The *Alintjara Wilurara Buffel Grass Operational Strategy* was prepared by Kurt Tschirner, Dr John Read, Justine Graham and Dr Matthew Ward following a planning day with the following stakeholders:

- Acacia Park Consulting
- Ahava Energy
- Ecological Horizons Pty Ltd
- Department of Environment, Water and Natural Resources (Alintjara Wilurara, Eyre Peninsula and South Australia Arid Lands)
- Department of Planning, Transport and Infrastructure
- Iluka Resources Ltd.

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The strategy has been developed with the involvement and cooperation of a broad range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

This strategy should be cited as follows: Tschirner, K. Read, J.L. Graham, J.K and Ward, M.J. (2012). *Alintjara Wilurara Buffel Grass Operational Strategy* Department of Environment, Water and Natural Resources.

Copies of the *Alintjara Wilurara Buffel Grass Operational Strategy* are available at:

*Cover image*: Buffel Grass (left) invading native vegetation, New Well, Anangu Pitjantjatjara Yankunytjatjara Lands. Image. J. Stelmann
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1 Executive Summary

The Alinytjara Wilurara Buffel Grass Operational Strategy aims to implement an effective buffel grass (*Cenchrus ciliaris and allies*) eradication and control program in the Alinytjara Wilurara (AW) region of the South Australian Department of Water, Environment and Natural Resources (DEWNR). This will assist the AW region to fulfil its vision of minimising the threat of buffel grass on culture, environment, safety and production.

Buffel grass or mamu tjani/tjanpi kura (devil grass/bad grass in Pitjantjatjara) has emerged as a significant threat to the culture and safety of Anangu communities in the AW region, because heavy infestations prevent traditional hunting, foraging and cultural activities and lead to dangerous fires. Buffel grass is also widely recognised as amongst the most serious environmental threats to the rangelands of Australia because it is an ecological transformer species, capable of destroying Australian ecosystems and threatening many plant and animal species with extinction.

Buffel grass rapidly invades disturbed and undisturbed landscapes, out-competes native grasses and shrubs and also threatens woodlands, communities and infrastructure with high frequency and high intensity fires.

Buffel grass is now widely distributed across the northern areas of the AW region, in particular the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, where dense infestations are causing considerable social, environmental and safety threats. Buffel grass has also colonised several localities in the Maralinga Tjarutja (MT) Lands and southern parts of the AW region where, if uncontrolled, will likely cause similar major problems that have been experienced in central Australia.

Current techniques and efforts have proven to be unsuccessful at controlling buffel grass at a statewide level. Control efforts will be much more successful if they are implemented in the early stages of buffel grass invasion. It is believed that a co-ordinated and well-resourced approach to buffel grass control will have the best chance of success in the southern part of the AW region. For effective on-going management of buffel grass, biological agents are likely to be the only feasible means of controlling dense infestations at a regional scale.

2 Introduction

Buffel grass, originally from southern Asia and eastern Africa, was deliberately introduced into the APY Lands in the 1980s to reduce dust around settlements. Originally spreading out from these communities along roadsides, buffel grass is now widespread in undisturbed vegetation throughout a significant part of the APY Lands and has also colonised several sites in the MT Lands and the Yalata-Nullarbor region over the past decade.

Buffel grass has been identified as a key threat in the pest management strategies for the AW Natural Resources Management (NRM) Board and has been noted for its impact on threatened species in the APY Threatened Species Recovery Plan, and in the Rare and Threatened Flora Management Plan for the APY Lands (AW NRM Board, DEWNR). Buffel grass is rated as "very high" on the weed control list for the region in the Weed Management Plan for the Northern and Western Region of the Department for Planning, Transport and Infrastructure (DPTI).
2.1 Threat

Environmentally, buffel grass is considered one of Australia’s worst weeds (Humphries et al. 1991), and more specifically a ‘transformer weed’ of the Australian rangelands (Bastin et al. 2008) due to its ability to transform structurally complex and diverse vegetation associations into monocultures. A more detailed description of the biology of buffel grass is found in Appendix 1.

Buffel grass is a key threat in the AW region due to its ability to burn and regenerate quickly after fire, its reproductive capacity and invasive nature. A key way in which buffel grass achieves dominance is by altering natural fire regimes to suit itself. It is highly flammable and regenerates after fire much more quickly than most native species, including spinifex. In this way it gains a competitive advantage and can very quickly dominate and replace native plants. Uncontrolled spread of buffel grass can lead to:

- increased frequency and intensity of fires in the landscape affecting native plant and animal communities and threatening safety and infrastructure
- suppression or localised extinction of native plants due to direct competition
- reluctance of Anangu to visit or maintain culturally important sites or hunt in infested regions
- erosion of carbon storage when woodlands are altered by fire regime to become frequently burnt grasslands.

2.2 Distribution

Buffel grass has become the dominant plant in several habitats and regions in the AW Lands (Figure 1). Photographs illustrating the extent of buffel grass spread in key AW habitats can be found in Appendix 2.

Broadscale mapping or control is not feasible throughout many extensive and dense buffel grass infestations in the APY Lands. Buffel grass infestations remain far more isolated in the MT Lands, with most infestations confined to the Oak Valley region, the Trans Australian Railway and the Eyre Highway (Figure 1). These infestations are currently mapped and managed.

2.3 Source Populations

Significant source populations outside the AW region include the townships of Coober Pedy, Tarcoola, Glendambo and Port Augusta, and the Stuart Highway. These are major nodes of entry into the AW region from vehicle traffic and must be addressed to achieve the buffel grass management aims of the AW Board.

Mapped source populations of buffel grass within the southern AW region include:

- the Eyre Highway
- the main road from Yalata to Maralinga
- Lake Dey-Dey Road (from Maralinga turn off to 30 km west of Oak Valley)
- town of Oak Valley (38 ha of buffel mapped)
- parts of the railway line west of Ooldea
- the railway line east from Ooldea to Tarcoola (the last 80 km is in the South Australian Arid Lands (SAAL) Region)
- areas around Cook.
A total of 64 known infested sites have been mapped within the southern AW region (Figure 1), with sites around Cook and from Ooldea to Tarcoola still to be mapped.

Figure 1. Buffel grass records from the Alinytjara Wilurara Natural Resource Management Region and management zone boundaries. The points in the Anangu Pitjantjatjara Yankunytjatjara Lands represent more of a general distribution rather than individual locations.
3 Operational Strategy

This strategy for the AW region has been developed following the review of the draft South Australia Buffel Grass Strategic Plan (May 2012) and consultation with stakeholders in the AW region, including a workshop held in Ceduna in August 2012. The State plan details important information that provides background for this strategy.

3.1 Vision

Minimise the impact of buffel grass on culture, environment, safety and production in the Alinytjara Wiluŋara region.

3.2 Aim of Operational Strategy

The aim of this Alinytjara Wiluŋara Buffel Grass Operational Strategy is to implement an effective buffel grass eradication and control program in the AW region.

3.3 Objectives and Actions

Objective 1:
Destroy infestations of buffel grass south of the APY Lands in the AW region by 2015.

Actions
1.1 Regularly survey southern AW region for buffel grass
1.2 Undertake buffel grass control
1.3 Ensure adequate data collection and mapping of survey data
1.4 Signpost known infestations
1.5 Ensure longevity of control and surveillance

Objective 2:
Detect, manage and monitor buffel grass in key sensitive localities within the APY Lands.

Actions
2.1 Ensure adequate data collection and mapping of management actions
2.2. Determine priority regions and secure traditional owner, community and executive support
2.3 Ensure that known infestations being managed are marked
2.4 Undertake buffel grass control in the APY Lands
**Objective 3:**
Raise awareness among the general public and key stakeholders, in particular Aboriginal communities.

*Actions*
3.1 Raise awareness of the threat posed by buffel grass and management options
3.2 Develop culturally appropriate mechanisms for engagement of Aboriginal communities
3.3 Promote vehicle hygiene to minimise the spread of buffel grass.
3.4 Promote personal hygiene to minimise spread of buffel grass on clothing/bedding etc.
3.5 Champion formation and momentum of a State Buffel Grass Taskforce (BTF)

**Objective 4:**
Promote research and development to increase effectiveness of buffel grass management.

*Actions*
4.1 Pursue optimal treatment strategies
4.2 Advocate research into biological controls

3.4 **Principles Underpinning the Operational Strategy**
The following four principles underpin this operational strategy:

1. The primary responsibility for buffel grass management rests with landholders but collective action is necessary where the problem transcends the capacity of the individual landholder to address it adequately.

2. A coordinated and strategic approach to managing buffel grass will not occur unless there is investment in increasing the capacity and ownership of all stakeholders.

3. Prevention through early detection and treatment are the most cost-effective techniques for buffel grass control.

4. Continued trials, development and research in concert with increasing stakeholder awareness and engagement are essential to meet the objectives of this plan. Therefore this strategy will adopt an adaptive management approach, with frequent review and modifications.
3.5 Key Stakeholders and Responsibilities

DEWNR AW plays a pivotal role in overseeing, coordinating and increasing the capacity of regional stakeholders to manage buffel grass in the region. This includes maintaining and building cooperative relationships with all relevant agencies and stakeholders to ensure the most strategic and effective use of available resources. Integral to this role is fostering and encouraging appropriate control efforts from government agencies and stakeholders at key localities outside the region to complement AW efforts.

Delivery of the AW Buffel Grass Operational Strategy is through an Authorised Officer who is responsible for:

1. Coordinating and prioritising buffel grass surveillance and control
2. Building capacity of Aboriginal communities, contractors and stakeholders (delivery agents) in implementing the strategy
3. Expanding and formalising rainfall reporting systems to better target management efforts in response to rainfall events. This can include requesting railway staff to assist in reporting.
4. Working with the AW Data Management Coordinator and other agencies to ensure standardised data collection and mapping procedures are developed and used.

The AW region will also work in collaboration with the State Buffel Grass Taskforce to provide:

1. Encouragement and support for stakeholders (e.g. source training) to undertake buffel grass management
2. Awareness and communication points identified in this plan
3. Ongoing research into new surveillance and control techniques suitable for buffel grass management, such as the development of trials to test herbicides.

The scale and complexity of required buffel grass management necessitates coordinated and strategic cooperation of many other stakeholders to achieve the aim and objectives of this strategy (Table 3). Other stakeholders include:

- Australian Government
- Biosecurity SA – Primary Industries and Regions SA (PIRSA)
- State Buffel Grass Taskforce
- AW Natural Resources Management Board
- Local government
- Traditional owners
- Private landholders
- State Government landholders
- DEWNR Pastoral Program
- Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE)
- DPTI
- Railway managers
- Mining industry
- Commercial contractors
- Volunteer organisations
- Interstate government agencies
3.6 Management Zones

The SA Buffel Grass Strategic Plan has developed management zones to prioritise the approach to buffel control within different regions. Management aims relating to Zone 1 and 3 are relevant to the AW region (Figure 1).

**Zone 1 – Manage buffel grass:**
Alinytjara Wilurara – Anangu Pitjantjatjara Yankunytjatjara (APY) Lands

Management aim: To reduce the overall impacts and further spread of buffel grass through applied research and targeted management, including protection of sensitive areas, key sites and assets.

**Zone 3 – Destroy infestations:**
Alinytjara Wilurara – all land in AW region south of APY Lands

Management aim: To eliminate buffel grass, locating and destroying all infestations by 2015.

3.6.1 AW Buffel Grass Operational Strategy approach for Zones 1 and 3

For the purposes of this operational strategy, the level of detail on surveillance and management activities differs for Zones 1 and 3. This reflects the current priority, knowledge and capacity for action of the AW region and associated stakeholders.

In Zone 3, where buffel distribution is well known and eradication is achievable, detailed management actions are provided for particular localities and subregions. Such detailed information on the distribution, priority of control and optimum methods for managing broadscale buffel infestations is not currently available for the APY Lands (Zone 1). A priority outcome of the adaptive management nature of this strategy will be to generate detailed information for the APY Lands, analogous to that presented for Zone 3 in this document, and to address the serious threats to culture, infrastructure, safety and biodiversity in Zone 1.

Table 1 provides a guide to prioritising the control of infestations. For example, isolated roadside, parking bay or railway infestations in dunefields adjacent to sandy creeks are absolute priorities for urgent buffel grass eradication, whereas infestations on heavily-grazed stony plains adjacent to other infestations are a considerably lower priority for control.
<table>
<thead>
<tr>
<th>Source potential</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Works yards (particularly where machinery, vehicles or road fill are stored)</td>
<td>Extreme</td>
</tr>
<tr>
<td>Railway ballast</td>
<td>Extreme</td>
</tr>
<tr>
<td>Egress points on tracks from infested roadsides</td>
<td>Extreme</td>
</tr>
<tr>
<td>Mid-track infestations (i.e. between wheel tracks)</td>
<td>Extreme</td>
</tr>
<tr>
<td>Roadside parking bays</td>
<td>Very high</td>
</tr>
<tr>
<td>Camping areas, racecourses</td>
<td>Very high</td>
</tr>
<tr>
<td>Roadhouse car parks</td>
<td>Very high</td>
</tr>
<tr>
<td>House yards, homestead areas, public parks</td>
<td>Very high</td>
</tr>
<tr>
<td>Roadsides</td>
<td>High</td>
</tr>
<tr>
<td>Waterpoints where stock or wildlife congregate</td>
<td>High</td>
</tr>
<tr>
<td><strong>Culture</strong></td>
<td></td>
</tr>
<tr>
<td>Significant cultural sites threatened by fire</td>
<td>Extreme</td>
</tr>
<tr>
<td>Important hunting/foraging areas</td>
<td>Very high</td>
</tr>
<tr>
<td>Iconic/tourism areas</td>
<td>High</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td>Adjacent to houses or fire-sensitive infrastructure</td>
<td>High</td>
</tr>
<tr>
<td><strong>Habitat</strong></td>
<td></td>
</tr>
<tr>
<td>Watercourses</td>
<td>Extreme</td>
</tr>
<tr>
<td>Sand dunes</td>
<td>Very high</td>
</tr>
<tr>
<td>Sand plains</td>
<td>High</td>
</tr>
<tr>
<td>Rocky hills</td>
<td>High</td>
</tr>
<tr>
<td>Triodia plains</td>
<td>Medium</td>
</tr>
<tr>
<td>Clay plains, gibber, limestone</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Land tenure</strong></td>
<td></td>
</tr>
<tr>
<td>Nature reserves</td>
<td>Very high</td>
</tr>
<tr>
<td>Pastoral remote from waterpoints</td>
<td>High</td>
</tr>
<tr>
<td>Pastoral adjacent to waterpoints</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Table 1.** Prioritisation of localised situations for buffel grass *Cenchrus ciliaris* surveillance, control and monitoring

### 3.7 Control Techniques

Optimal buffel grass control techniques vary according to size and accessibility of infestation, soil type, growth phase and value of adjacent vegetation. Details are provided in Appendix 3 and Table 2, which should be consulted prior to initiating buffel grass control.

Guiding principles for selecting appropriate control:

1. Herbicides are most effective on actively growing small plants – hence the advantage in spraying within six weeks of rain and possibly pre-treating by burning or slashing (before plants go to seed) to eliminate the problem of “dead thatch” obscuring green leaves for herbicide uptake.

2. Although glyphosate is effective in some cases, augmentation with residual herbicides is often cost-effective, particularly in inaccessible locations where prompt follow-up control is unlikely.
3. Herbicide selection is influenced by accessibility to clean water, soil type, potential resistance to particular herbicide groups, and planned long-term vegetation cover for the treated area. Use of strong residual herbicides may be optimal for railway ballast and work yards to prevent regrowth. Lower doses or less residual herbicides is preferred when rehabilitation with native or amenity vegetation is desirable.

<table>
<thead>
<tr>
<th>Situation</th>
<th>Growth phase</th>
<th>Optimal control method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated plants in native vegetation</td>
<td>All growth phases</td>
<td>• Map and mark&lt;br&gt;• Grub out and remove pre-seeding plants&lt;br&gt;• Residual herbicide</td>
</tr>
<tr>
<td>Dense patch in native vegetation</td>
<td>Actively growing/seedling&lt;br&gt;Dried</td>
<td>• Map and mark&lt;br&gt;• Herbicide application&lt;br&gt;• Fire and follow-up herbicide application</td>
</tr>
<tr>
<td>Fenceline</td>
<td>All growth phases</td>
<td>• Map and mark&lt;br&gt;• Residual herbicide application</td>
</tr>
<tr>
<td>Vehicle access tracks</td>
<td>Actively growing</td>
<td>• Map and mark&lt;br&gt;• Herbicide application</td>
</tr>
<tr>
<td></td>
<td>Seeding</td>
<td>• Herbicide application( use of residual where appropriate)</td>
</tr>
<tr>
<td></td>
<td>Dried</td>
<td>• Fire and follow up with residual herbicide</td>
</tr>
<tr>
<td>Growing under significant vegetation or near significant fauna sites</td>
<td>Actively growing</td>
<td>• Map and mark&lt;br&gt;• Grub out&lt;br&gt;• Careful use of herbicide</td>
</tr>
<tr>
<td></td>
<td>Seeding</td>
<td>• Grub out and remove</td>
</tr>
<tr>
<td>Around buildings/infrastructure</td>
<td>Actively growing/seedling</td>
<td>• Map and mark&lt;br&gt;• Grub out and remove&lt;br&gt;• Use of residual herbicide where appropriate</td>
</tr>
<tr>
<td></td>
<td>Dried</td>
<td>• Fire (if appropriate), slashing, herbicide application</td>
</tr>
</tbody>
</table>

**Table 2.** Guidelines for site specific control techniques

### 3.8 Surveillance and Control

A surveillance and control regime is required for the various geographic areas and land tenures across the AW NRM region to ensure a strategic approach is maintained. The flow chart in Figure 2 illustrates the surveillance and control requirements. For the purposes of this operational strategy, the southern AW region is subdivided into geographic management areas to help with more specific buffel control and planning. These areas also incorporate key source areas adjacent to the AW region (e.g. Stuart Highway). A detailed surveillance and control regime for the southern AW region is illustrated in Table 3. Development of an analogous regime for the APY Lands is an anticipated and needed outcome of the surveys and workshops identified in this strategy.
**Figure 2.** Flow chart illustrating buffel grass *Cenchrus ciliaris* surveillance and control regime and key responsibilities of staff in the Alinytjara Wiluŋara NRM region.
### Surveillance and control regime

<table>
<thead>
<tr>
<th>Type</th>
<th>Area</th>
<th>Responsibility</th>
<th>Surveillance timing</th>
<th>Control timing</th>
<th>Delivery</th>
<th>Control method</th>
<th>Audit / compliance</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>Oak Valley</td>
<td>Maralinga Tjarutja Oak Valley Inc</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Involvement by Oak Valley Land Management</td>
<td>Fire/herbicide</td>
<td>DEWNR AW</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Coober Pedy</td>
<td>Coober Pedy Council, DEWNR SAAL</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Commercial contractors</td>
<td>Mechanical/herbicide</td>
<td>DEWNR SAAL</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Glendambo, Tarcoola</td>
<td>DEWNR SAAL</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Commercial contractors</td>
<td>Mechanical/herbicide</td>
<td>DEWNR SAAL</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Port Augusta and surrounds</td>
<td>Port Augusta Council, DEWNR Northern and Yorke (N&amp;Y)</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Commercial contractors</td>
<td>Mechanical/herbicide</td>
<td>DEWNR N&amp;Y</td>
<td>Medium</td>
</tr>
<tr>
<td>Landscape</td>
<td>Tallaringa CP (Anne Beadell Highway)</td>
<td>DEWNR AW</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Commercial contractors</td>
<td>Coober Pedy, SAAL, Commercial contractors</td>
<td>Herbicide</td>
<td>DEWNR AW</td>
</tr>
<tr>
<td>Type</td>
<td>Area</td>
<td>Responsibility</td>
<td>Surveillance timing</td>
<td>Control timing</td>
<td>Delivery</td>
<td>Control method</td>
<td>Audit / compliance</td>
<td>Priority</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------</td>
<td>---------------------</td>
<td>----------</td>
</tr>
<tr>
<td>MT Lands</td>
<td>MT Council</td>
<td></td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Involvement by Oak Valley Land Management</td>
<td>Herbicide</td>
<td>DEWNR AW</td>
<td>High</td>
</tr>
<tr>
<td>Yellabinya and Nullarbor reserves</td>
<td>DEWNR AW</td>
<td></td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Requires dedicated surveillance trip</td>
<td>Herbicide</td>
<td>DEWNR AW</td>
<td>Medium</td>
</tr>
<tr>
<td>Defence Land (Anne Beadell Highway) including Maralinga Village</td>
<td>Australian Government</td>
<td></td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Requires dedicated surveillance trip</td>
<td>Herbicide</td>
<td>DEWNR AW</td>
<td>Medium</td>
</tr>
<tr>
<td>Exploration and mining areas</td>
<td>Individual companies</td>
<td></td>
<td>Within two weeks of large rainfall events in warm weather</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Commercial contractors, individual companies</td>
<td>Herbicide</td>
<td>DMTIRE</td>
<td>Medium</td>
</tr>
<tr>
<td>Mamungari CP (Anne Beadell Hwy)</td>
<td>DEWNR AW and Co-management Board, MT Council</td>
<td></td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Involvement by Oak Valley Land Management</td>
<td>Herbicide</td>
<td>DEWNR AW</td>
<td>Medium</td>
</tr>
<tr>
<td>Yalata Indigenous Protected Area (IPA)</td>
<td>Aboriginal Lands Trust</td>
<td></td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Yalata Land Management</td>
<td>Herbicide</td>
<td>DEWNR AW</td>
<td>Low</td>
</tr>
<tr>
<td>Primary Transport Corridor</td>
<td>Eyre Highway</td>
<td>DPTI and DEWNR AW</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Require dedicated surveillance trip arranged between DPTI and DEWNR AW, controlled by commercial contractor</td>
<td>Fire/herbicide</td>
<td>DEWNR AW</td>
<td>High</td>
</tr>
<tr>
<td>Type</td>
<td>Area</td>
<td>Responsibility</td>
<td>Surveillance timing</td>
<td>Control timing</td>
<td>Delivery</td>
<td>Control method</td>
<td>Audit / compliance</td>
<td>Priority</td>
</tr>
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</tr>
<tr>
<td>Oak Valley-Tjuntjuntjara Aboriginal Business Road</td>
<td>MT Council</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Involvement by Oak Valley Land Management. Requires dedicated surveillance trip</td>
<td>Fire/herbicide</td>
<td>DEWNR AW</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Ooldea Road</td>
<td>DPTI</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Requires dedicated surveillance trip</td>
<td>Fire/herbicide</td>
<td>DEWNR AW</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Railway</td>
<td>Australian Rail Track Corporation (ARTC)</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>ARTC to assume responsibility for these works with support from DEWNR AW</td>
<td>Herbicide</td>
<td>DEWNR AW</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Cook</td>
<td>Pacific National</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Requires dedicated surveillance trip</td>
<td>Fire/herbicide</td>
<td>DEWNRAW</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Stuart Highway</td>
<td>DPTI</td>
<td>Within two weeks of significant rainfall and favourable temperature conditions for growth</td>
<td>Two to three times per year, opportunistically following rainfall and good growth conditions</td>
<td>Requires dedicated surveillance trip</td>
<td>Herbicide</td>
<td>DEWNR AW</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>

**Table 3a.** Surveillance and control regime for buffel grass *Cenchrus ciliaris* in the southern Alinytjara Wiluŋara NRM region. The matrix demonstrated in Table 3b was used to prioritise areas for surveillance and control.

<table>
<thead>
<tr>
<th>Priority</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density and distribution of buffel</td>
<td>Buffel confined to small defined areas</td>
<td>Moderate spread</td>
<td>Buffel widespread requiring large effort to reach</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Infestations easy to access (e.g. main roads and fence lines.)</td>
<td>Buffel moderately difficult to access</td>
<td>Buffel spread out to remote areas and difficult to reach by vehicle</td>
</tr>
<tr>
<td>Risk of spread</td>
<td>Buffel plants in high traffic or water flow areas and likely to spread easily</td>
<td>Buffel in moderately high spread areas</td>
<td>Buffel in stable and slow spread areas (e.g. Stony plains)</td>
</tr>
</tbody>
</table>

**Table 3b.** Decision criteria for prioritising control areas for buffel grass *Cenchrus ciliaris* in the Alinytjara Wiluŋara NRM region.
Areas of buffel infestation identified in Table 3 and particularly the APY Lands will likely need to be broken down into subregions to develop management consideration and priorities involving risk of infestation. For example, the large area making up the MT Lands may need to be separated into:

- Cook to Watson Track
- Cook to Vokes Hill Corner Road
- Maralinga Village to Emu Junction Road
- Cook to WA Track.

3.8.1 Case study – control of buffel grass at Oak Valley

The Oak Valley community lies in the southern part of the AW region and is a central point for vehicle traffic heading north to the Anne Beadell Highway and beyond, west to Tjuntjuntjara in WA, and south to Ooldea and Cook. Buffel grass infests the township and its surrounds posing a great risk of further spread into otherwise buffel-free areas within the AW region. The AW NRM Board recognised the need to deal with this source population as the infestation was still manageable and there was a great risk of seed spread through vehicle traffic and the transient nature of Oak Valley’s inhabitants.

The AW NRM Board began control works at Oak Valley in 2008 and the density and extent of buffel infestation was mapped with the aid of a GPS mobile device. An area of 41 hectares in and around the township was sprayed with Glyphosate 510 at a rate of one litre to 100 litres water foliar herbicide at a regime of one spray in winter and two in summer. The timing of spraying operations was dictated by the season and subsequent growth stage of buffel to ensure the most effective herbicide uptake and kill rate.

When control operations began, 800 litres of glyphosate mix was used in a day to treat the infestation. As a result of this successful program, glyphosate usage declined in 2012 to 300 litres of spot spraying to treat a much reduced and very manageable infestation.

In 2011-12 individual buffel clumps were burnt with the aid of a drip torch to remove bulk plant matter from buffel clumps to produce smaller, actively growing plants at a uniform growth stage, allowing the most efficient and effective use of foliar herbicide. The timing of burning and subsequent foliar application is seasonally dependant and requires appropriate surveillance. This includes an inspection two weeks after major rain by an AW authorised officer who uses vehicle-mounted spraying equipment as standard practice.

ChemCert training has been provided to 12 people from the Oak Valley community as well as experience in on-ground spraying operations with AW staff. Those trained, continue to assist in the control program.

The buffel grass infestation at Oak Valley is now under control and there is a greatly diminished threat of this location acting a source of seed spread into large areas of the region that are currently buffel free. Our success demonstrates that when resourced appropriately, buffel grass can be removed from key locations through diligent observation and use of burning and herbicides at optimal times.

The strategic direction for buffel grass control in Oak Valley rests with increasing the capacity of the community to manage buffel grass autonomously, with DEWNR AW providing a support, data management and auditing role.
3.9 Reporting

An end of financial year report quantifying surveillance and control efforts is required to allow the assessment of management efforts on a year to year basis. Variations in rainfall and the degree of mapping and control in different regions and seasons will inform subsequent resource allocation. This information will also be required to justify current funding and provide a basis for pursuing future funding opportunities.

Reporting will be broken down into the following three actions:

1. Site-based report on actions and population status
2. Six monthly report on surveillance and control efforts
3. Annual report on surveillance and control efforts and results

A standardised reporting template for recording data from buffel grass surveillance and control efforts is presented in Appendix 7.

3.10 Communication and Awareness

A key component to the success of this plan will be raising the profile and awareness of buffel grass in the AW region to stakeholders and the wider community. Key points raised during consultation for this plan included the need to:

- develop and promote best practice guidelines to prevent and control buffel grass spread
- liaise with industry and stakeholder bodies to promote greater awareness about buffel grass in the AW region, including signage
- pursue media opportunities to promote buffel grass awareness
- lobby local, state and federal bodies to improve funding for the control of buffel grass.

Detailed examples to achieve better education and awareness of buffel grass in the AW Lands are listed in Appendix 4.
## 4 Action Plan

Key actions to be implemented by AW staff and contractors are outlined in Table 4 below.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Action</th>
<th>Description</th>
<th>Sub-action</th>
<th>Description</th>
<th>Detailed action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Destroy buffel grass south of the APY Lands in the AW region by 2015</td>
<td>1.1</td>
<td>Regularly survey southern AW region for buffel grass</td>
<td>1.1.1</td>
<td>Identify key introduction pathways as a focus for surveillance</td>
<td>1.1.2</td>
<td>Authorised officer to ensure surveillance undertaken by stakeholders as identified in responsibility matrix (Table 3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.1.2</td>
<td>Survey all geographic zones south of APY Lands at least twice a year</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.1.3</td>
<td>Check priority areas and source populations every two months during growing periods</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.1.4</td>
<td>Develop rainfall reporting mechanism to source key on ground information</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1.1.5</td>
<td>Undertake surveillance of known buffel grass populations within two weeks of significant rain (&gt; 6mm) in warm weather (&gt; 22 degrees)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>Undertake buffel grass control</td>
<td>1.2.1</td>
<td>Control buffel grass as soon as possible to ensure optimal kill</td>
<td>1.2.1.1</td>
<td>Apply best practice control methods including optimal timing as outlined in operational strategy (Table 3)</td>
</tr>
<tr>
<td></td>
<td>1.3</td>
<td>Data collection and mapping</td>
<td>1.3.1</td>
<td>Standardise data collection and mapping procedures to conform with statewide standards</td>
<td>1.3.1.1</td>
<td>Quarterly update of data base for all work undertaken</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.3.1.2</td>
<td>Six-monthly report of surveillance and control efforts</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.4</td>
<td>Signposting of known infestations</td>
<td>1.4.1</td>
<td>Install markers at central point in known infestations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Action</td>
<td>Description</td>
<td>Sub-action</td>
<td>Description</td>
<td>Detailed action</td>
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<tr>
<td>1.5</td>
<td>Ensure longevity of control and surveillance</td>
<td>1.5.1</td>
<td>Budget and plan for all control and monitoring works</td>
<td>1.5.1.1</td>
<td>Apply for funds to carry out control and monitoring of buffel grass in AW region</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5.2</td>
<td>Lobby state government for declaration of buffel grass as declared pest species</td>
<td>1.5.2.1</td>
<td>Pursue re-submission of key threatening process nomination of buffel grass to the federal government</td>
<td></td>
</tr>
<tr>
<td>2. Detect, manage and monitor buffel grass in the APY Lands</td>
<td>2.1</td>
<td>Ensure adequate data collection and mapping of management actions</td>
<td>2.1.1</td>
<td>Survey and map buffel grass distribution near margins of known infestation (e.g. Tankanu, Walakara, Makiri, Warru Pintji)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>Determine priority regions and secure traditional owner, community and executive support</td>
<td>2.2.1</td>
<td>Hold community awareness and approvals meetings where necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.2.2</td>
<td>Identify containment lines where appropriate to prevent spread from established infestations into new areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3</td>
<td>Ensure marking of known infestations being managed</td>
<td>2.3.1</td>
<td>Install markers at central point of infestations designated for control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.4</td>
<td>Undertake buffel grass control in APY Lands</td>
<td>2.4.1</td>
<td>Determine optimal surveillance and control regime for each infestation (e.g. APYLM, IPA staff, contractors)</td>
<td>2.4.1.1</td>
<td>Apply best practice control methods including optimal timing as outlined in operational strategy (Table 3)</td>
</tr>
<tr>
<td>3. Raise awareness among the general public and key stakeholders, in particular Aboriginal communities</td>
<td>3.1</td>
<td>Increase awareness of the threat posed by buffel grass and management options</td>
<td>3.1.1</td>
<td>Initiate dialogue with resource industry peak bodies</td>
<td>3.1.1.1</td>
<td>Discuss with South Australian Chamber of Mines and Energy (SACOME)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.1.2</td>
<td>Inform the general public of the threat posed by buffel grass</td>
<td>3.1.2.1</td>
<td>Discuss with DMITRE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>3.1.2.2</td>
<td>Discuss with individual mining companies</td>
</tr>
<tr>
<td>Objective</td>
<td>Action</td>
<td>Description</td>
<td>Sub-action</td>
<td>Description</td>
<td>Detailed action</td>
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<td></td>
<td></td>
<td></td>
<td>3.1.2.3</td>
<td>Seek media opportunities</td>
<td>3.1.2.3</td>
<td>Seek media opportunities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.1.2.4</td>
<td>Provide information packs to regional general public outlets such as roadhouses, caravan parks and public toilets</td>
<td>3.1.2.4</td>
<td>Provide information packs to regional general public outlets such as roadhouses, caravan parks and public toilets</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.1.2.5</td>
<td>Promote awareness in Aboriginal communities e.g. posters, information sessions and DVD in local languages</td>
<td>3.1.2.5</td>
<td>Promote awareness in Aboriginal communities e.g. posters, information sessions and DVD in local languages</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.1.2.6</td>
<td>Promote awareness in schools</td>
<td>3.1.2.6</td>
<td>Promote awareness in schools</td>
</tr>
<tr>
<td>3.1.2.7</td>
<td></td>
<td></td>
<td>3.1.3.1</td>
<td>Write letters, arrange meetings and site visits, utilise media and social media</td>
<td>3.1.3.1</td>
<td>Write letters, arrange meetings and site visits, utilise media and social media</td>
</tr>
<tr>
<td>3.2</td>
<td>Develop culturally appropriate mechanisms for engagement of Aboriginal communities</td>
<td>3.2.1</td>
<td>Conduct and record ongoing consultations with Aboriginal community members about buffel grass</td>
<td>3.2.1</td>
<td>Develop a story book around Aboriginal perspectives of buffel grass</td>
<td></td>
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<tr>
<td>3.2.3</td>
<td></td>
<td></td>
<td>3.2.1.1</td>
<td>Develop a story book around Aboriginal perspectives of buffel grass</td>
<td>3.2.1.1</td>
<td>Develop a story book around Aboriginal perspectives of buffel grass</td>
</tr>
<tr>
<td>3.2.4</td>
<td></td>
<td></td>
<td>3.2.2</td>
<td>Form AW buffel grass working group involving community representatives</td>
<td>3.2.2</td>
<td>Form AW buffel grass working group involving community representatives</td>
</tr>
<tr>
<td>3.3</td>
<td>Promote vehicle hygiene to minimise the spread of buffel grass</td>
<td>3.3.1</td>
<td>Develop and promote weed seed hygiene standards for all staff and visiting contractors to AW region</td>
<td>3.3.1</td>
<td>Publish and distribute best practice steps promoting vehicle hygiene for visiting contractors (particularly earthmoving equipment, swags and camping gear.)</td>
<td></td>
</tr>
<tr>
<td>3.3.2</td>
<td></td>
<td></td>
<td>3.3.1.2</td>
<td>Identify no-go areas for vehicle access that are high-risk source infestations</td>
<td>3.3.1.2</td>
<td>Identify no-go areas for vehicle access that are high-risk source infestations</td>
</tr>
<tr>
<td>3.3.3</td>
<td></td>
<td></td>
<td>3.3.2</td>
<td>Attend scheduled meetings</td>
<td>3.3.2</td>
<td>Attend scheduled meetings</td>
</tr>
<tr>
<td>3.4</td>
<td>Ensure AW region is represented in the State Buffel Grass Taskforce</td>
<td>3.4.1</td>
<td>Identify and recruit appropriate representatives</td>
<td>3.4.1</td>
<td>Identify and recruit appropriate representatives</td>
<td></td>
</tr>
<tr>
<td>3.4.2</td>
<td></td>
<td></td>
<td>3.4.2</td>
<td>Attend scheduled meetings</td>
<td>3.4.2</td>
<td>Attend scheduled meetings</td>
</tr>
<tr>
<td>Objective</td>
<td>Action</td>
<td>Description</td>
<td>Sub-action</td>
<td>Detailed action</td>
<td>Description</td>
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<td></td>
</tr>
<tr>
<td>4. Promote research and development to increase effectiveness of buffel grass management.</td>
<td>4.1</td>
<td>Pursue optimal treatment strategies</td>
<td>4.1.1</td>
<td>4.1.1.1</td>
<td>Install trials along Stuart and Eyre highways to trial application of residual herbicides</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.1.2</td>
<td>4.1.1.2</td>
<td>Develop trial sites to investigate use of herbicides following burning</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.1.3</td>
<td>4.1.2.1</td>
<td>In collaboration with partners, (e.g. universities) develop trials to measure seed longevity, regional buffel grass taxonomy, germination triggers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.1.4</td>
<td></td>
<td>Collect data on habitat and invasion history for established infestations, for improved predictive habitat modelling</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Advocacy for research into biological controls</td>
<td>4.2.1</td>
<td>Collaborate and communicate with scientific institutes</td>
<td>4.2.1.1</td>
<td>Seek lobbying opportunities with state/federal governments</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.** Alinytjara Wiluṟara Buffel Grass Operational Strategy showing key actions to be implemented by staff and stakeholders
5 Research and Development

The mission, visions and objectives of this Buffel Grass Operational Strategy and the State Strategic Plan will not be met using existing control techniques. A range of identified research and development programs are integral to the delivery of these strategies.

Research and Development typically requires three integral components:

1. **Instigation**: projects are only instigated after particular stakeholders identify, advocate and act as ‘champions’ for the research, even if they are not responsible for delivery. In nearly every case the AW stakeholders should/could play this role for R&D prioritised in this strategy.

2. **Implementation**: R&D projects require coordination, funding, resources and researchers. Depending on the complexity and regional specificity of the research, such initiatives may be better addressed by regional (AW), State (State Buffel Grass Taskforce) or national (CSIRO, universities) stakeholders.

3. **Study sites**: Most research requires access to suitable field study sites, which is typically best coordinated by regional groups.

Table 5 highlights a range of research initiatives that are necessary to assist with the success of this buffel grass strategy. AW is a collective term for the stakeholders involved in preparing (and owning) this buffel grass operational strategy. Advocacy, access to resources (including funds), on-ground actions and access to field sites can be provided by organisations, companies or individuals as well as government agencies. Also, since AW representatives will be members of the State Buffel Grass Taskforce (BTF), the potential exists for AW to take on some of the roles assigned to BTF where the resources and motivation exists.

Background information to each research question is detailed in Appendix 5.

<table>
<thead>
<tr>
<th>Research question</th>
<th>Instigation</th>
<th>Implementation</th>
<th>Field studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxonomy</td>
<td>AW</td>
<td>BTF</td>
<td>AW, BTF</td>
</tr>
<tr>
<td>Seed persistence</td>
<td>AW</td>
<td>AW, BTF</td>
<td>AW</td>
</tr>
<tr>
<td>Natural germination triggers</td>
<td>AW</td>
<td>AW</td>
<td>AW</td>
</tr>
<tr>
<td>Irrigation trials</td>
<td>AW</td>
<td>AW, BTF</td>
<td>AW, BTF</td>
</tr>
<tr>
<td>Soil chemistry</td>
<td>AW</td>
<td>AW, BTF</td>
<td>AW, BTF</td>
</tr>
<tr>
<td>Optimal treatment trials</td>
<td>AW</td>
<td>AW</td>
<td>AW</td>
</tr>
<tr>
<td>Alternative dust suppression</td>
<td>AW</td>
<td>AW</td>
<td>AW</td>
</tr>
<tr>
<td>Pastoral productivity</td>
<td>BTF, AW</td>
<td>BTF, pastoral industry</td>
<td>BTF, AW</td>
</tr>
<tr>
<td>Vehicle hygiene standards</td>
<td>BTF, AW</td>
<td>BTF, vehicle industry</td>
<td>BTF</td>
</tr>
<tr>
<td>Biological control</td>
<td>AW, BTF</td>
<td>BTF, CSIRO?</td>
<td>AW, BTF</td>
</tr>
</tbody>
</table>

Table 5. Buffel grass research and development priorities for Alinytjara Wiluŋara Region
### 6 Appendices

#### 6.1 Appendix 1 - Buffel grass biology

#### 6.1.1 Description
Buffel grass is an erect, deep-rooted, tussock forming, C4, summer-growing perennial grass. Seed heads are dense, white to purple in colour, growing in a spike-like raceme up to 15 cm long and are covered in clusters of bristles giving them a fluffy appearance. The flowering heads appear from November to May, or sporadically following rain (Smith 2002), and bristly burrs are borne on a zigzag central axis. Buffel grass has several qualities that enables it to survive and persist in harsh arid conditions. In addition to prolific seed production and opportunistic germination, buffel grass accumulates carbohydrates at the base of its stems for slow release when needed, and has a deep root system that enables it to access water supplies faster and for longer than most native herbs and forbs. Individual tussocks have a long lifespan and can readily re-sprout following fire.

#### 6.1.2 Reproduction
Buffel grass plants are bisexual and commonly reproduce by seed (produced with or without fertilisation) or vegetatively through rhizome or stolon production (Franks 2002). After ripening and shedding from the plant, seeds remain viable for 12 months or longer. Field experiments conducted near Alice Springs (Winkworth 1971) found that a small portion of the seeds can remain viable for up to four years in the soil, however only 10% were viable after two years. Generally at least 25 mm of rainfall is required for seed germination (Cavaye 1988), although new germinants can grow and set seed in as little as three to six weeks with sufficient moisture (T. Gurney pers. comm.) and re-shooting mature plants can flower within 10 days after a rainfall event (Puckey and Albrecht 2004; Barrett and Dixon undated).

Wildfires may encourage germination as the ashes are reported to make good seedbeds (Paull and Lee 1978). Franks (2002) suggests that buffel grass seeds are triggered to germinate by even minor forms of soil disturbance, including breaking of the soil surface by stock movement.

#### 6.1.3 Preferred habitat
Buffel grass is predominant in areas where summer rainfall varies from 150-550 mm, winter rainfall is less than 400 mm, mean minimum winter temperatures rarely fall below 5°C, and soil texture is loamy (Cox et al. 1988). It favours creeks, alluvial plains, calcareous areas and rocky ranges (Albrecht and Pitts 1997), however, it has been successful in a broad range of soil types and landscapes. Buffel grass also readily establishes in road and track verges, parking bays, towns and other disturbed areas. The introduction and spread of new cultivars, in conjunction with hybridisation and evolution of the buffel grass complex, are thought to be increasing the range of climates and landforms that are at threat from invasive buffel grass.

Climatic suitability for the establishment of buffel grass in the AW region shows 51% is very highly suitable and a further 38% is highly suitable (South Australian Buffel Grass Strategic Plan 2012).
6.1.4 Dispersal and persistence

Buffel grass spreads through dispersal of its fluffy burrs by water, wind, accidental transportation (e.g. in or on vehicles, animals, soils, etc.), inadvertent transport (e.g. in hay), or intentionally introduced by landholders seeking to establish an ‘improved’ pasture (Puckey and Albrecht 2004). Seeds rarely survive ingestion and it is unlikely that herbivores are responsible for significant spread of buffel grass in this manner (Gardner et al. as cited in Griffin 1993).

Seeds are commonly introduced into new areas along roads and tracks. Spread along roads and railways is assisted by vehicle draughts and movement of soil by graders and other machinery. From the road or track verge buffel grass then spreads into the surrounding vegetation by wind or water, with drainage lines acting as conduits for more distant dispersal (Puckey and Albrecht 2004).

Buffel grass may be slow to establish initially, but under favourable seasonal conditions it may spread readily and aggressively into undisturbed areas. Established buffel grass tussocks can remain dormant for long periods and plants can live for at least 20 years (Latz 1997). Leaves die off during dry or cold periods and new growth quickly emerges from the tussock with warm, moist conditions.
6.2 Appendix 2 - Illustration of buffel grass infestations in different habitats

**Plate 1.** A heavily buffel grass infested *Eucalyptus camaldulensis* creek bed on Kenmore Park, APY Lands, showing a tree that has been killed by intense buffel-fuelled fires. J. Read

**Plate 2.** An alluvial sandplain and rocky hill near Ernabella in the APY Lands that have been over-run by buffel grass. Fire sensitive and ecologically important perennial plants, including native figs, pines and spear-bushes are threatened by buffel grass fuelled fires in formerly fire-resistant rocky habitats. J. Read
6.3 Appendix 3 - Control techniques

6.3.1 Herbicides

Buffel grass must be actively growing for effective uptake of herbicides. In arid or semi-arid regions of South Australia the period of active growth is unpredictable and may be short-lived, so timing is very important for control. Foliar application of select herbicides to young plants or regrowth following rain provides the best opportunity for success. AW staff have trialled winter spraying (during warmer spells when there is green matter present) to complement the summer spraying program.

Roundup Biactive has been used on buffel grass with good results by AW staff, and a mix of Roundup and the residual Tussock (flupropanate) is being used by the DPTI weeds contractor along major roads. Glyphosate will always appear to have killed large established plants but it is very common for these plants to reshoot from the base, meaning they haven't been killed (D.Setchellpers.comm.). Studies in the USA have shown that mature plants developing an inflorescence can still produce viable seed following glyphosate application (D.Backer 2009).

Operators need to be mindful of water quality when mixing herbicides, especially glyphosate. The active ingredient can be diminished by suspended particles (silt/clay), inappropriate pH level and hardness (percentage of mineral salts content). Ideally, clean soft water with a pH of 3.5-4.0 should be used, however there are products commercially designed to alter pH and mineral levels so that mixing water of marginal quality may still be effective. Try lathering soap with the water as a rough rule of thumb test. If a 20c coin can be seen in the bottom of a nine-litre bucket after lathering, then the hardness of the water should be satisfactory.

Consideration needs to be given to resistance build-up to certain Group herbicides, e.g. Roundup Biactive (Group A), with different Group herbicides used to minimise the risk. The Group category relates to how the chemical works, including their different chemical make-up and mode of action. Herbicides registered and permitted for use on buffel grass include the Groups A, L, M and J. It is recommended that Roundup Biactive be used initially for buffel grass control with monitoring and the adaptive management framework used to maintain awareness of potential resistance build-up. An alternative Group herbicide should already be nominated to provide a seamless control effort when switching is required. New products are being continually developed and these should be assessed on an ongoing basis.

The main risk factors leading to glyphosate resistance have stemmed from:

- intensive use of glyphosate, e.g. every year or multiple times per year for 15 years or more
- heavy reliance on glyphosate
- no other weed controls.

Glyphosate resistance is present in annual ryegrass (Lolium rigidum) and in South Australia was documented in great brome (Bromus diandrus) in 2011 (Preston 2012). Populations of annual rye grass are also resistant to Paraquat (Group L) and have developed cross-resistance to a number of different herbicide groups.

To reduce the risk of herbicide resistance it is vitally important that herbicide control is conducted in a professional manner, following best practice to ensure complete coverage.
Near enough is definitely not good enough. Whichever method or technique is chosen for a particular site, the sole aim is to ensure no seed is produced.

Friedel et al (2009) provide an example of the very high cost of chemical control of buffel grass in arid regions following a project conducted at Alice Springs Desert Park in the Northern Territory between 1997 and 2007. The cost of labour and materials for herbicide spraying varied from almost $10,000 per hectare in 2000 in the initial stages of the project to $50 per hectare in 2006 for regular follow-up spraying after rain events once the buffel grass was largely under control. Over the 10-year period (1997-2007) the average cost was $5500 per hectare.

The high cost of herbicides and associated labour is a hindrance to control. All control programs require several years of follow-up treatment and monitoring, which further increases the cost. Therefore, flexibility in work plans must be maintained to allow the short notice allocation of staff and other resources to respond to rainfall events. Surveillance is critical in providing as much notice as possible to better organise work crews and minimise disruption to other duties.

6.3.2 Residual herbicides

Treatment intensity must ensure the death of buffel grass unless it is growing within or underneath threatened plant species or iconic specimens of long-lived perennials, or in important water catchments. Although control techniques will be tailored to minimise off-target risks, buffel grass control should err on the side of killing adjacent native vegetation. **Bare ground, even if it remains un-colonised for several years until the effects of residual herbicide diminish, is far less ecologically damaging than persistent buffel grass that will likely spread and eventually replace native vegetation on a far larger scale.**

The use of residual herbicides can be an important tool in ongoing buffel grass control, especially for small but high risk infestations where the opportunity to revisit infestations at the optimal time for control is unlikely. Off-target risks are minimised with appropriate training and site selection. Degree of control and duration will depend on soil texture, organic matter content, soil pH and rainfall. With granular herbicides, the equipment is very portable and can be carried in vehicles by land managers, environmental contractors and DEWNR staff while driving through the region on other business. This can allow an immediate control response to new sightings and not be necessarily dependant on a second trip to apply a foliar herbicide at the appropriate growth stage.

**Most soil active residual compounds are designed for bare ground results so the presence of higher amounts of ground cover will reduce their effectiveness.** Hence consideration should be given to reducing plant biomass by burning, cutting, pulling or grazing before application of residual herbicides.

Applying residuals to bare ground (post fire) on a blackened but not dead buffel grass stub will usually kill any reshoots, but the larger the original plant the chances are smaller of a 100% kill of reshoots (D.Setchellpers.comm.).

In situations such as railway ballast or other infrastructure where there is a requirement for no vegetation at all, the use of residuals provides ongoing control at little or no risk to other vegetation.
There is an urgent need to register residual herbicides for use on buffel grass in South Australia. Currently the Eyre Peninsula (EP) NRM Board holds a Minor Use permit for using Graslan on boxthorn but Graslan is not registered for use on buffel grass. Other residuals may be more appropriate and these should be investigated. Velmac is a granular residual that is rainfall activated. Velpar is in liquid form which can start working soon after application if there is sufficient soil moisture. Other more ‘forgiving’ products to be considered are Oust, Trimac and Arsenal Xpress. Trimac has been trialled on the railway line south of Loxton and has also been authorised by SA Water for use on its land (D.Setchellpers.com).

Arsenal Xpress contains glyphosate for initial knockdown and imazapyr as the residual. It is the most expensive of the three but also the kindest to off-target vegetation. Oust and Trimac provide some knockdown action with all three providing pre and post emergence control. Oust and Trimac will last longer and provide a greater degree of control in alkaline soils with low organic matter. All three herbicides require mixing with water for application and require soil moisture activation (rainfall) for best results. If these products are trialled, concentrations should start out low (less than the manufacturers recommended rate, e.g. 50% for Oust) and then build up to the desired level of effect.

The choice of which residual herbicide to use will come down to weighing up the best application technique. Factors in this assessment should include availability of clean water, soil type, risk to non-target species, intention to reseed or replant, and the great risk of spillage during transport of liquid herbicides compared to granular herbicides (Table A1).

<table>
<thead>
<tr>
<th>Transport considerations</th>
<th>Equipped to deal with liquid herbicide transport, clean-up/spillage</th>
<th>No</th>
<th>Use granular</th>
<th>Yes</th>
<th>Choice of liquid or granular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Clean mixing water available</td>
<td>No</td>
<td>Use granular</td>
<td>Yes</td>
<td>Choice of liquid or granular</td>
</tr>
<tr>
<td>Herbicide action</td>
<td>Significant knockdown required</td>
<td>Yes</td>
<td>Use Arsenal Xpress (contains glyphosate) or flupropionate/glyphosate mix</td>
<td>No</td>
<td>Choice of liquid or granular</td>
</tr>
</tbody>
</table>

**Table A1.** Decision matrix for determining optimal residual herbicide

**6.3.3 Mechanical**

Simple physical removal of buffel grass may be considered for new, small infestations. This method causes soil disturbance which can promote germination from the soil seed bank, meaning future monitoring and potential control efforts will be required. Care must be taken with seeding plants to prevent seed dispersal. Options include burning the plant material on site or bagging for removal. The latter has to be weighed up against the risk of seed escape into un-infested areas and the potential mixing of different hybrids/cultivars. The application of residual chemicals can be a good option to kill any subsequent germination at these sites and is indeed an alternative to mechanical grubbing.
**6.3.4 Fire**

Fire or slashing followed by application of herbicides may be integrated to improve foliar uptake and to manage larger infestations. Fire as a stand-alone control technique is generally ineffective but will result in the removal of bulk material and many seeds, providing a uniform growth stage that can be sprayed more effectively. Slashing requires strict machinery hygiene to prevent seed dispersal into other areas.

For best results a cool fire will generally require a knockdown foliar spray follow-up (e.g. glyphosate) while a hot fire requires residual herbicides onto bare soil. Deep burning with piled spinifex on isolated infestations could be recommended as a stand alone control technique. The temperatures generated kill the established plants and any seed in the soil, but is very labour intensive. The gas flamethrowers and residual herbicide approach for isolated infestations is considered the "next best" technique because it is a lot less labour intensive (D.Setchell pers.com.) Care should be taken to only use fire or flamethrowers during cool, still weather conditions that prevent fire from spreading.

**6.3.5 Biological control**

Biological control is the most cost effective management method for dense areas of many weeds. However, as buffel grass is recognised as a valuable forage species in some parts of Australia, the application or even investigation of biological control agents requires careful management, awareness and advocacy. There are currently no accepted or proven biological control agents for buffel grass, nor any attention or resources allocated to pursue such options. As such investigation of bio-control agents is key priority of the research and development section of this plan (section 5).
6.4 Appendix 4 - Communication and awareness

1. Seek assistance of the Department of Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) in promoting awareness within the mining industry.
2. A media campaign, including news releases to radio, local and national newspapers and internet.
3. Buffel grass information packs and displays at regional roadhouses, pubs, caravan parks etc. Options include DVDs, fact sheets and posters.
4. Awareness raising in Aboriginal communities, including the use of posters, information sessions and videos in local languages.
5. Education program in schools involving presentations to students.
6. Presentations at town council meetings and through the Outback Areas Authority.
7. Contact with community organisations, non-government organisations (e.g. Conservation Council and Arid Recovery), volunteer and ‘friends’ groups, and 4WD clubs, including use of social media such as Facebook.
8. Additional road signage highlighting buffel grass control areas, similar to signs currently used by the Eyre Peninsula (EP) NRM Board (Plate 7).
9. Clear, concise and accessible information for the pastoral industry on the long-term cost/benefits of buffel grass as a pasture species when compared with native pastures.

Plate 3. Effective road signage on Eyre Highway used by the EP NRM Board. K Tschirner
6.5 Appendix 5 - Research and development

6.5.1 Biological control

No currently recognised control techniques can deliver significant benefits to the widespread areas in the APY Lands that have already been devastated by buffel grass, nor adjacent areas that will inevitably be colonised and transformed.

Although there are no approved bio-control agents in Australia for buffel grass, it is affected by several diseases and an insect pest. The most important diseases are buffel blight, caused by fungal pathogen *Pyricularia grisea*, and ergot (*Claviceps* spp.) affecting seed production (Perrott 2000). A condition known as buffel grass dieback in areas of central Queensland has been described but the causal agent(s) are unknown (Makiela et al. 2008). The buffel grass seed caterpillar (*Mampayarhodoneura*) is the only major insect pest. *Mampaya*, has which has been recorded in warmer, higher rainfall areas of Queensland, presents an option for near pastoral regions since infested pastures retain their nutrients but exhibit limited seed production. These features suggest that the perceived productivity benefits of perennial buffel grass pastures can be retained, whilst its invasiveness is reduced.

Identification or confirmation of specific biological control agents, ideally with relatively low dispersal abilities so that pastoral values in parts of Queensland and the Northern Territory were not unduly threatened, would be the single greatest advancement in the management of buffel grass. Isolated buffel grass infestations in the APY Lands such as those at Watarru, Kalka or Walalkara could be valuable field trial sites once potential agents with low risk to native grasses had been identified by laboratory trials.

Potential biological control agents could include factors that have reduced the vitality of propagated buffel grass in Queensland, and agents that have coevolved with buffel grass in its natural range. Collaboration with researchers from the United States, where buffel grass is also considered a serious threat to property, tourism and the environment, could also prove profitable.

Instigation of research into biological control of different varieties of buffel grass will require strong state and national advocacy by all stakeholders in South Australia, especially indigenous communities in the AW Lands who are most seriously affected by the expansion of buffel grass.

6.5.2 Optimal treatment strategies

Trials and demonstrations of different buffel grass control techniques for various circumstances and areas in the AW Lands should provide greater precision and confidence in optimal control techniques. Densely infested areas adjacent to several communities could be used for replicated trials of different treatment regimes, including:

- direct spraying with several active or residual herbicides at different concentrations
- application of herbicides following burning or slashing
- modification of soil chemistry and encouragement of competing plant species.
Buffel grass is known to struggle to germinate or persist in soils with a pH below 7 or with high manganese or aluminium concentrations. Hence there may be available methods to reduce the viability of buffel grass without using herbicides that restrict growth of desirable plants.

These sites could also potentially be used for the trials of biological agents with limited dispersal capabilities. Trials of different herbicides (including residuals) could be undertaken in accessible infestations along the Stuart or Eyre Highways to provide additional best practice guidelines for choice of chemicals for a given situation.

Research into management techniques being used interstate and overseas should be an ongoing process.

6.5.3 Regional buffel grass taxonomy

The different varieties of buffel grass introduced to, or evolving in, Australia have demonstrated considerable variation in their response to rainfall, disease and soil chemistry. Optimal and potential techniques to suppress or eliminate buffel grass will therefore likely depend on the particular genotypic or phenotypic composition of individual stands. However, the distribution and relative invasiveness of different buffel grass varieties within the AW region is not known and is a key knowledge gap for effective management, particularly in Zone 1 where rapid elimination by generic herbicides is not feasible. Identification and mapping of buffel grass varieties is therefore integral to broadscale management, with priority given to densely infested and aggressively spreading areas within the AW region and core source populations in the SAAL and Northern and Yorke NRM regions.

6.5.4 Seed persistence

Optimal buffel grass surveillance and control require confidence in seed persistence characteristics of different varieties under field conditions. Seed viability should be monitored by revisiting sites of confined treated infestations following summer rainfall for up to five years. This approach provides information on seed viability under field conditions using the same resources integral to monitoring.

Germination success of collected seeds through time could also be compared. The viability and longevity of seed from very young plants is also required so that the urgency of control of rare small germinants from sub-optimal rainfall events can be determined. Due to the risk of trials being contaminated by external seed sources, germination trials are likely best conducted in buffel grass free areas. However, due to the risk of inadvertently spreading buffel grass, these trials need to be closely monitored and managed. Ideally a site that experiences similar climatic conditions as priority infestations will be used rather than artificial laboratory-based study sites. A potential study site may be the controlled area of Iluka’s Jacinth Ambrosia mine, which is monitored regularly.

6.5.5 Germination triggers

Determining the minimum rainfall and temperature for germination will inform optimal surveillance and monitoring strategies. Readily monitored infestations adjacent to weather stations, ideally at Umuwa, Ernabella, Marla and Coober Pedy, could be monitored routinely for buffel grass germination, with natural germination events subsequently related to weather data.
Artificial germination trigger trials could include encouraging germination of accessible infestations by irrigating with water from hoses, water carts or even CFS trucks. Readily accessible buffel grass infestations targeted for removal (such as Eyre Highway, Southern Stuart Highway, Port Augusta and Roxby Downs) could be irrigated with several application rates of water during a dry warm spell to determine whether irrigation can be used as a tool for germinating buffel grass seed. Care must be taken to ensure that resources are available for treating potential germinations before they set seed. If successful, this technique may enable the seed sources of accessible infestations to be depleted in dry times, when non-irrigated buffel grass control options are limited, and in turn minimise efforts required during widespread rain-initiated germination.

6.5.6 Alternative dust suppression

Trials of persistence and effectiveness of alternative dust suppression techniques, e.g. organic sprays, hydromulch, conventional mulch, clean gravel or course sand and revegetation with native species will be required to complement buffel grass control in highly trafficked areas where dust can cause health issues.

6.5.7 Relative productivity of buffel grass versus natural grasslands

Research in Queensland has indicated that buffel grass pasture productivity may attenuate significantly as soil nutrients are exhausted or biological agents become established. If the long-term productivity of buffel grass pastures is shown to be less than, or not significantly greater than natural grasslands, the enthusiasm of some members of the national pastoral community for continued plantings and opposition to broadscale control techniques will likely wane. The productivity of beef cattle as determined by weight, condition and/or calving success could be compared in carefully replicated studies involving paddocks that are heavily and lightly infested with buffel grass.

6.5.8 Vehicle hygiene standards

In collaboration with major 4WD accessories manufacturers and 4WD dealers/designers, research could be conducted into vehicle and chassis parts most likely to collect seeds. Ways could then be developed to reduce this threat and significantly reduce the spread of buffel grass from heavily infested localities.
6.6 Appendix 6 – Reporting format for surveillance and control

<table>
<thead>
<tr>
<th>Date of Observations</th>
<th>Area</th>
<th>Marker or Reference #</th>
<th>GPS coordinates</th>
<th>Plant Density</th>
<th>Nature of infestation</th>
<th>Date of control</th>
<th>Type of Control</th>
<th>Growth stage of plants</th>
<th>Estimated No. of plants controlled</th>
<th>Conditions at time of treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. 1/1/2013</td>
<td>Oak Valley</td>
<td>OV1</td>
<td>Easting, Northing</td>
<td>C</td>
<td>around township fringes</td>
<td>2/1/2013</td>
<td>Foliar spray (Glyphosate)</td>
<td>flowering</td>
<td>&gt;100</td>
<td>Calm, sunny</td>
</tr>
<tr>
<td>2/1/2013</td>
<td></td>
<td></td>
<td>Easting, Northing</td>
<td>C</td>
<td>e.g. roadside, following creek, surrounding buildings</td>
<td></td>
<td>Foliar spray (Glyphosate)</td>
<td>flowering</td>
<td>0 to 10</td>
<td>(e.g. hot, windy, cool, overcast)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Easting, Northing</td>
<td>C</td>
<td>e.g. roadside, following creek, surrounding buildings</td>
<td></td>
<td>Foliar spray (Glyphosate)</td>
<td>flowering</td>
<td>0 to 10</td>
<td>(e.g. hot, windy, cool, overcast)</td>
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<td>Easting, Northing</td>
<td>C</td>
<td>e.g. roadside, following creek, surrounding buildings</td>
<td></td>
<td>Foliar spray (Glyphosate)</td>
<td>flowering</td>
<td>0 to 10</td>
<td>(e.g. hot, windy, cool, overcast)</td>
</tr>
</tbody>
</table>

**Notes:**
- **Plant Density:** S - Sparsely spread, C - Growing closely, D - Plants dense
- **Nature of infestation:** e.g. roadside, following creek, surrounding buildings
- **Conditions at time of treatment:** e.g. hot, windy, cool, overcast
7 References


