Proposed Expanded Willogoleche Hill Wind Farm
Mid-North, South Australia

Environmental Statement

Volume 2: Main Text

Proposed Expanded Willogoleche Hill Wind Farm

Mid-North, South Australia

Environmental Statement

Volume 2: Main Text

December 2010

Contract Owners: International Power (Australia) Pty Ltd

Level 37 Rialto North Tower
525 Collins Street, Melbourne VIC 3000
AUSTRALIA

Contact: Simon Klapish
Ph: +61 3 9617 8315
Email: simon.klapish@ipplc.com.au
Web: www.ipplc.com.au

Planning Advisors: Wind Prospect Pty Ltd

PO Box 389
Christies Beach SA 5165
AUSTRALIA

Ph: +61 8 8384 7755
Fax: +61 8 8384 7722
Email: admin@windprospect.com.au
Web: www.windprospect.com.au

Acknowledgements

International Power (Australia) Pty Ltd acknowledges the assistance, contribution and cooperation of the following organisations in preparing this report:

- C L Rowe and Associates Pty Ltd
- Environmental and Biodiversity Services
- Hart Aviation Services Pty Ltd
- Lawrence Derrick and Associates
- Sonus Pty Ltd
- Swanbury Penglase Pty Ltd
- Vivienne Wood Heritage Consultant Pty Ltd

Thanks also to the property owners, farm managers and all their families who are a part of the proposed wind farm development.

Abbreviations

ABA	Australian Broadcasting Authority
ABC	Australian Broadcasting Corporation
ACA	Australian Communications Authority
AGO	Australian Greenhouse Office
AHC	Australian Heritage Commission
AusWEA	Australian Wind Energy Association (now Clean Energy Council)
Auswind	Australian Wind Energy Association
CASA	Civil Aviation Authority
CFS	Country Fire Service
COP	Conference of Parties
CSIRO	Commonwealth Scientific Industrial Research Organisation
DAAR	Division of Aboriginal Affairs and Reconciliation
DEH	Department for Environment and Heritage
DD	Department of Defence
DIT	Department of Industry and Trade
EPA	Environmental Protection Agency
EPBC Act	Environment Protection & Biodiversity Conservation Act 1999
ESAA	Electricity Supply Association of Australia
IPCC	Intergovernmental Panel on Climate Change
OLS	Obstacle Limitation Surface
PIRSA	Department of Primary Industry and Resources of South Australia
RNE	Register of the National Estate
SAGRN	South Australian Government Radio Network
WTG	Wind Turbine Generator

Main Text

Table of Contents

List of Tables

List of Figures (Volume 3)

List of Photomontages and Wireframes (Volume 4)

Viewpoint 1

- Photomontage – 26 Turbine Layout
- Cumulative Wireframe – 26 Turbine Layout
- Photomontage – 37 Turbine Layout
- Cumulative Wireframe – 37 Turbine Layout

Viewpoint 2A

- Photomontage – 26 Turbine Layout
- Cumulative Wireframe – 26 Turbine Layout
- Photomontage – 37 Turbine Layout
- Cumulative Wireframe – 37 Turbine Layout

Viewpoint 2B

- Photomontage – 26 Turbine Layout
- Cumulative Wireframe – 26 Turbine Layout
- Photomontage – 37 Turbine Layout
- Cumulative Wireframe – 37 Turbine Layout

Viewpoint 3

- Photomontage – 26 Turbine Layout
- Cumulative Wireframe – 26 Turbine Layout
- Photomontage – 37 Turbine Layout
- Cumulative Wireframe – 37 Turbine Layout

Viewpoint 4

- Photomontage – 26 Turbine Layout
- Cumulative Wireframe – 26 Turbine Layout
- Photomontage – 37 Turbine Layout
- Cumulative Wireframe – 37 Turbine Layout

Viewpoint 5A

- Photomontage – 26 Turbine Layout
- Cumulative Wireframe – 26 Turbine Layout
- Photomontage – 37 Turbine Layout
- Cumulative Wireframe – 37 Turbine Layout

Viewpoint 5B

- Photomontage – 26 Turbine Layout
- Cumulative Wireframe – 26 Turbine Layout
- Photomontage – 37 Turbine Layout
- Cumulative Wireframe – 37 Turbine Layout

List of Appendices (Volume 5)

1. INTRODUCTION

1.1 The Proposal

The Willogoleche Hill Wind Farm was consented by the Regional Council of Goyder ("RCG") in November 2004 (Development Number: 422/0078/04), and more recently was deemed to be substantially commenced on the 22 November 2009 (Letter from RCG ref 3.71.4.1 dated 12th October 2009).

Since the original development approval in 2004 there has been a significant step change in wind turbine technology, with higher capacity turbines and associated increases in turbine dimensions. In response to this, and to maximise the generation capacity of the site International Power (Australia) Pty Ltd (International Power) seeks provisional development plan consent for a new configuration of Willogoleche Hill Wind Farm. This proposal differs from the existing, approved Willogoleche Hill Wind Farm in two key respects:

- the number of turbines is to be increased from the existing 26 to 37 (i.e. up to 11 new turbines); and
- the maximum blade tip height is to be increased from 130 metres to 152 metres. This remains below the CASA 500 foot airspace corridor (152.4 meters), thereby not requiring night lighting under current guidelines.
- Approval is sought for the final positioning of the 37 turbines within a radius of 100 m from the locations indicated in Figure 2 and Figure 3.
- The additional eleven turbines along with associated crane hardstand areas will be accompanied by extensions to the roads and underground cable network of the existing consented wind farm, and other associated infrastructure including cable marshalling infrastructure;

Given the scale of the project and lead times anticipated for completion, Development Plan Consent is requested:

- which has up to seven (7) years for project completion, and up to five (5) years for substantial commencement on site, allowing for the project to be phased (if necessary) to cater for market fluctuations, long lead times for transmission connection modelling and construction, and the potentially lengthier lead times for turbine delivery and financing activities.

In support of this request we point out that in 2008 International Power was granted development approval for the expansion of Pelican Point power station in South Australia, which allows us 10 years for project completion.

Similarly, within Victoria it is now common for councils and planning panels to grant planning permits for wind farm projects which allow for substantial commencement to occur up to 5 years from the date of the permit being granted, with a further 2 years to complete construction (consistent with International Power's planning permit for Winchelsea Wind Farm issued by the Surf Coast Shire in Victoria). These timelines recognise the variable nature of the electricity and renewable energy markets along with of the extended time necessary to achieve financial close for large infrastructure construction projects in Australia.

Collectively, this proposal is referred to from here on as the expanded Willogoleche Wind Farm project.

The nearest turbine is approximately 3.5 km west of the town of Hallett in the Mid-North region of South Australia. The turbines will be erected for the purpose of generating electricity from wind energy.

The proposal was made known publicly in September 2010 via householder/community letters and a community open day in Hallett on October 20th. Feasibility studies commenced many months ago. Results of public consultations and feasibility assessments are presented in this Environmental Statement, as part of the Development Application for the expanded Willogoleche Wind Farm proposal.

The purpose of the Environmental Statement is to support the Development Plan Consent application associated with the construction and operation of the expanded Willogoleche Wind Farm.

The Environmental Statement may also be used in support of subsequent Land Division Consent applications associated with the lease of land for the turbine sites and associated infrastructure.

Referral will also be made to the Federal Department of the Environment, Water, Heritage and the Arts in conjunction with this application for consideration under the *Environment Protection & Biodiversity Conservation (EPBC) Act 1999*.

1.2 The Proponent

The expanded Willogoleche Wind Farm proposal is being developed by International Power, a wholly owned subsidiary of International Power plc of the UK. International Power is a leading independent power generator and the largest independent electricity generator in Australia. Worldwide it has 20,949MW (net) of capacity in operation (34,408MW gross capacity) and 1,393MW (net) under construction. International Power owns and operates power plants in the UK and Europe, North America, the Middle East, Asia and Australia. Within its portfolio International Power has 1,341MW of operating wind generation, which includes 46MW in South Australia at Canunda near Millicent. Other Australian assets include Pelican Point, Mintaro, Snuggery, Port Lincoln and Dry Creek in South Australia, Hazelwood and Loy Yang B in Victoria, and the Kwinana cogeneration plant in Western Australia.

This Environmental Statement has been prepared to provide a project description, site description, discuss all potential effects of the wind farm on the existing environment and community, and the measures proposed to mitigate any potential adverse effects.

The Environmental Statement has been prepared in five volumes, and comprises:

- Volume 1 – Executive Summary
- Volume 2 – Main Text (*this volume*)
- Volume 3 – Figures
- Volume 4 – Photomontages
- Volume 5 – Appendices

NOTE: The subject matter of this report involves the use of technical words, units and terms with which the reader may be unfamiliar. A glossary and list of unit conversion factors has been included in Appendix 1 and reference to this may be of assistance.

Volume 2 (this volume) provides a general project description, a general and detailed environmental assessment for the site. An outline of the contents of this volume is provided below.

Chapters 1-6 provide a project rationale and a project description of the expanded Willogoleche Wind Farm proposal. They also outline planning factors, detailed designs, and the land titles involved in the project, as well as summarising the public consultation process.

Chapters 7-17 contain the bulk of the environmental assessments for the expanded Willogoleche Wind Farm project. They describe:

- The existing physical, ecological and social environments of the region
- Impact assessment information
- Impact mitigation measures

Chapter 18 provides an outline of the benefits of the expanded Willogoleche Wind Farm project in terms of greenhouse gas savings.

2. PROJECT RATIONALE

2.1 Introduction

There has been growing global recognition of the need to mitigate the environmental effects associated with fossil fuel energy generation. Such thought has manifested into international, national and state-wide commitments supporting the development of clean and sustainable energy projects. The expanded Willogoleche Wind Farm development will play an important role in addressing both the local and global call for such projects.

Since the original development approval in 2004 there has been a significant step change in wind turbine technology, with higher capacity turbines and associated longer blade lengths being introduced. This has led to the need for greater spacing between turbines, due to taller towers and larger rotor diameters to capture and covert more electrical energy from the wind resource. With increasing numbers of wind farms being connected there is increasing demand on the high voltage transmission system and therefore, to make the most of limited grid connection opportunities, maximising wind farm capacity on a given site assists project economy of scale and minimises the impact on supporting infrastructure.

2.2 Climate Change – A Global Issue

The consensus of scientific opinion as presented to world governments by the Intergovernmental Panel on Climate Change (IPCC)[1] is that there is a link between man's actions and a variety of climate-related issues. Industrialisation and the resultant emissions of greenhouse gases from the burning of fossil fuels have created, and continue to exacerbate, a global environmental problem – the Greenhouse Effect.

The phenomenon of the Greenhouse Effect can easily be understood as being due to the excess levels of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other greenhouse gases (collectively known as CO_2-e, or CO_2 equivalent) within the Earth's atmosphere, that trap the heat energy from the sun, causing higher than 'normal' surface temperatures. It has been well documented that the Greenhouse Effect is accelerating climatic change on earth. It is predicted that this phenomenon will significantly impact both agricultural and natural environmental systems around the world. It is anticipated that increasing surface temperatures will threaten the stability and functionality of natural ecosystems as well as the productivity of agricultural and aquaculture systems. Such effects have profound implications on human survival worldwide.

In 2007, the IPCC Working Group III (WG III) released a report titled *Mitigation of Climate Change*. The report outlines estimates that the world would need to reduce greenhouse gas emissions by 50-85 per cent of 2000 levels by 2050 to stabilise concentrations to a level which may minimise the most harmful impacts.

An effective way to reduce greenhouse gas emissions is to meet current and growing energy demands by the establishment of renewable energy generation (such as wind power), which would displace generation from fossil fuel sources and thereby prevent the release of further greenhouse gas emissions.

[1] The Intergovernmental Panel on Climate Change (IPCC) is a body established by the World Meteorological Organisation and the United Nations Environment Programme to research and report on the scientific, technical and socio-economic aspects of climate change.

2.3 International Initiatives

Global environmental policies and programs have evolved since the 1992 Earth Summit in Rio de Janeiro, against a background of international research that has led to a growing understanding of the seriousness of global climate change and atmospheric pollution.

The international consensus was first summarised in the Geneva Ministerial Declaration of July 1996. This Conference of the Parties (COP2), addressing the United Nations Framework Convention on Climate Change (UNFCCC) concluded that:

> *The balance of evidence suggests a discernible human influence on global climate. Without specific policies to mitigate climate change, the global average surface temperature relative to 1990 is projected to increase by about 2 ^{0}C...by 2100: average sea level is projected to rise by about 50 centimetres ... above present levels by 2100. Stabilisation of atmospheric concentrations at twice pre-industrial levels will eventually require global emissions to be less than 50 % of current levels.*
>
> *The projected changes in climate will result in significant, often adverse, impacts on many ecological systems and socio-economic sectors, including food supply and water resources, and on human health. In some cases, the impacts are potentially irreversible.*
>
> *Significant reductions in net greenhouse gas emissions are technically possible and economically feasible by utilising an array of technology policy measures that accelerate technology development, diffusion and transfer.*
>
> *The findings of the Second Assessment Report indicate that the continued rise of greenhouse gas concentrations in the atmosphere will lead to dangerous interference with the climate system, given the serious risk of an increase in temperature and particularly the very high rate of climate change.*

These conclusions, representing unprecedented unanimity at the international level, demonstrated the need for action by all tiers of government to avert the deleterious effects of climate change. The foundation of our national response includes the encouragement of renewable energy generation projects through sustainable development initiatives, as well as the complementary development of energy conservation and efficiency measures and lifestyles.

The Third Session of the Conference of the Parties (COP3) took place in Kyoto, Japan, in December 1997, to consider the measures necessary to combat the threats to the global climate identified at COP2. The result was the establishment of the *Kyoto Protocol*, under which industrialised countries aim to reduce their collective emissions of greenhouse gases by 5.2 % below 1990 levels by 2008-2012. Amongst many measures, such initiatives specifically and strongly encourage Governments to pursue emission reductions by actively promoting the development of domestic renewable energy projects.

The ninth Conference of the Parties (COP9) was held in Milan, Italy, in December 2003. The conference saw strong support for the immediate enforcement of the Kyoto Protocol, with many parties adding that its provisions should be implemented even though it is not yet legally in force. Consequently, on 10 March 2004, all provisions of the Kyoto Protocol were made legally binding in the European Union (EU) by a Decision of the European Parliament and the European Council. This means that the Kyoto Protocol has the force of EU law.

Following COP9, Russian President Vladimir Putin approved the treaty on 4 November 2004 and the Russian Federation officially notified the United Nations of its ratification on 18 November 2004. The following Conference of the Parties (COP10) in December 2004 came against the backdrop of the Kyoto Protocol's impending entry into force. With Russia's ratification the previous month, the Protocol was promptly ready to take effect in February 2005, establishing the first binding international commitments to limit greenhouse gas emissions and an international emissions trading system to promote cost-effective reductions.

At the Conference of the Parties (COP13) held in Bali, Indonesia, in December 2008, the newly-elected Australian government ratified the Kyoto Protocol. Later in the term of that Government the Mandated Renewable Energy Target was increased to 20% by 2020, and (following the Copenhagen round of negotiations in November 2009 - COP14), the MRET scheme was split into large scale and small scale renewable energy targets.

2.4 Australian Renewable Energy Policies

2.4.1 *The Australian Perspective*

In 2001, the IPCC produced a report titled, *The Regional Impacts of Climate Change: An Assessment of Vulnerability.* This report provides a regional review of the vulnerability to potential changes in climate of ecological systems, socio-economic sectors (including agriculture, fisheries, water resources, and human settlements), and human health. The report reviews the sensitivity of these systems, as well as options for adaptation, and contains predictions for Australia.

Further to this report, the CSIRO and the Bureau of Meteorology published *Climate Change in Australia 2007*. This publication is based on the IPCC report but provides updated information and summaries of specific Australian observations, scientific developments and studies. This report has been included in Appendix 2 of this ES (the document can be downloaded from (http://www.climatechangeinaustralia.gov.au/technical_report.php). The report presents specific global warming impacts for Australia, based on research completed within the Australian Climate Change Science Program by the CSIRO and the Australian Bureau of Meteorology in partnership with the Australian Greenhouse Office. They include:

- Annual temperature increases of approximately 1.0 °C by 2030, with warming as large as 1.8 °C in some inland regions
- Annual warming ranging from around 1.0 to 2.5 °C for the lowest assumed emission scenario, and 2.2 to 5.0 °C for the highest assumed emission scenario by 2070
- Decreases in precipitation of 2-5 % in most regions, with decreases reaching 10 % in south-west regions. Later in the century the projected precipitation changes are larger and more variable, with the range of annual precipitation change being -30 % to +20 % in central, eastern and northern areas in 2070
- Global sea level rise is projected to be 18-59 cm by 2100, with a possible additional contribution from ice sheets of 10-20 cm
- Storm surges occurring in conditions of higher mean sea levels will enable inundation and damaging waves to penetrate further inland, increasing flooding, erosion and the subsequent impacts on built infrastructure and natural ecosystems

The *Garnaut Climate Change Review Interim Report 2008* (Commonwealth of Australia 2008) describes how comparisons between observed temperature and sea level data and IPCC model predictions suggest that the climate system may be responding more quickly to increased emissions than previously indicated. The report outlines the implications for Australia of ignoring climate change, stating that Australia would suffer drastically from unmitigated climate change, enduring both direct and indirect costs through the effects on other countries of importance to Australia. The report further adds that Australia actually stands to benefit from an effective international mitigation effort, particularly through its exceptionally rich resources for renewable energy.

Wind energy was singled out by the IPCC as a technology of choice to bring new power online without contributing to global warming. Advanced wind turbine design and the development of large land-based wind farms are considered to bring significant reductions in greenhouse gas emissions from the energy sector.

2.4.2 *Australian Renewable Energy Policy*

Australian Federal Government policy currently provides encouragement and incentives for renewable energy generation, of which the Renewable Energy Target (RET) is a principal example.

In 1997, the Federal Government created the Australian Greenhouse Office (or AGO) to provide a whole of government approach to greenhouse issues. In March 2000, the Australian Greenhouse Office became an Executive Agency of Government. The Department of Climate Change was established in December 2007 as a result of the change in Federal Government, and it now oversees any issues previously managed by the Australian Greenhouse Office.

By ratifying the 1997 Kyoto Protocol in 2007, Australia made a commitment to limit greenhouse gas emissions growth to an 8 % increase on a 1990 base level by 2008-2012. The Australian Government has also developed a strategy to further reduce national emissions. Key elements, some of which did not meet their timetable, included:

- A commitment to reduce Australia's greenhouse gas emissions by 60 % on 2000 levels by 2050
- Implementing an emissions trading scheme by 2010 to deliver these targets (now under re-evaluation around carbon taxes, due for decisions by the end of 2011)
- Setting a 20 % target for renewable energy by 2020 to expand the use of renewable energy
- Investing in research and development of low emissions technologies

These initiatives demonstrate that the Federal Government attaches great importance to both greenhouse gas abatement programs as well as measures that support renewable energy projects. The initiatives also further emphasise the valuable contribution that renewable energy projects can provide to national and international greenhouse reduction targets.

2.4.3 *Renewable Energy Target (RET)*

The *Renewable Energy (Electricity) Act (2000)* established the framework for the implementation of the mandatory renewable energy target, and was passed by Parliament in December 2000. After the change of Federal Government in December 2007, the Government committed to increasing the (then) Mandatory RET (MRET) from 9 500 GWh to 45 000 GWh in 2020, to help ensure it achieves its goal of a 20 per cent share for renewable energy in Australia's electricity supply by 2020. The expanded measure is to be phased out between 2020 and 2030 as emission trading develops and prices become sufficient to ensure that a RET is no longer required to drive the use of renewable generation technologies.

At the Council of Australian Governments (COAG) meeting in December 2007, the Commonwealth and States agreed to work cooperatively, commencing early in 2008, to bring the existing MRET and the various State-based targets into a single, expanded national RET scheme by early 2009. COAG confirmed its commitment to cooperative concerted action to address climate change and agreed to finalise a comprehensive framework for addressing climate change in October 2008.

On 26 February 2010, the Federal Government announced changes to the RET scheme. From January 2011, the existing scheme will be separated into two parts – the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET) (Australian Government, 2010). The changes will enhance the RET by providing greater commercial certainty for households, large-scale renewable energy projects and installers of small-scale renewable energy systems like solar panels and solar water heaters.

The establishment of the expanded Willogoleche Wind Farm will make a significant contribution to achievement of the LRET by 2020, and particularly when the current REC oversupply starts to run out in 2014.

2.5 South Australian Sustainable Energy Policy and Objectives

In 1994 the South Australian Government's *Sustainable Energy Policy* was developed by the Office of Energy Policy, which was consistent with and complementary to the National Greenhouse Strategy. The policy provided a strategic framework of programs aimed at improving energy efficiency, reducing our dependency on existing energy resources and increasing the use of renewable energy.

In addition, the State Government launched South Australia's Strategic Plan (Government of SA 2007), which states one of its targets to be:

> *"to increase the generation of renewable electricity to 20 % of all electricity generated in the state by 2014; and to increase the state's consumption of renewable electricity to 20% of the total by 2014."*

The State Government also initiated the nation's first climate change legislation, which came into law on 3 July 2007. The *Climate Change and Greenhouse Emissions Reduction Act 2007* made South Australia the first place in Australia to legislate targets to reduce greenhouse gas emissions. The legislation sets out three main targets:

- to reduce by 31 December 2050 greenhouse gas emissions within the State by at least 60 % to an amount that is equal to or less than 40 % of 1990 levels as part of a national and international response to climate change
- to increase the proportion of renewable electricity generated so that it comprises at least 20 per cent of electricity generated in the State by 31 December 2014
- to increase the proportion of renewable electricity consumed so that it comprises at least 20 per cent of electricity consumed in the State by 31 December 2014

Scientific data demonstrates that South Australia has some of the best wind resources in the nation. At present there are a number of wind farm projects at varying stages of development, constructionand operation, extending from the South East to the Eyre Peninsula.

2.6 Contribution of the expanded Willogoleche Wind Farm

The absolute level of production of electricity from a wind farm depends on a number of factors, principally the average wind speed of the site, the size and efficiency of the turbines, the site layout and the capacity of the grid. Commercial reality dictates that developers seek maximum site output, both to make a significant contribution towards national and state renewable energy targets, and to enable the electricity to be generated as cheaply as possible for the benefit of the consumer.

The expanded Willogoleche Wind Farm represents an attractive opportunity to meet these requirements. Based on the installation of potentially larger turbines of up to 3MW, the proposed larger project with up to 37 wind turbines and potential total installed capacity of around 111 MW could generate, on average, enough electricity to meet the needs equivalent to at least 65 000 average South Australian households (the average per household electricity consumption in South Australia is 6.12 MWh per year (Essential Services Commission of South Australia 2007)). This amount of energy from the expanded Willogoleche Wind Farm would contribute approximately 0.85 % of the "20 % by 2020" target under the 45,000GWh expanded RET, and would increase the potential site capacity by up to 33MW.

On the whole, wind energy is dispatched first onto the electricity grid. Therefore, it can displace generation which would otherwise be generated by fossil fuel sources (such as gas and coal). In turn, wind generation directly results in CO_2-e emissions savings. Using the most recent figures published in the National Greenhouse Accounts Factors (2010), we estimate that the expanded Willogoleche Wind Farm would displace approximately 340 000 tonnes of CO_2-e per annum, and approximately 6 814 000 tonnes over the 20-year operational life of the wind farm (see Appendix 3). Also, a typical wind turbine produces the equivalent of the energy required to manufacture it in approximately 3-5 months of operation, after which it is a net producer of 100 % clean and renewable energy (BWEA 2007). The reduction in carbon dioxide emissions as a result of the expanded Willogoleche Wind Farm would be equivalent to taking approximately 87 000 four-cylinder cars off the road indefinitely. Further details of how the contribution of the expanded Willogoleche Wind Farm can contribute to greenhouse gas savings are presented in Chapter 18.

2.7 Community Benefits

There are a number of local, regional and indeed national community benefits that will arise from the proposed expanded Willogoleche Wind Farm. These include opportunities for local and regional employment, potential diversification of regional tourism interests, direct income for landowners and their families involved in the wind farm project, educational opportunities and the overall long-term benefit to be gained from reduction in national greenhouse gas emissions. Community benefits are addressed in more detail in Chapter 17.

In addition to these benefits, International Power will contribute to local project funding in the form of the expanded Willogoleche Wind Farm Trust Fund. The Trust Fund will be created to ensure that a proportion of the revenue of the wind farm is redirected into local community projects, with particular focus on the nearby township of Hallett, such as:

- Contributing to the local community-based clubs and projects
- Sponsorship of local events/field days/facilities
- Local environmental/cultural heritage projects

2.8 Summary

Climate change has been recognised as a global problem, with both international and national initiatives developed to mitigate potential impacts.

Federal and State Government policy provides the encouragement of energy generation from renewable sources, in order to both reduce harmful atmospheric emissions as well as to meet future demand for energy with diverse and secure supplies.

The development of the proposed expanded Willogoleche Wind Farm would result in the generation of a significant amount of renewable electricity for supply to the National Electricity Market.

It would contribute to the Federal Government's increased target to 20 % of electricity demand being generated from large scale renewable energy sources by 2020. It would displace energy that would have otherwise been generated using fossil fuels, thus reducing emissions of greenhouse gases and assisting in Australia's international obligations to control harmful atmospheric emissions.

The expanded Willogoleche Wind Farm is highly suited to wind energy generation due to a combination of outstanding wind resource, and grid capacity at a nearby connection point. This will enable the development of a high-yielding and efficient wind farm, providing power for approximately 65 000 households.

A typical wind turbine produces the equivalent of the energy required to manufacture it in approximately 3-5 months of operation, after which it is a net producer of 100 % clean and renewable energy.

A number of community benefits will arise from the development of the proposed wind farm, including available funds for community based and managed projects.

3. PLANNING THE DEVELOPMENT

3.1 Introduction

The planning process for the expanded Willogoleche Wind Farm involves a number of steps, and the consideration of a number of statutory regulations and industry guidelines. This chapter summarises the regulatory framework in which the project is developed, and describes the strategic planning process for the proposed expanded Willogoleche Wind Farm project. This process involves planning, design and appraisal work at three distinct levels:

- Site Selection – at a broad scale in order to identify a discrete study area within which proposals for wind farms could be developed, through the analysis of a wide range of technical and environmental criteria
- Site Assessment – of a selected project area to identify all ecological, social, cultural and commercial sensitivities, assets and constraints
- Detailed Site Design – of the wind farm, involving the design of the site layout, access arrangements, type and finish of the turbines and all ancillary structures, in response to various technical, operational, environmental and social constraints to the development within the identified study area

This chapter also presents the land tenure details for the project area and timeframe matters.

3.2 Regulatory Framework

The development of the expanded Willogoleche Wind Farm has been planned in accordance with a number of State and Commonwealth Acts, principally the South Australian *Development Act 1993* and its companion Development Regulations 2008. It is under this Act that International Power seeks Development Plan Consent for the expanded Willogoleche Wind Farm proposal.

The *Development Act 1993* provides for the regulation of development in the State and the regulation of the use and management of land and buildings. Under this Act, councils develop their own Development Plans for implementation, against which development projects are assessed, and must comply. A compliance assessment of the wind farm proposal was carried out against the provisions of the Regional Council of Goyder Development Plan (PIRSA 2007) and the *Planning Strategy for the Development of Regional South Australia, January 2003* (see Appendix 4; CL Rowe & Associates 2010).

A number of other key Acts apply to the wind farm proposal and have a bearing on project planning, including the:

- *Aboriginal Heritage Act 1988*
- *Fire and Emergency Services Act 2005*
- *Environment Protection Act 1993*
- *Environment Protection and Biodiversity Conservation Act 1999* (Cwth)
- *Native Title Act 1993* (Cwth)
- *Native Vegetation Act 1991*
- *Radiocommunications Act 1992* (Cwth)
- *Heritage Act 1993*

Also the expanded Willogoleche Wind Farm proposal has been planned, and the Environmental Statement prepared, in consideration of the Australian Wind Energy Association's *Best Practice*

Guidelines for Implementation of Wind Energy Projects in Australia 2002 (as revised in 2007), Planning SA's *Planning for Wind Farms – Guide for Applicants 2002* and the Environment Protection Authority's *Wind Farms: Environmental Noise Guidelines 2009*.

3.3 Site Selection

A range of factors are considered during the 'site selection' phase, which affects the suitability of an area for a wind farm, and which can potentially constrain development.

Through its appraisal, in consideration of all factors, the currently approved 26 turbine Willogoleche Hill Wind Farm site was initially identified as meeting all required criteria. Since the time of it's consent, the increase in the Federal Government's RET scheme, the difficulties with grid connection options and the high cost of the proposed substation and connection, and the step changes in wind turbine technology, opportunities to increase the size of the project were identified. The expanded project capitalises on these changed political, technical and commercial conditions, to provide for an improved project with greater benefits to all stake holders.

The additional turbines within the expanded Willogoleche Wind Farm proposal are located on the same land titles and effectively capitalise on the high wind resource to utilise additional ridge lines to the west and east of the approved site. The proximity to the existing consented Willogoleche Hill Wind Farm further accentuate the positive nature of the site, with the potential to integrate the expanded wind farm into the proposed infrastructure and construction process thereby minimising the impact required for the additional turbines.

3.4 Site Assessment

A wind farm site feasibility study addressing specific design criteria was undertaken. This study included site assessment of a number of environmental, social and commercial factors such as ecology, cultural heritage, visual amenity and communications.

A presentation of various assessments, results and proposed management is contained in Chapters 7-18.

3.5 Detailed Site Design

Assessment of the results of the wind farm feasibility studies are used to refine the layout of turbines and other infrastructure for the wind farm.

3.5.1 *Technical and Practicality Factors*

A number of technical and practicality factors influence final turbine layout. These include:

The distance between turbines: Distances should in general be equivalent to at least three times the diameter of the turbine rotor proposed for use, in order to ensure that each turbine operates in relatively undisturbed wind. This 'rule of thumb' will vary from turbine to turbine depending on the characteristics of the turbine itself, the wind resource on the site, and the topography.

Internal access tracks: These must interlink turbines, and be constructed up to 6m in width (up to 12 m during construction), and at a gradient suitable for use by heavy vehicles. They should be of stone construction, the nature and colour of which should be appropriate to the land use and landscape of the site. Turning circle radii should be adequate for manoeuvring long loads within the site.

Substation, switchgear yards and buildings location: The Substation, including switchgear yard and buildings, should be located on level ground at a convenient location adjacent to the point of export of the electricity from the site into the ElectraNet electrical transmission system. For the Willogoleche Wind Farm Extension additional grid infrastructure will not be required, as this will be shared with the existing consented wind farm.

Site access: Site access should utilise existing access where possible. The access point will be up to 12 m wide during construction with an appropriate splay in order to accommodate turbine deliveries and site construction vehicles. A gradient criterion must be adhered to. For the expanded Willgoleche Wind Farm no change to the original site access will be required, due to the incremental nature of the capacity increase.

3.5.2 *Environmental Requirements*

In addition to the technical and practicality factors of wind farm site design, the following environmental requirements, which bear directly on site design, are considered:

Turbine micro-site location: Turbines should be located near existing tracks or field boundaries where possible, to minimise disruption to the primary agricultural use of the land and minimise any vegetation clearance or disturbance. They should not be located on identified areas of high conservation value, and if they are proposed in proximity to identified sensitive environments, effective environmental management actions are required.

Separation from dwellings: The turbines should be located so that no neighbouring residential dwelling experiences noise exceeding the EPA noise criteria within their *Environmental Noise Guidelines* for wind farms, or 'shadow flicker' effects. It is likely that such effects will be felt at a distance of less than 750 m for noise and 1200 m (or up to 10 rotor diameters) for shadow flicker. A full analysis of potential noise impacts is presented in Chapter 16. Discussions on shadow flicker effects are presented in Chapter 12.

Visual amenity: Visual effects of a wind farm are highly variable depending on the perceptions of the viewer. However, visual amenity from nearby residences, main roads and points of interest are considered and assessed in Chapter 12.

Ecology: Site selection and detailed site design should be such that any ecological impact is avoided or reduced to acceptable levels. Any residual effects should then be appropriately managed to ensure no significant environmental impacts occur. Ecological assessment of the wind farm site allows significant environmental features to be identified (if any) and allows planning for appropriate management. Discussions on ecological issues are presented in Chapter 9.

Cultural heritage: Site layout should not interfere with or disturb any known sites of Aboriginal or non-Aboriginal heritage. Treatment of such sites is required to be in accordance with relevant legislation and includes negotiation with affected parties. Discussions on cultural heritage issues are also presented in Chapter 11.

Colour: An appropriate colour for the turbine towers and blades should be identified in light of the main views and backgrounds likely to be experienced. The finish should also be matt to reduce glare effects and 'glinting'.

Other: Other environmental considerations include the impact on local farming operations and public facilities such as telecommunications links, and on aircraft operations in the area.

3.5.3 *Safety Requirements*

All commercial wind turbines are designed to engineering standards to ensure their safe operation in all conditions. The designs are independently audited by internationally recognised classification societies, such as *Germanische Lloyd*, and receive type approval.

Wind turbines are safe for use in public access areas. For instance, in Swaffham in the UK, a 1.5 MW turbine with a 65 m tower, and 35 m blades, was approved for installation, and has been installed less than 400 metres from a supermarket and housing, and makes up part of an Ecotech Discovery Centre display. The turbine has a public viewing platform built into it, positioned approximately 60 m up the tower directly under the nacelle (Ecotricity 2007). The local townsfolk have embraced this wind turbine, and have encouraged the wind energy developer to install a second, similar machine at the site. The 1.3 MW turbines located at the Codrington Wind Farm in Victoria are also on display for the public, with guided tours leading up to the base of one of the turbines.

Fire prevention and control will be of paramount importance during the construction and operation of the wind farm site. All aspects of the project will adhere to the *Fire and Emergency Services Act 2005*. Fire risk (during construction and operation) is managed by a number of measures. Dedicated monitoring systems (*e.g.* SCADA) detect temperature increases in the turbines and shut them down when the threshold temperature is reached, thus reducing fire risk. Firebreaks around each turbine are maintained to minimise the risk of fire (*e.g.* from any electrical fault) spreading to any nearby vegetation and pastures. All turbines will be equipped with fire extinguishers to combat any outbreak of fire. The electrical control system in each turbine is enclosed in the steel tower, hence reducing the risk of a fire spreading due to an electrical fault.

The tracks to the turbines themselves may also act as firebreaks, as well as providing access for fire fighting vehicles along the range. Other fire prevention/response measures include the presence of an equipped fire fighting vehicle(s) on-site during construction, maintenance vehicles equipped with basic fire fighting equipment, working cooperatively with the local CFS to ensure they are well informed and effectively prepared for a response (including providing CFS with maps showing turbine locations and gates, and providing access keys and turbine identification information), and the implementation of safety procedures and a project safety plan. This shall include emergency prevention and response measures for events such as a chemical spill and fire, and will require site induction to safety and response measures.

Consultation with the South Australian Country Fire Service (CFS) will take place to ensure that all aspects of fire prevention and response are addressed.

All related high voltage electrical works would be installed and operated to relevant national and international standards and regulations ensuring the highest level of safety.

The permanent wind monitoring masts will be designed to prevent unauthorised persons from climbing them.

All on-site and public safety issues will be addressed by the approved project safety plan and Emergency Response Plan to be developed and implemented by the appropriate contractor(s).

3.6 Locality and Land Tenure

The proposed wind farm is located on the same land boundaries as that for the approved 26 turbine Willogoleche Hill Wind Farm, in the Mid-North of South Australia, approximately 3.5 km west of the township of Hallett. The area of land-take for the associated infrastructure of the wind farm, once-operational, will be less than 1.0 % of available land.

The land proposed for the project area is freehold land, falling within land Certificate of Titles Volumes 5212, 5696, 5192 and 5664 in the Hundreds of Anne and Hallett. A number of land uses exist in the region, which are described in Chapter 10. Broadly speaking, they are agriculture, mineral exploration and recreation. A total of 7 land titles are included in the proposal. Land tenure details are presented in Table 3.1.

Table 3.1 Land tenure details for the proposed expanded Willogoleche Wind Farm project area

Title number		Hundred(s)	Size (ha) (approx.)
Volume	Folio		
5192	721	Anne	195.2
5212	588	Anne	292.9
5212	587	Anne	236.4
5192	720	Anne	237.2
5696	283	Anne	264.1
5664	454	Hallett	708
5192	718	Hallett	344.8
Total			2278.6

3.7 Planning Matters

Approval is sought for the Proposal as presented in Chapter 1, which includes the final positioning of up to 37 turbines within a radius of 100 m of the locations indicated in Figure 2 and Figure 3.

International Power is applying for Development Plan Consent to allow for substantial construction of up to 37 turbines to be substantially commenced within 5 years of the date of Consent, and for the substantial completion date of the project within 7 years of the date of Consent, in line with wind farm projects in Victoria, other large infrastructure projects in South Australia, and to take into consideration the current energy market conditions.

The actual timing of construction will principally be driven by the length of time taken to obtain other permits and authorisations, attaining Board approval/project financing for commencement and the long lead times for wind farm components, with particular emphasis on lead times for transmission connection to ElectraNet's 275kV system.

4. PUBLIC CONSULTATION

4.1 Approach to Consultations

Public consultation for the project commenced during the early stages of project planning and feasibility in September 2010. Consultations at this time aimed to inform the general public, neighbouring residents, statutory regulators and other stakeholders of the project, in order to identify issues that require addressing during project planning and design. Public consultation has taken place since the early stages of the original (26 turbines approved) Willogoleche project (and since) and has targeted all interested and potentially affected parties. Consultation took the form of:

- Letters of notification to various stakeholders, both local, state and national groups and agencies
- Letter drop to neighbouring residents
- Public exhibition held in the Hallett Town Hall (20th October, 2010)
- Consultation meetings with various stakeholders and council planners

4.2 Stakeholders

The stakeholders listed below were provided with information regarding the proposed development and were invited to provide any comment, information or guidance in the course of the project development and in the preparation of this Environmental Statement. Copies of the responses (where given in writing or via email) are included in Appendix 5.

- Country Fire Service (CFS), Hallett
- Aboriginal Affairs and Reconciliation Division
- Department of Environment and Heritage, Heritage Branch
- Department of the Environment and Natural Resources – Burra National Parks and Wildlife Service
- Friends of the Heysen Trail (Burra)
- Hallett Community and Sports
- Hallett Historical Society
- National Trust (Burra Branch)
- Natural Resource Management Boards (Murray Darling Basin, Northern & Yorke)
- Native Vegetation Council
- Ngadjuri Walpi Juri Lands & Heritage Association Inc.
- Northern Areas Regional Council
- Minister for Energy, Infrastructure and Transport
- Minister for Environment and Conservation
- Planning SA
- Primary Industries and Resources SA (PIRSA)
- Regional Development Australia – Yorke and Mid-North
- State Emergency Services (SES), Hallett

It should be noted that correspondence with consultees will continue as required throughout the various stages of the project.

Letters were distributed to approximately 130 neighbouring residences in the Hallett and Booborowie postal zones. These letters provided background information for the project and

provided a name and contact details for a representative to be discuss any concerns with the project.

4.3 Stakeholder Response

A number of local community stakeholders have provided input into the proposal, raising a broad range of issues for consideration. Such input from local groups and individuals is important during the development of the project in order to mitigate adverse impacts to the local community as far as practical. Issues raised have been addressed, and have resulted in a number of modifications to the original layout.

CASA will be consulted following receipt of Development Plan Consent regarding the requirement for aviation lighting. Further details about the implications of wind farms for aviation are discussed in Chapter 15.

Some users or managers of various radio communications, telecommunication and television services have provided advice on the likely effect of the proposed wind turbines on their transmission signals. Guidelines for turbine placement are available from the Department of Administrative and Information Services (DAIS), who manage the South Australian Government Radio Network (SAGRN), with regards to their facilities and the SAGRN. All advice received has been used in conjunction with results of electromagnetic interference studies (see Chapter 13) to develop a compliant turbine layout.

Advice has been sought from the Aboriginal Affairs and Reconciliation Division (AARD) with regard to any registered sites or places of heritage located within the project area. In conjunction with this, a desktop study was carried out on the archaeological and cultural heritage of the project area (see Chapter 11). A detailed site survey will be conducted post consent in consultation with AARD and the relevant Aboriginal Heritage group to continue to develop the project in a manner that is sensitive to heritage values.

Consultation with environmental stakeholders such as the Native Vegetation Council ("NVC") and particularly the Department of Sustainability, Environment, Water, Population and Communities ("DSEWPC") will continue, with their input into the development process being critical for the appropriate environmental management of the proposed wind farm site.

4.4 Public Information forum

A public forum was held for the proposed expanded Willogoleche Wind Farm at the Hallett Community Hall in Hallett on Wednesday 20th October 2010. Residents of the area were advised of the information forum by way of the local newspaper and by individual letters sent to households so that local residents could attend during the day.

The public information forum presented provisional details of the proposed expanded Willogoleche Wind Farm, including its likely appearance illustrated by means of plans and photomontages. In addition, a time-lapse photography computer model/DVD of the project was run continuously on a large television screen, which compared the existing 26 approved turbines with the expanded 37 turbine layout, including proposed changes to the maximum blade tip height (this computer model, produced by Truescape, is provided as part of the material being lodged with the Council). A number of information panels and brochures were also displayed. These contained information about the project and wind energy in general and included a series of Frequently Asked Wind Energy Questions.

Over 70 people attended the public information forum. Attendees were invited to complete a public opinion survey (contained in Volume 5 Appendix 8), of which 22 people did so. 68% of respondents were in favour of the expanded Willogoleche Wind Farm proposal, (but this is not to claim this level of support as being a statistically representative sample).

A copy of the public opinion survey, results, analysis of results, and photographs from the forum are contained in Appendix 8.

4.5 Summary

Consultation for the expanded Willogoleche Wind Farm proposal was conducted by way of letters to stakeholders, face-to-face contact with neighbouring residents, a public information forum and consultation meetings with various stakeholders.

Stakeholders included statutory bodies, local interest groups and regional residents. A number of consultees have responded, providing input or advice for the proposal.

The public information forum, held on 20 October 2010 at the Hallett Community Hall, was attended by over 70 local and regional residents. Results of the public opinion survey completed at the public information forum show that 68% of survey respondents approved of the wind farm proposal.

5. GENERAL PROJECT DESCRIPTION

The proposed expanded Willogoleche Wind Farm project consists of the installation of thirty-seven (37) wind turbines, an onsite underground electrical cable network, an above ground high voltage marshalling yard (potentially), access tracks, crane hardstand areas, up to two (2) permanent wind monitoring masts, site operations facilities and appropriate site signs. The project also includes a grid connection 2.4km to the South-West of the southernmost turbine, consent for which has been obtained by ElectraNet. The proposed wind farm expansion would result in an installed capacity of up to 111MW, depending on the model of the turbine selected. Operation of the wind farm is to be carried out by a combination of remote computer control and local operations and maintenance staff.

5.1 Location and Site Layout Design

The expanded Willogoleche Wind Farm is designed to be located along the northern high altitude ridges of, and spurs along the Willogoleche Hill Range (Figure 1). The range is of moderate to high elevation (550-680 m above sea level; Australian Height Datum), predominantly running in a north-south direction. The nearest township is Hallett, which is located approximately 3.5 km east of the proposed site.

Approval is sought for the amended positioning of the 26 consented turbines and final positioning of an additional 11 turbines within a radius of 100 m from the locations indicated in Figure 2 and Figure 3 for all turbine locations. This layout is based on a number of technical, environmental and social factors and results of site assessments. The layout ensures optimum, undisturbed use of the measured and predicted wind resources after accommodating constraints.

5.2 Turbines

The turbines proposed for the development are likely to be around 3 MW machines (although could vary from anywhere between 2.1 MW and 3.3 MW, depending on the turbine selection, which will occur during engineering and contractual negotiations); the Suzlon S88, 2.1 MW machine (as installed at the Hallett Wind Farm) being typical of the type of wind turbine that would be installed. Alternative turbines would be very similar in appearance, size and all major characteristics, although longer blade lengths and higher hub heights would be considered to maximise energy production. The Siemens SWT-3.0-101 is a typical example of a larger turbine.

A sample specification sheet for the Suzlon S88 turbine and Siemens SWT-3.0-101 is included in Appendix 9. The turbines are three-bladed, semi-variable speed, pitch regulated machines, with the rotor and nacelle mounted n a reducing cylindrical steel tower. Each turbine will rise approximately 125-152 m from the ground to the tip of the blades, with typical tower heights of between 80 and 100 m, and with blades between 40 and 56 m in length. It should be noted that a likely height will be around 130 m, although the height used for visual assessment analysis takes the maximum possible option as the extreme case (see Chapter 12). As examples, the Suzlon S88 2.1 MW turbine with its new 95m rotor blade assembly, would be 127.5 m tall from base to blade tip; a Siemens 3MW turbine with a 101m rotor diameter would be 130.5m to blade tip; and a Vestas V112 3MW turbine on a 95m tower would be 150m at the blade tip. Most turbines begin to generate energy at wind speeds in the order of 4 ms^{-1} (14.4 kph) and shut down (for design and safety reasons) in wind speeds greater than 25 ms^{-1} (90 kph). The blades typically rotate at about 15 rpm at low wind speeds and up to 18 rpm at higher wind speeds.

Three types of foundations for the turbines will be considered: a standard cement slab foundation; a slab plus rock anchor foundation; or a mono-pile. The type of foundation used will depend on geo-

technical characteristics of the site, turbine selection and costing factors. A description of foundation types is contained in Chapter 6.

5.3 Site Electrical System

The electricity produced by each wind turbine generator would most likely be transformed from 690 V up to 33 000 V (33kV) by a transformer generally located within or adjacent to each turbine, (although some turbine models generate at 12kV and then collect and transform the power for small groups of turbines up to 33kV) (see Image 7 of Appendix 10). Underground electrical cables will be installed at a depth of between 0.8-1 m below the ground surface to conduct the electricity from the turbines to the substation. The underground electrical cables will most likely follow site access tracks where practical (See Image 5 of Appendix 10).

5.4 Crane Hardstand

Site access tracks would have areas of hardstand (approximately 20 m by 35 m) adjacent to each wind turbine for use by cranes during construction (see Image 1 of Appendix 10 and Appendix 11). The clearing of native vegetation for the construction of access tracks and hardstand areas will be avoided where possible. If clearing is found to be unavoidable, this will be appropriately managed through the environmental management plan and be subject to conditions applied by the Native Vegetation Council. The tracks would be surfaced with local stone (where possible) to required load bearing specifications. The nature and colour of surfacing would be selected to minimise visual impact prior to construction. The tracks and hardstand areas would be maintained throughout the operational life of the wind farm and used principally for the periodic maintenance of the wind turbines.

5.5 Site Access

A preliminary investigation considering the possible access roads to the wind farm site has been carried out. Main roads which could potentially be used include the Barrier Highway (running through Burra, Mount Bryan and Hallett), the Clare-Peterborough Road and the Jamestown-Hallett Road. All of these roads are bitumen and are unlikely to require upgrade or modification to accommodate the construction traffic and loads.

A number of suitable, secondary roads in the area are likely to be used for access to the wind farm. Some sections of these secondary roads may require resurfacing or upgrading, while some corners may also require modifications in order to accommodate construction traffic loads.

Other access consists of informal tracks leading to the wind farm site and on-site tracks between turbines and hardstand areas. The onsite access track system will be rationalised and, where possible, these tracks will follow existing farm tracks and fire tracks that traverse the ridgelines along the ranges. All tracks leading from main and secondary roads and all on-site access tracks are likely to require a full upgrade to accommodate the construction traffic loads, as well as for maintenance purposes during operation. These details will be verified with the local council closer to construction. A guide to the potential access points from existing roads is contained in Figure 3.

Access tracks will be a maximum of 6 m wide once the wind farm is operational (tracks may be up to 12 m wide during construction), and surfaced with compactable, non-slippery gravel. Base material (where full track upgrades are required) will consist of an appropriate interlocking rock/stone (see Image 2 of Appendix 10). Materials may be sourced locally, where possible, and in consultation with local councils. Measures will be taken to minimise the risk of the spread of weeds and disease from materials brought in for construction purposes.

All roads to be upgraded will be engineered to standards specified in the relevant documentation and guidelines for roads, to ensure no adverse impacts are created. All access points, traffic scheduling and road upgrades will be planned in conjunction with the Regional Council of Goyder, Transport SA and other relevant parties.

5.6 Monitoring Masts

Up to two permanent 80-100 m wind monitoring masts will be installed on-site. The purpose of the monitoring masts is to provide necessary information for the performance monitoring of the wind turbines. The wind monitoring masts would be of a guyed, narrow lattice or tubular steel design. Applications for the permanent on-site monitoring masts will be submitted once the final design of the turbine layout has been confirmed and the preferred locations of the masts determined. An illustration of how a typical monitoring mast appears on-site is shown in Image 3 of Appendix 10.

There are currently two temporary wind monitoring masts installed on-site to provide necessary wind data for project development and planning; a 40m mast and a 65m mast.

5.7 Grid Connection

The consented grid connection point for a new ElectraNet substation is located approximately 2.4km south-west of the southernmost turbine on the site, on McAskill Rd, Willalo (Hundred of Anne, Title Volume/Folio references 5254/550 and 5469/728 for substation and cable underground route), SA Department of Planning Development Number 422/V015/09 (see Figure 4 and Appendix 12). The ElectraNet owned 275 kV transmission line passes adjacent to this substation location. The substation site is expected to require between 2 to 5 ha of land and will include standard grid connection infrastructure and buildings (see Appendix 12). The chosen location minimises the visual impact of the wind farm by siting the substation away from frequently used public roads and is as close as practically possible to the wind farm site and the 275kV transmission line. This position also allows for the wind farm's internal electrical infrastructure and grid connection to have a reduced visual impact by utilising underground cabling to the substation.

Detailed substation design for the grid connection infrastructure will be completed by ElectraNet once wind farm capacity, turbine type and transformer decisions have been determined, and in conjunction with other relevant agencies and landowners. If for technical reasons the proposed connection point becomes unfeasible, International Power would propose to consult with the local council to determine what impacts this will have on the development approval process. Council will then determine whether the changes to the grid connection require minor or major amendments to the application or whether a separate application for the connection is possible.

5.8 Project management

The expanded Willogoleche Wind Farm is currently being developed by International Power. Project management will continue under International Power unless commercial or other arrangements change. All project and construction management will comply with the appropriate company's Quality Assurance System and Environmental Management System, or equivalent, ensuring that relevant procedures, statutory requirements and operational standards are met. Project management will also comply with the project Environmental Management Plan (EMP) (see Appendix 13).

Project management will also be in accordance with this Environmental Statement and any subsequent documents developed, such as Environmental Management Implementation Plans (EMIPs) and Work Procedures. A base Environmental Management Plan has been developed for the project, which contains a summary of proposed environmental management actions (see

Appendix 13). It will be a requirement that all actions contained in the EMP are considered and incorporated into the site's EMP and other environmental documentation. The construction contractor will address on-site and public safety issues, through the development and implementation of a project Health and Safety Plan. This shall include emergency prevention and response measures for events such as chemical spill and fire.

It should be noted that if ownership arrangements change all project responsibilities, including management commitments in this Environmental Statement and other relevant documents, planning and other approval conditions, will be transferred to the new owner of the project.

5.9 Summary

The expanded Willogoleche Wind Farm proposal consists of the installation of thirty-seven (37) wind turbines, an onsite underground electrical cable network, an above ground high voltage marshalling yard (potentially), access tracks, crane hardstand areas, up to two (2) permanent wind monitoring masts, site operations facilities and appropriate site signs.

The connection of the wind farm to the grid is to be via ElectraNet's consented substation and connection works approval, (SA Dept of Planning and Local Government application 422/V015/09, approved on 1 Dec 2009), approximately 2.4km south west of the southernmost wind turbine via a standard substation located adjacent to the existing 275 kV transmission line owned and operated by ElectraNet.

The project is currently being developed and managed by International Power. Project management will be in accordance with the relevant Quality Assurance System and Environmental Management System, as well as the commitments contained in this Environmental Statement and other approval conditions contained in any project approval documentation.

6. SITE WORKS

This chapter provides a brief description of the construction, operation/maintenance and refurbishment/decommissioning work required at the expanded Willogoleche Wind Farm site.

6.1 Pre-construction Works

Prior to the main construction commencing, a number of enabling works and further site planning would be undertaken, including:

- Detailed site investigation including geotechnical investigations involving a series of trial pits and/or boreholes
- Upgrading the surfaces of local roads and access tracks where required
- Widening the junctions or corners of local roads, entrance/access points where required
- Widening the existing gateways, or inserting new gateways, in between paddocks where required
- Stripping and careful storage of existing soil from the areas which would be affected by construction activities, including the tower bases, high voltage marshalling yard, access track areas, crane hardstand areas and temporary laydown/carpark areas
- The construction of a secure works facility, with project owner and subcontractors field offices (portables), carpark, laydown yard and toilet facilities (temporary)
- Erection of signage on roads
- Enabling works for the locating of a mobile concrete batching plant (temporary, if required)
- Enabling works for the locating of a rock crushing plant (temporary, if required)
- Environmental survey and refinement (if necessary) of the Environmental Management Plan, Health and Safety Plan, Traffic Management Plan and any other documentation as required under the planning authorisation
- Preparation of works procedures

6.2 Construction Works

The principal components of the construction activity on site are discussed below. Construction activity is likely to occur over a period of approximately 18-22 months.

6.2.1 *Site Access Tracks and Crane Hardstand Areas*

Site access tracks and crane hardstand areas require surfacing in order to cater for construction traffic and machinery. This would involve the excavation of the tracks and hardstand areas to an agreed depth, prior to the laying of a compactable interlocking stone base and top dressing. It is anticipated that the soil and rock that is removed will be stored on-site at convenient locations for re-use within the development area or immediate vicinity. Site access points would be gated and secured, and appropriate warning signs erected.

During construction, site access tracks are constructed at a width of up to 12 m to allow for passing construction traffic, large mobile cranes, and other long and wide loads. Once the wind farm is operational, the access tracks will be reduced in size to a maximum of 6 m in width, acknowledging that traffic from this point onwards will principally involve commercial vehicles.

The crane hardstand areas will be sized at approximately 40m by 50m.

Land that is disturbed that is not part of the land-take for the life of the wind farm will be reinstated.

6.2.2 *Turbine Bases*

If slab turbine foundations are required, the construction of the foundation for each wind turbine would involve the excavation of approximately 450 m^3 of ground material (of which 200 m^3 would be used as back fill around the turbine bases) to a depth of approximately 2 m. Shuttering and steel reinforcement would then be put in place and concrete poured to form the base in-situ. The upper surface of each base would finish approximately 1 m below ground level with either a central column with bolts to support the tower, or the base section of the tower set into the concrete.

If slab plus rock anchor turbine foundations are required, the construction of the foundation for each wind turbine would involve the excavation of approximately 300 m^3 of ground material to a depth of approximately 2 m. Shuttering and steel reinforcement would then be put in place and concrete poured to form the base in-situ. The upper surface of each base would finish at ground level with either a central column with bolts to support the tower, or the base section of the tower set into the concrete. The rock anchor piles are drilled prior to concrete pour, and are up to a depth of approximately 20 m. The rock anchors are stressed and secured once the concrete has cured sufficiently (see Image 4 of Appendix 10).

If mono-pile turbine foundations were required, the construction of the foundation would involve the excavation of approximately 50 m^3 (of which 30 m^3 would be used as back fill) of ground material to a depth of approximately 10 m, using a rock drill. A tubular section with tower connection flanges would then be inserted in the hole and concrete then poured in-situ. The flange would finish slightly above the surface of the ground to allow connection of the tower.

6.2.3 *Electrical Connections*

Either prior to or during turbine base construction, the underground site electrical system would be installed. This would involve the cutting or excavation of trenches to a depth of between 0.8-1 m, for the laying of the underground cabling that links the wind turbines (see Image 5 of Appendix 10). All trenches would be backfilled and marked with warning tape once the cables were laid.

The majority of the underground cabling will be located adjacent to the access tracks. The general procedure followed for the laying of underground cables will be:

- Preparation work, including installation of gates/temporary removal of fences as required
- Use of an excavator or rock saw to dig a trench (0.6 m wide by 1.1 m deep)
- Materials excavated will be stored on-site adjacent to the trench for subsequent back-filling of the trench
- Laying of bundled cables within a bed of protective sand
- Installation of warning sheet indicating the presence of the cable approximately 350 mm below the surface
- Backfilling and compaction of previously excavated material in layers by use of a vibration plate compactor to prevent erosion, all in accordance with Engineering Specifications

On completion the cable route may be marked with small marker posts and the surrounding vegetation will be allowed to regrow. The sand used for cable protection will be sourced locally where possible.

6.2.4 *Turbine Erection*

The turbine components would be delivered to the site on semi-trailers. The method of construction would involve the use of a small mobile crane for the ground assembly operation. A larger 600-

1000 tonne mobile crane (or alternatively a 300-400 tonne crawler crane), together with the smaller tailing crane, would be required to erect the turbines once ground assembly is complete (see Image 6 of Appendix 10). Erection is likely to take approximately 2-3 days per turbine.

6.2.5 *Temporary Site Infrastructure*

Site works will require the erection of temporary infrastructure such as portable field offices, toilet facilities, materials storage areas and parking bays. This infrastructure will be typical of that used at construction sites, however it is unlikely to include full accommodation facilities (see Image 8 of Appendix 10).

Traffic signage required as part of traffic safety during construction will be installed by the contractor, in compliance with relevant regulations and in accordance with any permits obtained for traffic management.

Signage may be erected on the Barrier Highway (running through Burra, Mount Bryan and Hallett), the Clare-Peterborough Road and the Jamestown-Hallett Road and outside the township of Hallett and other critical locations from the outset of construction, directing all vehicles associated with the construction site to the site office. Sightseeing traffic will be managed towards safe, prominent viewpoints where they may view the wind farm, but not in a way that would jeopardise the safety of sightseers or the progress of construction. Additional signage would be located near to the site, providing information about the turbines, the companies involved in the projects and essential safety information and telephone numbers. The need for a pull-off bay for sightseers' cars will also be assessed. Negotiations with the Regional Council of Goyder, Transport SA and other affected parties will be initiated to determine final signage locations and various works required.

6.2.6 *Ancillary Construction Activities: On-site Concrete Batch Plant*

A concrete batching plant may be established on site to supply concrete for the foundations of wind turbines. The establishment of the batching plant has yet to be decided. This is dependent on a number of factors including type of footings used, proximity of alternate supply and identification of suitable locations. The concrete batching plant including material stockpile area would be located in an area on site approximately 30 m by 30 m. It is estimated that the plant would have the capacity of 25 m^3 (60 t) per hour.

The site would be located in an area of relative flatness and away from severe slopes and variations. The plant would be established during the preliminary stages of site preparation civil works for the development.

Aggregate, sand and cement would be stored within the concrete batch plant area for use as required. Cement would be delivered on site in enclosed container trucks as needed and stored in enclosed silos. Aggregates and sand will be delivered in standard bulk material delivery trucks and stockpiled for use as required. Concrete manufactured on site would be loaded into concrete agitators for transport to the turbine locations on site.

Under the *Environment Protection Act 1993 – Schedule 1*, Concrete Batching Works are considered a "prescribed activity of environmental significance". This classification requires any such works to have a Licence from the Environment Protection Authority where the capacity of production of concrete exceeds 0.5 m^3 per production cycle. Should the proponent decide to establish a concrete batching plant on site, liaison with the EPA will be undertaken to assess the need for a licence for its operation.

6.2.7 *Hazardous Materials and Waste*

Construction activities will require the storage of certain hazardous chemicals and wastes, such as fuels, oils and other machinery lubricants and liquids. Bulk storage of cement and other construction materials may also be required.

It will be a requirement that hazardous materials be stored on or off-site in specific lay-down/storage areas, and will be handled and stored according to regulatory requirements and Australian Standards *AS1940, 'The Storage and Handling of Flammable and Combustible Liquids'* and other relevant standards. Any hazardous waste will also be appropriately stored and later removed for off-site disposal at an appropriate disposal facility.

A more comprehensive description of management strategies for hazardous materials, waste and bulk storage is outlined in the EMP (Appendix 13).

6.3 Operation

Once operational, the wind farm would be monitored both by on-site staff and by remote staff. Aspects of the wind farm operation to be dealt with by on-site staff would include safety management, environmental conditions, landowner management, routine servicing, malfunction rectification and site visits. Those functions to be monitored by the remote computer include turbine performance monitoring, wind farm reporting, remote resetting and maintenance coordination.

6.4 Maintenance

Maintenance staff are likely to be on-site throughout the year, making routine checks of the wind turbines on an ongoing basis. Major planned maintenance would be carried out approximately twice a year on each wind turbine. Each planned major maintenance visit would potentially involve a number of maintenance vans (two technicians per van) onsite.

6.5 Refurbishment and Decommissioning

6.5.1 *Refurbishment*

After approximately 20-25 years of operation (or sooner if deemed economically viable), the nacelles (top section of the turbine) and towers can be removed and replaced. Old nacelles and towers are removed from site for recycling. Nacelle replacement would potentially extend the life of the wind farm for another 20 or so years.

Alternatively, all wind turbines will be decommissioned at the end of their operational life (see Section 6.5.2 below), and new foundations, towers and nacelles installed in the same or nearby locations. Any material change to the wind farm layout, or significant changes to the turbine technology, will be referred to the Regional Council of Goyder as an amended proposal. It would also be subject to the regulations and guidelines of the day.

Refurbishment requires transportation and installation equipment and facilities, similar to that used during initial construction.

6.5.2 *De-commissioning*

At the end of the operational life of the wind farm, the turbines and all other above ground infrastructure on-site will be dismantled and removed from the site. The tower bases would be cut back to below ploughing level or topsoil built up over the footing to achieve a similar result. The land

will be returned to prior condition and use. A compressor and rock breaker would be needed to carry out the cutting work if necessary.

The access tracks, if not required for farming purposes or fire access, would be removed and the site reinstated to original condition and use. Access gates, if not required for farming purposes, would also be removed.

The underground cables occur below ploughing depth and contain no harmful substances. They can be recovered if economically attractive or left in the ground. Terminal connections would be cut back to below ploughing levels.

All such refurbishment and decommissioning work would be the responsibility of the wind farm owner. Experience in Denmark and The Netherlands shows that sale of the scrap metal and other valuable items salvaged from the turbines and electrical components would more than meet the cost of decommissioning.

6.6 Fire Management

As discussed in Section 3.5.3, fire management is an important part of both wind farm project planning and the community consultation process. All aspects of the expanded Willogoleche Wind Farm project will adhere to the *Fire and Emergency Services Act 2005*, and will be in consideration of the *Australian Wind Energy Association's Best Practice Guidelines: Fire Management* (2006).

Despite the low risk that wind farms present, fire management is a major concern within the Mid-North region of South Australia, and planning for fire prevention and an effective and informed response is of paramount importance. Not only does effective planning in regard to fire management provide wind farm proponents with assurance that minimum damage would result from a fire incident, it also reassures the local community and enables the rural fire service to confidently plan and execute an effective response.

Appropriate fire management actions for all stages of the wind farm development (*i.e.* pre-construction, construction, operation and decommissioning) include:

- Adherence to all regulations under the *Fire and Emergency Services Act 2005*
- Installation of access tracks at least 5 m wide (7 m for corners) and with appropriate vertical clearance and suitability for all weather conditions
- Provision of basic fire-fighting equipment at each active site, including fire extinguishers, knapsacks and other equipment suitable for initial response actions
- Maintaining provision for mobile telephone and UHF radio communications
- Provision of onsite identification of individual turbine locations and access gates for fire-fighting services, and an undertaking to provide local rural fire service groups with access to gates
- Consideration of total fire ban days in regard to hours within which construction takes place
- Providing the Country Fire Service (CFS) with:
  - A construction works schedule
  - Maps of final turbine layout and identification information for individual turbine sites
  - Access road plans and locations of access gates
  - Security information such as location of locked gates and restricted access areas
  - Location of any additional water supplies installed for construction activities
  - Location of potential landing pads for fire-fighting aircraft or helicopters

The CFS has been notified of the proposed wind farm project and further consultation will continue. Details of the wind farm site (such as turbines, access tracks and gate locations) will be provided to assist their internal response planning. Specific fire prevention and response measures are outlined in the project EMP (see Appendix 13). Furthermore, an Emergency Response Plan will be developed in consideration of CFS guidelines and further consultation with regional and local rural fire groups, and would include agreed notification protocols, contacts and response actions.

6.7 Summary

Pre-construction works involve final site surveys (for heritage and environment), geotechnical investigations and preparation activities. Construction works involve the grading and surfacing of access tracks and turbine footprints, and the installation of the wind farm infrastructure as well as temporary works facilities, including storage areas. Land that is disturbed, that is not part of the land-take for the life of the wind farm, will be reinstated.

Operation of the wind farm is controlled remotely, with the majority of site visits required being that by maintenance staff. At the end of the term of the wind farm the facility may either be refurbished or decommissioned. Decommissioning will involve the removal of all above ground infrastructure and land reinstated.

7. APPROACH TO ENVIRONMENTAL ASSESSMENT

International Power, along with a number of specialist consultants and stakeholders, have worked together during the feasibility and planning stages of the expanded Willogoleche Wind Farm proposal to determine the baseline environmental conditions at the site, identify potential impacts and develop management strategies to mitigate those impacts where possible.

The assessment process has involved stakeholder consultations, site-specific survey work (including desktop and on-ground assessment) carried out by specialist consultants, and observation of relevant literature. These assessments, along with stakeholder input, have been consolidated into this document. All external assessments and consultations have been extensively drawn upon to develop an optimal wind farm design that balances environmental, social, economic and cultural needs.

7.1 Consultations

A consultation program has continued since the outset of the proposal. The principal aim of the consultation program was to invite individuals and organisations to provide comment and input into the project as key stakeholders, in the early stages of the planning process. Details of stakeholders consulted are outlined in Chapter 4 of this Environmental Statement.

Stakeholder input, where received, has been valuable in both the acquisition of baseline environmental information, as well as the further development of site environmental management requirements. Environmental stakeholder involvement also forms a valuable relationship between the developer and statutory agencies. Copies of the responses (where given in writing or via email) are presented in Appendix 5.

7.2 Literature Review

International Power and its consultants have sourced and drawn information from a range of literature during the progression of the expanded Willogoleche Wind Farm project, having several benefits. Foremost, it has provided guidance on management priorities and objectives. It has also detailed the existing environmental conditions for characteristics such as soils, water resources, significant fauna, flora, habitats and cultural heritage.

International Power integrated information derived from various sources associated with the expanded Willogoleche Wind Farm area into this Environmental Statement.

7.3 Specialist Studies

A number of specialist studies have been carried out in order to determine and assess potential environmental and social effects of the project and their management. They are:

- Ecological studies
- Noise assessments
- Electromagnetic interference (EMI) studies
- Cultural heritage studies
- Aviation
- Landscape
- Planning Report

Leading independent consultants carried out the ecological, noise, electromagnetic interference, cultural heritage, aviation and landscape studies along with a planning report. The site's climatic,

geological, soil and water resource attributes were investigated using relevant databases and literature.

7.4 Environmental Management Overview

Site management of the expanded Willogoleche Wind Farm project will be in accordance with this Environmental Statement and the baseline project Environmental Management Plan (EMP) contained in Appendix 13. The EMP includes a soil and water management strategy, and a scope for the production of various other site management plans, to be implemented by the on-site contractor(s). It also outlines the overall environmental management plan for the site. It will be a requirement that all actions contained in the EMP are considered and incorporated into any site environmental documentation.

The environmental management actions for the project apply to all on-site activities, including construction, operational and decommissioning/refurbishment activities. The management strategy for decommissioning/refurbishment activities may require updating at the time, based on industry best practice and regulatory requirements of the day, although it would include, as a minimum, strategies summarised in Appendix 13 of this Environmental Statement.

8. PHYSICAL ENVIRONMENT

This chapter discusses the physical environment of the expanded Willogoleche Wind Farm project area. It presents the existing situation for a number of regional characteristics and discusses potential impacts and mitigation measures, where relevant.

8.1 Methods

Information regarding the site's climate, geology, air, soils and water resources was mainly derived from a literature review. As such, International Power sourced several documents and extracts for review, whilst the results of stakeholder consultation alerted the development team to other documentation that should be consulted.

8.2 Climate

Similar to most areas in southern South Australia, the Hallett region experiences a Mediterranean climate, with cool to mild wet winters and hot dry summers (Graham *et al.* 2001). Historically the mean annual rainfall in the Mid-North region has ranged from less than 200 mm up to 600 mm, with an average regional rainfall of around 470 mm (Bureau of Meteorology 2008). The mean summer rainfall is 19.8 mm, as recorded in January, and the mean winter rainfall is 57.6 mm, recorded in July. The average maximum temperature for January is 31.1 °C and 14.2 °C for July.

8.3 Geology

The project area contains a number of low-lying ridgelines running north-south, characteristic of that found in the Mid-North region (Graham *et al.* 2001). These ridges form part of the Mount Lofty Block.

The geology of the ridgelines and ranges included in the project area consists of combinations of Proterozoic tillites, quartzites, slates, shales, siltstones and dolomites. There are also Cainozoic slope deposits on some ranges and recent alluvial plains between them (Department of Mines 1964).

8.4 Air

8.4.1 *Existing Situation*

The airshed quality in the area surrounding the proposed wind farm site is assumed to be good. Local industry consists of farming practices; generally having a negligible impact on air quality. The exceptions to the farming environment (besides townships) are the existing Hallett power station, located 11km west of the project area, and the Hallett Wind Farm, located to the south and west of the project area. The power station operates as a peaking plant, periodically generating electricity as required by demand. The nearest industrial centre is located at Jamestown, approximately 30 km north-west of the project area.

8.4.2 *Potential Impacts*

Some air emissions are expected from on-site construction activities in the form of exhaust emissions from construction vehicles and generation of dust. However, emissions will be minimal, localised, and short-term and have an overall negligible impact.

Dust emissions may occur during construction activities from the use of construction machinery including, for example, earthwork machinery operating at turbine locations and access tracks. Dust may also be generated by other construction traffic travelling along access tracks and roads. Earthwork activities for turbines will be located on working paddocks and away from residential

areas. As such, any dust emissions from earthworks are expected to have a negligible impact on neighbouring residences or residential areas.

The operation of the proposed expanded Willogoleche Wind Farm will produce negligible atmospheric emissions. In fact, the wind farm will contribute significantly to the reduction of CO_2 emissions (see Chapter 2).

8.4.3 *Management*

Vehicle emissions will be minimised by ensuring that all machinery used on-site is kept in good working order.

Site earthworks for turbines will be located on ridge tops and away from residential areas. As such, any dust emissions from earthworks are expected to have a negligible impact. Further, dust suppression practices such as watering down in adverse conditions, can reduce dust emissions from construction traffic. All access roads will be of an appropriate standard, with most surfaced with compacted gravel. Full details of environmental management actions relating to air quality control are listed in the EMP (Appendix 13).

8.5 Soils

8.5.1 *Existing Situation*

Soil types of the eastern scarp of the Mt Lofty Ranges are dominated by uniform clays or clay loams (Graham *et al.* 2001). The Northern and Yorke Agricultural Districts Integrated Natural Resource Management Plan (NYADINRMC 2003) and West Broughton Soil Conservation Board (2002) indicate further that non-arable, shallow stony soils with variable rock outcrops occur along the majority of the ridges of the Northern Mt Lofty Ranges. Generally soils of the region are formed either on basement rock, or on outwash sediments. Soils vary in physical condition, from hard-setting/sealing surface soils (some with poor subsoil structure), to soils with no significant soil structure problems. Gentle slopes and plains contain mainly deep texture contrast soils with calcareous subsoils, while some areas contain highly saline soils.

Salinity induced by the rising water table in the Hallett region ranges from negligible to moderately high (highly saline seepage). Management of salinity is regarded as one of the top three land management priorities in the Mid-North region (NYADINRMC 2003). It is also noted that some of the high productive gradients and flats within the Mid-North region are at increased risk of surface soil acidification.

8.5.2 *Potential Impacts*

Soil types found within the overall project area are considered to have a low risk of wind erosion but predominantly moderate to high risk of water erosion (NYADINRMC 2003). Regions under cultivation are associated with a decline in soil structure and organic matter. These factors can also contribute to water and wind erosion (West Broughton Soil Conservation Board 2002). The risk of water erosion is at its highest during sustained, high rainfall events.

The potential for soil erosion exists during the construction of wind farm infrastructure; such as access roads, turbine bases and cable trenches; that is, where earthworks and soil disturbance takes place. Inadequate protection of exposed surfaces during construction can lead to erosion from rainfall events. Erosion events can lead to siltation and consequential habitat disturbance both on and off-site, decreased productivity from loss of top soil, disturbance to soil structure and general instability of soil.

The use of chemicals and hazardous materials on-site also attracts the potential for soil contamination through misuse or spillage.

8.5.3 *Management*

A number of management actions will be implemented to manage surface runoff and exposed soil surfaces to ensure that erosion events do not occur. These will be detailed in a Soil and Water Management Plan to be developed prior to construction (see Appendix 13). Such actions will include siting access tracks and cable trenches both along ridge tops and along contours as far as practicable (or as per expert advice), covering and stabilising appropriately exposed soil surfaces subject to an erosion risk where earthworks are carried out, and filtering silted runoff before it leaves the site. Refuelling procedures for plant and equipment and the management of hazardous materials and wastes will also avoid soil contamination.

8.6 Water and Drainage

8.6.1 *Existing Situation*

The water resources of the Willogoleche Range are part of the Broughton River catchment. This catchment falls under the jurisdiction of various government agencies, such as the Northern and Yorke Natural Resources Management Board and the Department of Water, Land and Biodiversity Conservation.

The Broughton River catchment is located in the Mid-North region of South Australia, approximately 130 km north of Adelaide and encompasses an area of 5671 km^2. The flows into Spencer Gulf and is frequently dry due to low rainfall and groundwater inflows. The watercourses in the catchment once encompassed a wide variety of environments, ranging from open woodlands and low woodlands through to tall open shrublands.

Since European settlement, the majority of the watercourses in the region have been significantly modified, and the biodiversity values of the system are currently low, particularly in terms of a lack of native vegetation following widespread vegetation clearance. There are few natural surface water bodies in the vicinity of the project area that retain water permanently. All creeks and potential wetland areas (low-lying areas) are ephemeral.

8.6.2 *Potential Impacts*

General construction activities, such as excavation, trenching, concrete batching, and other earthworks, have the potential to impact surface and ground waters in a number of ways. These include: modification of surface drainage; siltation from erosion and runoff; siltation effects from catchment runoff; contamination of water resources; and, direct disturbance to groundwater aquifers.

Construction of the wind farm will not require the modification or redirection of any surface water features. It is also unlikely that any direct impact on groundwater resources from earthwork activities will occur, given the depth of the aquifers at locations where trenching and excavation works will be required. If there is a risk of entering the more shallow sections of the groundwater aquifer, potential impacts will be assessed. However, there are no construction activities that pose a direct threat to groundwater resources.

If refuelling is required on-site, there is the potential for water contamination from fuel spillage if not managed appropriately.

8.6.3 *Management*

A number of management actions will be implemented to manage surface runoff and exposed soil surfaces to ensure that erosion events do not occur. Appropriate refuelling procedures and the management of hazardous materials and waste will also prevent soil and water contamination.

Such actions include siting access tracks and cable trenches along ridge tops and following contours as far as practicable, covering and stabilising appropriately exposed soil surfaces subject to an erosion risk where earthworks are carried out, and filtering silted runoff before it leaves the site to prevent down-slope siltation of habitats and watercourses.

Where it is found that construction activity may impact on shallow groundwater resources – in use for stock or domestic purposes – construction of these sites will be effectively engineered to prevent any detrimental effects.

8.7 Summary

The Hallett region experiences a Mediterranean climate of hot dry summers and cool wet winters with a mean annual rainfall of 470 mm.

Geologically, the region is a part of the Mount Lofty Block, principally composed of a combination of Proterozoic tillites, quartzites, slates, shales, siltstones and dolomites, mixed with Cainozoic slope deposits and recent alluvial plains. The outwash alluvial plains comprise the lower lying lands between the ranges.

Soil types are dominated by uniform clays and/or clay loams. Chiefly non-arable, shallow stony soils with variable rock outcrops occur along the majority of the ridges. Soils of the region are either formed on basement rock, or on outwash sediments. Soils vary in physical condition, from hard setting/sealing surface soils (some with poor subsoil structure), to soils with no significant soil structure problems. Soil types found within the project area are considered to have a low risk of wind erosion but predominantly moderate to high risk of water erosion.

Erosion events can lead to siltation and subsequent habitat disturbance both on and off-site, decreased productivity from loss of top soil, disturbance to soil structure and general instability of soil. Soil erosion will be avoided by the management of surface runoff and exposed soil surfaces, as indicated in the project EMP.

Since European settlement, the majority of the watercourses in the region have been significantly modified, and the biodiversity values of the system are currently low, particularly in terms of a lack of native vegetation following widespread vegetation clearance. There are few natural surface water bodies in the vicinity of the project area that retain water permanently. All creeks and potential wetland areas (low-lying areas) are ephemeral. Principally, the water resources of the region are under the jurisdiction of various government agencies. Potential impacts to on-site and off-site water resources will be avoided through the soil and water management practices outlined in the EMP. The project is not expected to result in any permanent impact to soil stability or water quality in the area.

9. ECOLOGICAL ENVIRONMENT

9.1 Introduction

The general ecological features of the project area are presented in this chapter, along with an assessment of potential impacts and proposed management measures to mitigate those impacts.

9.2 The Expanded Willogoleche Wind Farm

As discussed in previous chapters, the proposal for the expansion of the Willogoleche Wind Farm includes an additional 11 turbines compared to the existing consent of 26 turbines.

In addition to these 11 turbines, the layout of the expansion proposal amends the locations of the existing consented (Development Number: 422/0078/04) 26 turbines, whereby 15 are located within the 100m radius allowed by the consent, whilst 11 have moved by a maximum of 296m from the original turbine locations.

The ecology surveys were undertaken as two separate sections; one for the revised locations of the 26 turbines and a second for the additional 11 turbines. Because of this approach to the assessment, this chapter addresses the impact of the 11 additional turbines separately from the revised layout of the original 26 turbines.

9.3 Revised Impact on Original Consent

In this section the impact of the 26 turbines of the expansion layout will be compared to the existing consented layout. Extensive ecological survey work was undertaken on the Willogoleche Hill during the original application process in 2004. In order to understand the potential impact of the variation, it was decided to repeat certain aspects of the ecology survey focussing on the significant species and communities that were identified during the original survey work, namely the native vegetation and Pygmy Bluetongue Lizards.

9.3.1 *Existing Observed Situation*

To date a number of ecological site surveys were carried out to determine the extent of occurrence and likelihood of occurrence of various fauna and flora species on Willogoleche Hill. The first surveys were conducted in the Spring and Autumn of 2003 and 2004 as part of the original Development Application (Development Number: 422/0078/04) for the 26 turbines of the Willogoleche Hill Wind Farm (EBS 2004).

9.3.2 *Existing Flora*

Two vegetation communities were observed within the project area. These were a Lomandra multiflora ssp. Dura Tussock Grassland and an Exotic Grassland/Herbland.

The Lomandra multiflora ssp. Dura Tussock Grassland was considered to be in a good condition, and variations in quality were observed to be minor. The Exotic Grassland/Herbland was in a poor condition as it was dominated by exotic species and had been heavily grazed.

9.3.3 *Existing Fauna*

No species of national or state conservation significance were observed within the site. Whilst the Lomandra multiflora ssp. Dura Tussock Grassland is known to offer habitat to both the Pygmy Bluetongue lizard (“PBT”) and the Flinders Worm-Lizard, neither of these species was observed during the survey work.

9.3.4 *Survey Method for Turbines T01 to T26 of Expansion*

Figure 2 shows the locations of turbines referenced T01 to T26. The field survey was conducted on 15-17 and 25-26 February 2010 by EBS staff. The survey area included the 26 turbine locations and proposed amended locations (survey buffer of approximately 100 m radius) and associated track and cable routes (survey corridor of approximately 50 m).

9.3.5 *Vegetation associations and condition*

The survey area was accessed on foot, other than areas containing Cropping Land. The vegetation survey included recording all native and introduced flora species, vegetation associations and vegetation association condition ratings. The vegetation condition ratings given to vegetation associations within the survey area were based on the significant environmental benefit ("SEB") ratios provided in Table 4 of Appendix 14.

9.3.6 *Flora survey results*

Fifty-three flora species were detected during the current survey. This includes 32 native species and 21 weed species. Appendix 14 provides a complete list of native flora species detected in each vegetation association and Appendix 14 provides a complete list of weed species detected within each vegetation association.

9.3.7 *Threatened flora species observed*

One flora species, Cryptandra sp. Long hypanthium (Long-flower Cryptandra), which has a rare rating under the National Parks and Wildlife Act 1972 ("NPW Act"), was recorded as a scattered species within the Austrostipa sp. (Spear-grass) Grassland association. No flora species listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999, ("EPBC Act") were detected within the survey area.

9.3.8 *Threatened ecological communities*

Six areas within the Lomandra multiflora ssp. dura (Hard Mat-rush) Tussock Grassland were identified during the survey as potentially meeting the criteria of Iron-grass Natural Temperate Grassland of South Australia threatened ecological community under the EPBC Act (1999) (refer to Figure 9 of Appendix 16 for the six locations).

All areas highlighted as potentially meeting the assessment criteria were surveyed during the spring of 2010 to identify all native flora species present which will enable an assessment against the EPBC Act criteria. The results of this further survey work are included in Appendix 16.

9.3.9 *Declared and environmental weed species*

Three weed species detected during the current field survey are listed as declared species under the Natural Resource Management Act 2004 (see Table 11 of Appendix 14). Five environmental weed species were also detected during the current survey.

9.3.10 *Vegetation associations*

The survey area contained three vegetation associations and areas of cropping land (see Figure 5 for vegetation association mapping). A description of each vegetation association can be found in Appendix 14.

Table 9.1 Observed Vegetation Associations within areas of T01 to T26

Vegetation Association	Percentage of Project Area	Percentage of Vegetation Association with SEB Ratio 4:1 or less
Lomandra multiflora ssp. dura Tussock Grassland	27.6	31.4%
Austrostipa sp. (Spear-grass) Grassland	55.3	91.5%
Exotic / Native Grassland	4.4	100%
Cropping Land	12.8	100%

9.3.11 *Pygmy Blue-tongue Lizard presence/absence survey*

The majority of the area surveyed was considered to be unsuitable PBT habitat due to dense ground cover vegetation, steep terrain, rocky terrain and a lack of spider burrows. Approximately 80 spider burrows were searched within habitat near the locations of WTG22, WTG23 and WTG24. A further 36 spider burrows were searched within the cable route alignment which starts at WTG26 and dissects Willalo Road. The majority of the spider burrows searched contained spiders. No PBTs were detected within the current survey area.

9.3.12 *Condition assessment*

The majority of the native vegetation associations present in the project area have been considerably disturbed. 73% of the native grassland associations have a Significant Environmental Benefit Ratio of 4:1 (Considerable Disturbance) or less. The Austrostipa sp. Grassland is in the worst condition with 91.5% having an SEB of 4:1 or less (Considerable Disturbance). The Lomandra multiflora ssp. Dura Tussock Grassland is in a much better condition with 31.4% having an SEB of 4:1 or less (Considerable Disturbance). The exotic/native grassland was dominated by exotic grasses with 100% having of 4:1 or less (Considerable Disturbance).

9.3.13 *Comparison of 2004 and 2010 Survey Results*

9.3.14 *Flora*

Compared to the 2004 survey, the range of plant species has increased from 26 native species to 32 native species (weed species increased from 15 to 21).

The main difference arises from the distribution of the vegetation associations. In the 2004 surveys the dominant vegetation association was the Exotic/Native Grassland. In the 2010 survey Austrostipa sp. Grassland makes up some 55% of the project area and was not extensively classified as such during the 2004 survey. In the 2004 survey it is likely that due to the poor condition of the Austrostipa sp., this area which is now classified as Austrostipa sp. Grassland, was previously recorded as an Exotic/Native grassland mix due to the relative proportions of exotic to native grasses present. The locations of the Lomandra multiflora ssp. Dura Tussock Grassland have also shifted significantly from the original 2004 survey probably for similar reasons and the recovery of the native grasses present.

The difference between the survey results and recovery of native species may be due to a number of factors, including potential changes in grazing regimes within the survey area, climatic conditions

and flora species present at the time of the surveys, which over the six years since the original survey can significantly change survey results.

9.3.15 *Fauna*

As per the 2004 survey work, no fauna species of national or state conversation significance were observed on the site.

9.3.16 *Impact of Proposed Expansion Layout T01 to T26*

Of the 26 turbines, reference T01 to T26 of the proposed expanded Willogoleche Wind Farm, 15 are located within the 100m radius allowed by the original consent (Development Number: 422/0078/04), whilst 11 are proposed to be moved by a maximum of 296m from the original turbine locations.

Figure 2 shows the locations of those turbines which are to be moved more than 100m from the original Development Approval. Whilst the quality of vegetation on the project site surveyed has improved significantly, turbines T01 to T26 of the proposed expanded layout will not have a significantly greater impact compared to the consented layout. Table 9.2 below lists the variations, based on the 2010 survey results. Based on the 2010 survey of vegetation associations, it can be seen that in 7 out of the 11 turbine locations where turbines have been relocated in excess of the permitted 100m position limit, the vegetation associations of the expanded layout are the same as that for the original Development Approval. For 3 out of 11 turbine locations of the original Development Approval, the vegetation association was not surveyed in 2010 .

Table 9.2 Vegetation Associations of the Expanded Layout Compared to the Development Application Number: 422/0078/04, based on 2010 survey results.

Expanded Layout Turbine Reference (EBS Figure 2, Appendix 14)	Distance of turbine from original DA position	Distance of turbine from 100m DA position limit	Present Vegetation Association of Original DA positions [1]	Vegetation Association of Amended turbine positions [1]	Turbine or infrastructure located within EPBC listed *Iron-grass Grassland of South Australia?*[2]
T04	204m	104m	Unconfirmed[3]	B	
T08	217m	117m	A	A	Yes
T09	190m	90m	A	A	
T10	198m	98m	A	A	
T11	132m	32m	A	A	
T12	173m	73m	A	B	
T13	200m	100m	Unconfirmed[3]	B	
T14	121m	21m	B	B	
T21	119m	19m	A	A	Yes
T22	206m	106m	Unconfirmed[3]	A	
T23	296m	196m	A	A	

1. A Lomandra multiflora ssp. dura Tussock Grassland
   B Austrostipa sp. (Spear-grass) Grassland
   C Cropping
   D Exotic/Native Grassland
2. Appendix 16 – Willogoleche Wind Farm Assessment against the EPBC Criteria for Iron-grass Grassland Threatened Ecological Community, EBS 2010
3. These areas were not surveyed in the recent 2010 EBS study

9.4 Ecological Impact of 11 Additional Turbines

9.4.1 *Field survey*

Figure 3 shows the locations of turbines referenced B-T01 to B-T12 (please note that B-T11 was removed from the proposal).The field survey was conducted between 15-17 and 25-26 February 2010 by EBS staff. The survey area included the 11 turbine locations (survey buffer of approximately 100 m radius) and associated track and cable routes (survey corridor of approximately 50 m).

9.4.2 *Vegetation associations and condition*

The survey area was accessed on foot, other than areas containing Cropping Land. The vegetation survey included recording all native and introduced flora species, vegetation associations and vegetation association condition ratings. The vegetation condition ratings given to vegetation associations within the survey area were based on the significant environmental benefit (SEB) ratios provided in Table 4 of Appendix 15.

9.4.3 *Pygmy Blue-tongue Lizard presence/absence survey*

A presence/absence survey for PBTs was conducted in areas containing potential PBT habitat. A corridor of approximately 50 m (track and cable routes) and 100 m (turbine locations) within identified potential PBT habitat area was searched for spider burrows (potential PBT burrows). All potential PBT burrows located whilst walking the survey area were checked for PBT occupancy by using an optic fibre scope ('Burrowscope'). Spider burrows that were not checked with the 'Burrowscope' included any burrows that were inhabited by large ants or that had an opening diameter of less than 5 mm (considered too small for juvenile PBTs).

9.4.4 *Other Fauna*

The area was extensively surveyed during 2004. The results from this survey work have been used to assess the impact upon other fauna species and birds.

9.4.5 *Ecological Impact of B-T01 to B-T12 of Expanded Willogoleche Wind Farm – Survey Results*

9.4.6 *Flora survey results*

Fifty-three flora species were detected during the current survey. This includes 32 native species and 21 weed species. Appendix 4 of Appendix 15 provides a complete list of native flora species detected in each vegetation association and Appendix 5 of Appendix 15 provides a complete list of weed species detected within each vegetation association.

9.4.7 *Threatened flora species observed*

One flora species, Cryptandra sp. Long hypanthium (Long-flower Cryptandra), which has a rare rating under the NPW Act, was recorded as a scattered species within the Austrostipa sp. (Spear-grass) Willogoleche Wind Farm Expansion, Ecological Assessment Grassland association. No flora species listed as threatened under the EPBC Act (1999) were detected within the survey area.

9.4.8 *Threatened ecological communities*

Four areas within the Lomandra multiflora ssp. dura (Hard Mat-rush) Tussock Grassland were identified during the survey as potentially meeting the criteria of Iron-grass Natural Temperate Grassland of South Australia threatened ecological community under the EPBC Act (1999) (refer to Figure 4 of Appendix 15 for the four locations).

All areas highlighted as potentially meeting the assessment criteria required a survey during spring 2010 to identify all native flora species present which will enable an assessment against the EPBC Act criteria. Results are detailed below.

9.4.9 *Declared and environmental weed species*

Three weed species detected during the current field survey are listed as declared species under the Natural Resource Management Act 2004 (see Table 11 of Appendix 15). Five environmental weed species were also detected during the current survey.

9.4.10 *Vegetation associations*

The survey area contained three vegetation associations and areas of cropping land (see Figure 3 of Appendix 15). These are listed in table 9.3 below. The table shows that Lomandra multiflora spp. Dura Tussock Grassland is in a very good condition compared to the Austrostipa sp. Grassland.

Table 9.3 Expanded Willogoleche Wind Farm B-T01 to B-T10 – Vegetation Associations

Vegetation Association	Percentage of Project Area	Percentage of Vegetation Association with an SEB Ratio of 4:1 or less
Lomandra multiflora ssp. dura (Hard Mat-rush) Tussock Grassland	27.2%	0%
Austrostipa sp. (Spear-grass) Grassland	48.3%	65.4%
Exotic / Native Grassland	8.6%	100%
Cropping Land	15.9%	100%

9.4.11 *Assessment of potential Iron-Grass Natural Temperate Grassland of South Australia*

Due to the quality of the Lomandra multiflora ssp. dura (Hard Mat-rush) Tussock Grassland observed on the Willogoleche Hill Wind Farm site, EBS Ecology (EBS) were contracted to undertake an assessment of potential *Iron-Grass Natural Temperate Grassland of South Australia* communities. These were highlighted as possibly occurring in previous surveys conducted by EBS and are legislated as a threatened ecological community (TEC) under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*. The methodology and results from the survey are detailed in Appendix 16.

Six of the seven sites assessed qualified as Condition Class B Iron-Grass Natural Temperate Grassland of South Australia. Generally, these sites were present along the tops of the ridges in the most exposed positions where soils were very shallow and exposed rock covered 5-20 % of the surface area. Lower slopes had a higher percentage of exotic grass species cover and reduced frequency of native herbaceous species, thereby not fulfilling criteria for the threatened ecological community. All sites were exposed to grazing pressure from sheep and Western Grey Kangaroos.

The turbines and associated tracks and cables of the expanded Willogoleche Wind Farm have been designed to avoid areas of the listed TEC as far as practicable. However, given there will be some residual clearance required it will be necessary to submit a referral under the *Environment Protection and Biodiversity Conservation Act 1999* regarding the nationally listed threatened ecological community *Iron-grass Natural Temperate Grassland of South Australia*.

9.4.12 *Pygmy Blue-tongue Lizard presence/absence survey*

The majority of the area surveyed was considered to be unsuitable PBT habitat due to dense ground cover vegetation, steep terrain, rocky terrain and a lack of spider burrows. Thirty-five spider burrows were searched within habitat near the locations of B-T03 and B-T05. The majority of the spider burrows searched contained spiders. No PBTs were detected within the current survey area.

9.5 Ecological Impact of the expanded Willogoleche Wind Farm - Potential Impacts

9.5.1 *General Fauna*

Wind farm developments have the potential to impact fauna by one or more of the following:

- Destruction or fragmentation of habitats
- Disturbance leading to displacement and barriers to movement
- Noise disturbance during construction or operation
- Direct interaction with wind turbines (birds and bats)
- Direct loss of species during construction, maintenance or refurbishment/decommissioning

The following discusses these potential impacts as they are relevant to fauna species in general and, where relevant, to bird and bat species (see Sections 9.3.2 and 9.3.3).

9.5.2 *Destruction or fragmentation of habitats*

The construction activity that is proposed for areas of national significance; for example, within the areas of the critically endangered Hard Mat-rush (*Lomandra multiflora* spp. *dura*) Tussock Grasslands will be micro-sited to avoid as much of the native vegetation within the communities as possible. This proposal includes access tracks and cable routes routed around the key areas of the EPBC listed *Iron-grass Natural Temperate Grassland of South Australia*, sited in less significant areas of vegetation. Impacts within these areas are not anticipated to result in the isolation of parcels of habitat. While there is likely to be some fragmentation effects, the potential impacts are considered minor and will be minimised by the utilisation of reduced width tracks where possible; creating minimal disturbance. Also, construction activities will be guided through appropriate environmental management plans.

There may be some disturbance to the habitats of reptile species during the construction phase of the wind farm, due to the ability of some species to live in very degraded habitats (*i.e.* exotic grasslands) which make up the majority of the project area. However, the loss of habitat will be minimal and localised. Indirect disturbance may also occur, from incidences such as uncontrolled runoff causing siltation off-site. However, appropriate management practices will be in place to ensure impacts are avoided where possible.

9.5.3 *Noise disturbance during construction*

Noise impacts from construction works and refurbishment/decommissioning may result in the temporary displacement of species, when noisy machinery is utilised. However, such disturbances are anticipated to be short-term and localised.

9.5.4 *Direct loss of species during construction, maintenance or refurbishment/decommissioning*

Direct mortality or injury may occur during construction, maintenance or decommissioning activities (*e.g.* machinery or vehicle related deaths to species), particularly for some reptile species that may live in the exotic grassland habitats. However, any injury or mortality to species is likely to be minimal, as the majority of the project is located in poor habitat areas. Care will be taken to avoid the loss of any significant reptile species found to occur in the area, as discussed below. See Sections 9.3.2 and 9.3.3 for discussions on birds and bats respectively.

The Environmental Management Plan presented in Appendix 13 is anticipated to carefully guide all construction, maintenance and refurbishment/decommissioning activities at the site to mitigate these potential environmental impacts. As such, the impacts upon fauna species at the expanded Willogoleche Wind Farm are expected to be negligible.

9.5.5 *Birds*

9.5.6 *Disturbance leading to displacement and barriers to movement*

Wind farms overseas have been known to act as barriers to the movement of various bird species (Drewitt & Langston 2006), which may lead to disruption of ecological links between feeding, breeding and roosting areas. Disturbances are most notable where the wind farm covers a large area, where several wind farms are located within close proximity to each other or where turbines are placed in close proximity to each other. There are several studies indicating negative effects up to 600 m from wind turbines; that is, a reduction in bird use of or absence from the area close to the turbines (*e.g.* Hess 1999 and Langston & Pullan 2002, in EBS 2004). Migration of species and the movement between nesting grounds and feeding grounds of species may be impacted. The design of a wind farm can alleviate the potential barrier effects by allowing wide corridors between clusters of turbines (Drewitt & Langston 2006) or by maintaining space between clusters.

The spacing of turbines has been maximised between blade tips to at least 300m, which allows for the movement of birds species using these habitats. It is therefore unlikely that the expanded Willogoleche Wind Farm will have a significant impact on the movement of local bird species within the area, due to low bird activity and the limited habitat available in the project area.

9.5.7 *Noise disturbance during construction or operation*

During construction there may be some disturbance to birds inhabiting the project area due to noisy construction activity. These effects are considered to be localised and short-term. Noise associated with the operation of the turbines may affect the behaviour of birds in adjacent areas, although the likely extent of disturbance has not been well-documented. Disturbance to birds is usually thought to taper off at distances of 50 m from the source of the noise, although some studies have shown birds avoiding turbine fields in open areas by up to several hundred meters (Hess 1999, in EBS 2004). Due to the lack of available information in this area, it is difficult to predict the impacts. Some raptors, particularly Wedge-tailed Eagles, could be affected by the presence of turbines overhead as they are notoriously susceptible to disturbance.

9.5.8 *Direct interaction with wind turbines*

Experience at wind farms overseas has shown varying levels of interactions between birds and wind turbines (Hess 1999, in EBS 2004; Percival 2000). It is, however, generally considered that the total bird collision mortality associated with wind farms is significantly low compared with the impacts of other man-made structures in the landscape; such as buildings, cars, windows and communication

towers. Erickson *et al*. (2001) found that in the United States wind farms were responsible for less than 0.01 % of total bird strike.

Historically, bird collisions with turbine blades have generally been more significant in areas that support high numbers of waterbirds and raptors, or are in the path of migration routes. Birds which often fly high over the landscape may also be more susceptible to collisions with wind turbines.

A high frequency of mortality has also been attributed to the design of earlier turbines and wind farms, which saw turbines being placed very close together, with fast spinning blades closer to the ground (Hess 1999, in EBS 2004), and turbine designs that had nacelles and blades mounted on lattice towers. It has also been suggested that the placement of turbines is the most significant factor relating to bird mortality with turbines (Erickson *et al*. 2001; Percival 2000). In the US it has been found that a greater spacing between turbines seems to have reduced bird mortality. Indeed, well-spaced, tall solid tower turbines with much slower blade rotation than older models are now the norm for modern day wind farms, and will also be the case for the expanded Willogoleche Wind Farm.

Although research measuring the impacts of wind farms in Australia has been relatively rare, more evidence is starting to emerge as the wind farming industry grows. Some of the first studies into the interaction between birds and wind turbines in Australia were conducted for Pacific Hydro by Dr Charles Meredith (Biosis Research) at three south-eastern Australian wind farms, and were presented in July 2003 (see Appendix 17: AusWEA: Wind Farms & Bird & Bat Impacts). Dr Meredith found bird deaths at the three wind farms to be below the levels predicted (and accepted) during the wind farm approvals process. Further, no rare or significant bird species were recorded to have been struck by the turbines. The study also found a very low mortality rate for waterbirds and large raptors. As the Australian wind industry enters its next stage of development, more and more information is being presented which indicates that mortality rates at Australian wind farms are in fact lower than in the Northern Hemisphere (see Appendix 17: AusWEA: Wind Farms & Bird & Bat Impacts).

9.5.9 *Raptors*

At some wind farm sites in other countries, including in California (USA), raptors have been reported as killed or injured in large numbers by moving blades (Percival 2003). However, the wind farms described in these studies are earlier developments, with differing turbine design than contemporary styles. In more modern wind farms, raptors have been subject to strike, within acceptable and predicted limits, at the Woolnorth Wind Farm in northwest Tasmania, and at the Starfish Hill Wind Farm near Cape Jervis in South Australia. The potential for the raptor species to be subject to blade strike from the proposed expanded Willogoleche Wind Farm cannot be ruled out. However, as has been shown with modern wind farm designs, maximising turbine spacing and using solid (as opposed to lattice) towers to reduce perching opportunities, are key factors in significantly reducing bird strike frequency, particularly for raptors (Percival 2003).

A number of raptor species were observed in or near the survey area. Due to the vegetation associations present on the site, there would be no nesting in the project area. There was a low number of raptors recorded during the survey. As such, it is expected that the wind farm proposal would have a low to moderate impact on the raptors in the area.

9.5.10 *Birds flying high over landscape*

A number of species that occur, or are likely to occur, in the vicinity of the study site fly at heights that may lead to interactions with wind turbines. Raptor species hunting on the ranges and soaring on up-drafts are at risk of being struck as well as night-flying birds, including migratory birds and

water birds. The likelihood of many of these species colliding with wind turbines may be low, but it is difficult to predict, as little data exists on the interactions of such species with wind turbines.

9.5.11 *Threatened bird species/birds of conservation significance*

No birds of national or state conservation significance were recorded at the Willogoleche site during the surveys, although some are known to occur within the region. Most of the birds of conservation significance that may occur within the proposed expanded Willogoleche Wind Farm are likely to occur as occasional visitors with most species occurring in low numbers across the region. As none of these species are (or are likely to be) abundant on the site, it is unlikely that significant numbers of individuals are at risk of collision with turbines.

The risk posed to individual birds by the presence of wind turbines is difficult to predict, due to the lack of knowledge of species-related bird-turbine interactions in an Australian context. As has been shown in modern wind farm designs worldwide, however, maximising space between turbines, siting wind farms in areas where raptor and migratory species concentrations are low, and using solid as opposed to lattice towers to reduce perching opportunities are key factors in significantly reducing bird strike frequency.

9.5.12 *Overall impact on birds*

The overall impact of the expanded Willogoleche Wind Farm development on birds is likely to be low, however the impact on individual species is difficult to gauge. Overseas experience has shown that bird collisions with turbine blades can be significant; however this is usually in areas where there are high concentrations of raptors and migratory species. Additionally, a higher impact has occurred in areas where higher concentrations of turbines are constructed compared to modern wind farm designs. Coupled with the fact that many of these turbines are atop lattice towers, they reveal higher mortality yields, as is the case with some Californian wind farms (Percival 2003; Hess 1999 in EBS 2004).

No species of state or national significance were recorded at the site during the field survey. The Plains-wanderer and the Australian Painted Snipe may utilise habitats within the site occasionally, however it is likely that they would be rare visitors to the site and would rarely be abundant at the site. Consequently, the impact of the proposed wind farm on birds of conservation significance is expected to be low.

Most migratory species would be relatively uncommon or rare within the proposed project site, and occur irregularly or seasonally, which would reduce the impact of the wind farm on such species.

Bird mortality may be minimised by spacing turbines so that birds have routes that they can take without the interference of turbines. Most of the bird species that may occur on-site and are at risk from the turbines are raptor species. They usually occur at low densities, with most being seasonal visitors to the area. Even assuming a relatively conservative bird strike collision rate for species that potentially exist in the Willogoleche region, it is thought that the overall population density of species would not be seriously at threat, given the total population numbers of species present in the entire Mid-North are reasonably sustained and no highly threatened species are active in the region. The overall viability of bird populations is not anticipated to suffer from this project given that there are many other suitable higher quality habitats for species occurring in the greater area.

9.5.13 *Bats*

The bat species that are likely to occur on site are relatively common with none of them having a national or state conservation rating. The impact of the proposal on bat species is unclear and difficult to predict. Bats have been recorded as killed at several wind farms (Hess 1999, in EBS 2004),

but little is known about the interaction of bats with wind turbines. A study by Keeley *et al*. (2001) has developed some estimation on quantitative assessment of risk of the number of bats killed per turbine per year. Values range from 0.74 to 2.5 bats killed per turbine per year. Only one bat species has been found to be subject to mortality from wind farms in south-eastern Australia. Little else is known about the interaction of bats with wind turbines. They are known to use large structures as foraging markers, but it is not known whether they would be able to detect and/or avoid the turbine blades.

The numbers of bats around turbines and, therefore, the risk of collision may be increased if insects are attracted to turbines. There may be some risk of collision at the expanded Willogoleche Wind Farm which would result in mortality, however overall impacts are expected to be low.

There will be no clearance of woodland habitats within the survey area which could result in direct removal of potential roosting habitat for bats, and possibly direct mortality of roosting bats. As clearance of woodland habitats will be unnecessary, any effects of this nature are expected to be low.

9.5.14 *Cumulative Impacts – Avifauna*

It is anticipated that there could be a minor cumulative effect on bird and bat species in the region and that it would probably vary between species depending on their range. The wind farms that are either already operating or planned for the region collectively have the potential to cause cumulative impacts upon the avifauna that exist or are likely to exist within the whole region and, as such, discussion of the potential cumulative impacts of wind farm development in the region is warranted.

The cumulative impacts of wind farms in the Mid-North on birds in the region are difficult to quantify. Bird numbers and activity in the region are considered to be comparatively low in regards to other regions. Although the possible bird strike rate at a wind farm development may be expected to be low, as discussed, the effect may be significant for long-lived species with lower reproduction rates. With the collection of wind farm developments either already operational or planned for the area and the cumulative effect of these strikes over time, particular species may decline in the region.

The species most at risk of cumulative impacts from wind farms include raptors, which are likely to range over most of the region, and are known to soar above ridge tops and forage in the open areas surrounding the ridges. Collision with turbines and other infrastructure such as electricity cables is a risk for species that fly through or hover over the ridges. The majority of raptors occur at low densities within the region, with most being seasonal or irregular visitors to the area. Regional studies are needed to collect data and gain insight into raptor use of the wind farm areas in a regional context, and to accurately assess the cumulative impacts that wind farms may have.

A significant obstruction (or barrier effect) to bird movements in the region could result if inadequate space is provided between sites. Instead of flying between the sites, birds may fly around the outside of the wind farm. Where this occurs and bird movements are displaced as a consequence, it may lead to disruption of ecological links between feeding, breeding and roosting areas (Langston and Pullan 2002, in EBS 2004).

Several studies indicate that there can be negative effects up to 600m from wind turbines; that is, a reduction in bird use of or absence from the area close to the turbines (Hess 1999 & Langston and Pullan 2002, in EBS 2004). Therefore, there is the potential for a group of wind farms, if inadequately spaced, to significantly impact upon the migration of species and the movement between nesting grounds and feeding grounds. Also, while some species may be confined to the habitat of one site,

and so only be exposed to a limited number of turbines, others may range over two or more sites, thereby increasing their exposure to turbines.

As discussed, wind farm design can alleviate any barrier effect and reduce the potential for bird-strike by:

- Maintaining corridors or wide separation distances between sites
- Maximising spaces between individual turbines within sites

The spacing between each of the sites that are either operational or proposed for the Hallett region has been maximised to allow safe passage of bird and bat species between them. Also, the design of wind farms within the region maintains distances of at least 300m between individual turbines within sites. Such spacing greatly reduces the risk of bird and bat interaction with the turbines, as it allows the movement of individuals within each respective site. These measures will reduce the potential for bird mortality within each site, subsequently reducing the potential cumulative impact on birds within the region.

The cumulative impact of wind farms in the Mid-North on bat populations may also cause declines in the number of certain species, however the regional distributions and behaviour of bats in the region is poorly studied. The foraging behaviour and known flight path of bats needs more investigation, to determine their utilisation of the project areas.

Overall, it is considered unlikely that the proposed development will have a significant cumulative impact on bird and bat species in the area, as a result of a combination of factors:

- The wide spacing maintained between turbines
- The large distances separating the sites
- The intrinsic turbine structural design
- The low population density of species in the area
- The slow speed at which turbine blades rotate

Furthermore, even assuming a relative conservative interaction rate for bird species at risk, it is thought that the overall population viability of species would not be seriously at threat, given that the total population numbers of species present in the Mid-North region are reasonably sustained and that there are many other suitable habitats for the species within the region (EBS 2004). Regional bird and bat monitoring programs will be conducted to provide an assessment of the cumulative impacts of wind farm developments in the region upon bird and bat species.

9.5.15 *Flora and Vegetation Associations*

The principal impact to flora species and vegetation associations from a wind farm development is direct losses through clearance. The potential for indirect effects on flora exists if factors such as drainage, soil erosion, locations of stockpiles, soil compaction near trees and soil and weed movement are not carefully managed.

Table 9.4 below lists the vegetation associations present in the additional 11 turbine locations proposed for the expanded Willogoleche Wind Farm.

Table 9.4 Vegetation Associations on 11 Additional Turbines of the expanded Willogoleche Wind Farm

Turbine Reference (EBS, Figure 3 Appendix 15)	Vegetation Association of Proposed 11 additional turbines	Is the turbine located within EPBC listed *Iron-grass Grassland of South Australia*'
B-WTG01	Lomandra Tussock Grassland	No
B-WTG02	Austrostipa sp. Grassland	No
B-WTG03	Austrostipa sp. Grassland	No
B-WTG04	Austrostipa sp. Grassland	No
B-WTG05	Austrostipa sp. Grassland	No
B-WTG06	Lomandra	No
B-WTG07	Lomandra Tussock Grassland	No
B-WTG08	Lomandra Tussock Grassland	No
B-WTG09	Lomandra Tussock Grassland	No
B-WTG10	Lomandra Tussock Grassland	Yes
B-WTG12	Exotic/Native Grassland	No

Due to the required locations of the turbines on the ridgelines of the Willogoleche site it will not be possible to avoid all species of national conservation significance, although careful design in this proposal has been used to minimise the impact as far as practicable. Micro-siting will be used wherever possible to further avoid the EPBC listed *Iron-grass Grassland of South Australia*. Cable and access tracks have been routed around the EPBC listed *Iron-grass Grassland of South Australia* to minimise the impact as far as practicable.

Where clearance of native vegetation is unavoidable, an application will be made to the Native Vegetation Council to seek a conditional grant to clear.

A referral is being concurrently lodged under the EPBC Act 1999.

9.5.16 *Protected Areas*

The closest areas to the proposed site that are listed as conservation areas are the Mokota Conservation Park and Pandappa Conservation Park; located approximately 40 km to the south-east and north-east of the site respectively. No significant wetlands occur within the region. There will be no direct impact on conservation reserves, as none occur within the project area or in the near vicinity. Indirect impacts, such as run-off or erosion, are unlikely to occur as on-site practices will be in accordance with the EMP and will ensure such events are effectively avoided or appropriately managed.

9.6 Mitigation and Management

9.6.1 *Fauna*

Mitigation and management of potential impacts to fauna includes appropriate planning of the turbine layout and access track locations to avoid areas of potential habitat for significant fauna as much as possible.

Although native grasslands usually lack diversity in regard to fauna species, the Hard Mat-rush (*Lomandra multiflora* ssp. *dura*) Tussock Grassland patches are considered to have a moderate-high habitat value for several species of conservation significance. These include the nationally endangered Pygmy Bluetongue Lizard and the nationally vulnerable Plains-wanderer. The entire

survey area is also potential habitat for the vulnerable Flinders Worm Lizard. These species were not identified in the survey area.

These areas will also be managed in accordance with the project Environmental Management Plan (EMP), and any proposals for clearance of native vegetation within the survey area will be referred to the Native Vegetation Council for approval under the *Native Vegetation Act (1991)*. Further details of appropriate management of these habitats are presented in the EMP appearing as Appendix 13.

Pre-construction micro-site surveys will also be undertaken along all areas that could potentially be disturbed during construction activities to identify any areas of significant habitat to be avoided and any significant reptile species. Access to such areas will be managed and, where appropriate, restricted. If required, translocation to nearby suitable habitats will take place of any significant reptile species found. Surveys and translocation will be carried out by a qualified ecologist.

The turbine layout at each cluster maintains relatively large distances between turbines of at least 300 m between blade tips, which will aid in minimising the potential for raptor-turbine interactions. The solid steel towers will also prevent use by birds for perching. Lattice masts used for wind monitoring are of a small lattice design only, which will also prevent most raptors and other medium to large sized birds from perching.

A bird and bat monitoring program will be established to monitor any potential effects of the wind farm on bird and bat populations. Such a program will be developed during the pre-construction phase of the project and implemented during the construction phase of the project. The monitoring program will draw from, and be in line with, current Best Practice Guidelines. An annual regional raptor monitoring program will also be implemented to detect any future impacts (if any) of the wind farm development in the region. Regional monitoring will be conducted for a minimum of five years, following which a review will be conducted to determine whether further monitoring is required.

The EMP will effectively mitigate any potential environmental impacts of habitat disturbance, direct mortality, and indirect disturbance, upon other fauna species known to occur in the region.

9.6.2 *Flora and Vegetation Associations*

Planning of turbine layouts and access track locations at wind farms is conducted so that areas of known significant and threatened vegetation are avoided as far as possible. The areas that do exist provide vital refuge and resources for common and threatened native fauna in the area, regardless of their condition. Consequently, clearance of such areas will be avoided and the infrastructure corridor will mostly be in the vegetation in the poorest condition.

Avoidance of key threatened ecological communities has been minimised through effective project planning and design. Either this vegetation occurs in areas which will not be significantly impacted by proposed project works, or the vegetation will be protected from the development through effective buffer zones, relating to vehicle movement and machinery tracks and parking of vehicles and machinery. Stockpiles of materials and any associated infrastructure (*e.g.* tracks) will be placed in cleared land where upon no native vegetation will be impacted, where possible.

Although most areas of threatened vegetation can be avoided, a small proportion of the native *Iron-grass Grassland of South Australia* may require clearance for the construction of two turbine bases and associated infrastructure. Any clearance required of the Threatened ecological community will be the subject of a referral made under the Environmental Protection and Biodiversity Act 1999. Any clearance of any native vegetation required will be subject to assessment by the Native

Vegetation Council.

One flora species, Cryptandra sp. Long hypanthium (Long-flower Cryptandra), which has a rare rating under the NPW Act, was recorded as a scattered species within the Austrostipa sp. (Spear-grass). It is possible that this species could be impacted upon by the construction process. However, management of this species will involve detailed planning to ensure that the impact on this vegetation will be minimised during construction activities.

A pre-construction micro-site survey will be undertaken in all areas that could potentially be disturbed during construction activities. This will identify any areas that should be avoided and to which access should be restricted. Surveys will be carried out by a qualified ecologist.

The proliferation of exotic flora species, particularly declared and environmental weeds, will be avoided during all phases of the wind farm development through effective planning and management procedures. Mitigation measures will be put in place regarding vehicle movement and soil movement on the site to avoid the spreading of exotic flora species. Impacts to individual flora species and vegetation communities are predicted to be minimal overall, and any impacts will be effectively managed through an appropriate vegetation strategy appearing with the EMP (see Appendix 13).

9.7 Summary

Several ecological surveys have been undertaken in the expanded Willogoleche Wind Farm area. Flora and fauna species present, vegetation communities present and habitat attributes of the Willogoleche Hill Wind Farm Expansion area were assessed. Searches of state and national databases were also conducted to determine other species previously recorded or potentially present in the area. Various references and reports were also consulted.

A number of fauna species, both native and introduced, were detected at the site during the surveys. No nationally threatened fauna species were recorded at the site during the surveys. It is anticipated, that some bird species of conservation significance may occur at the proposed site, as the habitats within the site are known to support some of these species. Listed migratory bird species are also expected to occur within the site, and several migratory bird species were observed during the ecological survey.

The survey suggests that the proposed site potentially supports several bird species that may be susceptible to interactions with wind turbines. However, relatively low numbers of individuals would be expected on site, most occur irregularly or seasonally, and are rare or uncommon in abundance. The nationally vulnerable Plains-wanderer may potentially use the site, however it would be an irregular visitor and is not likely to occur in significant numbers.

Extensive survey worked targeted to identify the presence of the nationally threatened Pygmy Bluetongue Lizard (endangered) indicated its absence from the site.

Native Grasslands that exist in the vicinity of the proposed site could provide suitable habitat for the Flinders Worm Lizard (vulnerable), but neither this species nor any other threatened reptiles were observed during any of the surveys. It is possible that they are present within the area, albeit in low numbers.

The total impact of the wind farm development on fauna species and their habitat is likely to be low. There will be some impact to a small proportion of threatened vegetation communities, which may provide habitat for some species. Management actions, such as micro-site surveys prior to construction, the relocation of significant reptile species found, monitoring, and actions to

regenerate disturbed areas will result in any impacts to these species, communities and habitats being negligible. A referral will be submitted under the *EPBC Act (1999)* to ensure appropriate management of any impact on species listed under its legislation (nationally listed species).

Flora surveys were undertaken at the expanded Willogoleche Wind Farm site during February 2010. A number of species were observed, including both native species and introduced species. Some species of state and regional conservation significance were recorded, including one flora species, Cryptandra sp. Long hypanthium (Long-flower Cryptandra), which has a rare rating under the NPW Act, was recorded as a scattered species within the Austrostipa sp. (Spear-grass). All threatened species will be avoided where possible to minimise the impact by construction activity.

Three different vegetation associations were observed during the flora surveys of the proposed site. The condition of the vegetation communities varies, with each of the communities having been disturbed to various levels, mainly through grazing.

The proposed wind farm development will have a low overall impact on the native flora of the site, as it will seek to avoid significant disturbance to native vegetation. The majority of the development is proposed to occur within the Austrostipa sp. Grassland, and the Lomandra Tussock Grassland will be avoided wherever possible; certainly where this meets the criteria for the EPBC listed Iron-grass Grassland Threatened Community. Development occurring in native vegetation communities will be minimised and will be appropriately managed through an EMP and be subject to assessment and conditional consent by the Native Vegetation Council and a referral process through the EPBC Act.

No conservation reserves are located within, or in the near vicinity, of the project area.

Overall, the potential impact of the proposed development upon the ecological value of the site is relatively low, with impacts on these areas able to be mitigated by the implementation of appropriate management actions through the project EMP. As such, the proposed wind farm is not expected to have any significant adverse effects on the site's ecological environment.

10. LAND USE

This chapter describes the predominant existing land use of the wind farm project site and surrounding area. It then describes the potential impacts of the wind farm on each of these land uses, and proposes mitigation measures.

10.1 Existing Situation

10.1.1 *Agricultural Land Use*

The project area is located in the Regional Council of Goyder, within the Northern Areas General Farming Zone, which generally encourages the preservation of land for agricultural purposes. Accordingly, the predominant land uses are agriculture based, with the main farming activities being livestock grazing and cereal cropping.

The predominant stock grazed in the area are sheep, with significant sheep stud and stock enterprises occurring in the region. Some cattle grazing also occurs. The project area is in the vicinity of Goyder's line, which provides a guide to the separation point between lands suitable for sustainable cropping and other cultivation, and land that is only suitable for grazing (Flinders Ranges Research 2008). Cereal and other cultivation crops occur on some lower slopes and flats between the ranges. Significantly, once the wind farm is operational, there will be very limited interference with the existing agricultural use of the land.

10.1.2 *Recreational Land Use*

The Mid-North region is host to a number of recreational activities. The prominent recreational facilities include the Heysen Trail for bushwalking and the Mawson Trail for bicycle riding. Also, the Dare's Hill Circuit Tour is one of the self-drive tours promoted regionally. Both the Mawson and Heysen Trails pass through the Willogoleche Wind Farm in an east-west direction through its southern vicinity.

Experience in both Australia and overseas has shown that recreational activities can successfully continue and coexist with an appropriately designed wind farm, which is the anticipated result of the expanded Willogoleche Wind Farm project.

10.2 Potential Impacts

10.2.1 *Agricultural Land Use*

The 37 turbines proposed for the expanded Willogoleche Wind Farm would be located within 7 titles totalling approximately 2278.6 ha. The area of land-take once operational would consist only of that required for the footprints of each of the possible 37 turbines (including fire breaks of approximately a 5 m radius), access tracks, crane hardstand areas, a potential cable marshalling area and wind monitoring masts. Together these total approximately 38 ha (1.7%) of the arable land. The revised 26 turbines and infrastructure occupy around 28 hectares, with the additional 11 and associated roads and reticulation occupying 10 hectares (or around 0.4%).

The diversification of income to the landowner as a result of the wind farm may allow for less intensive grazing practices on the ranges, which will have benefits to native flora and soil in the area.

During construction, the establishment of works facilities such as electricity, water, toilets, and subcontractors' field offices would also be required, as well as wider access tracks for construction vehicles. Such facilities, however, will be of a temporary nature and not form part of the long-term land-take for the wind farm.

Depending on the time of year when construction activities begin, there may be some disruption to land use activities for site owners, such as paddock ploughing, seeding or livestock grazing and breeding. There may also be times when a particular access point is blocked, or when a paddock is experiencing a high level of construction activity. However, such impacts will be temporary and managed in consultation with site owners. Disturbance to stock on neighbouring properties from noise and construction activity is expected to be minimal and temporary. From experience in wind farms overseas and locally, any noise emitted from wind turbines once commissioned is shown to be of little concern to stock.

As discussed in Chapter 8, construction activity and subsequent earthworks have the potential to cause soil erosion and thus decrease productivity due to the loss of topsoil if not managed effectively. Also, the movement of construction vehicles to and from sites may potentially spread agricultural weeds and diseases from infested to un-infested areas. Effective environmental management will be implemented in order to minimise such risks.

Access regimes may change for some landowners with the installation of new access tracks and gates between wind turbine sites. Existing access will be used where possible and access points can be secured if required by landowners.

In areas where the wind farm is operational, normal farm practices will resume. However, care will be needed when carrying out vermin control (shooting) within the vicinity, or in the general direction of wind turbines. Aerial spraying practices will also require care by pilots to avoid turbines.

10.2.2 *Recreational Land Use*

The Heysen and Mawson Trails run through the expanded Willogoleche Wind Farm. Potential impacts to these facilities can include disruption to access and visual impact. Throughout the construction process International Power will keep the trail operators informed of any activities that will impact upon the use of these trails. It is not expected that the expansion of the Willogoleche Wind Farm will increase the impact on these facilities more than the existing consented Willogoleche Wind Farm. The section of these trails running through the expanded Willogoleche Wind Farm (approximately 2.5km) makes up a very small proportion of these trails entire length.

10.3 Management

The management of potential impacts to land uses within the project area is of paramount importance. The following describes some mitigation measures.

10.3.1 *Agricultural Land Use*

The design of the layout of wind turbines minimises the effects on the use of agricultural land by rationalising land-take areas and using existing tracks where possible. Further to this, any land that is not part of the final land-take will be reinstated after disturbance. Following reinstatement, residual loss of land for agricultural use would be confined to the areas occupied by the 37 individual turbines, fire breaks, access tracks and crane hardstand areas. This would amount to approximately 38 ha in total (or 1.7 % of the total project area).

Any loss of land within the agricultural holding would be restricted to the duration of the life of the wind farm. Following this, the wind farm would be decommissioned and the land that was part of the wind farm land-take would be reinstated and once again be available for agricultural use.

Earthworks required for the installation of the turbines, access tracks and underground cabling will be effectively managed to ensure no significant erosion or site sedimentation occurs as a result of construction activity. An EMP will be implemented, which will outline appropriate soil and water

management procedures and remedial action strategies. Such procedures will include topsoil stockpiling and installation of erosion prevention devices where required.

All areas disturbed during construction, major maintenance and refurbishment/decommissioning that are not part of land-take will be reinstated. This will be achieved by replacing topsoil and re-sowing crop pasture, or replacing other flora species as negotiated with the relevant affected parties and regulatory authorities. Reinstated areas will be monitored for up to one year, and remedial measures such as seeding or further mulching will be undertaken on any areas that do not show satisfactory regeneration. This includes land disturbed for underground cables, which would be reinstated following laying of cables. Cables would be buried at a depth suitable to operate farm machinery under normal conditions (approximately 0.8-1 m).

Actions will be taken to prevent and control the spread of agricultural weeds and plant diseases to un-infested areas. These will include identification of risk species occurring in the region and potentially infested areas that may be traversed, implementing hygiene procedures where required (such as vehicle blow-down) before entering un-infested sites, sourcing outside materials from low risk sources, monitoring site access tracks to determine any new infestations, and carrying out appropriate remedial actions in the event that an outbreak occurs.

Inconvenience to landowners and their normal farming activities will be minimised through consultation and forward planning. The Project Manager will endeavour to work with landowners to determine those periods when certain farming activities must be carried out, and construction activity timing and procedures will be tailored to meet the affected landowner's needs as much as possible. The landowners will be updated on a regular basis regarding construction activity procedures and programming.

Access to the wind farm sites will be via existing access tracks and gates where possible, with new access points and tracks rationalised to minimise land-take and maintain security interests. Access gates may be padlocked if required by the landowner.

Fire prevention and control will be of paramount importance during the construction and operation of the wind farm site. Consultation with the Country Fire Service (CFS) is continuing to ensure all aspects of fire prevention and response are addressed. Prevention measures include fire breaks around turbine towers, presence of an equipped fire-fighting vehicle(s) on-site during construction, major maintenance and decommissioning/refurbishment, working cooperatively with the local CFS to ensure they are well-informed and effectively prepared for response, and the implementation of safety procedures and an Emergency Response Plan (see Chapters 3 and 6). It should also be noted that the turbines themselves have internal fire detection systems.

10.3.2 *Recreational Land Use*

The Heysen and Mawson Trails run through the expanded Willogoleche Wind Farm. The Wind Farm will be designed such that there will be no direct impact upon the trails. During construction of the Wind Farm it may be necessary to temporarily disrupt or restrict access across the trails. This will be done in full consultation with the trail operators. Diversions will be put up where necessary and information provided to trail users regarding the construction operations. Post-construction and subject to council approval, it may be appropriate to install permanent information boards relating to the Willogoleche Wind Farm.

10.4 Summary

The expanded Willogoleche Wind Farm project is proposed to be developed within the Northern Areas General Farming Zone of the Regional Council of Goyder.

Approximately 38 ha (1.7 %) of arable and grazing land would be lost to non-agricultural use, for the duration of the economic life of the wind farm. This includes land-take for turbines, access tracks, crane hardstands, and other wind farm infrastructure. This loss of land within the agricultural holding would not significantly affect farm productivity. The wind farm therefore would not have significant adverse effects on existing agricultural land use.

Land management issues, such as soil conservation, fire prevention, weed control and access have been considered and will be effectively managed to ensure a negligible impact to landowners and their neighbours.

The prominent recreational facilities in the area include the Heysen Trail and Mawson Trail. The Dare's Hill Circuit is also a recreational feature of the area. Potential impacts to these facilities can include disruption to access and visual impact. However, these impacts are expected to be negligible at most, due to the distance of the proposed site from these facilities. Visual impact is assessed in Chapter 12

11. CULTURAL HERITAGE

Under the *Aboriginal Heritage Act 1988* all Aboriginal sites, objects and places are protected, while under the *Heritage Act 1993* all non-indigenous registered heritage sites are protected. International Power commissioned two desktop assessments of the heritage values in and around the project area, and the results and recommendations are presented in this chapter.

This chapter firstly describes the cultural geography, anthropology and heritage of the development area and its immediate surroundings by reference to known archaeological sites. It also predicts the likelihood of the occurrence of cultural items, of both Aboriginal and European heritage, within the development area. Mitigation measures are also proposed to avoid, reduce or mitigate any potential adverse impacts.

An application pursuant to Section 12 of the Aboriginal Heritage Act 1988 was submitted in 2007. The Aboriginal Affairs and Reconcilliation Division ("AARD") determined that no Aboriginal Sites or Objects were identified with the project area. This section thus deals largely with the area required for the additional 11 turbines proposed for the expanded Willogoleche Wind Farm. Appendix 18 includes the 2007 survey report produced on behalf of the AARD.

11.1 Methods

Information on the cultural heritage of the proposed wind farm site has been gathered through consultation with Aboriginal and historical groups. A desktop study was conducted in December 2003 by TimeMap Pty Ltd (Walshe & Bonell 2003), which involved an archaeological and anthropological assessment of the general Hallett region. A copy of the report is contained in Appendix 18.

An additional desktop study was conducted in September 2010 by Vivienne Wood Heritage Consultant Pty Ltd to specifically address the expanded Willogoleche Wind Farm proposal. The report for this study can also be found in Appendix 18.

The major aims of the studies were:

- To identify and research known Aboriginal sites and places and non-Aboriginal archaeological sites and heritage places
- To present the known Aboriginal archaeological and anthropological background information and post contact history
- To identify areas of potential sensitivity in regard to Aboriginal and non-Aboriginal sites and heritage places
- To develop recommendations in regard to Aboriginal and non-Aboriginal sites and heritage places

Databases and registers searched as part of these studies included:

- Sites Register (Department of Aboriginal Affairs and Reconciliation)
- The State Heritage Register (Heritage Branch, DEH, South Australia)
- Register of the National Estate Database (http://www.ahc.gov.au/register/easydatabase/database.html)
- Australian Heritage Places Inventory (http://www.heritage.gov.au/ahpi/search.html)
- National Trust of South Australia

In addition to these desktop studies an on-site walkover survey will be conducted with a qualified archaeologist/anthropologist and recognised representatives/elders of the local Aboriginal groups to identify any further cultural heritage sites to be avoided during construction and operation activities.

11.2 Existing Situation

11.2.1 *Known Indigenous Heritage Sites*

Results of searches of registers, databases and relevant literature have shown that there are no registered or recorded Aboriginal sites, objects or places within the project area.

The proposed development area is situated clearly within land previously recognised as Ngadjuri country, according to maps originating from research in the 1930s-50s by respected anthropologist Norman B. Tindale. Tindale (1937, 1974 in Wood 2010) identifies Ngadjuri territory as stretching from Angaston and Gawler in the south, to Port Pirie and Orroroo in the north, and westward to Crystal Brook. Their eastern boundary is the eastern scarp of the Mount Lofty Ranges. By all accounts, the Ngadjuri peoples occupied the landscape for many thousands of years (Wood 2010).

Geological and anthropological investigations commenced in the Mid-North of South Australia in the early 1900s. Through these investigations, a number of archaeological finds have been recorded in the region. Among them are the internationally recognised engraving sites as well as painting sites in the Olary region (approximately 190 km north-east of Jamestown), a series of peckings on rock faces at Deep Creek (approximately 8 km east of Burra) and rock engravings and campsites in the Porcupine Ranges (approximately 80 km north-east of Jamestown). As well as archaeological finds, in 1926 two investigators noted that the vehicle track connecting Olary to Burra (still the major highway route today) appeared to follow a 'main native route', chosen in all instances because of its topography (Walshe & Bonell 2003).

More recent archaeological investigations in the Mid-North were carried out by Anderson (2000 in Walshe & Bonell 2003). This investigation focused on Ngadjuri country and lists 89 sites in the Mid-North region. The list includes sites maintained on the Register of Aboriginal Sites, South Australia, as well as unregistered sites recorded during the project. Most of the registered and recently recorded sites are engraving sites, followed by stone artefact scatters and a very small number of culturally modified trees, painting sites, quarries and stone arrangements (Walshe & Bonell 2003).

11.2.2 *Areas of Potential Archaeological Sensitivity*

Sites of significance to Aboriginal and Torres Strait Islander peoples can take the form of stone artefact scatters/campsites, quarries, stone arrangements, scarred trees, burials, rock holes, painting sites and engraving sites (Wood 2010). The Mid-North of South Australia contains a rich and diverse archaeological record.

In the absence of site-specific investigative results, predictions can be made about the incidence of potential heritage sites, the site types and the degree of site preservation from the results of regional investigations.

Ancient engraving sites or petroglyphs are the most common site type recorded in the broader region of the study area. These have come to be known as engravings in the Panaramittee style (after the station where they were first recorded (Edwards 1964)). The proposed area for the wind farm development is associated with the highest scarps above valley floors, creeks and gorges, which significantly reduces the potential for engraving sites to be identified in the study area.

Freshwater sources are the key to most site locations, particularly engravings and campsites. Peaks, ridges and scarps offer potential for stone cairns, quarries and painting sites. Woodlands and valleys

have some potential for culturally modified trees and campsites. Ground surface visibility increases with surface erosion, wind deflation and loss of vegetation. This will improve the potential for locating sites, but sites will consequently be of poorer status (Walshe & Bonell 2003). Cairns which represent Aboriginal burial sites are often found in the Mid-North on high windy ridges, which are also common locations for wind farms.

11.2.3 *Indigenous Anthropology and Sites of Relevance*

Two Ngadjuri 'legends' were recorded by Tindale in 1937 (Walshe & Bonell, 2003). One legend tells the story of an old woman and her two dogs who travel across Ngadjuri country, and is associated with formations in the Parachilna Gorge, to the north in the Flinders Ranges. The second legend recorded by Tindale relates the story of Eagle and Crow and is focussed on an Aboriginal campsite near Orroroo, to the north of the study area. This story is shared by the Adnyamathanha people of the Flinders Ranges and also the Nukunu people (Turnbridge 1988, in Walshe & Bonell 2003).

According to Horton (1994, in Walshe & Bonell 2003), dreaming tracks travel through Ngadjuri country which lie "…near the southern end of the great trading and exchange routes which extended northwards to the Gulf of Carpentaria". Ochre, pituri, grinding slabs and other objects are well known to have been traded back and forth along this route, via Lake Eyre in central South Australia (McBryde 1987 and Mulvaney & Kamminga 1999 in Walshe & Bonell 2003).

While there are no recorded or registered sites of Aboriginal heritage in the area, stone cairns that represent burials are the most likely sites to be present in the project area and caution is required if any stone cairns are encountered.

Walshe & Bonell (2003) consider it likely that there will be anthropological interests for the study area, but do not consider it unexpected nor unusual. Such interests (if any) will be identified during the site survey to be carried out with relevant indigenous representatives, and managed accordingly.

It is not possible to say what archaeological materials may be below the surface. Therefore the recommendations are that excavations are monitored by the Ngadjuri representatives, and should any sites be located, work should cease and the Division of Aboriginal Affairs and Reconciliation of the Department of Premier and Cabinet be notified as soon as possible.

11.2.4 *Native title, Heritage Agreements and Restricted Areas*

There are no Native Title Claims over the project area. Ngadjuri have not registered a Claim over the study area and there are no Indigenous Land Use Agreements in effect. The Ngadjuri Heritage Committee is recognised as the key indigenous representative group for the study area, as advised by the Aboriginal Affairs and Reconciliation Division (Walshe & Bonell 2003).

11.2.5 *Known Non-indigenous Heritage Sites*

Searches of the Register of National Estate database, the Australian Heritage Places Inventory and the National Trust of South Australia found no recorded sites, places or areas of non-indigenous heritage within the project area (Walshe & Bonell 2003).

Non-indigenous history in the region began in the late 1830s, with the advent of the pastoral industry and establishment of sheep graziers in the region. Farmers arrived in the area in the period from November 1870 to May 1871, in time to sow and reap their crops in the 1871 harvest. Late in 1871, the first town blocks in Jamestown were sold.

The settlement of farmers into the area and the growth of the townships to service those farmers was rapid in the 1870s. It was rapid because the natural vegetation of the largely treeless tussock

grassland was easily cleared so that crops could be sown. By 1880 the whole area was settled, and the construction of homesteads and outbuildings, shops, and community facilities such as institutes, schools, churches and flour mills proceeded at a rate that has never been achieved since. The District Council was formed in 1875, and in 1878 Jamestown became a corporate town.

The growth of Jamestown, following its initial settlement in late 1871 and early 1872, was astonishing. By 1877 over a hundred stonemasons were employed in the town to construct the various shops, churches, and houses, and by 1878 most of the business area in Ayr Street had been built. By 1881 Jamestown had a population of 995, a number that remained more or less static for the next thirty years (Northern Areas Council 2006).

In 1845 copper was discovered in Burra (approximately 50 km southeast of the site) resulting in a population boom and intensive mining activity in this area, until 1877. The significance of the township of Burra within the history of pastoral settlement and the mining industry of South Australia is demonstrated by the multiple listings in all the state and national heritage registers, and by its status as a Heritage Area.

11.2.6 *Areas of Potential Non-indigenous Heritage Sensitivity*

The highest potential for sites or structures of non-indigenous heritage are associated with the pastoral industry; such as huts, windmills, water tanks, stone walls, fences and ruins. There is a low potential for features associated with the mining industry due to the study areas being on scarps and peaks, above watercourses. The potential for hotels, post offices and general stores is also considered to be low in view of the proposed development areas being well outside of any known township or village.

11.3 Potential Impacts

11.3.1 *Impacts on Indigenous Heritage*

There are no recorded sites of Aboriginal Heritage within the project area. There is the potential, however, for sites of Aboriginal importance to exist (as yet unrecorded) in the expanded Willogoleche Wind Farm project area, and caution is required with respect to this.

A site-specific ground survey will aim to identify any non-recorded sites within the project area that require avoidance during construction and operation activity. An appropriate management strategy will be put in place to address any further sites identified during construction or operation activities to ensure site protection as determined by the *Aboriginal Heritage Act 1988* (see Section 11.4.1).

11.3.2 *Impacts on Non-indigenous Heritage*

There are no listed heritage buildings, sites or places within the project area, although there are many records for the region, mostly within regional townships (see Appendix 18). Sites of potential heritage value include ruins, huts, windmills, water tanks, stone walls and fences that are scattered throughout the region. Turbine and access track locations will not encroach on any significant heritage features, thus impact to potential heritage sites is considered to be negligible.

11.4 Management

11.4.1 *Indigenous Heritage*

In addition to the desktop studies undertaken, an independent survey will be initiated prior to construction, or if required a Section 12 process with the Division of Aboriginal Affairs and Reconciliation (AARD). The process will involve close consultation with relevant Aboriginal groups and, if required, a walkover survey of areas that will be disturbed during construction of the wind farm by a qualified archaeologist/anthropologist(s) as required, as well as recognised representatives from the relevant local Aboriginal groups. Site recording will allow for micro-siting to avoid particular areas.

The existing cultural heritage agreement will be updated prior to construction to allow the relevant Aboriginal groups to monitor the construction of the wind farm as necessary.

Areas that offer a higher potential for revealing archaeological or anthropological sites will particularly be targeted during the survey and include:

- Prominent geographical features
- Deflated surfaces of moderate gradient
- Fresh water sources
- Outcropping good quality quartzite or silcrete
- Overhangs and exposed faces
- Peaks and passes

Avoidance of indigenous heritage areas can be maximised by avoiding the areas of greatest sensitivity as listed above and generally there is a lower potential for archaeological sites to be located on a ridge. If it is determined after the survey, that wind turbines or other wind farm features are proposed for an area of archaeological and/or cultural heritage significance, discussions with the relevant aboriginal group will take place to resolve the ways in which to avoid or minimise potential impacts, and the layout design or wind farm feature will be altered accordingly, if required. Such sites will also be flagged (or pegged) and all site personnel will be informed of such areas and instructed that they are 'no go' zones.

Consultation will be carried out with identified local Aboriginal groups and other interested parties with regards to potential cultural heritage issues, including anthropology, within the project area, to ensure all issues are appropriately addressed.

Appropriate management actions for responding to accidental/incidental heritage site disturbance during construction, will be included in the environmental management plan for the project. Such actions will be in line with legislative requirements.

11.4.2 *Non-indigenous Heritage*

All turbine locations and construction activity will occur away from known sites of non-indigenous heritage significance. The archaeological survey carried out on-site will include a search for potential non-indigenous heritage sites. If such sites are found, they will be flagged (or pegged) and all site personnel will be informed of such areas and instructed that they are 'no-go zones'.

Appropriate management actions for responding to accidental/incidental heritage site disturbance during construction, will be included in the EMP for the project. Such actions will be in line with legislative requirements.

11.5 Summary

Results of the desktop archaeological/anthropological studies undertaken by Vivienne Wood Heritage Consultant (Appendix 18) revealed that there are no known Aboriginal sites within the project site boundary. However, due to a historical gap in the investigative surveys undertaken over the project area and the environmental indicators present, there is a potential for archaeological and anthropological sites to be present.

If necessary a further Section 12 process with be initiated for the additional 11 turbines of the expanded Willogoleche Wind Farm. The existing Section 12 determination indicated that there were no Aboriginal Sites or Aboriginal Objects with the project area for the original consented 26 turbine Willogoleche Wind Farm. Further work on the site will include a pre-construction walkover survey of areas that will be disturbed during construction of the wind farm by a qualified archaeologist/anthropologist(s) as required, as well as by recognised representatives from the relevant Aboriginal groups. If such areas are found, discussions with the relevant aboriginal group will take place to resolve the ways in which to avoid or minimise potential impacts, and the layout design or wind farm features will be altered accordingly if required. Management during construction will be negotiated via a cultural heritage agreement detailing the monitoring processes used and actions to respond to additional finds and incidental/accidental disturbance.

No sites of non-indigenous heritage were recorded for the project area. All potential sites, such as old homesteads and ruins, will be avoided. Management actions will also be put in place to respond to incidental/accidental disturbance of potential sites.

Given the nature of the terrain in the project area, the nature of potential sites that may be identified on-site and the management practices to be put in place on identifying sites, there is likely to be a negligible impact to the heritage values of the project area.

12. VISUAL AMENITY

Wind farms can influence the visual amenity of an area in a beneficial or negative way, depending on the scale and features of a landscape and, more importantly, the subjective perceptions of the viewer. A discussion of public perceptions of wind farms is contained in Appendix 20.

This chapter provides an outline of the methods used to assess visual impacts of the proposed expanded Willogoleche Wind Farm, which were carried out by International Power. The objectives of the assessment were to:

- Define the viewshed of the development and determine sensitive viewing locations
- Define the landscape character and quality of the setting
- Define community perceptions to wind farms that may influence the sensitivity level of viewers
- Describe the visual character of the main components of the development
- Assess the visual impacts of the development
- Identify siting and layout measures that will minimise the adverse visual impacts of the development

A preliminary visual assessment is presented here, with the results of the specialist study being undertaken by Swanbury Penglasse to be submitted to Council as supplementary information early in 2011. The aim of the preliminary visual assessment is to establish the current landscape values, predicted visual influence of the expanded Willogoleche Wind Farm proposal and other potential visual effects.

Details of the potential visual impacts of wind farms in general are discussed, as are the management strategies employed at the expanded Willogoleche Wind Farm in light of such potential impacts. The visual assessment takes not only the proposed expanded Willogoleche Wind Farm into account, but also utilises a range of measures to assess the cumulative visual impact that will occur due to other existing and proposed wind farms being located in the area of the expanded Willogoleche Wind Farm. In past visual assessment studies, commonly the individual wind farm impact analysis and the cumulative impact analysis are separated into two distinct sections. However, in this case the expanded Willogoleche Wind Farm is located adjacent to an existing wind farm and therefore it becomes quite difficult to assess the visual impact of the proposed wind farm in isolation. For this reason, this section will assess both the individual and cumulative impact of the proposed expanded Willogoleche Wind Farm.

The principal visual impact of a wind turbine development is visual influence; that is, the degree to which the development would intrude upon the viewshed of people living, working or pursuing recreational activities within the area. Wind turbines are usually placed in exposed locations and therefore cannot easily be hidden. It is inevitable then that a wind farm will result in some visual impacts, from some locations. Impacts of this nature should not be regarded as negative only. Some studies confirm beliefs that wind farms can add a positive feature to a landscape (*e.g.* Lothian 2006, Dudleston 2000), and it is well-documented that public opinion generally supports the technology. Dr Andrew Lothian (Lothian 2006) presented a paper focused on the visual impact of wind farms in South Australia and found that:

> "Wind farms generally had a positive effect on landscapes of moderate to lower perceived scenic quality."

The landscapes of moderate to lower scenic quality (as rated by survey participants) were similar to those present within the proposed expanded Willogoleche Wind Farm site; containing:

- broad flatter undulating hills and valleys
- grazing land
- cereals
- scattered vegetation
- scattered trees on grassland
- dams

12.1 Methods

A range of methods were used by International Power to assess the likely visual impact of the expanded Willogoleche Wind Farm. The methods included desktop assessments, consultation with various affected stakeholders and on-ground surveys. A number of computer software programs were also used to predict the view from surrounding areas of the expanded Willogoleche Wind Farm. Together these methods provide a thorough analysis of the potential visual impact of the wind farm.

The visual assessment techniques detailed below all assumed that the expanded Willogoleche Wind Farm would consist of turbines up to 152m tall, including a 96m tower section and a 112 m blade diameter. This presents a worst case scenario for visual assessment. The assessment considers the potential impacts of the expanded Willogoleche Wind Farm itself, in association with other existing wind farms or wind farms under construction and in comparison to the original consented Willogoleche Hill Wind Farm.

12.1.1 *Significant Landscapes and Viewpoint Identification*

One of the most commonly used methods to determine significant viewpoints in landscape assessment is consultation with visual user groups. Visual user groups include individuals and groups who live in or travel through the region in which the landscape modification is proposed to take place. International Power has previously consulted various visual user groups in order to determine significant viewpoints in the area, including local residents, walking and cycling groups and the local council. The latest round of consultation focussed primarily on the local council, landowners and neighbouring residents and did not raise many issues regarding the visual impact of the proposed development. A desktop review and site inspection to identify local scenic values and relevant viewpoints, such as major and local roads, was also conducted. Proposed wind farms are generally met with both positive and negative views, but initial consultation about the visual impact of the expanded Willogoleche Wind Farm resulted in very little concern being identified amongst visual user groups.

12.1.1 *Zone of Theoretical Visibility (ZTV)*

A ZTV assessment involves the use of computer software to predict the number of turbines which will be visible from areas surrounding the wind farm. This information can be used in conjunction with information about significant viewpoints to make a clearer assessment of which viewpoints require a more in-depth assessment. The ZTV model can be run to assess whether certain parts of the turbine are visible from locations around the wind farm; in this case the modelling calculated whether the turbine tips could be seen from surrounding areas. The ZTV analysis relies on contour information to assess whether the topography of the land will prevent a clear line of sight between the wind farm and relevant viewpoints. It can be a useful tool as an initial assessment of the likely areas of visual influence by the wind farm. However, the analysis cannot take into account factors

such as buildings and trees, which means that it can only be used as a guide, and an on-ground survey needs to be undertaken to make a more certain assessment of the visibility of the wind farm from the viewpoint.

12.1.2 *On-Ground Survey - Visual Modification and Sensitivity*

The method employed for the on-ground survey was based on the concept that the visual impact of a proposed development is determined by evaluating the degree of visual modification due to the development in the context of the visual sensitivity of surrounding land use areas. Varying levels of visual impact result from varying levels of visual modification and visual sensitivity.

The visual modification level of a proposed development can be best measured as the level of visual contrast between the development and the existing visual environment. A high degree of visual modification will result if the main features of the development contrast strongly with the existing landscape.

Visual sensitivity is a measure of how critically a change to the existing landscape will be viewed from various use areas. Different activities undertaken within the landscape setting have different sensitivity levels. The visual sensitivity of a development depends on a range of viewer characteristics. The key characteristics used in this study were:

- Distance of the development from the viewpoint
- The wind farm's visibility from identified viewpoints
- Land use
- Landscape character including existing infrastructure
- Visual sensitivity of viewpoint

Five locations were chosen around the expanded Willogoleche Wind Farm region for an on-ground survey and photomontage location viewpoints, which involved taking photos of the view towards the wind farm and an assessment of the factors outlined above.

Within the visual boundary (or Zone of Theoretical Visual Influence) the degree of visual modification will generally decrease as the distance from the development site to various viewing locations increases.

12.1.3 *Photomontages*

Photomontages are useful visual assessment tools which provide a representation of what the completed wind farm would look like in the landscape. This is useful to provide affected stakeholders with a likely view of the wind farm from certain locations; enabling stakeholders to better assess the visual impact of the potential wind farm. There are a number of steps involved in the creation of a photomontage:

- Locations are selected. The results of prior visual assessment studies such as stakeholder consultation, on-ground surveys and ZTVs all assist in selecting the most significant viewpoints for photomontages to be created.
- A series of digital photos are taken from the viewpoint aimed at the wind farm. The location and height of the viewpoint is recorded.
- The photos are joined together using panoramic software.
- WindFarm software is used to place an accurate representation of the turbines within the panorama. A number of complex calculations are involved to ensure that when the photomontage is viewed from a certain distance, it represents the correct field of view which

would be seen from the actual viewpoint. This ensures that the superimposed turbines are a realistic representation as far as the software allows.

12.1.4 *Wireframes*

Photomontages are an ideal way of assessing the potential impact of the wind farm on the existing landscape. However, from viewpoints which are a significant distance from turbines, a photomontage can often underestimate the likely visual impact of the turbines. This is because the turbines are so small on the image, that it can become nearly impossible to make them out against the sky backdrop, especially if the photos were taken on a cloudy or hazy day. This situation was encountered in some instances when assessing the cumulative impact of the expanded Willogoleche Wind Farm. Other existing and proposed wind farms in the area are up to 30-40 km from some of the proposed project area. Turbines will still have some degree of visual impact even at this distance, especially in a cumulative sense, as a significant number of wind farms exist or are proposed for the region.

A wireframe analysis uses a similar method to the photomontages. The only differences are that a panoramic photo is not included, and instead of turbines being superimposed in a matt white/grey colour for a realistic simulation, the turbines for each individual wind farm in the analysis can be coloured differently so that the viewer can easily ascertain the number of different wind farms which will be visible from the viewpoint.

It must be noted that whilst the sizes of the turbines in the cumulative wireframes have been calculated to be a realistic representation of what will exist, the colouring of the turbines and lack of landscape for the wind farms to be absorbed into results in a greatly exaggerated prediction of the likely cumulative visual impact of the proposed/existing wind farms. As with a Zone of Theoretical Visibility study, the wireframe method does not take into account obstacles that are not part of the contours of the land including buildings and trees, which can significantly change the view from an area.

12.1.5 *Shadow Flicker and Glinting*

Another visual assessment method used was a shadow flicker analysis. Shadow flicker occurs as a result of the wind turbine blades passing between the sun and a receptor point. A receptor point is commonly a window in a house. Shadow flicker may potentially occur under certain combinations of geographical position and time of day. Due to the nature of the sun, the effect can only occur for limited periods during a day and on limited days in a year.

It is generally accepted that shadow flicker ceases to be a problem when the receptor point is greater than around 10 blade diameters from the wind farm (Clarke, 1991). In the case of the proposed expanded Willogoleche Wind Farm development, this equates to a distance of up to 1200m (i.e. based upon a worst case 120m rotor diameter). As there are a few houses that are located at approximately this distance from the proposed wind farm, a full shadow flicker assessment was undertaken and the results are presented in Section 12.3.3 below.

A secondary visual effect that could occur is glinting; the effect of light being reflected from turbine blades. This usually occurs when the blades are wet, or rotating in strong sunshine. The likely incidence of glinting is impossible to predict, but experience suggests that this is a relatively rare occurrence, especially with modern turbine blades, which have non-reflective coatings.

Glinting will generally occur when the sun is at a low angle, and is therefore more likely to occur in the middle of the day in winter rather than summer, or early morning or late afternoon throughout the year. The locations that will primarily be affected will be within 1 km, where the turbines lie

directly between the viewer and the sun. Glinting is significantly reduced when non-reflective paints are used, and this will be the case for the blades of the expanded Willogoleche Wind Farm turbines.

12.1.6 *Effects of Lighting*

Aviation warning lights (or obstacle hazard lighting) can be required on tall structures, in accordance with Civil Aviation and Safety Authority (CASA) requirements. With current CASA requirements under review, International Power commissioned an independent aviation safety assessment to determine the potential need for aviation lighting. The results of this aviation risk assessment have found that lighting is not required on the wind turbines. However, this requirement could be reviewed again after the release of updated regulations from CASA (see Chapter 15 for a full discussion).

Any lighting required would constitute either a single light or two lights mounted on the top of the nacelle where it will be visible to aircraft. To minimise visual impact on the ground plane environment, some shielding of the lights is permitted, provided it does not compromise their operational effectiveness.

From more distant sensitive locations, direct views to the navigational lighting will be obscured from view by vegetation surrounding rural residences and intervening elevated topography. For a number of sensitive locations in the regional setting, such as rural residences and the Barrier Highway, visible lighting is most likely to appear as gentle points of light. From sensitive viewing locations within the local setting, the navigational lights will be highly apparent.

The exact impact of night lighting is difficult to define, as it is dependent on individual perceptions and sensitivities, as well as the presence of existing light at the viewing source.

12.2 Existing Situation

12.2.1 *Landscape Survey*

The wind farm area is located in the agricultural districts of South Australia's Mid-North, in an area classified as Primary Production , of the North Mt Lofty Ranges.

Topographically, the region exhibits either undulating, low, moderate or high areas of relief. The ridges and spurs of the Willogoleche Hill Range (maximum elevation 670 m AHD) are the main physical features of the site. The ranges are aligned predominantly in a north-south orientation, while the spurs generally run from the ridgeline down to the west.

The broad valleys to the west and east of the range sit at approximately 500 m AHD and are characterised by broad shallow flat-bottomed valleys between prominent north-south ranges/ridgelines.

The ridgelines where the turbines will be placed are gradual to steeply sided and predominantly covered by grass. The majority of the landscape has been extensively cleared of native vegetation and utilised for agricultural activities, with the main activities being cropping, and sheep and cattle grazing. As such, the area is typical of most Australian agricultural landscapes. Paddocks are predominantly open and typically large in scale. Fences and roads define paddock boundaries.

Vegetation is not a prominent feature of the landscape. It occurs only as scattered pockets of trees and shrubs, mostly around farm residences and fencelines. Single or small clusters of eucalypts 10-15 m high are confined to sections of the lower slopes and in road reserves. Other native vegetation areas include native grasslands, which appear to blend in with pastures.

An intricate network of roads links the settlements and scattered properties of the region. The principal sealed roads in the area are the Barrier Highway, the Clare-Peterborough Road, the Jamestown-Whyte Yarcowie Road and the Hallett-Jamestown Road (Wilkins Highway). The majority of the remaining network comprises secondary sealed and unsealed roads.

Scattered and dispersed dwellings, sheds, farm machinery, electricity transmission and distribution lines and telecommunications towers add human influences to the landscape. Of the dwellings situated mainly in open land, most are surrounded by trees, sometimes interspersed with sheds, farm machinery or gardens. In nearly all cases, these dwellings and the immediate features described above are set in the context of an agricultural setting, including farm paddocks and farm infrastructure.

The proposed wind farm development is contained within the Regional Council of Goyder. Jamestown is the prominent town in the region, with approximately 1800 residents. Several small rural centres occur within the wider area. These towns typically have fewer than 200 residents and service the local farms. The small rural towns are typical of those found in regional South Australia, consisting of residential blocks and a town centre with various services.

All of the townships and their surrounding landscapes in the region have human features typical of Australian agricultural localities. Buildings, radio masts, household antennae, stobie poles and grain storage facilities add vertical elements to the scene in most parts, where a backdrop of cleared agricultural land further sets the agricultural context of the landscape.

12.3 Visual Impact Assessment and Potential Impacts

The sections below assess the visual impact of the proposed expanded Willogoleche Wind Farm from an individual site perspective (ZTVs, on-ground survey, photomontages and shadow flicker analysis), and also from a cumulative perspective (ZTVs and wireframes).

12.3.1 *Zone of Theoretical Visibility (ZTV)*

ZTV maps were produced using WindFarm software. Figure 6 includes ZTV maps for the expanded Willogoleche Wind Farm for an individual case and also from a cumulative perspective. The cumulative map shows existing consented wind farms and those under construction in the vicinity; The expanded Willogoleche Wind Farm, The Bluff Range, Brown Hill Range, North Brown Hill, Mount Bryan and Hallett Hill. The maps assess the number of turbine tips (out of a possible 37 in the case of the expanded Willogoleche Wind Farm project) visible from all locations within approximately 20 km of the expanded Willogoleche Wind Farm site.

The ZTV technique presents a worst case scenario of views, as it is unable to consider local features that can disrupt views such as road banks, vegetation, buildings and other human induced infrastructure. As such it is limited in its use and has been used as an initial guide for visual assessment. In a general sense, however, the ZTV output successfully demonstrates the diversity of the visual influence throughout a landscape; that is, the changing numbers of turbines or clusters potentially in view throughout the landscape. It must be emphasised that this output provides a worst case scenario, and is not entirely accurate of the visual influence of the wind farm over the project area, as it cannot consider vegetation effects and other infrastructure mentioned above. A more accurate prediction of the visual influence of the wind farm is presented in Sections 12.3.2, 12.3.3 and 12.3.4 below.

A ZTV map is very useful for significant viewpoint identification, and the ZTV analysis guided much of the viewpoint selection for the on-ground survey, photomontage and cumulative wireframe analyses.

12.3.2 *On-ground Survey*

Predicted views of the expanded Willogoleche Wind Farm site were assessed from the selected viewpoints. As such, the predicted views take into consideration the vegetation, sheds and other infrastructure that may also be within view. Landform interruption plays an important part in the predicted views, as does distance to the turbines. Figure 7 shows the viewpoint locations which were used in the on-ground survey.

Many of the viewpoint locations are seen in the context of a cleared, agricultural landscape. Generally the views also contain electricity transmission lines, single-wire earth return (SWER) lines, water pumping windmills, townships or other vertical man-made elements. In terms of townships, Hallett will have significant exposure to the expanded Willogoleche Wind Farm.

On-ground survey results show that the viewpoints from residences, townships and the local road network offer some clear views of many turbines. Also, some views are obstructed by vegetation, landform or surrounding infrastructure. The large-scale agricultural landscape of the area has shown it is able to absorb development on the scale of the wind farms already in the region, and thus the expanded Willogoleche Wind Farm is likely to also be absorbed by the existing landscape.

Photomontages and Wireframes

Photomontages and Wireframes were created for the three wind farm layouts to allow an assessment of the proposal; Consented 26 Turbine Layout (130m blade tip), Revised 26 Turbine Layout (130m blade tip) and proposed 37 turbine layout, including the 11 additional turbines (152m blade tip). A total of twenty-one photomontages and twenty-one wireframes were created for the layouts at the five (5) individual viewpoints. These were created using WindFarm software, which is one of the most highly used and regarded software packages used by the global wind industry. The viewpoint locations can be seen in Figure 7. The photomontages have primarily been designed to assist with the visual impact assessment of the expanded Willogoleche Wind Farm, in the context of the existing environment, which includes existing wind farms. Some of the montages also feature the Bluff Range Wind Farm (currently under construction), and therefore also provide a platform for assessing the cumulative impact of the expanded Willogoleche Wind Farm. The montages keep the 'field of view' to 65 degrees, as this is realistically what the human eye can envisage in 'one picture'. In other words, it is impractical to produce a montage which covers 180 degrees, because even if the wind farm did dominate the horizon for 180 degrees around the viewpoint, the central horizontal field of view for a human is only about 60-70 degrees. In cases where the wind farm(s) take up more than this field of view, they have been separated into two individual montages.

Photomontages are presented in Volume 4. The viewpoints represent a diverse range of views around the expanded Willogoleche Wind Farm from a range of directions and distances. The sections below give a brief summary of each of the montages.

Viewpoint 1

This viewpoint is located on the Hallett-Jamestown road on the western side of Willogoleche Hill at the intersection of Booborowie Road. Relatively unobstructed views of the expanded Willogoleche Wind Farm will be experienced at this viewpoint location by motorists travelling in an easterly direction on the Hallett-Jamestown Road. The layout of the turbines from this aspect form a wide view which in conjunction with very minor remnant vegetation including scattered trees and agricultural elements in the foreground, will result in the turbines having significance in the landscape from this viewpoint. Turbines at the northern end of the project will be most prominent from this viewpoint, the closest being at 2.8km, while the southernmost turbine will be at a distance of approximately 8.5km.

Viewpoint 2

This photomontage is separated into two separate montages as the viewshed of the wind farm from this viewpoint is greater than 65 degrees. This viewpoint is located just outside Hallett on the Hallett-Jamestown road approximately 3.4 km from the nearest expanded Willogoleche Wind Farm turbine. The road out of Hallett travels directly towards the expanded Willogoleche Wind Farm site. Whilst some remnant vegetation cover and agricultural elements including homesteads, farm sheds public infrastructure exists in the foreground, the project area is largely exposed from this viewpoint and therefore most turbines will be clearly exposed and visible. Many of the turbines which will be visible will have all or the majority of the tower, nacelle and blades in view depending on siting of individual turbines. Existing wind farms in the Bluff Range, Brown Hill, Hallett Hill and North Brown will also be visible, however the distance between the viewpoint and the turbines results in the turbines being only a minor feature on the horizon.

Viewpoint 3

Views orientate NW from the viewpoint which is located approximately 6km south of the Hallett township on the western side of the Barrier Highway. The distance between the viewpoint and the turbines results in the turbines being of a relatively unobtrusive scale particularly those to the northern end of the project area. The nearest turbine is 5.9km from the viewpoint. Whilst turbines within this viewpoint are relatively unobstructed, the visual impact of the turbines is to a degree mitigated by the foreground landscape, which comprises large amounts of vegetation including large trees, agricultural elements, stobie poles and fence posts.

Viewpoint 4 A & B

This viewpoint is located on a minor collector road to the south of the wind farm at the intersection of Hacklins Corner Road and North Booboorowie School Road, approximately 5 km from the nearest expanded Willogoleche Wind Farm turbine. Significant vegetation including medium to large trees exists in the immediate foreground of this viewpoint. These trees do not obstruct the view of the expanded Willogoleche Wind Farm from the viewpoint however do screen much of the Bluff Range wind farm to the north-west which is currently under construction. The wind farm appears clustered due to the linear orientation of the wind farm from this viewpoint which causes overlapping of turbine blades. The vast majority of turbine towers, nacelles and blades are visible from this location. Other infrastructure includes the ElectraNet 257Kv transmission line, stobie poles, homestead, and agricultural equipment.

Viewpoint 5 A & B

The viewpoint is located on the Booboorowie Road, which is a secondary unsealed road which experiences low traffic volumes. The easterly aspect of this viewpoint is perpendicular to the north-south orientation of the wind farm. The viewshed is greater than 65 degrees and has therefore once again been separated into two montages. The closest turbine is approximately 4.4km away. The majority of the Willogoleche range is exposed from this viewpoint, however tall trees and infrastructure associated with a homestead located within the foreground largely obstructs a portion of turbines.

Summary

The photomontages show that the expanded Willogoleche Wind Farm will be clearly visible from the selected locations along the surrounding road networks. From most locations however, the wind turbines will form part of a landscape which has already experienced significant modification, and agricultural elements form a dominant part of the landscape. The landscape also includes the

existing Brown Hill, Hallet Hill, North Brown Hill and Bluff Range (currently under construction) Wind Farms, and the montages show that the expanded Willogoleche Wind Farm will integrate into this modified landscape appropriately.

The viewpoints were selected to ensure that the montages showed a visual representation of the wind farm from the most affected areas, and there will also be many areas in the surrounding landscape where the turbines are visible.

The montages which included views of existing wind farms and those currently under construction, showed that the proposed expanded Willogoleche Wind Farm is likely to be absorbed into the landscape with little difficulty. In a setting which already includes a significant amount of infrastructure such as electricity transmission lines, sheds, roads and existing wind farms, the expanded Willogoleche Wind Farm is not expected to have a significant impact on the landscape.

12.3.3 *Shadow flicker*

Shadow flicker is generally a problem only at residences within ten rotor diameters around the wind farm. To ensure that the wind farm layout design minimised any potential shadow flicker problems, an assessment was carried out on all houses in the proximity of the expanded Willogoleche Wind Farm. The houses are shown in Figure 8b, where they are also given a numerical identifier. In the assessment a worst case of 1200 m was used which represents more than ten rotor diameters for likely candidate turbines such as the Vestas V112 which has a 112m rotor diameter.

Currently the only country in the world which has a set of shadow flicker guidelines is Germany[2]. The guidelines have also been used in other countries around the world. The guidelines stipulate that a shadow flicker analysis should calculate the amount of time (daily and yearly) at receptor points (such as a house window) for which a blade covers at least 20 % of the sun, and where the sun is at least 3 degrees above the horizon. The guidelines also advise that no shadow receptor should receive more than 30 hours of shadow flicker per year or 30 minutes of shadow flicker in any one day. It is important to note that the shadow flicker calculation is an extreme worst case scenario as it assumes that the sun is shining brightly between when it rises and sets every day of the year, that the rotor blade disc is perpendicular to the line between the receptor and the sun, and that the turbine blades are rotating. Obviously this will not be the case, and therefore a shadow receptor which is calculated to receive 30 hours of shadow flicker per year will more likely receive 10-20 hours of shadow flicker per year.

An initial shadow flicker assessment was undertaken using WindPro (industry standard software) which did not utilise obstacles at all. Obstacles include trees, sheds and other objects which can prevent shadow flicker impacting a receptor. The results for the houses assessed are shown in Table 12.1 following. Figure 8b shows the results graphically and the location of the residences referred to in Table 12.1.

As shown in Table 12.1, the only residence which is expected to receive an unacceptable amount of shadow flicker is residence 9. Residence 9 has a financial interest in the project. Further analysis can be conducted to determine whether the property has any screening objects around the residence which would naturally reduce the amount of shadow flicker present. Inspection of aerial photography indicates that there is considerable vegetation along the Western side of the residence which will significantly reduce or eliminate the potential for shadow flicker occurring.

Overall it is predicted that the shadow flicker will occur at one financially involved residence. It is expected that due to vegetation around this property, Shadow Flicker will not be an issue at the

[2] Notes on the Detection and Assessment of Immissions Caused by Wind Power Plants (Notes on WPP Shadow Casting) (Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windenergieanlagen (WE-Schatten-Hinweise)) (13/03/2002)

expanded Willogoleche Wind Farm.

Table 12.1 Shadow flicker assessment without obstacles.

Residence (Figure 8b)	Shadow Hours/Year	Shadow days per year	Max Shadow Hours/Day
1	0:00	0	0:00
2	0:00	0	0:00
3	0:00	0	0:00
4	0:00	0	0:00
5	0:00	0	0:00
6	0:00	0	0:00
7	0:00	0	0:00
8	0:00	0	0:00
9[1]	53:21	136	0:35
10	0:00	0	0:00
11	0:00	0	0:00
12	0:00	0	0:00
13	0:00	0	0:00
14	0:00	0	0:00
15 (not on Figure 8b)	0:00	0	0:00
16	0:00	0	0:00

1. Financial Landowner

12.4 Management

It is inevitable that structures of the size of the proposed wind turbines at the expanded Willogoleche Wind Farm will have some level of visual impact. However, a number of parameters have been incorporated into the design of the wind farm with the aim of minimising visual impact. These include:

- Consultation with local visual user-groups, including local residents, and the local council to incorporate their sensitivities over certain views of the wind farm into the design.
- The wind farm received 64 % support from the 22 survey respondents at the public exhibition held at the Hallett Hall in October 2010. This suggests that the majority of the community surveyed support the proposed layout and predicted levels of visual impact of the project.
- Full shadow flicker analysis was undertaken, to ensure that no households receive an inappropriate amount of shadow flicker as a result of the wind farm.
- Ensuring turbine towers and blades are white or light grey in colour, so that they blend in with the sky and clouds and reduce glinting as much as possible.
- Ensuring only modern rotors that spin relatively slowly are used.
- Ensuring access to the site is designed to utilise existing farm tracks and roads where practical, thereby minimising the need for new access points and new access tracks on the landscape.
- Tracks will be constructed to follow contour lines as much as possible, which will minimise cut and fill and consequential landscape scarring.

- Ensuring electrical connections within the site (*i.e.* cables between the turbines and the switchgear building) are located underground, in order to further reduce potential visual impacts.
- Identifying height limits (the wind turbines at the expanded Willogoleche Wind Farm will be no higher than 152 m).

12.5 Summary

A preliminary visual assessment has been carried out prior to obtaining the results of a specialist study. The aim of the visual assessment is to establish the current landscape values, predicted visual influence of the wind farm and other potential visual effects. A variety of methods have been used in the visual assessment of the proposed expanded Willogoleche Wind Farm, such as public consultation, ZTV, photomontage production, wireframe assessment and assessment of shadow flicker effects.

Results of the preliminary landscape assessment carried out for the expanded Willogoleche Wind Farm project show that the regional context is one of an agricultural land setting, made up predominantly of cleared land used for intensive grazing and cropping. Human influences including roads, dwellings, sheds, buildings and vertical elements such as telecommunications masts, grain silos and both lattice mounted transmission line towers and stobie poles occur within the region.

It was found during the consultation process that the majority of visual user groups did not hold major concerns regarding the landscape significance of the expanded Willogoleche Wind Farm. The wind farm was assessed from five viewpoints; incorporating different methods, distances and directions.

There are a number of potential visual effects associated with the wind farm. The likely incidence of glinting is impossible to predict, but experience suggests that this occurs relatively rarely, and will be reduced by the use of non-reflective paint on turbines. Whilst shadow flicker effects are likely to be experienced at one residence, the effects are not likely to be a significant issue due to the screening provided by local vegetation. Current safety assessments show that aviation warning lights should not be required on the turbines, however this will be subject to lighting requirements currently under review by CASA. To minimise visual impact, some shielding of the lights is permitted, provided it does not compromise their operational effectiveness. The exact impact of any night lighting required is difficult to define, as it is dependent on individual perceptions and sensitivities, as well as the presence of existing light at the viewing source. The expanded Willogoleche Wind Farm will have some degree of visual influence, but it is expected that this will be moderated by the existing landscape modification and its location in proximity to existing wind farms.

The majority of available views would be seen in a cleared agricultural land setting. Many human-induced features add to the setting, which will enable the wind farm to integrate well into the existing landscape.

Overall, the cumulative visual effect of the expanded Willogoleche Wind Farm in combination with other wind farms in the region is predicted to vary throughout the area, being greatly influenced by the location of the viewpoint and the relative location of the sites and landscape features. Given the distances between sites and the generally open landscape around the project area, it is considered that the development is well-suited to the scale of the landscape and is unlikely to give rise to an unacceptable cumulative visual influence. The final results of the Landscape and Visual impact assessment being undertaken by Swanbury Penglasse will be provided to Council as supplementary information early in 2011.

13. ELECTROMAGNETIC SIGNALS

Electromagnetic signals (or radio waves) are transmitted throughout the country as part of communication systems by a wide range of operators. Such systems are used for radio broadcast, television, mobile phones and mobile and fixed radios. Electromagnetic signals generally require a clear path between transmitting and receiving points. Obstructions can potentially cause interference to the signal.

There is potential for interference from any large structure, including wind turbines, which may be installed within or close to the signal path. The physical presence of structures in communications pathways may interfere with signals, or signals may be reflected from rotating blades, which in turn would degrade the performance of the signals (Bacon 2002). Electromagnetic emissions from generators and other machinery also have the potential to affect signals. However the emissions from modern wind turbine generators are considered to be negligible, given the nature of the generators used and the strict IEC regulations that manufacturers must conform to regarding such emissions (Auswind 2006).

This chapter describes the existing radio/communication systems that operate within the expanded Willogoleche Wind Farm site, as well as television broadcast services, and provides an assessment of potential interference effects, and possible mitigation measures. Information in this chapter has been derived from an independent report compiled by Lawrie Derrick & Associates, and NDC (see Appendix 21 & 22).

The Bureau of Meteorology ("BOM") operates Automatic Weather Stations ("AWS") and various weather radar sites around Australia. The location of these facilities has been assessed against informal guidance provided by BOM and it has been concluded that the expanded Willogoleche Wind Farm will not impact these facilities. The nearest BOM AWS is at Clare High School which is over 46km distant, and the nearest BOM radar facility is at Buckland Park which is 134km from Willogoleche Hill. The interaction with the BOM sites is therefore not discussed further in this section.

13.1 Methods

Electromagnetic signal experts have been consulted to assess the potential interference to radio/communications and television (TV) signals. Full copies of reports by Lawrence Derrick & Associates are contained in Appendix 21. Guidelines provided by DAIS (Telstra 2003) on minimising the impact of wind farms on the South Australian Government Radio Network (SAGRN) were also used to guide project design. The following section outlines the assessment approaches to measuring interference.

13.1.1 *Radio/Communications Investigations*

Electromagnetic signals can be transmitted from: one fixed point to another fixed point (point-to-point links); one fixed point to several fixed points (point-to-multipoint links); or from one fixed point to a number of points (multipoint transmission). Fixed point-to-point links are commonly used for services such as monitoring signals, data networks and distributing broadcast signals. Multipoint transmissions are commonly used for services such as telemetry systems and remote telephone services (PB Power 2003).

Lawrence Derrick & Associates were provided with a search area that included the entire wind farm site. All links in or around this area were researched using the Australia Communications and Media Authority (ACMA) Register of Radiocommunications Licences.

For any identified link or transmission source Lawrence Derrick & Associates determined a buffer zone to ensure that the wind turbines do not cause interference. For point-to-point links the buffer zone is based on the First Fresnel Zone which indicates the distance from the link at which an obstacle must be placed to avoid interfering with the signal.

13.1.2 *Television Investigations*

A pre construction TV survey at 22 sample dwellings within 10km of the Willogoleche Hill wind farm was undertaken between the 31st August and 4th September 2009. This representative sample of residents were surveyed to qualitatively rate their TV reception with ACMA minimum acceptable levels to determine the degree of vulnerability TV reception may have wind farm effects.

The probability of impacts on terrestrial TV reception from wind turbines is highest in locations where there are turbines close to residences located in the path to the TV transmitters. Residences on the eastern side of Willogoleche range, which potentially will have turbines in the path to TV transmitters at The Bluff (near Port Pirie), were therefore sampled to a greater extent.

Where residences did not have digital reception at the time of survey, a digital bench mark observation was made available by using a digital set top box (DSTB) or digital TV set for testing purposes. This survey involved the assessment of digital reception from The Bluff transmitter. However in most cases where analogue only reception was used, residents did not have the appropriate UHF antenna installed for digital reception.

13.2 Existing Situation – Types of Services

13.2.1 *Radio/Communications*

The communications signals within the vicinity of the expanded Willogoleche Wind Farm originate from facilities both within and outside of the proposed project area. These facilities are used for fixed point-to-point, multipoint and omni-directional transmission, providing for services such as mobile radio and mobile phone.

Results of radio/communications investigations show that there are three point-to-point link pathways that are close or within the expanded Willogoleche Wind Farm area. These pathways contain microwave point-to-point links, two operated by ElectraNet and one by the South Australian Government Radio Network (SAGRN). The link travels between the communications tower at Mt Cone and the tower at Brown Hill.

A number of Point to Multipoint (PMP) base stations are registered at sites at Burra, Jamestown, Peterborough, Gladstone and Garad. These stations operate in the microwave bands however the remote customer ends are not registered. It is therefore not possible to check if any paths between the PMP bases and the customer/remote ends pass through turbines.

There are two mobile base stations located on the wind farm site (refer to Appendix 21) operated by Optus and Telstra respectively. The distance to the nearest turbines are approximately 245m and 253m respectively.

13.2.2 *Television*

The area surrounding the proposed expanded Willogoleche Wind Farm is in the television licence area of the Spencer Gulf North main station located near Port Pirie at the Bluff. In addition, or as an alternative, some residents also receive TV “out of service area” from the Adelaide main stations at Mount Lofty. Currently digital TV services are also available in the area from Port Pirie or Adelaide

Services. Pay TV is available from Austar in the area. A few residents also had free to air satellite services.

Australia is currently phasing out analogue TV and converting to digital only TV. Analogue transmissions are planned to cease during the period 1st July to 31st December 2010 for Spencer Gulf and 1st July to 31st December 2013 for Adelaide. In some instances the existing analogue antenna systems at residences may not be of suitable standard for reliable digital reception.

Potential Impacts

13.2.3 *Radio/Communications*

Physical structures such as wind turbines have the potential to degrade radio/communication signal quality by obstructing or encroaching the signal pathway. Buffer zones around link pathways can be set to protect the integrity of the signals.

The links identified by Lawrence Derrick & Associates that pass within or close to the project area have a recommended buffer zone of approximately 85.5m to avoid any degradation of signal quality. The turbine layout, including amended consented positions and additional turbine locations, has been designed to ensure this buffer zone is maintained to ensure any potential impacts to radio/communications services are avoided. Turbines are located at least 138m of the buffer zone boundary. As with the original consented project the expanded Willogoleche Wind Farm project is unlikely to cause interference to radio/communication pathways.

The layout design also provides a buffer of over 245m to the mobile base stations located within the project area (refer to Attachment 6 of Appendix 21). This buffer meets the 3m minimum setback requirement. It is recommended that this buffer will avoid any near field interference effects. Given the turbines are placed on a ridgeline, any interference would not be significant compared to the existing shadowing caused by the ridgeline itself.

Registered PMP base stations exist within the general 50 km study area, however the remote customer ends are not registered. As most base sites are some distance from the wind farms it is unlikely that customer sites will be in the vicinity of the wind farm.

13.2.4 *Television*

Moving structures, such as the moving blades of a wind turbine, can cause degradation of television reception through the scattering of signals. The degree of degradation depends on a number of factors including strength of the signal, type of signal (ie analogue v digital), relative position of the transmitter and receiver and antennae quality and positioning.

Results of the preliminary TV reception survey found picture quality varied considerably at the time of the survey from good to very poor. Due to the hilly terrain signals were low in some instances from the Bluff, requiring reception of the distant Adelaide stations. Reception of Adelaide stations from the Northern end of the project area may be vulnerable due to the very low direct signal levels and potential scattering of signals from proposed turbines to the south. TV reception at homesteads located to the western side of the Willogoleche Range with currently good TV reception from the Bluff are not expected to be effected by the proposed expanded Willogoleche Wind Farm.

In some cases digital reception was also unstable, however in one case the use of a Digital Set Top Box provided stable reception at least for the period of observation. As significant numbers of residences surveyed did not have UHF antennas installed which will be required for digital reception from the Bluff, there may be more potential interference cases from turbines. There may, however,

be issues with TV antenna systems faults or setup which make the TV reception susceptible to turbine interference.

The completed individual TV survey results are contained in Attachment 1 of Appendix 22. Attachment 4 & 5 of Appendix 22 indicate the locations of residences surveyed.

13.3 Management

13.3.1 *Radio/Communication*

The turbine layout, including amended consented positions and additional turbine locations, has been designed to avoid any potential impacts to radio/communications services, including links and towers.

Although the allocated buffers are considered adequate, the relevant service providers/stakeholders will be informed of the finalised wind farm proposal. Should it be found that the turbines do cause detrimental effects on communication systems operating around the project area, a strategy will be developed in consultation with affected parties to rectify the problems.

13.3.2 *Television*

A selection of local residences in areas that may experience interference to television signals as a result of the wind farm have now been surveyed, and will be surveyed again post- operation of the project. Any interference to television transmissions measured during operation would then be rectified to ensure reception is restored to all local users affected by the turbines. Potential solutions for reception restoration include:

- Upgrading existing antennas at affected locations to industry best practice and provide affected households with digital decoders
- Providing satellite TV to all those affected (although GTS/BKN is not available via Satellite)

Any other residents that find they experience degraded television reception from the operation of the Willogoleche Wind Farm project will have the reception investigated and rectified using one of the mitigation measures above.

13.4 Summary

Three microwave link pathways and two mobile base stations have been identified within or in the vicinity of the proposed expanded Willogoleche Wind Farm. For the microwave links, the minimum recommended buffer zones between the proposed wind turbines and the centreline of the link has easily been maintained. The design also provides for a 245m buffer zone between turbines and the mobile base stations, resulting in negligible predicted impact.

Some television interference from the expanded Willogoleche Wind Farm turbines is predicted for services transmitted from The Bluff (near Port Pirie). However, mitigation measures will be implemented in order to rectify any interference experienced. These measures may include upgrades of existing antenna, provision of digital set top boxes and the provision of satellite TV.

14. ROADS AND TRAFFIC

This chapter provides a description of access roads likely to be utilised during construction, major maintenance events and refurbishment/decommissioning. Potential impacts to roads and traffic conditions are discussed, as are proposed management strategies.

14.1 Potential Impacts

A number of main and secondary roads could potentially be used to access the wind farm site for construction, maintenance, refurbishment/decommissioning and visiting purposes. One of these roads is the Barrier Highway, a main road link running through the Mid-North region through to the Flinders Ranges. Other roads to be potentially utilised include a number of secondary roads used predominantly by local and regional residents.

Planning for the use and upgrading of access roads will be carried out by way of negotiation with authorities such as the Northern Areas Council and Transport SA. Traffic scheduling will also have to be planned in conjunction with these authorities.

14.1.1 *Construction*

Construction traffic for the installation of the expanded Willogoleche Wind Farm will be present over a period of approximately 20-22 months and has the potential to disrupt local and regional traffic flow and volumes. The traffic will consist of:

- Articulated semi-trailers (extendible and regular trailer sizes) – transporting initial establishment equipment, materials and turbine components
- Tipper trucks - to bring stone for the access tracks and to remove soil
- Bulldozers – for roadworks on site
- Concrete mixers – to transport concrete from the batching plant to the turbine bases
- Cranes – one 30-50 tonne mobile crane for assembling the turbines on the ground, and one 600-1000 tonne mobile crane (or 300-400 tonne crawler crane) for wind turbine installation
- Conventional 4WD vehicles and sedans used by on-site personnel

During the construction period the most significant transport impacts are likely to occur during the installation of the wind turbines. Each of the potential 37 turbines will require three or four escorted, extendible trailers for the tower, up to three for the blades and one for the nacelle. Additional loads will consist of concrete, steel reinforcement, base tower sections, road stone and other construction materials being delivered to the site.

There will also be a number of on-site or local movements, particularly of concrete mixers as they move from the batching plant to the wind turbine bases, to pour tower footings. These on-site/local movements can number between three and 30 movements per footing, depending on the foundation type being laid.

Load weights of equipment and components will vary. The heaviest loads are expected to be the 600-1000 tonne crane (weighing around 135 tonnes) and the nacelle (weighing around 60 tonnes). The longest loads will be those for the blades, which will have trailer lengths of up to 55m long.

Load specifications will be provided to the Regional Council of Goyder and Transport SA (where required) to assist in access and traffic planning prior to construction.

Overall, the expanded Willogoleche Wind Farm project would see an estimated increase in construction traffic of around 40% compared to the original consented 26 turbine Willogoleche Wind Farm.

14.1.2 *Operation*

Operational traffic will be restricted to maintenance and inspection vehicles, or other approved traffic use (*e.g.* visitors), which will make periodic visits to the site. Vehicles used will be standard 4WD vehicles, sedans or vans. Maintenance of access roads during the life of the wind farm will enable access to the site for maintenance and inspection purposes.

Occasionally there may be need for larger vehicles such as cranes, semi-trailers and bulldozers/graders: the first two needed for replacement of significant components of the wind turbine if failure occurs; the latter for road maintenance. These events will be seldom.

14.1.3 *Public Visits*

Experience gained from operational wind farms at Starfish Hill in SA, Albany and Esperance in WA, Ravenshoe in QLD, Crookwell and Blayney in NSW and Codrington in Victoria suggests that there can be a great deal of interest generated in the local area during the construction phase of a wind farm. This was found to be true during the construction of the Brown Hill and Hallett Hill Wind Farms and is expected to continue to a lesser degree during the construction of other wind farms in the Hallett-Jamestown area.

A certain degree of extra traffic is anticipated on the local roads surrounding the expanded Willogoleche Wind Farm project, both during and after construction. Regular monitoring would assist the Project Manager to address any road issues that may arise as a result of the development.

14.1.4 *Access Upgrades*

Preparation of access roads and tracks for construction traffic will result in a number of local roads and existing farm tracks being fully upgraded. This will be of benefit to local and regional road users, and to the local CFS and landowners.

All access roads and tracks will be maintained during the life of the wind farm. Landowners and the CFS also have the option of requesting (and negotiating) that on-site tracks are left in place following wind farm decommissioning.

Upgrade and maintenance work has the potential to impact on roadside vegetation (and resident fauna), where road widths require expansion around corners, or along on-site tracks, if not carried out sensitively.

14.1.5 *Road Degradation*

The volume of construction traffic required during the construction period could potentially result in the degradation of road conditions along some of the unsealed roads used. Regular monitoring of road condition, and maintenance work, will ensure access roads are maintained to appropriate standards for transport operations and safety.

14.1.6 *Traffic Delays and Public Safety*

There may be some delays to local and through traffic along the Barrier Highway, Hallett-Jamestown Road and local secondary roads during times that trucks carrying construction equipment pass through the area. The increased traffic in the local area also has the potential to create road safety

issues for local road users. Appropriate management actions will ensure safe driving conditions are maintained and that any delays experienced will be infrequent and short-term.

14.2 Management

14.2.1 *Access Upgrades*

Upgrade works will be carried out in consultation with the Regional Council of Goyder and Transport SA to ensure works comply with relevant legislative requirements and requirements of turbine manufacturers to ensure the safe transport of turbine components.

Disturbance to existing roadside vegetation will be avoided through management actions contained in the project EMP. Such actions will include:

- Planning of road expansion works to avoid significant ecological and heritage areas where practicable.
- A pre-construction flora survey to be carried out by a qualified botanist to determine the extent of significant roadside vegetation/habitat in areas of the road network requiring upgrading. If significant vegetation is likely to be impacted upon by road upgrades, an application will be made to the Native Vegetation Council regarding the proposed impacts, and the activity of road widening will be carefully managed through an appropriate EMP and any offsets required to mitigate any adverse impacts.
- A pre-construction fauna survey to be carried out by a qualified ecologist to identify significant fauna in areas of the road network requiring upgrading. Appropriate actions for the management of any significant fauna found will be implemented as part of an appropriate EMP.

14.2.2 *Road Degradation*

Preparation works for access roads and tracks will involve resurfacing or complete rebuilding of roads or tracks to ensure road conditions are appropriate for safe and effective transport of wind farm components. During construction, the Project Manager will ensure that regular inspections of road conditions are conducted and will implement remedial action where required to maintain satisfactory road conditions.

Roads and access tracks will be maintained during the operational life of the wind farm, in consultation and cooperation with the Regional Council of Goyder and Transport SA.

14.2.3 *Traffic and Public Safety*

Anticipated delays will be minimised as much as possible by strategic scheduling of traffic loads (usually managed by Transport SA) and advanced warning of potential transportation times. The oversized loads will require a safety escort. Likely management actions to be implemented include:

- Stone and other material for the roads to be sourced from local quarries (where possible) thus reducing long-distance haulage
- Public notices of traffic restrictions or conditions to be posted regionally, as necessary
- Appropriate warning signs to be erected in the vicinity of the site (to Transport SA specifications)
- All oversized and heavy load vehicles to use the approved routes and scheduled timing
- Safety/police escort vehicles to be used where appropriate

- Instructions to be given to on-site personnel to always remain courteous to all road users and maintain awareness of traffic conditions

Public viewing locations and suitable parking areas and facilities will be determined and established so that site visits do not disadvantage existing road users. These areas will be determined in consultation with the Northern Areas Council and Transport SA. Signage for site visitors may also be required, including information on safety and 'no go' areas.

14.3 Summary

Access roads for the wind farm will consist of both main and secondary roads, with some sections of secondary roads requiring upgrading to cater for construction traffic. The planning of such works will be carried out in consultation with the Regional Council of Goyder and Transport SA.

Upgrade work on roads will avoid the disturbance of significant flora and fauna through the implementation of pre-construction surveys and the project EMP. Regular inspections of road condition and ongoing maintenance will ensure road conditions are maintained for the life of the wind farm.

Traffic issues including public safety and increased visitations will be addressed in consultation with Transport SA and local council to ensure increased traffic does not significantly impact on road safety in the region.

15. AVIATION

The impact and risks associated with the original Willogoleche Wind Farm DA were assessed in the supporting Environmental Statement for the Hallett Wind Farms in 2004. Since 2004 the aviation activity in the Hallett area has not significantly changed. Since 2004, two of the four consented Hallett Wind Farm projects have been built (Brown Hill Range Wind Farm and Hallett Hill), a third is under construction (Bluff Wind Farm) and a further wind farm (North Brown Hill) is near completion. These wind farms have not had an impact upon aviation in the area and the expansion of the Willogoleche Wind Farm is not expected to change the conclusions of the original Environmental Statement for the consented Willogoleche Hill Wind Farm, which indicated that the entire Hallett Wind Farm cluster would have a minimal effect on aviation.

A desktop study was conducted in October 2010 by Hart Aviation Pty Ltd to assess Aviation Safety Impacts associated with the expanded Willogoleche Wind Farm. This chapter presents a discussion on the aviation activity in the project area, potential impacts from the wind farm and appropriate mitigation actions drawn from the Hart Aviation Pty Ltd study. The full study is included as Appendix 23.

15.1 Existing Situation

15.1.1 *CASA Requirements*

CASA released Advisory Circular AC 139-18(0) in July 2007 to provide advice for wind farm developers with regard to turbine lighting (see Appendix 7). At the time of writing, this Circular was withdrawn by CASA and is currently under review. CASA have also advised that their statutory power to require obstacle marking and lighting on obstacles under Civil Aviation Safety Regulations (CASR) Part 139 only applies within the vicinity (approximately 30 km) of a licensed aerodrome. Therefore, CASA cannot currently mandate the lighting or marking of structures outside the vicinity of aerodromes. Having said this, CASA is currently undertaking an appropriate safety study into the risk to aviation posed by wind farms and intends to develop a new set of guidelines. This process will include appropriate consultation with industry and stakeholders on wind farms and a risk management approach with respect to aviation. In the absence of current CASA regulations International Power has commissioned an independent aviation safety assessment to identify potential impacts and necessary mitigation measures.

In essence, CASA is concerned with two main aviation issues with respect to wind farms. The first is the protrusion of wind turbines into the Obstacle Limitation Surface (OLS) of aerodromes or their vicinity to the OLS. The OLS is essentially a defined area of airspace above and around a licensed aerodrome. The second issue is the height of turbines outside the OLS, but still in areas of aviation activity (air traffic).

Advice from CASA has revealed that there are no licensed aerodromes within the project area or in the near vicinity. The nearest major licensed aerodrome is at Port Pirie, approximately 75km north-west of the project area. As there are no Licensed aerodromes within a 30km radius of the project area, there are no concerns regarding aerodrome operations or an OLS that are relevant to the expanded Willogoleche Wind Farm project.

There is an unlicensed aerodrome at Jamestown, approximately 30 km from the site. Similarly, Tiverina Park is a private unlicensed airfield located approximately 2.5km east of the expanded Willogoleche Wind Farm at its nearest point.

With regards to turbine height, according to the now withdrawn CASA Advisory Circular AC 139-08(0), CASA advise that if a structure (including a turbine in a wind farm) is proposed to be 110 m or more above ground level, the proposal needs to be assessed (or endorsed) by CASA for the need for obstacle lighting. Hart Aviation has conducted preliminary assessment which considers the proposed turbine height as well as the amount and type of aviation traffic at the proposed turbine (or wind farm) site, to determine the likely need for obstacle lighting.

CASA's obstacle lighting advice for wind farms has previously been that sufficient individual turbines should be lighted to indicate the extent of the group of turbines. CASA advised that red medium intensity obstacle lights are placed on the turbines at intervals not exceeding 900 m, and that it may be possible to make the outline of the wind farm conspicuous by using fewer synchronised lights. To minimise visual impact on the environment, some shielding of the obstacle lights has been permitted, provide it does not compromise their effectiveness.

The results of the aviation assessment presented here will be reviewed against any emerging CASA requirements to confirm appropriate mitigation measures have been put in place.

15.1.2 *Agricultural and Other Activities*

Agricultural aerial spraying is known to occur in the region for crop pest management and to top-dress pastures (nutrient application). Pest management is likely to occur annually, while top-dressing may occur every five years or so.

A number of private landing strips have been identified around the project area on low lying land, used by landowners.

The CFS may, from time to time need to fight local fires through aerial spraying.

15.2 Potential Impacts

15.2.1 *Civil and Defence Aviation*

Tall structures have the potential to obstruct or present a safety hazard for aircraft, if sited in an OLS or in areas with high levels of air traffic. The turbine height proposed for the expanded Willogoleche Wind Farm is up to 152 m. Final turbine height will depend on the model of turbine deemed to be suitable (and successful) for installation. Although the project is proposed to be located approximately 75 km from the nearest aerodrome and OLS, local air traffic levels still need to be considered. In view of this and the proposed turbine height, an independent aviation assessment was carried out on the expanded Willogoleche Wind Farm, and the proposal will also be submitted to CASA for assessment under emerging regulations, to determine the need for obstacle lighting to alert aircraft pilots to the location of the wind farm.

The assessment by Hart Aviation found that the nearest licensed aerodrome is at Port Pirie, approximately 75 km north-west of the area. As such, there are no issues of concerned regarding the possibility of any penetration on the obstacle limitation surfaces (OLS) of any licensed aerodrome.

As an unlicensed aerodrome, Jamestown Aerodrome is not required to define an obstacle limitation surface (OLS). However, should one be defined, as a non instrument approach Code 3 aerodrome, the OLS would not extend beyond 4 km from the aerodrome. Consequently, no wind turbine within the expanded Willogoleche Wind Farm would penetrate such an OLS. In addition the expanded Willogoleche Wind Farm should have no impact on Night VFR or IFR operations into Jamestown Aerodrome or VFR operations to and from Jamestown Aerodrome.

The Tiverina Park airstrip is suitable for private small light aircraft VFR operations only. Being

unlicensed there is no requirement to define an obstacle limitation surface (OLS). However, should one be defined, as a non-instrument approach Code 2 aerodrome, the OLS would not extend beyond 2.5 km from the aerodrome. Consequently, no wind turbine within the expanded Willogoleche Wind Farm would penetrate such an OLS.

Any VFR operations to and from Tiverina Park would be subject to the same Lowest Safe Altitude ("LSALT") requirements as Jamestown Aerodrome and it is not expected that the presence of the expanded Willogoleche Wind Farm turbines would have any adverse impact on such operations.

The expanded Willogoleche Wind Farm will not affect any sector or circling altitude, nor any approach or departure, or any en route or grid lowest safe altitudes (LSALT). The farm will not impact on Precision/Non-Precision Navigational Aids, HF/VHF Communications, Advanced Surface Movement Guidance and Control Systems, Radar or Satellite/Links.

The expanded Willogoleche Wind Farm is well clear of the airspace controlled by Air Traffic Services out of Adelaide, Edinburgh and Port Pirie Airports and the operating height of aircraft over the area is such that the presence of the wind farm would have no effect at all. There are no aircraft traffic control issues nor is there any potential influence on any instrument approach procedures or aeronautical navigation aids.

Discussions with the Department of Defence and the RAAF AIS proved un-informative. However, HART Aviation's investigations did not identify any Defence-related low level operational or training routes in the vicinity of the proposed expanded Willogoleche Wind Farm. Further, there is some evidence that the Department of Defence has assessed wind farm developments in the region and has not identified any issues of concern. Nevertheless, the Department of Defence should be consulted.

Lighting facilities on turbines or around wind farms have the potential to have two main negative impacts. The first is the visual amenity of the wind farm area at night (see Chapter 12), both for local residences and visitors. The second impact relates to local bird and bat populations (see Chapter 9). Some bird and bat species are known to be attracted to some types of lights, for either navigational purposes or for feeding. This attraction may increase the probability of interaction with the wind turbine blades.

HART Aviation has noted that the proposed maximum tip height for the wind turbines in the expanded Willogoleche Wind Farm is 152 m (~499 ft) above ground level (AGL) i.e. less than 500 ft AGL. Under these circumstances, HART Aviation is of the view that the risk to aviation operations in the vicinity of the proposed expanded Willogoleche Wind Farm is sufficiently low such that obstacle lights are not required for the wind turbines.

This view that the risk to aviation operations is low is based on the following: -

- There are no certified or registered aerodromes within the wind farm area or in the near vicinity. The nearest certified or registered aerodrome is at Port Pirie, approximately 75 km north-west of the proposed wind farm site. As such, there are no concerns regarding aerodrome operations or any defined OLS that are relevant to the proposed expanded Willogoleche Wind Farm.

- There is one private unlicensed airfield near to the proposed expanded Willogoleche Wind Farm boundary. This is Tiverina Park Airfield, approximately 2.5 km east of the wind farm site. This airfield is only suitable for ad hoc VFR traffic. Operations from this airfield will not be affected by the presence of the wind farm.

- The next nearest uncertified and unregistered aerodrome is Jamestown Aerodrome, approximately 30 km to the north-west. The presence of the wind farm will have no adverse effect on any operations from this aerodrome. Other aerodromes are further away.

- With the exception of approved low level operations (such as aerial agricultural spraying, search and rescue, fire fighting, etc.) VFR aircraft operations are required to be at a minimum height of 500 ft AGL, which would be above the highest point of any of the wind turbines within the expanded Willogoleche Wind Farm.

- Night VFR or IFR aircraft operations are required to abide by lowest safe altitude requirements, which ensure all such operations which would be above the highest point of any of the wind turbines within the expanded Willogoleche Wind Farm.

- Any approved low level operations, by their very nature, are required to check for any obstacles which might impact on such operations, before undertaking any such operations. All such operations would be day VFR.

- The proposed expanded Willogoleche Wind Farm turbines will not affect any sector or circling altitude, nor any approach or departure, or any enroute or grid lowest safe altitudes (LSALT). They will not impact on Precision/Non-Precision Navigational Aids, HF/VHF Communications, Advanced Surface Movement Guidance and Control Systems, Radar or Satellite/Links.

- There are no known low level military flight routes or military aircraft training areas within the vicinity, but such needs to be confirmed with the Department of Defence.

Overall, despite the proposed increase in blade tip height to 152m and the proposed addition of 11 turbines, the impacts to aviation safety are not significantly increased from the original consented project.

15.2.2 *Agricultural and Other Activities*

The expanded Willogoleche Wind Farm has the potential to impact on agricultural aerial spraying activities, as the turbines may potentially present physical obstacles that need to be negotiated when carrying out aerial spraying. This is likely to be more relevant to top-dressing activity, which can occur atop the ranges in the area. Pest management activities are more likely to occur over crops which are located on the lower slopes of the ranges away from the turbines.

Aerial spraying, seeding or fertilising operations, be they by helicopter or fixed wing aircraft, within the confines of any wind farm and below the top of the wind turbines is potentially hazardous and not recommended. Due to the ecological make-up of the majority of the expanded Willogoleche Wind Farm which is mainly native grasses, it is not anticipated that this will have a significant impact on the farming operations in the area.

There are no specific regulations regarding flying distances to vertical structures, except for occupied buildings. The expanded Willogoleche Wind Farm will adversely impact on aerial agricultural operations. However the safety issue can be addressed by “seeing and avoiding” or preferably not undertaking any aerial agricultural operations within the confines of turbines.

Aerial fire fighting activities which require the use of helicopter or fixed wing aircraft, while in some circumstances is possible, are potentially hazardous and not recommended. HART Aviation is of the opinion that any operations of fixed wing aircraft for fire fighting purposes within the confines of the proposed expanded Willogoleche Wind Farm would be hazardous and are not recommended. This is a position held in respect of all wind farms.

The existence of wind turbines has the potential to limit the flexibility of operations of helicopter ambulance services within the confines of the wind farm, but it would not be an issue outside the boundaries of the wind farm. This is a common factor for all wind farms.

The private landing strips identified within the vicinity of the project area occur on the low-lying areas at least 2.5km from any proposed turbine. Their orientation is also such that aircraft would take-off either parallel to a range or away from a range. As such, the proposed wind farm is expected to have no effect on the use of private landing strips.

Regarding Airservices, the Willogoleche Wind Farm will not affect any sector or circling altitude, nor any approach or departure, or any en route or grid lowest safe altitudes (LSALT). The wind farm will not impact on Precision/Non-Precision Navigational Aids, HF/VHF Communications, Advanced Surface Movement Guidance and Control Systems, Radar or Satellite/Links.

15.3 Management

15.3.1 *CASA Requirements*

The risk to aviation operations would be further reduced if, in the fullness of time, the wind turbines were identified on the relevant aeronautical charts i.e. both the civil WACs and the RAAF produced chart series. This is considered essential risk mitigation element. Pending such identification on maps, it would be advisable to ensure that all aviation operators are made aware of the existence of the wind farm. Airservices, if they were made aware of the wind farm, would normally do this via NOTAM action covering both the construction phase and prior to identification on maps. It is, therefore, essential that the wind farm developer advise both Airservices and the RAAF AIS.

HART Aviation is of the view that the overall risk to aviation operations in the vicinity of the proposed Willogoleche Hill Wind Farm, even during the night or in low visibility conditions, is sufficiently low such that obstacle lights are not required for the wind turbines.

On receipt of Development Plan Consent for the wind farm, and with the release of CASA guidelines regarding wind farm management, Wind Prospect will consult with CASA on the issue. Wind Prospect will be seeking a balanced solution, which gives consideration to impacts on local residences as well as the safety of aviators. If CASA do not consider that the turbines pose a significant aviation risk, none of the turbines will require lighting. In either case, Wind Prospect will commit to shielding provisions allowed under existing CASA guidelines. The shielding restricts the downward component of light to 5 % of nominal intensity emitted below 5 degrees below horizontal and zero light emission below 10 degrees below horizontal.

15.3.2 *Agricultural and Other Activities*

Agricultural aerial spraying activities will be largely unaffected by the wind farm. Aerial spraying can be undertaken within a few wingspans of obstacles, however there will be more time on ground needed in the preplanning process than would be the case if the obstacles did not exist. Given proper pre-planning and procedures, aerial applications adjacent to and within the expanded Willogoleche Wind Farm, whilst not recommended do not represent an unsafe aircraft operational situation. However the efficiency of aerial application in the vicinity of wind turbines and overhead transmission lines may be affected.

Appropriate information regarding the wind turbine layout and dimensions will be supplied to the CFS, if required, to assist in their planning and execution of fire response.

15.4 Summary

CASA administers regulations for the intrusion of structures into aerodrome OLS and tall structures in other airspace. Parts of these regulations include lighting requirements for tall structures. The proposed turbine height is up to 152 m, which requires that CASA assess the proposal. However, at the time of writing however, CASA withdrew their Advisory Circular regarding turbine lighting for wind farms, hence there are no current guidelines to guide wind farm developers. In the absence of such guidelines Hart Aviation were engaged to conduct an independent aviation safety assessment. The results of this assessment show that so long as the turbine remain below 152m in height, due to the low risk to aviation, lighting is not required. This result will be confirmed with CASA once they have re-issued guidance on wind farm management.

Should CASA recommend that obstruction lighting is required on specific turbines, Wind Prospect will negotiate with CASA to strike a balanced solution, which takes into account the impact on local residents as well as the safety of aviators. Shielding will be incorporated to mitigate the visual impact of the lighting.

There are no licensed aerodromes within, or in the vicinity of, the expanded Willogoleche Wind Farm project area, so there are no concerns with regards to aerodromes or OLSs.

Agricultural aerial spraying activities will be largely unaffected by the wind farm. Given proper pre-planning and procedures, aerial applications adjacent to and within the expanded Willogoleche Wind Farm, whilst not recommended, do not represent an unsafe aircraft operational situation.

Private airstrips and landing grounds are located near the proposed wind farm, however pilots operating at such airstrips are responsible for ensuring that they are aware of the conditions on and surrounding these landing sites.

16. NOISE

The unique acoustic emissions from wind turbines can be a potential problem for residents located close to them. Noise assessments are carried out to predict the likely noise levels under worse case conditions for comparison with *"Wind Farms, Environmental Noise Guidelines"* (July 2009), developed by the Environment Protection Authority of South Australia (EPA). This document was developed to manage noise emissions from wind farms in South Australia.

This chapter begins with a description of the phenomena of turbine noise, and then presents the EPA compliance criteria contained in their guidelines. Specialist noise assessments were conducted by Sonus Pty Ltd based on the Suzlon S88, 2,1 MW turbine (see Appendix 24) and the Siemens SWT-3.0-101, 3 MW turbine (see Appendix 25). The methodology for predicting noise levels at nearby residences is discussed and the predicted results are presented. Noise associated with wind farm construction activities is also discussed and potential mitigation measures are outlined.

16.1 Introduction

16.1.1 *Turbine noise*

There are two main sources of noise emissions from wind turbines. The first is aerodynamic noise from the rotation of the blades. Noise is generated by the blades passing through the air and passing the tower, with the noise primarily arising at the tip and back edge of the rotor blade. The noise level increases with increasing wind speed and thus rotation speed.

The second source of noise is mechanical noise from the operating components of the turbine located in the nacelle. Mechanical noise has virtually disappeared from modern wind turbines, due to improved engineering, with more concern about avoiding vibrations. Other technical improvements include elastically dampened fastenings and couplings of the major components in the nacelle, and a certain amount of sound insulation. The basic components themselves, including gearboxes, have developed considerably over the years with modern wind turbine gearboxes using "soft" gearwheels; that is, toothed wheels with hardened surfaces and relatively elastic interiors.

A typical turbine likely to be used at this site is the Suzlon S88, 2.1 MW machine (although the actual turbine used could vary from anywhere between 2.1MW and 3MW, depending on the turbine selection closer to the time of construction). The 2.1 MW machine is a pitch-regulated upwind wind turbine with active yaw and a three-blade rotor approximately 88 m in diameter. The hub height is likely to be 80 m above ground level (see Appendix 9).

The warranted sound power levels for two specific turbines were used to calculate the resulting noise for affected houses at different wind speeds. This sound emission depends on wind speed and is predominately aerodynamic arising from the blades as they move through the air and pass the tower. There is no tonal component to the noise.

The noise emitted from turbines is a function of the wind speed, with higher wind speeds producing higher turbine noise levels up to a certain point. However, in a similar way, background noise levels (see Table 16.1) also increase with increasing wind speed, with background noise generally increasing at a greater rate than turbine noise at high wind speeds.

It should be noted that whilst the Suzlon and Siemens machines have been used for the noise assessment within this planning application, the noise assessment will be re-run using the final turbine model selected for the project, which will have a different noise profile. The assessment will then inform the final wind farm design to ensure it meets noise compliance guidelines.

16.1.2 *Background Noise*

Background noise is generated primarily by wind action on vegetation. The level of background noise will vary over a site, depending on the surrounding topography, presence of vegetation and other sources of noise present in an agricultural environment. Obviously, this source of noise cannot be easily controlled, but forms part of the noise prediction equation for a wind farm site.

16.1.3 *Construction and Decommissioning*

There will be some noise emissions from the construction and decommissioning of the wind farm, however such emissions will be localised and temporary. Sources of emissions during construction include vehicle traffic, cement batching and possibly rock crushing and compressors.

16.1.4 *Scope of EPA Guidelines*

The core objective of the EPA's *Wind Farms, Environmental Noise Guidelines* (EPA 2009) is to balance the advantage of developing wind energy projects in South Australia with protecting the amenity of the surrounding community from adverse noise impacts. The Guidelines were also developed to provide guidelines for acceptable levels of noise generated from wind turbines on those residents that do not have an agreement with the wind farm developer; that is, neighbouring landowners which are not part of the wind farm development (*i.e.* a 'relevant receiver'). However, this does not exempt developers of responsibilities regarding noise amenity for participating landowners who may be affected.

The noise assessment at the expanded Willogoleche Wind Farm considered 18 houses from the surrounding area, up to 4km from the nearest turbine. Three measurement locations were selected at three residences to represent background noise at the measurement location, and a number of residences within the vicinity. The representative residences included four landowner houses owned by parties involved in the wind farm development. The closest landowner house is located 764m from a turbine while the closest non-landowner house (neighbour) is located 1543m from a turbine site. Preliminary and detailed noise modelling was carried out to obtain predicted turbine noise levels at each of the representative properties identified and then the results were compared with EPA noise criteria.

16.1.5 *EPA Noise Criteria*

The EPA guidelines state that:

> *"The predicted equivalent noise level ($L_{Aeq,\ 10}$), adjusted for tonality in accordance with these guidelines, should not exceed:*
>
> - *35 dB(A) at relevant receivers in localities which are primarily intended for rural living, or*
> - *40 dB(A) at relevant receivers in localities in other zones, or*
> - *the background noise ($L_{A90,10}$) by more than 5 dB(A)*
>
> *whichever is the greater, at all relevant receivers for wind speed from cut-in to rated power of the WTG and each integer wind speed in between".*

The EPA guidelines also give consideration to the effects of topography and wind speed. Although noise levels from turbines can increase with wind speed, so does the background noise levels produced by the wind itself. The EPA guidelines also allow for landowners who are involved in the project to exceed these specific guidelines; however any noise from a development must not unreasonably interfere with the enjoyment of the residence. International Power has also applied

international guidelines to these residences, where noise levels do not exceed 45dB(A) outside the residence (Working Group on Noise from Wind Turbines (Final Report, ETSU for DTI, 1996)) nor 30dB(A) within the residence (World Health Organisation, Guidelines for Community Noise, 1999), to protect from sleep disturbance.

16.2 Methods

This noise assessment was carried out for all 37 wind turbine locations of the expanded Willogoleche Wind Farm that are the subject of this application; that is the variation to the 26 consented turbines and the 11 additional turbine locations. The predicted noise levels also take into account the noise contribution from the Bluff Range wind farm which is located approximately 5km west of the expanded Willogoleche Wind Farm.

Noise predictions were carried out at three representative dwellings identified within close proximity to the proposed wind turbines.

Noise from the proposed expanded Willogoleche wind farm was predicted for residences within the vicinity based on the CONCAWE noise propagation model and the sound power level data provided by the manufacturers for the Suzlon S88 turbine and the Siemens SWT-3.0-101 turbine. The applicable environmental noise criteria were determined using the EPA criterion based on background noise monitoring conducted in the vicinity of the wind farm.

Background noise levels were measured at three locations within the proposed site between the 6th August and the 27th August 2010. Three measurement locations at Residence 6, 10, 15 (refer to Appendix 24) were chosen to represent the background noise at these locations and a number of locations within the vicinity. Some residences included within the modelling were not represented by background noise modelling and therefore were assessed against the 40dB(A) criterion, which is the more conservative criteria.

Background noise was measured using specialised equipment (refer to Appendix 24) in 10 minute intervals at each of the three locations. During the background noise measurement periods, the wind speed was also measured in 10 minute intervals at two different wind masts located within the proposed wind farm project area. At each mast, the wind speed was measured at various heights in order to determine the average wind shear and subsequently the hub height (80m) wind speed in 10 minute intervals.

Background noise data collected at the three locations were correlated with the hub height wind speed and an analysis was undertaken. Based on this analysis, the background noise level at a range of wind speeds within the operating range of turbines is provided (refer to Appendix 24).

The comparison between the predicted noise levels and the environmental noise criteria was made to ensure that the expanded Willogoleche Wind Farm design complies with the criterion.

16.3 Existing Situation

The rainfall and wind speed data collected were used to determine the periods when weather directly on the microphone may potentially have affected the background noise measurement. Hence before further analysis, for periods which measured rainfall or wind speeds of greater than 5 m/s at the microphone for more than 90% of the measurement period, the measured background noise levels were discarded.

After data removal, the resultant background noise data collected at the three locations were correlated with the hub height wind speed, and a least squares regression analysis of the data was undertaken to determine the line of best fit for the correlations. The data and the regression curves are shown in Appendix B. Based on this regression analysis, the background noise level (L A90,10) at a range of wind speeds within the operating range of the turbines is shown in the table below.

Table 16.1 below lists the adjusted background noise levels at the representative residences discussed in Section 16.2 above.

Table 16.1 Adjusted background noise levels at representative residences

Residence	Background Noise Level, L A90,10 by Hub Height (80m) Wind Speed						
	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
6	30	30	31	33	34	36	38
10	29	32	35	39	42	45	48
15	27	28	29	31	32	34	36

16.4 Potential Impacts

16.4.1 *Impacts from Turbine Noise*

The predictions for the worst-case wind conditions (*i.e.* a cool humid night with no cloud and worst case wind direction for each property) were modelled at 18 residences within proximity to the wind farm . Table 16.2 gives the predicted noise levels at various wind speeds for the Suzlon S88 and Table 16.3 for the Siemens SWT-3.0-101.

The predicted noise levels at the 18 residences were then compared with the EPA criterion.

Table 16.2 Background noise and Suzlon S88 Noise Predictions

16.5 Residence	Noise Level by Hub Height Wind Speed (m/s)													
	6m/s		7m/s		8m/s		9m/s		10m/s		11m/s		12m/s	
	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*
1	40	*33*	40	*33*	40	*34*	40	*34*	40	*35*	40	*36*	41	*35*
2[2]	40	*37*	40	*38*	40	*38*	40	*39*	40	*40*	40	*40*	40	*39*
3[2]	40	*33*	40	*34*	40	*34*	40	*35*	40	*36*	40	*36*	40	*36*
4	40	*35*	40	*36*	40	*36*	40	*37*	40	*37*	41	*38*	43	*37*
5[1]	45	*36*	45	*36*	45	*37*	45	*37*	45	*38*	45	*38*	45	*38*
6	40	*36*	40	*36*	40	*37*	40	*37*	40	*38*	41	*38*	43	*38*
7[2]	40	*33*	40	*33*	40	*33*	40	*34*	40	*34*	40	*35*	40	*34*
8[1]	45	*35*	45	*36*	45	*36*	45	*36*	45	*37*	45	*38*	45	*37*
9[1]	45	*43*	45	*43*	45	*44*	45	*44*	47	*45*	50	*45*	53	*45*
10	40	*34*	40	*34*	40	*35*	44	*35*	47	*36*	50	*36*	53	*36*
11	40	*29*	40	*30*	40	*30*	44	*31*	47	*31*	50	*32*	53	*31*
12[2]	40	*29*	40	*30*	40	*30*	40	*31*	40	*31*	40	*32*	40	*31*
13[2]	40	*29*	40	*30*	40	*30*	40	*31*	40	*31*	40	*32*	40	*31*

14[1]	45	*32*	45	*33*	45	*33*	45	*34*	45	*34*	45	*35*	45	*34*
15	40	*33*	40	*33*	40	*34*	40	*34*	40	*35*	40	*35*	41	*35*
16[2]	40	*36*	40	*37*	40	*37*	40	*38*	40	*38*	40	*39*	40	*38*
17[2]	40	*37*	40	*38*	40	*38*	40	*39*	40	*39*	40	*40*	40	*39*
18[2]	40	*29*	40	*29*	40	*29*	40	*29*	40	*30*	40	*30*	40	*30*

1. Indicates a financially involved residence
2. Property not represented by background noise modelling – worst case criteria used

Table 16.3 Background noise and Siemens SWT-3.0-101 Noise Predictions

16.6 Residence	Noise Level by Hub Height Wind Speed (m/s)													
	6/ms		7m/s		8m/s		9m/s		10m/s		11m/s		12m/s	
	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*	Criterea	*Prediction*
1	40	*36*	40	*36*	40	*36*	40	*37*	40	*37*	40	*37*	41	*37*
2[2]	40	*37*	40	*38*	40	*38*	40	*39*	40	*40*	40	*40*	40	*39*
3[2]	40	*38*	40	*38*	40	*38*	40	*38*	40	*38*	40	*38*	40	*38*
4	40	*40*	40	*40*	40	*40*	40	*40*	40	*40*	41	*40*	43	*40*
5[1]	45	*41*	45	*41*	45	*41*	45	*41*	45	*41*	45	*41*	45	*41*
6	40	*41*	40	*41*	40	*41*	40	*41*	40	*41*	41	*41*	43	*41*
7[2]	40	*37*	40	*37*	40	*37*	40	*37*	40	*37*	40	*37*	40	*37*
8[1]	45	*40*	45	*40*	45	*40*	45	*40*	45	*40*	45	*40*	45	*40*
9[1]	45	*48*	45	*48*	45	*48*	45	*48*	47	*48*	50	*48*	53	*48*
10	40	*39*	40	*39*	40	*39*	44	*39*	47	*39*	50	*39*	53	*39*
11	40	*34*	40	*34*	40	*34*	44	*34*	47	*34*	50	*34*	53	*34*
12[2]	40	*34*	40	*34*	40	*34*	40	*34*	40	*34*	40	*34*	40	*34*
13[2]	40	*34*	40	*34*	40	*34*	40	*34*	40	*34*	40	*34*	40	*34*
14[1]	45	*37*	45	*37*	45	*37*	45	*37*	45	*37*	45	*37*	45	*37*
15	40	*37*	40	*37*	40	*37*	40	*37*	40	*37*	40	*38*	41	*37*
16[2]	40	*36*	40	*37*	40	*37*	40	*38*	40	*38*	40	*39*	40	*38*
17[2]	40	*37*	40	*38*	40	*38*	40	*39*	40	*39*	40	*40*	40	*39*
18[2]	40	*31*	40	*31*	40	*31*	40	*31*	40	*32*	40	*32*	40	*32*

1. Indicates a financially involved residence
2. Property not represented by background noise modelling – worst case criteria used

Of the 18 residences included within the noise modelling, four (4) are wind farm landowner residences and fourteen (14) are neighbouring residences. Results of noise level predictions show that none of the 14 neighbouring residences will experience noise levels above the EPA criterion for the Suzlon S88. Similarly the modelling indicates that no landowner residences will experience noise levels that exceed the EPA criterion using the Suzlon S88.

The noise predictions for the Siemens SWT-3.0-101 show that at wind speeds up to 10 m/s, the EPA's 2009 Guidelines will be exceeded at two residences. Modern turbines such as the Siemens machines are however able to operate in a mode known as 'Noise Restricted Operation'. The Noise Restricted Operation works by adjusting the power output from the wind turbine at any given wind speed in order to alter the noise parameters of the turbine. This mode of operation can be applied

to any number of turbines in the wind farm. In Appendix 25 Sonus have indicated that by reducing the noise from three turbines in the windfarm, namely WTG 23, 33 and 37, when the wind speed is between 6 m/s and 10 m/s, the expanded Willogoleche Wind Farm using Siemens SWT-3.0-101 turbines will be in compliance with the EPA's 2009 Guidelines.

The proposed wind farm is not anticipated to lead to any significant increase in noise levels for the residences around the proposed wind farm. However, further monitoring and modelling work will be carried out once a final turbine model has been chosen to confirm this.

16.6.1 *Impacts from Construction and Decommissioning*

There is a potential for noise emissions during construction, major maintenance and decommissioning. However, such emissions will be minimal, localised and temporary. Work times are unlikely to extend beyond normal work hours (*i.e.* 7.00 am to 6.00 pm), and will endeavour to comply with the EPA's information regarding Construction Noise (EPA June 2009).

16.6.2 *Cumulative Effect – Regional Proposals*

There are also cumulative impact considerations from other developments proposed or existing in the area, apart from the expanded Willogoleche Wind Farm. However, a development would need to be located within approximately 1-2 km of the proposed clusters in order to present a possible cumulative influence on noise.

The closest wind farm to the proposed expanded Willogoleche Wind Farm is the Bluff Range Wind Farm, currently under construction, with a minimum distance of 4 km between nearest turbines. The contribution of noise based on Suzlon S88 turbines from the Bluff wind farm has been included in the calculations for this noise assessment.

16.7 Management

16.7.1 *Turbine Noise*

International Power has developed a final wind farm layout that has all wind turbines at least 1543 m from neighbouring houses that are not a part of the project development. Of the 14 neighbouring houses, modelling results which include the cumulative emissions from the Bluff Range Wind Farm have shown that noise level predictions at all of these satisfied the EPA criterion for particular turbines, including the Suzlon S88.

The modelling also shows that for certain turbines such as the Siemens SWT-3.0-101, the noise criteria at the closest houses to the expanded Willogoleche Wind Farm may be exceeded. If it was decided to utilise these turbines, a number of them would be operated in so-called 'Noise Restricted' mode, which will dynamically alter the noise parameters of the selected turbines in order to achieve compliance with the EPA's 2009 guidelines. 'Noise Restricted Operation' has the drawback of reducing the power output from the turbines, but due to the limited number of turbines which are affected and the narrow band of wind speeds where the turbine noise exceed the EPA's 2009 guidelines, it is not expected that this 'Noise Restricted Operation' will significantly impact the overall generation from the wind farm.

Noise modelling will be performed once more after the turbine selection process has been completed to ensure the wind farm will comply with the EPA guidelines. If results of this further analysis show that the expected noise impacts exceed the EPA criteria, the location of the relevant wind turbine will need to be altered (or other technical adjustments made) until the predicted impacts are shown to be within EPA limits.

Compliance monitoring will also be undertaken during wind farm operation, in accordance with the EPA guidelines, to ensure actual noise levels are compliant with set criteria. Where any non-compliance is detected International Power would be directed by the EPA to rectify the matter to bring the wind farm into compliance. Beyond this, no further management in regards to turbine noise output is likely to be required.

16.7.2 *Construction and Decommissioning*

Noise emissions from construction, major maintenance or decommissioning/refurbishment work can be minimised by continued adequate maintenance of construction vehicles, and by ensuring work activities occur within recommended working hours, according to the EPA, where practicable (*i.e.* 7.00 am to 6.00 pm, Monday to Saturday and 9.00 am to 6.00 pm on Sundays). Any noise emissions from construction activity will be localised and temporary. Further management actions are proposed in Appendix 13.

16.8 Summary

Noise emissions from wind farms are unique, with the main source of noise being aerodynamic noise from the rotation of the turbine blades. Other temporary and localised noise emissions result from construction works.

The EPA's *Wind Farms, Environmental Noise Guidelines* (2009) stipulate noise criteria to be met at relevant receiver locations. Results of noise level modelling showed that the noise levels for all wind farm landowner residences neighbouring residences will meet the EPA noise criterion, and where the criteria are exceed, management of the operating Wind Farm will ensure compliance with the guidelines. Further noise modelling will be carried out after the final turbine selection has been made and during wind farm operation. In cases where the predicted or actual noise levels from this analysis exceed the EPA criteria, the relevant wind turbine location will be altered (or other technical adjustments made) until the impacts are shown to be within EPA limits.

Furthermore, vehicular or machinery noise experienced during either construction, major maintenance, or refurbishment/decommissioning events is expected to be only short term and will be effectively managed through appropriate procedures and plans.

The proposed expanded Willogoleche Wind Farm is not anticipated to lead to any significant increase in background noise levels at the nearest dwellings.

17. SOCIO-ECONOMIC IMPACTS

This chapter examines the contribution that the proposed expanded Willogoleche Wind Farm could make, both directly and indirectly, in terms of the economic and social well-being of residents and local businesses in the Mid-North.

17.1 Existing Situation

The Mid-North region is sustained predominantly through agricultural activities. Pastoralism commenced in the region in the 1830s, with predominantly sheep grazing and some cattle grazing occurring today. Cereal cropping also occurs in the region, however this activity is limited in its extent, given the vicinity to Goyder's line.

Some tourism activity also occurs, particularly around the old mining town of Burra which holds a wealth of mining heritage. Many of the small towns in the region have their own heritage attractions. Besides the local tourism interests in the region, the project area would also see a number of visitors that pass through to other areas, such as the Flinders Ranges and Broken Hill. These destinations see thousands to hundreds of thousands of visitors each year (South Australian Tourism Commission 2007a).

Several large and small rural centres occur in the region. The smaller townships include Hallett, Spalding, Mount Bryan, Whyte Yarcowie and Booborowie. These towns provide general services to the small populations they support - typically under 200 residents – and other regional residents.

The Hallett township is located approximately 3.5 km from the site and represents remnants of all of the historical themes of the Hallett region, including pastoralism, agriculture, transport and railways. Hallett lies along the Barrier Highway, which is a major state and regional route from Adelaide to Peterborough, the Flinders Ranges, and the Far-North, as well as a major national route from Adelaide to Sydney and Brisbane, via Silverton and Broken Hill.

Spalding is situated approximately 20 km from the proposed site and is uniquely situated at the centre of a network of creeks and rivers, which meet to form the Broughton River. The Spalding district consists of cropping and grazing land in fertile valleys, which predominantly run north and south.

Mount Bryan is a small town, located approximately 13 km from the proposed site. It comprises a small community with outlying farms producing cereal crops. Other forms of agriculture include cattle and sheep grazing and the locality is known for its famous merino stud. Mount Bryan was also historically a booming railway town in its day (Regional Council of Goyder 2004).

Whyte Yarcowie is located approximately 22 km north of the expanded Willogoleche Wind Farm site. In 1880, a railway station was built and Whyte Yarcowie was a prime example of an early 1900s bustling railway town in the region (Regional Council of Goyder 2004).

Booborowie is located approximately 17 km south-west of the site, nestled amongst the local ranges. It is a small, quiet town, spared the commercial expansion it was intended back in the 1800's.

Two larger rural centres occur in the region, providing some of the essential public services. They are Burra (1300 residents) within the Regional Council of Goyder, and Jamestown (1800 residents) within the Northern Areas Council.

Burra is located 29 km south of the project area. Its main economic ventures have been agriculture, mining, and tourism. Intensive copper mining activity occurred between 1845 and 1877, causing a

population boom in the area. After the mining ceased Burra became an agricultural centre for the region, and remains that way today. Its mining heritage has been preserved and is now an important part of the tourism industry that helps to support the town today. According to the South Australian Tourism Commission (South Australian Tourism Commission 2007a) nearly 10 000 people visited the Burra Heritage Passport Trail in 2006/07.

Jamestown is located approximately 32 km north-west of the project area. It was established in the 1870s and has been largely supported by the agricultural activities in and around the town. It saw the birth of the South Australian Farmers Union, and now services as a major rural centre for the region.

17.2 Potential Impacts

The development of the proposed expanded Willogoleche Wind Farm would have a number of positive socio-economic effects within the local area and the State, during both the construction and operation of the wind farm.

17.2.1 *Enhanced Agricultural and Land Viability*

Wind farms are a unique form of farm diversification that provide a valuable, sustainable rental income for participating landowners for the life of the wind farm. This diversification helps to increase the viability of the farming unit. Apart from the small amount of land occupied by access tracks, hardstanding areas, turbine towers and ancillary equipment, the land would continue to be fully available for agricultural use.

17.2.2 *Employment during the Construction, Operation and Refurbishment/Decommissioning Phases*

The construction contractor(s) for the expanded Willogoleche Wind Farm will be encouraged to source as much of the construction personnel as possible from the Mid-North region. Suitable local civil and electrical contractors can be identified and engaged on a cost-competitive basis. Historically, it has proved to be both valuable to the local community and cost-effective for the contractor to employ local contractors. Also, local involvement in maintenance operations could continue throughout the operational life of the wind farm, although maintenance outsourcing will be the decision of the turbine supplier.

There is a very good chance that a portion of the turbine components may be manufactured within Australia. An example company is Keppel Prince Engineering, who has operations in Mount Gambier and Portland. Keppel Prince fabricated the towers for a wind farm situated at Codrington near Portland, Victoria, and for a wind farm at Chalicum Hills, near Ararat, also in Victoria. RPG Australia is a company that predominantly manufactures wind towers at its Adelaide plant for many of Australia's wind farms, including the Hallett and Snowtown Wind Farms. In addition, the ongoing development and construction of wind farms in the Mid-North has enabled Suzlon Energy to plan a regional centre in Jamestown to accommodate an operations office, store and maintenance facility; which will potentially create employment opportunities for residents within the Mid-North region.

A report published in 2003 prepared for AusWEA (now the Clean Energy Council) (Appendix 17) contains estimates that for every megawatt (MW) of wind power installed, approximately 3.7 direct Australian job-years are created. This is based on 50 % of the manufacturing and engineering being carried out in Australia, which is in line with current practice. In addition, a further 11 indirect job-years are created. Also, it has been estimated that a typical 20 MW wind farm would create 2-3 direct Australian jobs for maintenance and operation (Passey 2003). In view of these estimates, the proposed expanded Willogoleche Wind Farm can potentially create a substantial number of direct

Australian job-years and direct, ongoing jobs for operation and maintenance. Many of these jobs potentially could be sourced locally, providing a boost for the regional employment market. These effects were evident during the construction of the Hallett Wind Farm, whereby local residents were employed during the construction phase of the wind farm. Similar employment opportunities for residents of Jamestown and Hallett in particular are expected to be created through the development of the expanded Willogoleche Wind Farm.

Wind farm construction and operation processes result in the opportunity for both local/regional employment and services, where the relevant services and skills are present. This has been demonstrated in the Mid-North of SA, where a study by Sinclair Knight Mertz (2010)[3] found that with the building of the Hallett projects (~350MW) expenditure in the region from construction activities alone would amount to around $111 million. Direct employment averaged at around 90 annual, full-time-equivalent positions. In our experience we have found that wind farm contractors value local services and employment, given the quality of services provided, the wealth of local knowledge and the stability that a local workforce brings

17.2.3 *Tourism*

Wind farms appear to generate great public interest, as is the experience in many regions of Australia including the southern region of Western Australia. The Esperance and Albany Wind Farms of southern Western Australia are highlighted as one of the major tourist attractions for the southern region of the state. An open day held during the construction of the Albany Wind Farm attracted over 1000 people in April 2001. Paths, boardwalks and informative displays have been erected principally for the benefit of tourists. Road counters placed across the access road to the Esperance Wind Farm (Wind Farm Road) measure approximately 80 cars per day (see Appendix 17).

The Mid-North has the potential of seeing many of the one million visitors moving through the general region each year, on their way to the Flinders Ranges and Outback regions. There are also another 450 000 visitors occurring each year within the Clare Valley (South Australian Tourism Commission 2007b). Taking into account other wind farm experiences discussed above, it is not unreasonable to estimate that at least 10 % of these visitors could take an interest in and visit the expanded Willogoleche Wind Farm and other wind farms in the region on their travels to and from these areas.

Increased traffic through the region provides economic opportunities through activities such as wind farm tours, souvenirs, food, drinks, accommodation, etc; thereby establishing a wind farm tourism industry. Increased exposure to other local attractions can also result.

Appendix 17 includes additional information on tourism (as well as effects on neighbouring property values) collated by AusWEA (Clean Energy Council). It shows that wind farms have either neutral or positive impacts in the areas they are located.

17.2.4 *Educational Benefits*

The expanded Willogoleche Wind Farm would be of potential benefit as an educational resource for regional schools and interest groups. The Crookwell, Blayney and Windy Hill wind farms in eastern Australia have already proved to be of considerable educational value to nearby schools in the study of technology, sustainability and the broader issues of human influence on the environment.

[3] SKM (2010) *Economic Impact Assessment of the Hallett Wind Farms* (http://www.agl.com.au/Downloads/AGL%20Final%20Economic%20Impact%20Report.pdf)

The Esperance Wind Farm is well known to primary and secondary schools throughout Western Australia, and many have used World of Energy – an Energy Information Centre in Fremantle – to study the Albany and Esperance wind farm projects in more detail. The Tararua Wind Farm on the North Island of New Zealand had school groups booked in the see the wind farm two years in advance.

17.2.5 *Community Fund*

In addition to these benefits, International Power will contribute to local project funding that exists in the form of the expanded Willogoleche Wind Farm Community Fund. The Community fund will be created to ensure that a proportion of the revenue of wind turbines is redirected into local community projects, with particular focus on the nearby township of Hallett, such as:

- Contributing to local community-based clubs and projects
- Sponsorship of local events/field days/facilities
- Local environmental/cultural heritage projects

17.2.6 *Fire Safety*

The tracks to the turbines themselves will act as firebreaks, as well as being available for use by local CFS fire-fighting vehicles for access along the range.

17.2.7 *Electricity Supply*

The expanded Willogoleche Wind Farm would provide a significant and clean contribution to electricity generation assets in the Mid-North for the operational life of the wind farm. Furthermore, this wind farm, if taken as a portion of a widespread wind farm implementation strategy across the state, may also contribute to stabilising the price of electricity to the consumer in the medium to long term; thereby counteracting the inevitable increase in fossil fuel prices (hence the increase in price of fossil-fuel fired electricity) of which we have recently seen evidence.

17.3 Summary

The economy of the Regional Council of Goyder relies on the combined effect of its population, agriculture and tourism. It is considered that the expanded Willogoleche Wind Farm will help to encourage diversification and growth of the local economy, and may also lead to considerable local and regional employment opportunities.

In summary, the socio-economic spin-offs from the proposed expanded Willogoleche Wind Farm can potentially include:

- Enhanced agricultural viability of the farms involved through rental income from the wind farm
- Local and regional employment (in both the construction of the wind farm, and in its subsequent maintenance)
- Income to local small business due to potential increases in tourism numbers through the region
- Local project funding through a Community Fund
- An educational resource for local schools, community organisations, and other interested groups
- An upgraded and well maintained fire track for the ranges
- A safe, environmentally friendly and diverse electricity supply for the Mid-North

- Clean, green energy production, making a significant contribution to the solution of national and global pollution/global warming problems

18. GREENHOUSE GAS SAVINGS

18.1 Introduction

As discussed in Chapter 2, the consensus of scientific opinion is that there is a link between man's actions and a variety of climate-related issues. Industrialisation and the resultant emissions from greenhouse gases from the burning of fossil fuels (*e.g.* coal and gas) has created, and continues to exacerbate, a global environmental problem – the Greenhouse Effect.

It has been well-documented that the Greenhouse Effect is accelerating climate change on earth, with the potential to (if it has not already) impact on both agricultural and natural environmental systems around the world. This is a particularly relevant point for the project area, with the agricultural industry being the dominant economic driver for the region.

Over recent decades, there has been a concerted global effort to understand and curb the Greenhouse Effect by setting targets to decrease and minimise the amount of greenhouse gases emitted from industry and domestic users. Part of this effort has been the facilitation and development of a renewable and clean energy industry, with wind energy being the forerunner in economic, safe, efficient and emission-free electricity production.

As a result of current electricity infrastructure in Australia, every kilowatt of electricity produced by wind energy displaces around one kilowatt of electricity that would otherwise be generated by fossil fuel generation (*i.e.* coal or gas). As wind energy produces no emissions, this effectively saves the equivalent amount of greenhouse gas from being emitted into the atmosphere and contributing to the Greenhouse Effect.

The proposed expanded Willogoleche Wind Farm will make a significant contribution to the state and national efforts to reduce greenhouse gas emissions. This chapter explains how this contribution is made.

18.2 Methods

Greenhouse gas savings are calculated using the predicted production of electricity from a wind farm (in megawatt hours, MWh) and the estimated CO_2-e emissions for the equivalent amount of electricity produced by conventional fossil fuel methods (*i.e.* coal and gas generation).

The absolute energy production of a wind farm depends on a number of factors, principally the average wind speed of the site, the size and efficiency of the turbines, the site layout and the capacity of the grid. Results here are based on the production from 3.0 MW turbines (a likely sized turbine to be installed on-site) and a capacity factor of 43 % (0.43), which takes into account all the other factors. Using 3.0 MW turbines would result in a realistic layout of 32 turbines compared to 37 turbines when using the smaller 2.1 MW turbines. Thus the CO2-e emissions calculations here are based upon 32 turbines.

The MWh per year potentially produced by the expanded Willogoleche Wind Farm is:

> Number of turbines x 0.4344 (capacity factor) x turbine power (MW) x 8760 (hours per year)
>
> 32 turbines x 0.4344 x 3.0 MW x 8760 = 365 300 MWh yr^{-1}

The Department of Climate Change and Energy Efficiency (2010) has advised that for every kilowatt-hour (kWh) of electricity generated using fossil fuel energy in South Australia, approximately 0.78 kilograms of CO_2-e are emitted into the atmosphere directly. Therefore:

1 MWh produced from fossil fuels = 0.78 tonnes of CO_2-e emitted

On the whole, wind energy is dispatched first onto the electricity grid. Therefore, it can displace generation which would otherwise be generated by fossil fuel sources (such as gas and coal). In turn, wind generation directly results in CO_2-e emissions savings. Following from this, every MWh of wind energy produced means 0.84 tonnes of CO_2-e emissions saved. That is:

1 MWh produced from wind = 0.78 tonne of CO_2-e saved

Therefore, the amount of CO_2 emissions offset by a wind farm will be:

Predicted wind farm output per year (MWh yr^{-1}) x avoided CO_2 emission (kg KWh^{-1})

The Department of Climate Change (formerly Australian Greenhouse Office) also provides formulas for the calculation of greenhouse gas emissions from a variety of fuel combustion methods and end user means (Department of Climate Change 2008). Emission factors are given as Full Fuel Cycle estimates, which takes into consideration the emissions from the entire production and consumption chain. For example, they consider not only the emissions from raw combustion of the raw fossil fuel material, but also emissions from fuel used to transport the raw material and end products.

18.3 Results

Based on the use of 3.0 MW turbines, the proposed expanded Willogoleche Wind Farm contains 32 turbines, with an estimated generation of 365,300 MWh per year. When this is transformed into equivalent CO_2-e emission savings, this generation amounts to approximately 284 934 tonnes of displaced (saved) emissions per year, and 5 698 680 tonnes saved over the 20-year operational life of the wind farm (see Appendix 3). The annual reduction in CO_2-e emissions as a result of the expanded Willogoleche Wind Farm would be equivalent to taking approximately 91 239 four-cylinder cars off the road permanently (based on Australian Bureau of Statistics (2008) Survey of Motor Vehicle Use, 12 months ended 31st October 2007).

Also, a typical wind turbine produces the equivalent of the energy required to manufacture it in approximately 3-5 months of operation, after which it is a net producer of 100 % clean and renewable energy (BWEA 2007).

The electricity produced by the proposed expanded Willogoleche Wind Farm would be enough to meet the needs of around 59 690 South Australian households (the average per household electricity consumption in South Australia is 6.12 MWh per year (Essential Services Commission of South Australia 2007).

18.4 Summary

Bringing about greenhouse gas savings is an important national and global priority to minimise future environmental effects of rapid global warming. The supply of energy through wind power is a significant mechanism to achieve such savings.

The proposed expanded Willogoleche Wind Farm will provide an opportunity to contribute to the emissions savings by displacing around 284 934 tonnes of CO_2-e emissions per year, and 5 698 680 tonnes over the 20-year operational life of the wind farm.

The proposed 37 wind turbines will also generate, on average, enough electricity to meet the needs equivalent of approximately 59 690 South Australian households.

19. REFERENCES

AusWEA (2004). *Wind Farms & Bird & Bat Impacts.* Fact sheet. Australian Wind Energy Association.

Auswind (2006). *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia*. Australian Wind Energy Association.

AusWEA (2006). *Best Practice Guidelines: Fire Management*. Fact Sheet. Australian Wind Energy Association.

Bacon DF (2002). *A proposed method for establishing an exclusion zone around a terrestrial fixed radio link outside of which a wind turbine will cause negligible degradation of the radio link performance*. Office of Communications website: http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/windfarms/. [Accessed: 26/6/08].

BWEA (2007). *Frequently Asked Questions.* British Wind Energy Association website: http://www.bwea.com/ref/faq.html#payback. [Accessed: 25/6/08].

Bureau of Meteorology (2008). Bureau of Meteorology website: http://www.bom.gov.au. [Accessed: 25/6/08].

Clarke, A.D. (1991). A Case of Shadow Flicker/Flashing Assessment and Solution. Open University, Milton Keynes, UK.

Commonwealth of Australia (2008). *Garnaut Climate Change Review. Draft Report.* June 2008.

Department of Climate Change (2008). *National Greenhouse Accounts (NGA) Factors.* Department of Climate Change, Commonwealth of Australia, Canberra.

Department of Mines (1964). *Geological Survey of South Australia*; Burra Sheet 1 54-5, zones 5 & 6. Department of Mines, South Australia.

Drewitt A and Langston R (2006). Assessing the impacts of wind farms on birds. *Ibis* 148 (Suppl. 1) 29-42.

Dudleston A (2000). *Public Attitudes towards Wind Farms in Scotland. Results of a Resident Survey.* The Scottish Executive Central Research Unit, Edinburgh.

Ecotricity (2007, October 29). *Swaffham I, Ecotech Centre.* Ecotricity website: http://www.ecotricity.co.uk/projects/op_ecotech.html. [Accessed: 23/6/08].

EBS (2004). Hallett Wind Farm Ecological Assessment. Environmental and Biodiversity Services, Keswick.

EBS (2010). Willogoleche Hill Wind Farm. WTG01 – WTG026. Ecological Assessment. Environmental and Biodiversity Services

EBS (2010). Willogoleche Hill Wind Farm. Extension. Ecological Assessment. Environmental and Biodiversity Services

EBS (2010). Willogoleche Wind Farm Assessment against the EPBC Criteria for Iron-grass Grassland Threatened Ecological Community. Environmental and Biodiversity Services

EPA (2009). *EPA Information: Construction Noise*. South Australian Environment Protection Authority.

EPA (2009). *Wind Farms Environmental Noise Guidelines*. South Australian Environment Protection Authority.

Erickson WP, Johnson GD, Strickland MD, Young Jr DP, Sernka KJ and Good RE (2001). *Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States.* National Wind Coordinating Committee (NWCC) Resource Document.

Essential Services Commission of South Australia (2007). *2006/07 Annual Performance Report: Performance of South Australian Energy Retail Market*.

Flinders Ranges Research (2008, August 6). *George W. Goyder*. South Australian History website: http://www.southaustralianhistory.com.au/goyder.htm. [Accessed: 27/6/08].

Graham A, Oppermann A and Inns RW (2001). *Biodiversity Plan for the Northern Agricultural Districts.* Department for Environment and Heritage, South Australia.

Government of SA (2007). *South Australia's Strategic Plan*. Government of South Australia.

Intergovernmental Panel on Climate Change (2007). *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, United Kingdom and New York, USA.

Keeley B, Ugoretz S and Strickland D (2001). Bat Ecology and Wind Turbine Considerations. *Procs. National Avian-Wind Power Planning Meeting* 4:135-146. National Wind Coordinating Committee, Washington, D.C.

Lothian A Dr (2006). *Visual Impact Assessment of Wind Farms in South Australia.* Paper presented to New Zealand Association for Impact Assessment Conference, Dunedin, New Zealand, 30 November 2006.

Northern Areas Council (2006, July 31). *History of Jamestown*. Northern Areas Council website: http://www.nacouncil.sa.gov.au/site/page.cfm?u=190. [Accessed: 1/8/08].

Edwards, R. 1964 Rock engravings and stone implements of Pitcairn Station, North Eastern South Australia. *Records of the South Australia Museum* 14(4):643-662.

NYADINRMC (2003). *Integrated Natural Resources Management Plan. Draft report for consultation*. Northern and Yorke Agricultural Districts Integrated Natural Resources Management Committee.

Passey R (2003). *Driving Investment, Generating Jobs: Wind Energy as a Powerhouse for Rural and Regional Development in Australia*. A report for the Australian Wind Energy Association.

PB Power (2003). *Proposed Myponga/Sellicks Hill Wind Farm Development: Public Environment Report.* Prepared for TrustPower. PB Power Pty Ltd.

Percival SM (2000). Birds and Wind Turbines in Britain. *British Wildlife.* October 2000.

Percival SM (2003). Birds and wind farms in Ireland: A review of potential issues and impact assessment. Ecology Consulting: Durham, UK.

PIRSA (2007). *Northern Areas Council Development Plan*. Department of Primary Industries and Resources SA.

Planning SA (2002). *Guide for Applicants – Wind Farms*. Planning SA, Government of South Australia.

Rowe CL & Associates (2010). *Proposed expanded Willogoleche Wind Farm, Mount Lofty Ranges near Jamestown, South Australia. Preliminary Planning and Land Use Assessment.* CL Rowe & Associates Pty Ltd.

.Regional Council of Goyder (2004). Regional Council of Goyder website: http://www.goyder.sa.gov.au/site/page.cfm?u=107. [Accessed: 30/6/08].

South Australian Tourism Commission (2007a). *Regional Tourism Profile: Flinders Ranges and Outback*. South Australian Tourism Commission website: http://www.tourism.sa.gov.au/publications/pubs.asp?archive=0&PubCatID=7. [Accessed: 1/7/08]

South Australian Tourism Commission (2007b). *Regional Tourism Profile: Clare Valley.* South Australian Tourism Commission website: http://www.tourism.sa.gov.au/publications/pubs.asp?archive=0&PubCatID=7. [Accessed: 1/7/08]

Telstra (2003). *Technical Report: Guidelines on Minimizing the Impact of Wind Farms on the SAGRN.* Issued to the Department of Administrative and Information Services, SA.

Walshe K and Bonell J (2003). *Archaeological and Anthropological Desktop Study of a Proposed Wind Farm Development Area, Hallett, South Australia. A Report for International Power Pty Ltd*. TimeMap Pty Ltd.

West Broughton Soil Conservation Board (2002). *West Broughton Soil Conservation Board District Plan September 2002.* Primary Industries and Resources SA and the Soil Conservation Council South Australia. Adelaide.