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Celebrating 50 Years in 2012
Wilkinson Murray is an independent firm established in 1962, originally as Carr & Wilkinson. In 1976 Barry Murray joined founding partner Roger Wilkinson and the firm adopted the name which remains today. From a successful operation in Australia, Wilkinson Murray expanded its reach into Asia by opening a Hong Kong office early in 2006. 2010 saw the introduction of our Queensland office and 2011 the introduction of our Orange office to service a growing client base in these regions. From these offices, Wilkinson Murray services the entire Asia-Pacific region.
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GLOSSARY OF TERMS

**SCOPE 1 GREENHOUSE GAS EMISSIONS**
Emissions released into the atmosphere as a direct result of an activity, or series of activities (including ancillary activities) that constitutes the facility.

**SCOPE 2 GREENHOUSE GAS EMISSIONS**
Emissions released as a result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do no form part of the facility.

**SCOPE 3 GREENHOUSE GAS EMISSIONS**
Emissions that occur outside the site boundary of a facility as a result of activities at a facility that are not Scope 2 emissions.
1 INTRODUCTION

1.1 Project Background

Sydney Zoo is seeking approval under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) for the construction of a zoo (Sydney Zoo) within the Bungarribee Precinct in the Western Sydney Parklands.

The project was declared to be State Significant Development (SSD). Assessment and approval is being pursued in accordance with the EP&A Act. The Secretary’s Environmental Assessment Requirements (SEARs) for the project have been issued and set out the environmental assessment requirements for the project.

This Greenhouse Gas Assessment has been prepared to address the relevant SEARs in relation to the preparation of the Environmental Impact Statement (EIS) for the project, and was conducted in general accordance with The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) National Greenhouse Accounts Factors, 2013.

1.2 The Project

The proposed development of Sydney Zoo will include:

- Animal exhibits across several enclosures of varying design for a range of native and exotic animals.
- Back-of-house buildings for exhibits.
- Main entrance building comprising entry/exit, and gift shop.
- Restaurant and café.
- Kiosks and amenities.
- Show arena.
- Picnic areas and gardens.
- Wetlands and waterways.
- Service building containing:
  - Administration areas;
  - Curatorial and food preparation areas; and,
  - Veterinarian space.
- Service yard with maintenance shelter.
- Main car park for approximately 475 vehicles, with an overflow car park for approximately 800 vehicles, accessed via an internal road connecting to the Great Western Highway.
- Bus parking.

Construction of the project is expected to take approximately 8 – 12 months to complete.
2 SITE DESCRIPTION

2.1 Site Location

The site is located approximately 33 kilometres west of the Sydney Central Business District, and approximately 15 kilometres east of Penrith. It falls within the Western Sydney Parklands, and is in close proximity to the Great Western Highway, M4 Western Motorway, and Westlink M7, providing excellent access to both the state and regional road network and surrounding parkland areas.

The project site is 16.5 hectares in size, and irregular in shape. Access will be from the Great Western Highway, approximately 75 metres from the southern border of the project site.

The site location is shown in Figure 2-1.

Figure 2-1 Site Location
3 ASSESSMENT METHODOLOGY

The following greenhouse gases have been identified as significant contributors to global warming:

- Carbon dioxide (CO2);
- Methane (CH4);
- Nitrous oxide (N2O);
- Synthetic gases; and
- Hydro fluorocarbons HFCs, SF6, CF4, C2F6.

No significant emissions of HFCs and synthetic gases are likely to occur as a result of the construction or operation of the project and have therefore been omitted from the remainder of the assessment.

Under the Department of Climate Change and Energy Efficiency protocol, GHG emissions are categorized as Scope 1, Scope 2 and Scope 3 emissions; which are defined as follows:

- **Scope 1 – Direct (or point-source) emission factors emissions**, are direct emissions from sources owned or operated by the facility. These may be calculated using ‘Point Source Emissions Factors’ as defined in the AGO Factors and Methods Workbook;

- **Scope 2 – Indirect emission factors** – emissions are GHGs released as a result of the generation of electricity, or the production of heat, cooling or steam purchased by the reporting company.

- **Scope 3 – Various emission factors** – emissions are all other GHG emissions that are not covered under Scope1 or Scope 2. Scope 3 emissions can include activities such as employees commuting to work; extraction, production and transport of fuels, materials and other goods; and use of products manufactured and sold.

In accordance with the SEARs for the project, this GHG assessment considers the following GHG emissions and energy consumption activities associated with the project:

**Scope 1 – Direct Emissions:**

- On-site generation of GHG emissions from mobile and stationary plant and equipment; and
- Consumption of electricity in site offices.
- Animals
- Gas used in kitchen
- composting

**Scope 2 – Indirect Emissions:**

- Electricity generated off-site of that is consumed on the site.
4 ESTIMATION OF GREENHOUSE EMISSIONS

Greenhouse gas emissions associated with the construction and operation of the project have been estimated based on information from the client, and published emissions factors. The emissions estimates are based on the best available design data for the project at the time of undertaken the assessment.

4.1 Construction Greenhouse Gas Emissions

Significant greenhouse gas emissions associated with the construction of the project will result from fuel combusted in earthmoving equipment and generators, and electricity used in site offices.

The bulk earthworks phase is anticipated to be carried out over a 3 – 4 month period, with the remaining construction activities being conducted over approximately 9 months. Table 4-1 presents the heavy machinery expected to be used during the bulk earthworks phase.

<table>
<thead>
<tr>
<th>Table 4-1 Bulk Earthworks Machinery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Item</td>
</tr>
<tr>
<td>Dozer</td>
</tr>
<tr>
<td>Excavator</td>
</tr>
<tr>
<td>Dump Truck</td>
</tr>
<tr>
<td>Front End Loader</td>
</tr>
<tr>
<td>Grader</td>
</tr>
<tr>
<td>Scraper</td>
</tr>
<tr>
<td>Roller</td>
</tr>
<tr>
<td>Water Cart</td>
</tr>
<tr>
<td>Compactor</td>
</tr>
</tbody>
</table>

The estimation of greenhouse gas emissions from the construction of the project has been made based on the following scenario:

- The bulk earthworks phase will last for four months (12 weeks);
- The machinery used during the bulk earthworks phase will be that outlined in Table 4-1; and,
- One site office would be maintained for the duration of the construction works (1 year); and,
- A 5 kVA generator would be used for construction power tools during a period of approximately 8 months.

The operation of mobile plant outside of the bulk earthworks phase would be negligible, compared to that during the bulk earthworks.

No greenhouse gas emissions associated with clearing vegetation have been included as the majority of the site will be re-vegetated.
The CO2 equivalent (CO2-e) emissions from the construction of the project are summarised in Table 4-2.

### Table 4-2 Summary of Estimated Construction CO2-e Emissions

<table>
<thead>
<tr>
<th>Source</th>
<th>CO2-e Emissions (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>507</td>
</tr>
<tr>
<td>Electricity</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>523</strong></td>
</tr>
</tbody>
</table>

#### 4.2 Operational Greenhouse Gas Emissions

The following section presents an estimation of greenhouse gas emissions associated with the operation of the project.

##### 4.2.1 Electricity Use

An estimation of the peak electrical load of the site has been provided by Evolve Engineering. It is estimated that the peak electric load, which is dominated by power for lighting, is approximately 2,430 kVA. Table 4-3 provides a breakdown of the major uses of electricity within the site.

The base electrical load for the site will be determined during detailed design, however for the purposes of assessment, it is assumed that the base load is 45% of the peak load.

Assuming a power factor of 0.95, the CO2-e emissions associated with electricity use at the site are 7,826 tonnes per annum.
4.2.2 Animals

The 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), prepared by the Intergovernmental Panel on Climate Change (IPCC) suggests that CO₂ emissions from livestock should not be included greenhouse gas inventories since the carbon sequestered in the animal feed is returned to the atmosphere through respiration, and the net effect on atmospheric CO₂ is zero. However in some animals, a significant portion of the carbon in their feed is returned to the atmosphere as methane (CH₄). Since CH₄ has a global warming potential which is 21 times higher than that of CO₂, the CH₄ emissions from animals requires consideration.

Some animals, referred to as ruminants, produce significant amounts of methane due to their digestive systems. Table 4-4 presents the various ruminants planned to be exhibited at the zoo.

Hippopotamus are classified as pseudo-ruminants and have conservatively been included in the assessment of CH₄ emissions from animals.
Table 4-4  Ruminant Animals

<table>
<thead>
<tr>
<th>Animal</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antelope</td>
<td>10</td>
</tr>
<tr>
<td>Giraffe</td>
<td>2</td>
</tr>
<tr>
<td>Hippopotamus</td>
<td>8</td>
</tr>
</tbody>
</table>

Methane emissions factors published in (IPCC, 2006) for a variety of ruminant animals have been used to estimate CH₄ emissions for the project. For each animal to be exhibited at the zoo, the CH₄ emission factor for the most similar species from (IPCC, 2006) has been adopted, and corrected based on the average species weight. The CO₂-e emissions from ruminant animals are summarised in Table 4-5.

Table 4-5  Greenhouse Gas Emissions – Ruminant Animals

<table>
<thead>
<tr>
<th>Animal</th>
<th>Details &amp; Assumptions</th>
<th>Emissions (tCO₂-e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antelope</td>
<td>• Closest (IPCC, 2006) species = deer.</td>
<td>4.2 per annum</td>
</tr>
<tr>
<td></td>
<td>• CH₄ emission factor = 20 kg/head/year</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No weight correction.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 10 head.</td>
<td></td>
</tr>
<tr>
<td>Giraffe</td>
<td>• Closest (IPCC, 2006) species = horse</td>
<td>1.5 per annum</td>
</tr>
<tr>
<td></td>
<td>• CH₄ emission factor = 18 kg/head/year</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Weight correction = multiply by 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 2 head.</td>
<td></td>
</tr>
<tr>
<td>Hippopotamus</td>
<td>• Closest (IPCC, 2006) species = buffalo.</td>
<td>46 per annum</td>
</tr>
<tr>
<td></td>
<td>• CH₄ emission factor = 55 kg/head/year</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Weight correction = multiply by 5.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 8 head.</td>
<td></td>
</tr>
</tbody>
</table>

| TOTAL    | 52 per annum                                            |                    |

4.3  Overall Emissions

The total estimated annual greenhouse gas emissions during the construction and operation of the project are 523 tCO₂-e and 7,878 tCO₂-e, respectively.

Australia’s total greenhouse gas emissions in 2012 amounted to 554.6 million tonnes of carbon dioxide equivalent (MtCO₂-e) whilst New South Wales, in 2012, accounted for 154.7 Mt of the total. Therefore, operation of the project will account for approximately 0.005% of current NSW emissions.
5 GREENHOUSE GAS MITIGATION AND ENERGY EFFICIENCY

This section presents a number of features of the project design and further recommendations to reduce greenhouse gas emissions and improve energy efficiency during both the construction and operation of the project.

In accordance with the Energy Efficiency and Ecologically Sustainable Design (ESD) report for the project, prepared by SLR Consulting, the following features are incorporated into the project design to increase energy efficiency:

- The proposed development will incorporate passive and active energy saving measures such as operable windows to enhance natural ventilation through Building 1 (Entry/Retail) and Building 2 (Restaurant);
- Ceiling fans are planned for Building 2 (Restaurant);
- A high performance double glazing system will be used including thermally broken windows aluminium framed with a minimum U Value of 2.9;
- High levels of natural light will be enable through the maximising of north facing facades;
- Incorporation of thermal mass: concrete slab construction is proposed for all floors throughout the development – concrete has amongst the highest thermal mass capacity of a range of common building products;
- Velux fixed skylights will be used for Building 3 (Admin/Curatorial);
- An efficient Variable Refrigerant Flow (VRF) air condition system is planned for conditioned spaces; and,
- A “Green Roof” is planned for Building 4 (Nocturnal/Habitat);

The Energy Efficiency and ESD report recommends the following measures to increase energy efficiency and reduce greenhouse gas emissions from the project:

- Line the inside of roof and/or ceiling constructions with a minimum of R3.5 insulation;
- Peak Energy Demand Reduction. A preliminary feasibility study concluded that a 250.9 kW Photovoltaic (PV) solar installation may reduce the peak electricity demand of the site by 11%; and therefore:
  - The estimated annual energy produced by the proposed 250.9 kW system is 321,415 kWh; and,
  - The estimated greenhouse gas reduction is approximately 344 tCO₂-e per annum.
- A self sufficient off-grid solar street lighting system to illuminate selected locations of the proposed site;
- A minimum 4-star energy efficiency rating is recommended for all dishwashers, refrigerators and washing machines;
- Heat pump or solar hot water systems should be investigated;
- LED and fluorescent lighting should be used where possible;
- Electricity sub-metering for uses consuming more than 10,000 kVA;
- Dedicated carspaces for low emission cars; and,
- Bicycle storage facilities to encourage patrons to cycle to the Zoo.
The following measures should be considered to mitigate greenhouse gas emissions during construction:

- Recycle or compost waste where possible;
- Choose nearby sources of fill and other building materials to reduce transport emissions;
- Ensure construction plant is regularly maintained to ensure optimum fuel efficiency;
- Where possible, operate construction plant at lower power settings to conserve fuel, and switch off engines when not in use; and,
- Plan construction activities to avoid double handling of fill and other materials.
6  CONCLUSION

A greenhouse gas assessment has been conducted for the proposed Sydney Zoo Development.

This study has identified sources of greenhouse gas (GHG) emissions associated with the construction and operation of the project, in accordance with the Secretary’s Environmental Assessment Requirements issued for the project.

Estimates of equivalent carbon dioxide have been predicted and it has been determined that the operation of the project will account for approximately 0.005% of current NSW emissions.

A number of recommendations have been made to mitigate greenhouse gas emissions from the construction and operation of the project, and to improve energy efficiency.