the pipeline itself will not be required to be licensed as it is not a scheduled development. However, the compressor stations at Longford and Cann River will be required to be licensed if they each produce more than 100 kg/day of NO_x or 500 kg/day of CO. Based on emissions data provided on similar compressors to be used at the Longford site (discussed in Section 5.3.2), the compressor station at Longford will require a licence.

The NSW EPA has indicated that the compressor station at Michelago will be required to be licensed if it consumes more than 300 kg/hour of fuel.

5.2 PIPELINE CORRIDOR

5.2.1 Accidental Releases

The impacts of accidental release and the necessary procedures to minimise risks related to health and safety, fire and explosion issues are detailed in the Safety, Risk and Emergency Response report undertaken by others and, as such, are outside the scope of this survey. The impacts of accidental release on greenhouse gas emissions are mentioned in Section 6.2.3.

The proposed pipeline will use the latest pipeline technology and materials and is designed to eliminate gas leakage. The potential adverse environmental impacts due to any accidental leakage of natural gas (other than health and safety, fire or explosion risks) would relate largely to the asphyxiation of natural biota (flora/fauna) in the vicinity of the leakages due to the displacement of air/oxygen. Such displacement/depletion is considered unlikely in relatively open, above-ground areas unless large, concentrated volumes were released under particular atmospheric conditions such as low turbulence and low wind speed. It is likely to be of most concern in confined or semi-confined spaces, above or below-ground within natural and artificial openings and within soil pores. Such effects are akin to problems in areas such as domestic waste landfills and other methane generating systems (e.g. accumulation of gas in pits, decay of surface vegetation, etc).

The proposed system for detection and control of accidental releases of natural gas from the pipeline provides sufficient means for the detection and rapid verification of any such potential impacts.

5.2.2 Planned Releases

Episodes of planned releases of gas from the system are infrequent and of a short duration (less than a couple of hours) episodic nature. Planned releases include:

- gas used for flushing the pipeline during commissioning of the pipeline;
- gas released during compressor station venting once a year for emergency and safety training;
- station blowdowns which are planned for approximately once every 10 years; and
- gas released during routine internal cleaning and inspection of the pipeline. This is carried out by inserting computerised cleaning devices ("pigs") at the scraper barrel stations. This work is undertaken approximately once every 10 years.

The volume of gas releases is difficult to estimate at this stage, but a natural gas release during these events will have negligible impact on ambient air quality as the events are of short duration and can be planned at times of favourable meteorological conditions so that the gas rapidly disperses in the atmosphere.

The impact of these releases on greenhouse gas emissions is discussed in Section 6.2.3.

5.2.3 Odour Impacts

Natural gas comprises mostly of methane (approximately 95%), which is an odourless and colourless gas, with mainly propane, ethane and butanol making up the rest of the gas. As a result, natural gas has very little odour. Odourants (mercaptans) are typically added to natural gas for safety reasons, so that gas leaks may be detected. Based on discussions with BHP Petroleum, it is understood that such odourants will not be added to the gas in the pipeline and that the odourants will be added after the sales taps.

5.3 COMPRESSOR STATIONS

Atmospheric impacts from the operation of the proposed compressor stations at Longford and the two future stations near Cann River and Michelago have been assessed by using air dispersion modelling to predict the maximum hourly and annual average ground level concentration of NO_x resulting from the operation of these facilities.

5.3.1 Air Dispersion Modelling

The approach taken has been to use a computer based air dispersion model with hourly meteorological data to estimate the ground-level concentrations, resulting from emissions from the compressor stations, at specified receptor points for each hour of the year using available meteorological data.

The dispersion model used in the assessment was the AUSPLUME dispersion model. AUSPLUME is a regulatory model which meets the requirements of Schedule E of the Victorian State Environment Protection Policy (The Air Environment) and recommended by the NSW EPA in air quality investigations. The model is an advanced Gaussian dispersion model based on the US EPA Short Term Industrial Source Complex Model

(ISC). A full technical description of AUSPLUME is presented in the AUSPLUME user manual (VEPA, 1986).

AUSPLUME takes as its inputs, stack configuration data, emissions data (based on known emission rates) and hourly meteorological data. Further detail on the stack configuration and emissions data is presented in Section 5.3.2. Detail on the meteorological data files used in the dispersion modelling are included in Section 5.3.3. In addition, information is also required on the location of various points in the surrounding terrain for calculating the concentration. These points are called receptors. For the purpose of modelling the emissions from the compressor stations, a receptor grid has been set up.

The model stores in memory the hourly concentrations that are calculated for each receptor point over the period for which the meteorological data applies. The stored hourly values of concentration are then used to determine the maximum hourly ground level concentration (glc) at each receptor for the meteorological data set and/or the glc for other appropriate averaging periods, in this case, the annual average.

The maximum and annual average glc's were estimated by modelling the impact of the emissions using the following parameterisations:

- the turbines were modelled as three separate stacks (point sources) 13 m tall with a 0.6 m diameter and emissions data detailed in Table 5.3;
- a polar receptor grid with a 2 km radius covering the nearest sensitive locations;
- a meteorological data file containing one years data was obtained from Esso Gas Plant for the period August 1991 to July 1992;
- building wake effects have been considered assuming a 10 m tall building.

All other parameters used were the AUSPLUME default values.

5.3.2 Emissions Data

Longford

The compressor station at Longford station will initially consist of two gas turbine compressors and will be upgraded to three compressors within five years of commissioning of the pipeline.

The Longford compressor station will be located in a metal shed on approximately 15 hectares of land with 10 to 12 hectares of the land acting as a buffer zone. The nearest residences are located more than 2 km from the proposed compressor station.

The compressor station will comprise of modern gas fuelled turbines fitted with dry low NO_x combustors and a gas filter to remove particulates. Exact details of the compressors have not been confirmed at this stage. Each turbine will be rated with a nominal output power at around 4 to 5 MW.

BHP Petroleum have supplied specifications for the type of turbines likely to be used, which are similar to turbines currently operating at facilities in Canada. Emission rates for the proposed gas turbines have been estimated from technical specifications from the suppliers of the turbines and are detailed in Table 5.3

Details of the compressor building are not known at this stage. Based on similar structures in Canada, a building height of 10 m has been assumed. Both the VEPA and the NSW EPA recommend that the minimum stack height not be less than 3 m below the height of the tallest structure. On this basis a minimum stack height of 13 m has been assumed.

TABLE 5.3 TURBINE EMISSION DATA (per unit)

SOLAR TURBINES [1] - Model Centaur 50-T58005	
Fuel flow	52.82 GJ/hr
Nominal net Output Power	4 436 KW
Engine Exhaust flow	67 101 kg/hr
	~52 100 Nm^3/hr
Exhaust Temperature	513°C
Design Stack Exit Velocity	15 m/s
Design Stack Diameter	0.6 m
Maximum Gas Turbine Emissions	
NO_x (25 ppmv at 15% 0_2, 513°C)	1.91 g/s
CO (50 ppmv, @ 513°C)	2.30 g/s
VHC (25 ppmv @ 513°C)	0.68 g/s

Note:
1 - Prospective supplier

Based on the above maximum emissions of CO and NO_x, the compressor station at Longford would require a licence as indicated in Section 5.1.2.

5.3.3 Meteorological Data

Longford

Meteorological data for Longford has been presented in the report "Climate and Meteorology, Eastern Gas Pipeline Project" (Enviromet, 1995). The meteorological data file used for dispersion modelling was prepared from wind and temperature recordings at Longford. Upper-level temperature data from radiosonde ascents at Laverton (some 200 km to the northwest of Longford) were used in calculating mixing depths. Atmospheric stability classes have been calculated using estimates of solar radiation (derived from the time of day) and cloud cover observations at Sale.

Windroses for the meteorological data at Longford for 1991/1992 are presented in Figure 5.

Other compressor site locations

The exact location of the remaining two proposed compressor stations has not yet been finalised, however their general location will be in open, rural areas most likely near Michelago and Cann River. A general description of the climate and meteorology of these areas has been summarised in Section 3.2.

Since there is no firm location for these stations or any site specific meteorological data, results of worst-case predicted glc's at the Longford site can be used to provide an indicative estimate of glc's resulting from emissions from the future compressor stations.

5.3.4 Modelling Results

A worst case scenario was adopted to model emissions from the compressor station using the emissions data in Table 5.3. It was assumed that the three turbines were all operating simultaneously at maximum capacity for the whole year and that there is a 100 % conversion of NO_x emissions to NO_2. The predicted glc's from the dispersion modelling at the proposed Longford compressor station site are presented in Table 5.4

CO emissions from the turbines are similar in magnitude to the NO_x emissions (refer Table 5.3). Therefore, given that the ambient criteria for CO is approximately two orders of magnitude higher than the ambient criteria for NO_x, it is reasonable to conclude that if the NO_x criteria are satisfied, then the CO criteria would certainly be satisfied also, and so it was not considered necessary to model CO directly.

TABLE 5.4 MAXIMUM PREDICTED NO_x CONCENTRATIONS AT LONGFORD

	Maximum Predicted GLC's at Longford (3 compressors @ full load) ($\mu g/m^3$)			
Pollutant	**100 m**	**500 m**	**1000 m**	**2000 m**
NO_x - 1 hour	279	137	134	105
NO_x - annual average	22	9	4	2

5.4 DISCUSSION

Dispersion modelling of NO_x emissions under maximum (worse case) operating conditions at the Longford compressor station site with a 13 m stack predicted maximum 1-hour and annual average glc's below the ambient criteria in both Victoria and NSW. The predicted maximum 1-hour glc was 279 $\mu g/m^3$ at 100 m from the plant and most values were below 200 $\mu g/m^3$.

The predicted maximum 1-hour glc was 105 $\mu g/m^3$ at 2000 m from the plant and most values were below 80 $\mu g/m^3$, more than three times lower than the accepted 1-hour limit.

The predicted glc's for NO_x have not been superimposed on background levels, as the existing levels of NO_x in the region are not known, although it is anticipated that the average background levels would be low as indicated in Section 3.3.

The modelling was performed for three turbines operating simultaneously. The Cann River and Michelago compressor stations will have two turbines and one turbine respectively. Therefore the likely glc's from these stations will be lower than Longford and will also be below the ambient criteria for Victoria and NSW.

6.0 GREENHOUSE GAS EMISSIONS AND OZONE DEPLETION

6.1 BACKGROUND

6.1.1 The Greenhouse Effect

The Greenhouse Effect is the phenomenon whereby certain gases, known as greenhouse gases, capture heat radiated from the earth and re-radiate it back to the earth This mechanism maintains the thermal balance that controls the earth's climate. It is now well established by a consensus of scientists that that balance may be being disturbed by steadily increasing concentrations of certain greenhouse gases, principally carbon dioxide (CO_2). This change is known as the enhanced greenhouse effect and it is predicted that it may change global climate patterns.

CO_2 is the main greenhouse gas of concern. It is the inevitable product of the combustion of fossil fuels and accounts for about half of the total enhanced greenhouse effect. The other main greenhouse gases are, methane, nitrous oxide (N_2O) and Chloro-Fluoro-Carbons (CFC's). The emissions of these other gases are much less than CO_2, but their effect in the atmosphere is significant because they are more effective as greenhouse gases. The relative effectiveness of greenhouse gases, known as Global Warming Potential (GWP), is strongly dependent on the period of time over which the effect is considered. When taken over 100 years the GWP of methane is 18-33 times greater than the same weight of CO_2. When considered on the basis of carbon content the relativity of methane to CO_2 is about 9 times. Similarly, one molecule of nitrous oxide is about 300 times more potent than a molecule of CO_2. Although CFC's are potent greenhouse gases there are none present in natural gas as noted in Section 6.3 below.

6.1.2 International Agreement to Control Greenhouse Gas Emissions

There is international concern that continuing uncontrolled emissions of greenhouse gases into the atmosphere will result in changes in the earth's climate with adverse consequences. Accordingly, the internationally agreed Framework Convention on Climate Change (FCCC) has been developed to encourage countries to control their emissions of greenhouse gases. Australia is a signatory to the FCCC and the Australian Governments have developed a National Greenhouse Response Strategy which is:-

> *To contribute towards effective global action to limit greenhouse gas emissions and enhance greenhouse gas sinks; to improve knowledge and understanding of the enhanced greenhouse effect; and to prepare for potential impacts of climate change in Australia.*

The key quantified principle in the development of response measures is that they should be directed towards:-

> *The interim planning target of stabilizing relevant greenhouse gas emissions based on 1988 levels, by the year 2000 and to reducing these emissions by 20 percent by the year 2005, subject to Australia not implementing response measures that would have net adverse economic impacts nationally or on Australia's trade competitiveness in the absence of similar action by major greenhouse gas producing countries.*

6.2 IMPACT OF PIPELINE ON GREENHOUSE GAS EMISSIONS

6.2.1 Fuel Substitution

The completion of the EGPP will make available additional natural gas supplies to Sydney and new natural gas supplies to townships along the route of the pipe. This gas resource will principally be used for domestic, industrial and power generation purposes. The increased availability of natural gas may also encourage the introduction of Compressed Natural Gas (CNG) fueled vehicles in the longer term. CNG fueled buses have already been introduced in some cities. Gas used in the domestic sector will almost exclusively substitute for the use of electricity for cooking, water heating and home heating. Gas used in the industrial sector will partly substitute for electric heating and will in part be used to substitute for heating oil in process heating applications.

Where the new source of gas is used for power generation it will probably be used in new gas turbine combined cycle (GTCC) power plants to meet additional electricity demand and to some extent to substitute for coal used in existing coal fired power stations. Additional gas fired power generation would not substitute for hydroelectric power from the existing Snowy Mountain Scheme because there is no economic advantage in backing off hydroelectric power generation.

The extent of penetration of gas from the new pipeline into each of these markets will depend on commercial decisions and market forces which will change with time and cannot yet be fully defined. For the purpose of estimating the impact of the EGPP on greenhouse gas emissions at an undefined point in time the following illustrative assumptions are made:

- 12% of the delivered gas will be used in the domestic sector;
- Gas used in domestic appliances will yield 26% less of its net calorific value as useful heat than electrically heated appliances;
- 40% of the delivered gas will be used in the industrial sector;
- 70% of the gas used in industry will substitute for coal-firing and 30% for oil-firing;
- Gas used in new or refurbished industrial appliances will yield 25% more of its net calorific value as useful heat than existing coal or oil-fired appliances;
- 48% of the delivered gas will be used in new GTCC power plants;
- A new GTCC power plant would operate at 50% overall thermal efficiency (net calorific value basis) from gas to power; and
- Electricity demand which is backed off (or additional electricity demand which is avoided) by the introduction of the new gas supply would otherwise be provided by coal fired power plants burning black coal with an overall thermal efficiency (net calorific value basis) of 35%.

On the basis of these assumptions the overall effect of fuel substitution is that the use of 1 GJ of natural gas would substitute for the alternate use of 0.15 GJ of heating oil and 1.26 GJ of black coal.

The amount of CO_2 emitted by burning fossil fuels depends on the ratio of carbon to hydrogen in the fuel. For the purpose of this illustrative comparison CO_2 emission factors of 51, 70 and 90 kg CO_2/GJ for natural gas, fuel oil and black coal respectively are assumed.

On this basis, assuming an increased natural gas consumption of 41 PJ per annum, 2.14 million tonnes of CO_2 would be emitted when the gas is burnt. This energy source would substitute for 53 PJ of black coal and 6 PJ of heating oil. These alternative fuels would emit 4.8 and 0.44 million tonnes of CO_2 respectively. Thus the effect of fuel substitution on direct CO_2 emissions from fuel combustion is that the use of natural gas would result in a reduction of CO_2 emissions of about 70% compared with alternate fuels displaced.

6.2.2 Full Fuel Cycle Considerations

In comparing the greenhouse gas emission implications of alternative uses of fossil fuels it is important to consider the additional emissions associated with the fuel supply systems and the associated emissions of other gases which make a contribution to the greenhouse effect. Table 6.1 shows a comparison of greenhouse gas emissions on a full fuel cycle basis for the gas which would be transmitted by the pipeline and a comparative energy supply scenario based on traditional fossil fuels. The derivation of the contributions of the external factors are set out below.

TABLE 6.1 IMPACT OF PIPELINE ON GREENHOUSE GAS EMISSIONS

Greenhouse Gas Source (Basis = 41 PJ/annum energy end use)	Thousands of tonnes of CO_2 per annum (or equivalent)	
	With pipeline	Without pipeline
Combustion of natural gas	2140	-
Combustion of heating oil	-	440
Combustion of coal in power station	-	4760
Methane losses and purge	1.9	160
Energy use in fuel supply system	48	110
Unburnt hydrocarbon emissions	190	-
N_2O emissions from coal combustion	-	110
Total	**2380**	**5580**

6.2.3 Methane Losses from Natural Gas Systems

Methane is a significant greenhouse gas, as noted in Section 6.1.1. In older gas distribution systems leaks of natural gas can amount to as much as a few percent of the total gas transmitted. In the context of greenhouse gas emissions, where a molecule of methane is equivalent to about 9 molecules of CO_2, losses of this magnitude would make a significant impact on total greenhouse gas emissions. In new installations with modern piping materials leakages of natural gas are virtually eliminated. Safety considerations and the avoidance of economic loss also contribute to the elimination of leaks. If a leakage rate 0.01% is assumed then leakages could contribute a greenhouse gas emission equivalent of about 1,900 tonnes of CO_2 per annum.

Accidental leakage of methane due to rupture of the pipeline could result in a large release of gas. In such an event, automatic shut-off valves would isolate the damaged section of pipe, but it is possible that all the gas from a 35km section of the pipeline would be released. The hazards associated with such an incident are considered in the Safety, Risk and Emergency Response report undertaken by BHP Engineering. A 35 km length of 430mm diameter pipe at 15,000 kPa pressure would contain about 550 tonnes of methane. The release of that quantity of gas would be equivalent in greenhouse gas terms to the release of about 13,000 tonnes of CO_2. In the context of the annual greenhouse gas emission saving of nearly 2.5 million tonnes per annum of CO_2 equivalent attributable to the use of the pipeline, the greenhouse gas emission consequences of the very unlikely occurrence of a pipeline rupture are insignificant

6.2.4 Methane Purging from Gas Compressor Station

Purging of gas from the gas compressor stations has to be carried out about once every ten years as a part of routine maintenance. The amount of gas purged is estimated to be 2,600 Nm^3 corresponding to about 1.9 tonnes of methane which would be equivalent in terms of greenhouse effect to about 46 tonnes of CO_2. Hence the greenhouse gas contribution of the purge would be equivalent to about 5 tonnes of CO_2 per annum.

6.2.5 Gas use in Transmission System

The gas compressor station proposed for installation at Longford to provide for transmission of the gas at the initial design flowrate, will be driven initially by two gas turbines. At full load the gas turbines will consume approximately 105 GJ/hr of natural gas which will produce about 48,000 tonnes of CO_2 per annum. The basing of this estimate on the initial design flow of 58 PJ of gas takes account of the backing-off of local gas supplies caused by the availability of competitive gas supplies through the new long distance pipeline.

6.2.6 Unburnt Methane from Combustion of Natural Gas

Incomplete combustion of natural gas will result in some emissions of hydrocarbons to atmosphere. Data for the gas turbines used for gas compression indicates 99.3% fuel combustion as a worst case. For all applications it is assumed that fuel conversion will average 99%. In terms of greenhouse gas emissions this release of unburnt hydrocarbons corresponds to about 190,000 tonnes of CO_2 per annum.

6.2.7 Methane Emissions from Coal Mining

New South Wales has a coalfield methane leakage factor of 0.5 kg of methane per GJ of energy in the coal (Reference ERDC 1991). Thus the annual coalbed methane release corresponding to 53 PJ per annum of black coal would be 26,500 tonnes. If released to atmosphere this amount of methane would have a greenhouse effect contribution equivalent to about 640,000 tonnes of CO_2 per annum. In the context of greenhouse gas response strategy, such a large emission of methane would probably require mitigation. For the purpose of the present conceptual comparison it is assumed that 75% of the coalbed methane is drained from the mine and burnt to convert it to CO_2. This would have the effect of reducing the greenhouse gas contribution attributable to coalbed methane to about 160,000 tonnes per annum of CO_2.

6.2.8 Energy Uses in Coal Mining, Oil Refining and Transport

Coal mining is a significant consumer of electricity. A typical mining operation might use about 45 kWh of electricity per tonne of coal mined. This corresponds to an additional demand for coal for power generation amounting to about 2% of the coal produced. The consequent CO_2 emissions corresponding to this energy use would amount to an additional 95,000 tonnes per annum.

The energy requirements for oil refining typically amount to about 4% of the energy content of the crude oil input which is used a refinery fuel. Accordingly, additional CO_2 emissions associated with the production of the fuel oil will be about 18,000 tonnes of CO_2 per year.

The energy requirements for transportation of coal from the mine to the power plant will depend on the distance involved. If the coal has to be transported 100 km the corresponding energy use would be of the order of 0.05% of the energy content of the coal. This is insignificant in comparison with the energy requirement for coal mining.

6.2.9 Nitrous Oxide (N_2O) Emissions from Coal Combustors

Nitrous oxide is formed in high temperature coal combustion systems at the rate of about 7 grams of N_2O per GJ of fuel used (Bavaro 1995). The annual N_2O emissions corresponding to the combustion of 53 PJ per year of coal use would be about 370 tonnes per annum. N_2O has a GWP about 300, so the corresponding additional contribution to greenhouse gas emissions is equivalent to about 110,000 tonnes of CO_2 per year.

6.3 IMPACT OF PIPELINE ON OZONE DEPLETION

Depletion of ozone in the upper atmosphere is another phenomenon which is attributed to the presence of CFC's released into the atmosphere. CFC's are man-made compounds used as solvents, refrigerants and propellants. The use of CFC's is being phased out under the terms of the Montreal Protocol. Natural gas does not contain any CFC compounds, nor are any created when natural gas is burnt, therefore the EGPP will have no impact on the phenomenon of ozone depletion.

7.0
AMELIORATIVE MEASURES

7.1 PIPELINE CONSTRUCTION

As discussed in the previous sections, there is the potential for the generation of dust during the construction of the pipeline and the compressor stations. There is also the potential for the generation of dust by wind erosion should there be strong winds during the period where dry surfaces are exposed or disturbed.

Measures which can be taken during the construction of the pipeline and compressor stations to minimise the potential for dust impacts in sensitive areas are outlined below:

- watering of unpaved roads and exposed areas during the construction phase;
- rapid rehabilitation of the disturbed areas; and
- restricting dust generating activities during unfavourable meteorological conditions, particularly if receptors are downwind of such activities

Given the largely remote nature of the pipeline corridor and the duration of the construction, potential dust impacts can be successfully managed so that dust nuisance is negligible.

7.2 PLANNED RELEASES

Natural gas released during planned releases will have negligible impact on ambient air quality as the events are of short duration and can be planned at times of favourable meteorological conditions so that the gas rapidly disperses in the atmosphere.

The impact of planned releases are shown in Section 6 to be small with respect to the greenhouse gas issue, but the quanity of gas released should be minimised where possible. It is understood that the pipeline will be flushed with gas as part of the commissioning and this gas released to the atmosphere. To reduce the Global Warming Potential it is better to flare the gas after flushing.

7.3 COMPRESSOR STATIONS

The EGPP compressor stations will be remotely located in relatively non-polluted airsheds. The predicted ground level concentrations and emissions from the EGPP compressor station turbines are below the ambient guidelines. BHP Petroleum propose to use dry low NO_x burners on the gas turbines with NO_x of 25 ppmv or less. There should be no requirement for further control or ameliorative measures for the turbines.

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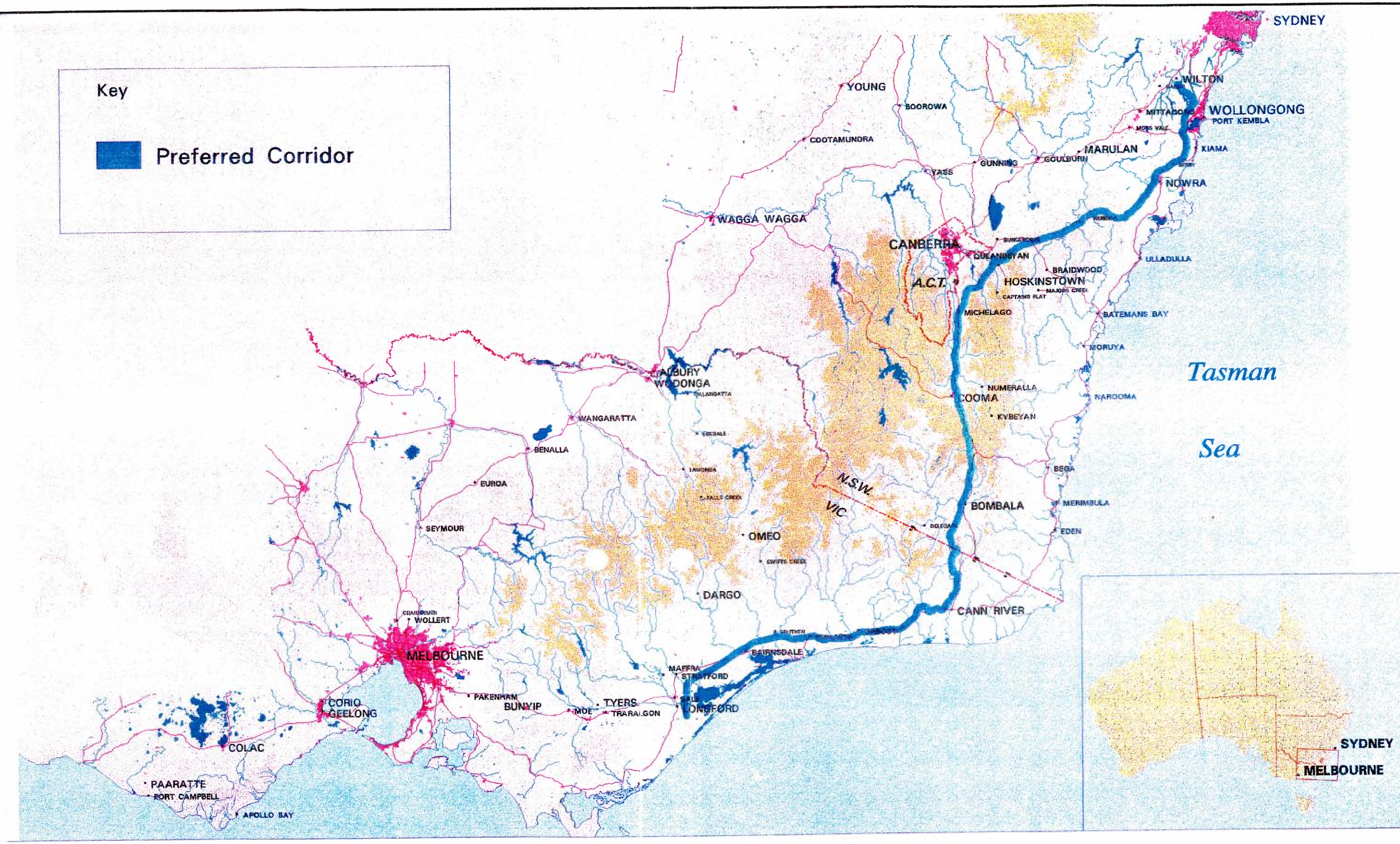
FIGURES



Scale 1: 2 500 000

0 25 50 75 100 125 150

Kilometres

Australian Map Grid
Universal Transverse Mercator Projection

Data sourced from Digital Chart of the World and AUSLIG GEODATA

DESIGNED JW	**Woodward-Clyde**	REVISION A	**BHP PETROLEUM**	
DRAWN LJE	Engineering & sciences applied to the earth & its environment	SCALE AS SHOWN	**EASTERN GAS PIPELINE PROJECT**	
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APPROVED		FIGURE 1	PREFERRED GAS PIPELINE CORRIDOR	
DATE				

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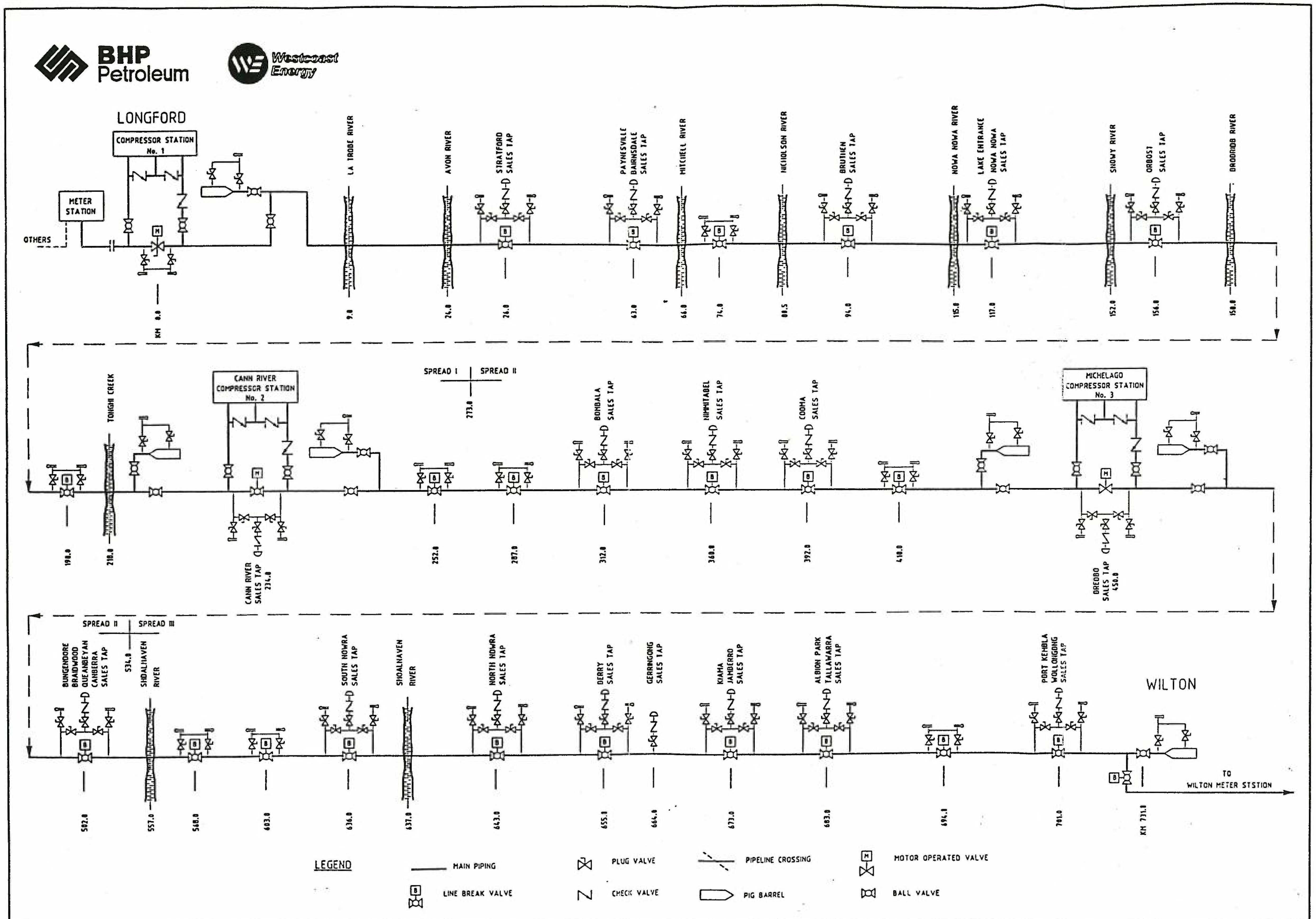

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FIGURE	2

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EASTERN GAS PIPELINE PROJECT

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SCHEMATIC GAS PIPELINE

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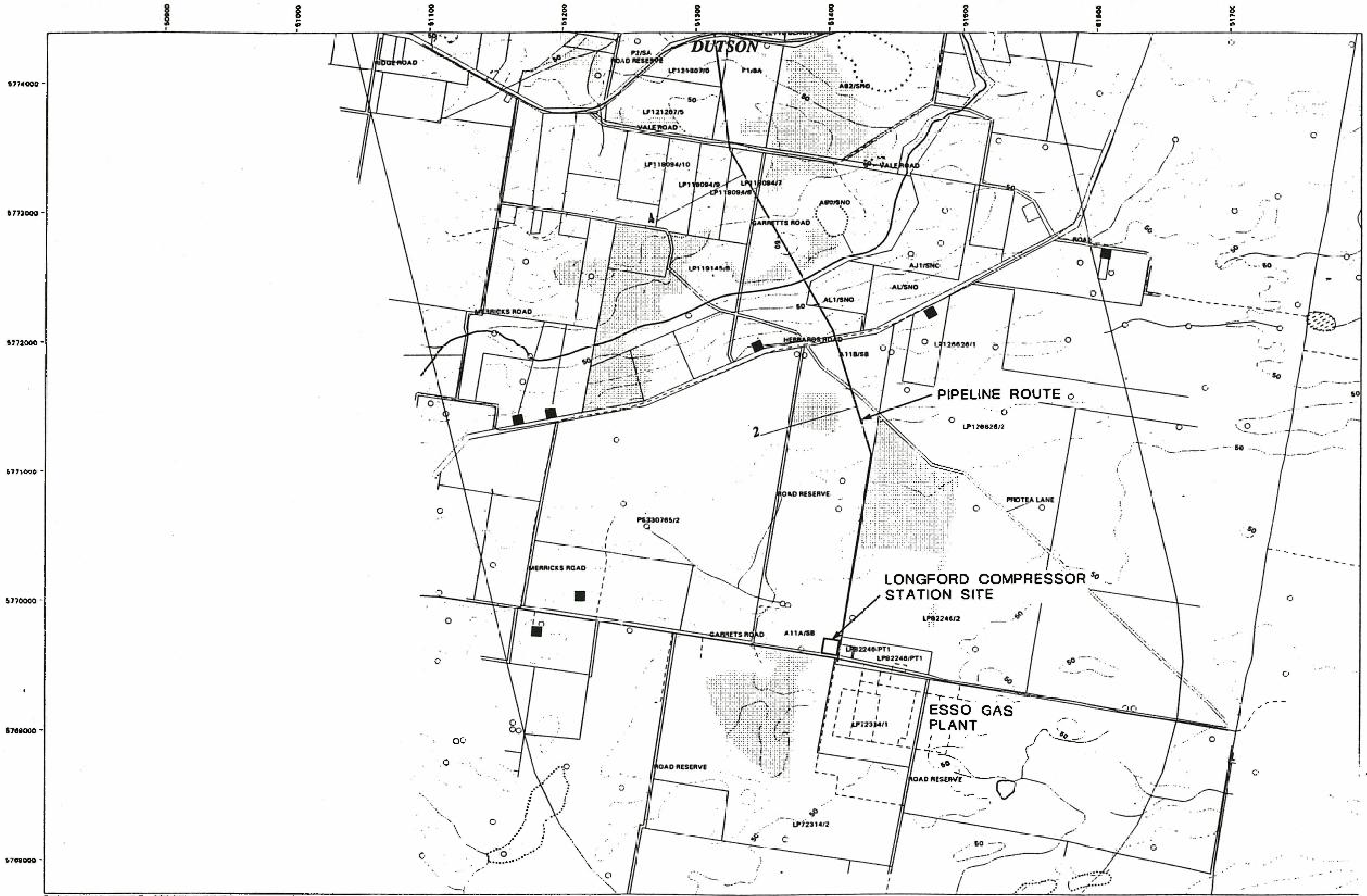

PRELIMINARY ALIGNMENT – SUBJECT TO REVIEW

BHP

Westcoast Energy

Data Sourced From:
NSW Land Information Centre,
Victorian Office of Geographic

EASTERN GAS PIPELINE PROJECT
TOPOGRAPHIC AND CADASTRAL MAPPING

SHEET 1 OF 89
MAP NO : A3-4
MAP REVISION : 5.1
DATE : 5/6/95

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LEGEND

■ RESIDENTIAL DWELLINGS

DESIGNED JW DRAWN LJE CHECKED BL APPROVED B Liddle DATE 19/9/95	Woodward-Clyde Engineering & sciences applied to the earth & its environment AGC Woodward-Clyde Pty Limited Level 6 486-494 Pacific Highway St Leonards, NSW, Australia 2065 Tel (02) 9934 6700 Fax (02) 9934 6710	REVISION A SCALE AS SHOWN DRAWING A3I 23/02G.003 FIGURE 3	BHP PETROLEUM EASTERN GAS PIPELINE PROJECT TITLE: TOPOGRAPHIC AND CADASTRAL MAPPING

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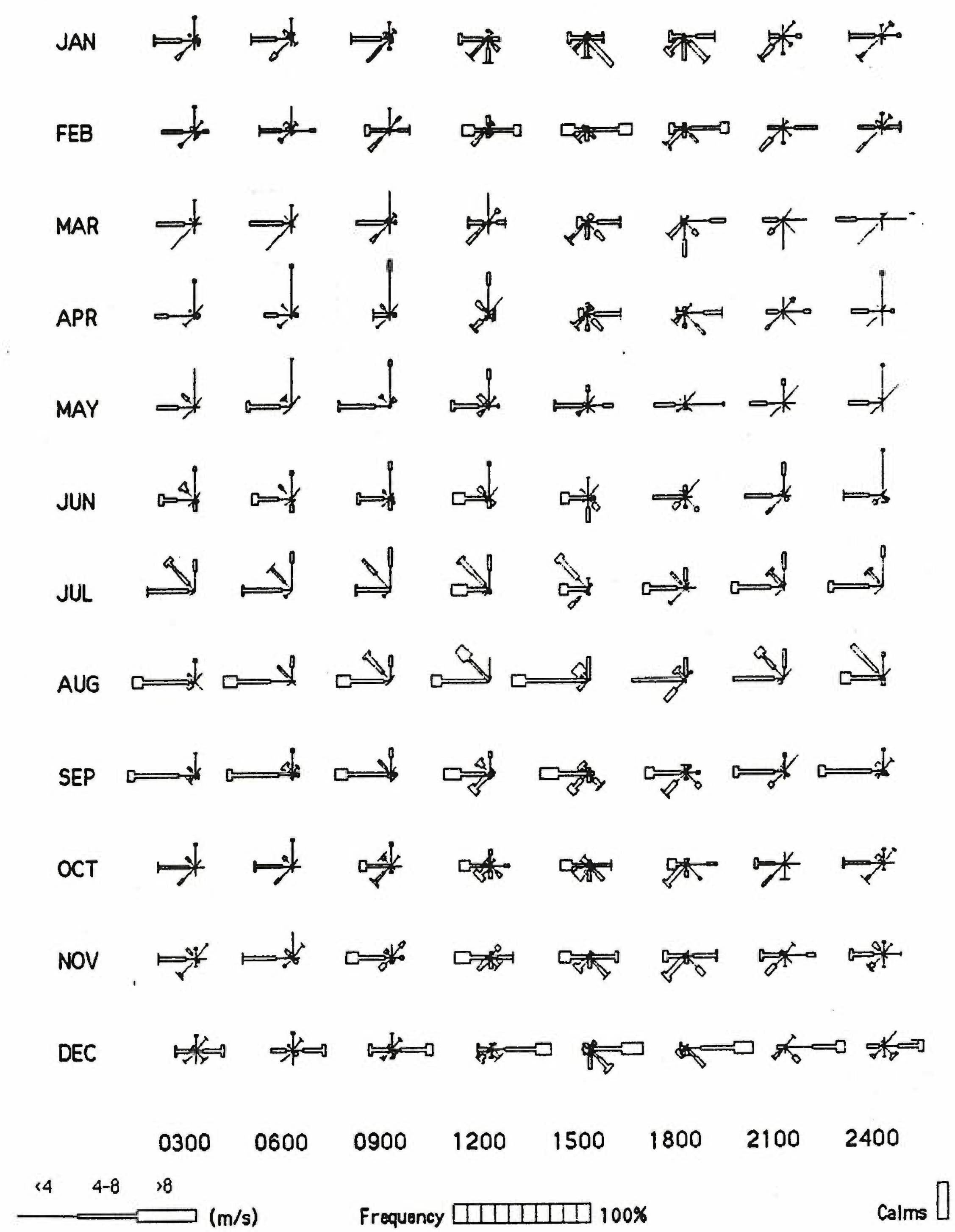
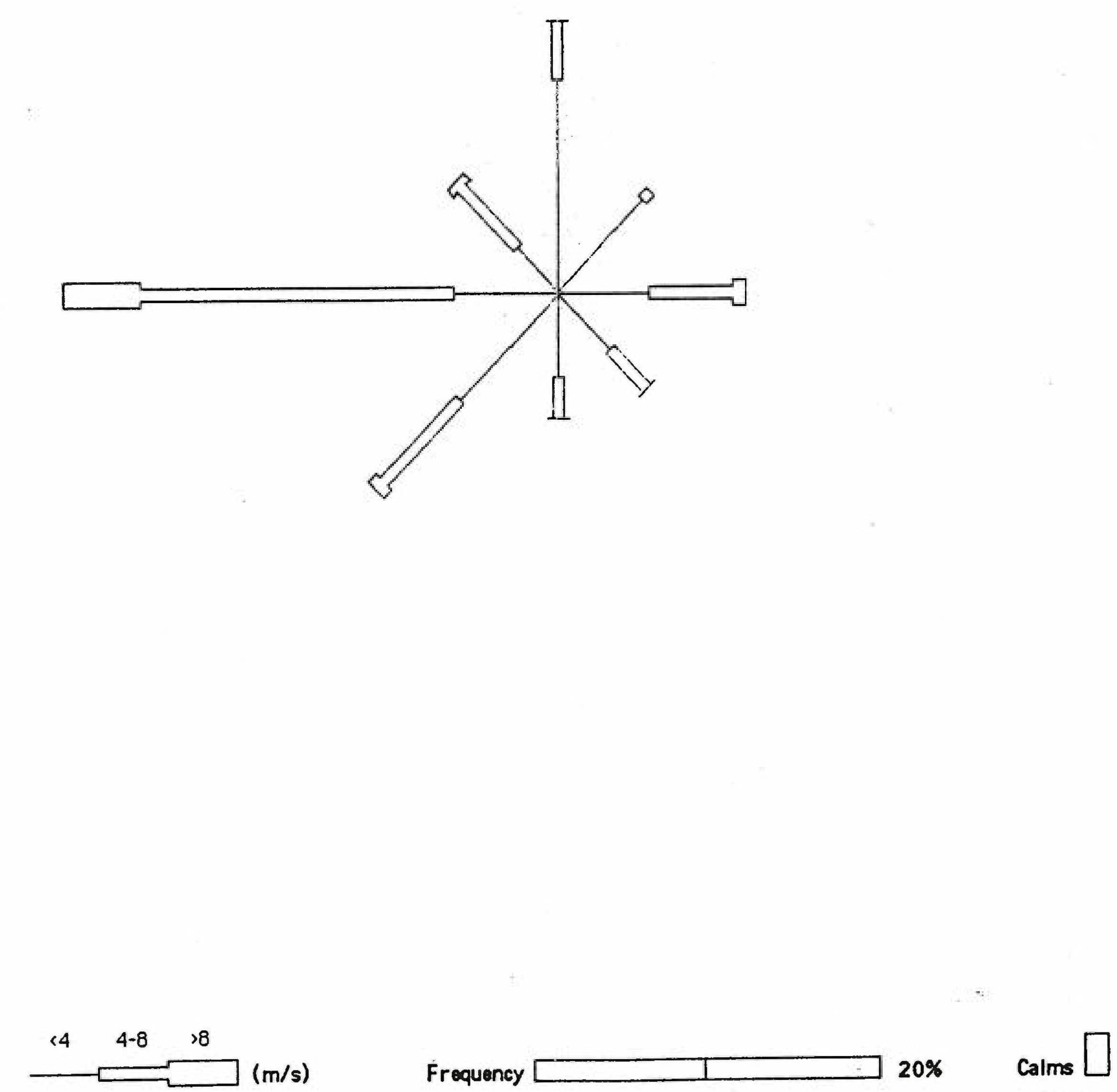


Longford 22AUG91 to 16MAR93

Figure: Three Hourly Wind Roses



Longford 22AUG91 to 31AUG92

Figure: Annual Wind Rose

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FIGURE	5

BHP PETROLEUM
EASTERN GAS PIPELINE PROJECT

TITLE:

LONGFORD WINDROSES

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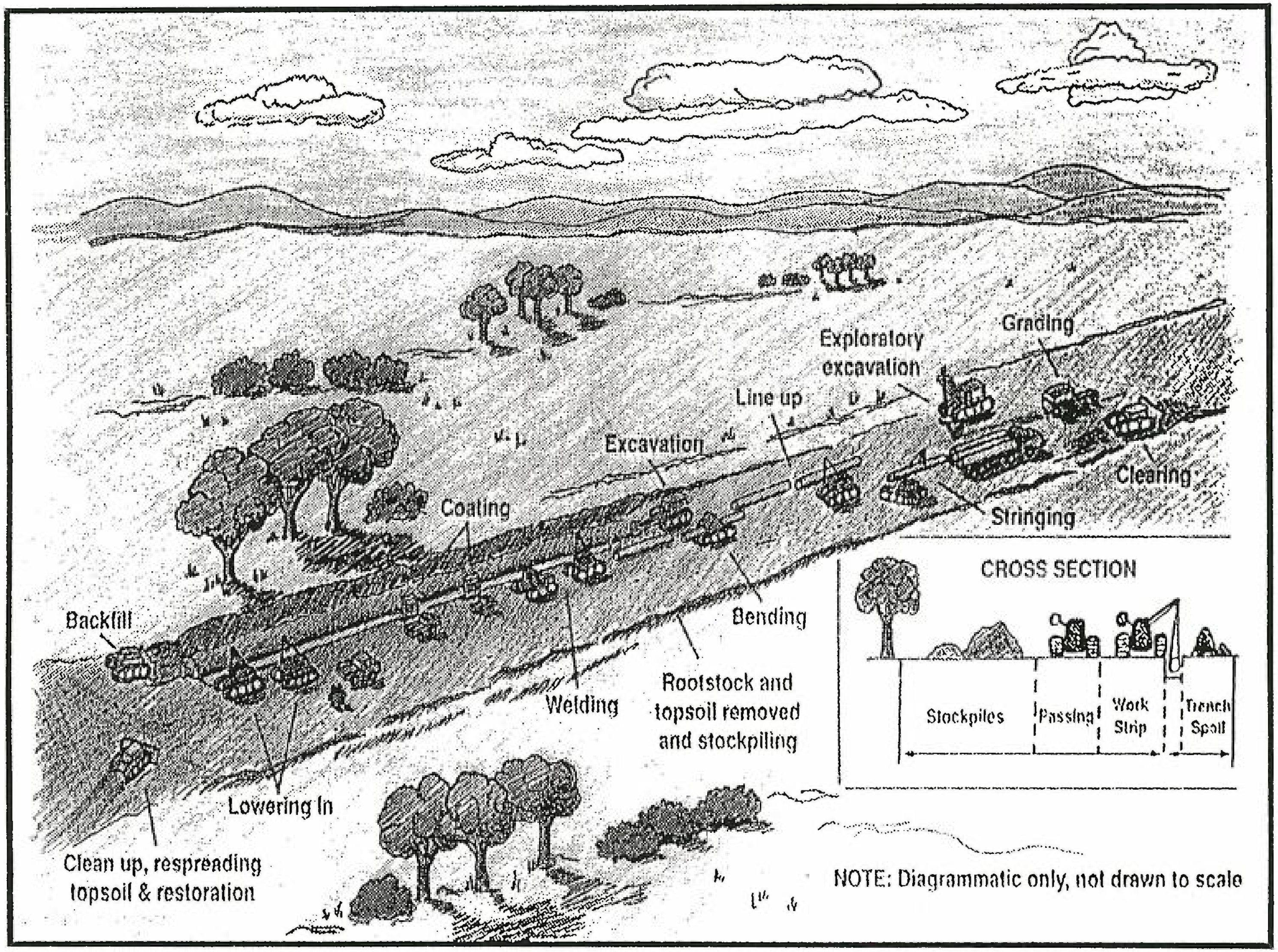

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DESIGNED JW	Woodward-Clyde Engineering & sciences applied to the earth & its environment	REVISION A	BHP PETROLEUM EASTERN GAS PIPELINE PROJECT
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APPROVED B Liddle	AGC Woodward-Clyde Pty Ltd Level 6, 486-494 Pacific Highway St Leonards, NSW, Australia 2065 Tel (02) 9934 6700 Fax (02) 9934 6710	DRAWING A31 23/01G.004	TYPICAL PIPELINE CONSTRUCTION SPREAD
DATE 21/9/95		FIGURE 4	

SYD/LJE/2-94

PLATES

Plate 1 : Esso Gas Plant near compressor station site at Longford .

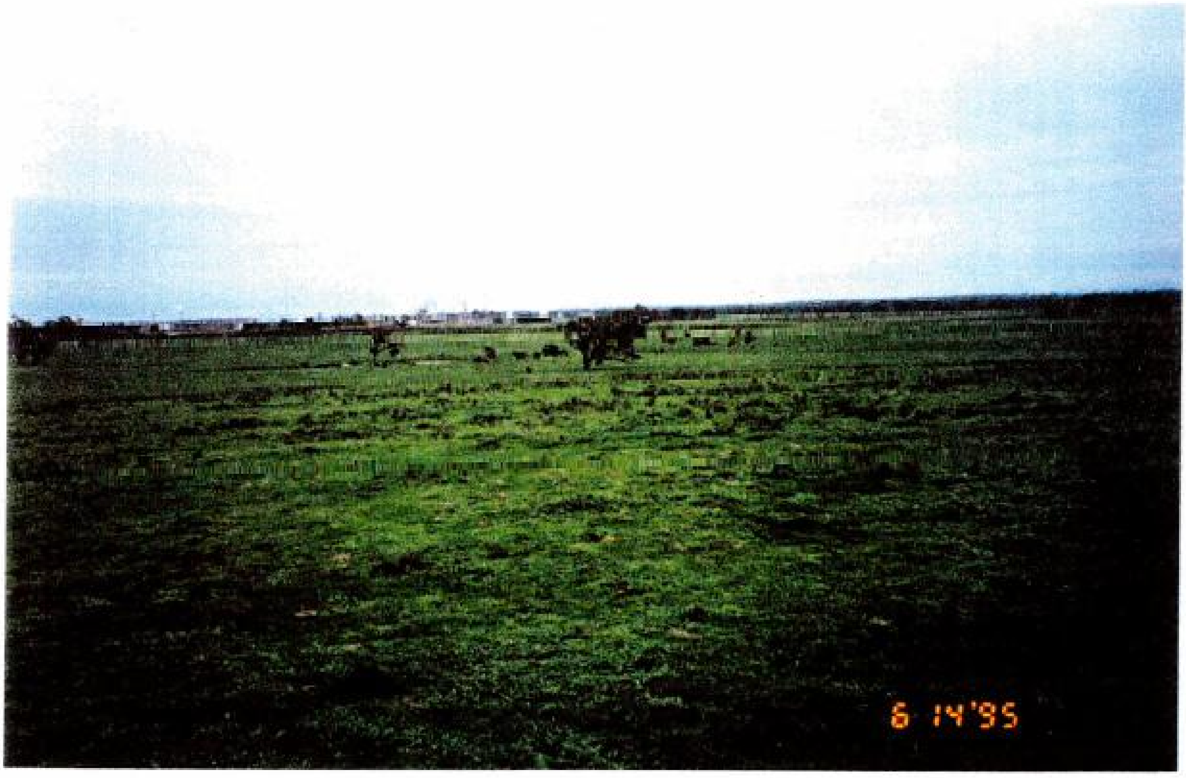

Plate 2 : Esso Gas Plant and surrounding terrain at Longford .

Plate 3 : Pipeline route near Orbost (transmission easement looking east) - Spread I .

Plate 4 : Pipeline route near Victoria and NSW border - Spread II

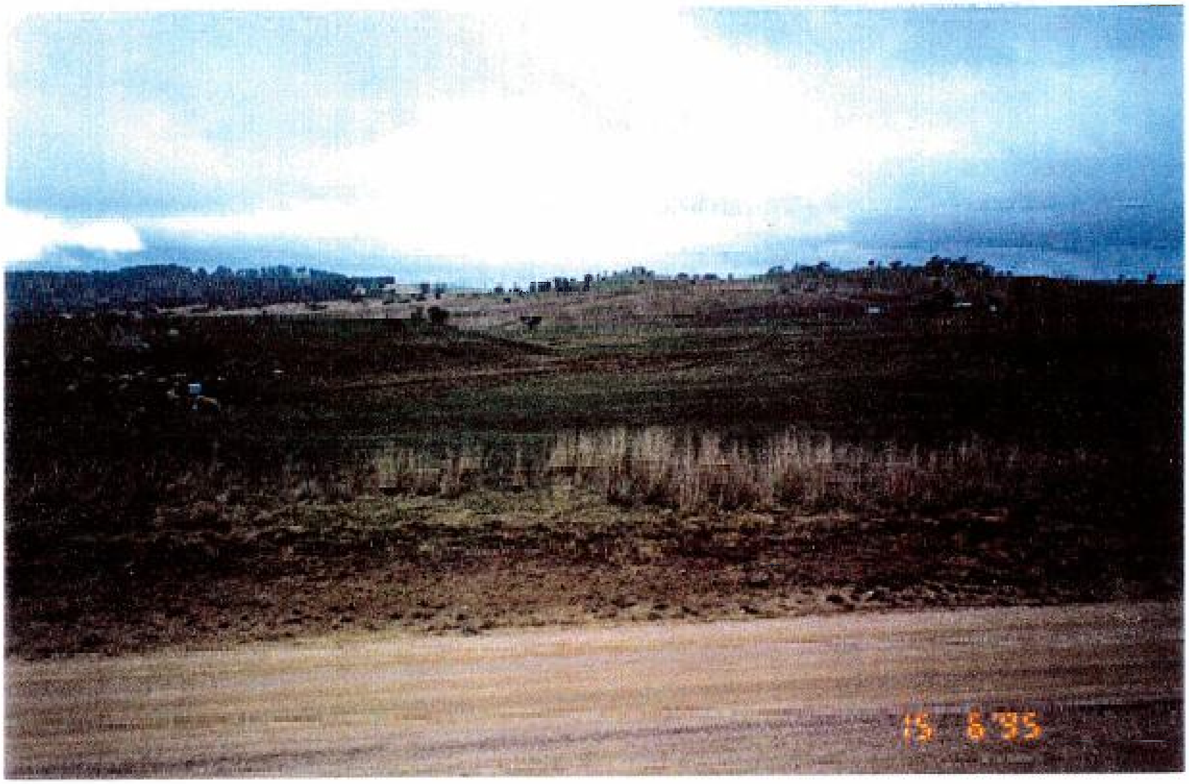

Plate 5 : Southern Tablelands near Mila in vicinity of pipeline route - Spread II .

Plate 6 : Pipeline route near Berry (transmission easement looking north) Spread III .

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