Yoganup Ecological Link

27 July 2016

Focus on Sustainable Development

- Integration of economic, environmental and social consideration into best practice
- Single point accountability on sustainability across the business
  - Manager Sustainability
- Single point accountability on rehabilitation and closure across the business
  - Manager Rehabilitation and Closure

Monitoring Nov 2014

Focus on Sustainable Development

- Iluka's goal: To rehabilitate more land than we disturb over a five year period
  - achieved in each of the past three years
  - 2,592 hectares rehabilitated since 2011
  - 95% to the previous land use of pasture and cropping; 5% to native vegetation
  - 759 hectares scheduled for rehabilitation in 2016; 205 hectares at Yoganup
  - willingness to address complex environmental and social challenges

	Total disturbed	Total rehabilitated June 2016
Australia	14,047 ha	8,903 ha
United States	4,119 ha	3,349 ha
TOTAL	18,166 ha	12,252 ha

Partnerships

- Iluka collaborates with range of research institutions
- Research aims to
  - address knowledge gaps
  - promote industry best practice
  - protect and enhance biodiversity
  - improve land rehabilitation practices
- Existing Partnerships
  - The University of Western Australia
  - University of Adelaide
  - Virginia Tech (USA)
  - Botanic Gardens & Parks Authority, WA

ILUKA CHAIR
in Vegetation Science and Biogeography

ILUKA

Iluka Resources formed a partnership with The University of Western Australia (UWA) in March 2013 to research the restoration of areas of kwongan heathland near Eneabba in the Mid West of Western Australia.

The partnership's primary focus is the sponsorship of the Chair in Vegetation Science and Biogeography at UWA's School of Plant Biology, The University Western Australia. The sponsorship has been committed for a five-year term and is valued at $1.3 million.

Since commencing, the Iluka Chair has developed a research program to examine two major research themes: vegetation classification and mapping, and the ecology of plant functional traits, both in kwongan vegetation. The first theme is to ensure rigorous description of vegetation is done with the most advanced scientifically-validated methods available. The second theme is to expand the knowledge of how that vegetation functions and is assembled (its reproduction and establishment, water and nutrient acquisition, resilience to disturbance such as fire – i.e. its fundamental ecology) to help with functional restoration after mining and refine targets to achieve restoration.

Research outputs contributed to by the Chair since 2013 include:

- currently enrolled students – four PhDs, one MSc;
- completed students – one PhD, one MSc and four Honours; and
- numerous publications – including four books, 47 peer reviewed journal articles and book chapters with a further 11 articles in submission.

The Chair organised a major international conference, the annual meeting of the International Association of Vegetation Science (IAVS), in Perth in September 2014. Approximately 200 scientists attended, including many from overseas. This was an opportunity to showcase the vegetation of Western Australia and the research collaboration taking place between Iluka and UWA. Iluka's Principal Rehabilitation Scientist also presented a paper at the conference.

Australian Research Council Linkage Project

The Chair was awarded $354,000 (over three years) from the Commonwealth Government to continue research on rehabilitation of the kwongan vegetation in the Eneabba region in July 2015.

The Australian Research Council Linkage Project "Functional Trait Approach to Restoration of Species Rich Shrublands" is an international collaboration between Iluka, The University of Western Australia, Tronox, Hungarian Academy of Sciences, University of Waikato and Université de Montréal.

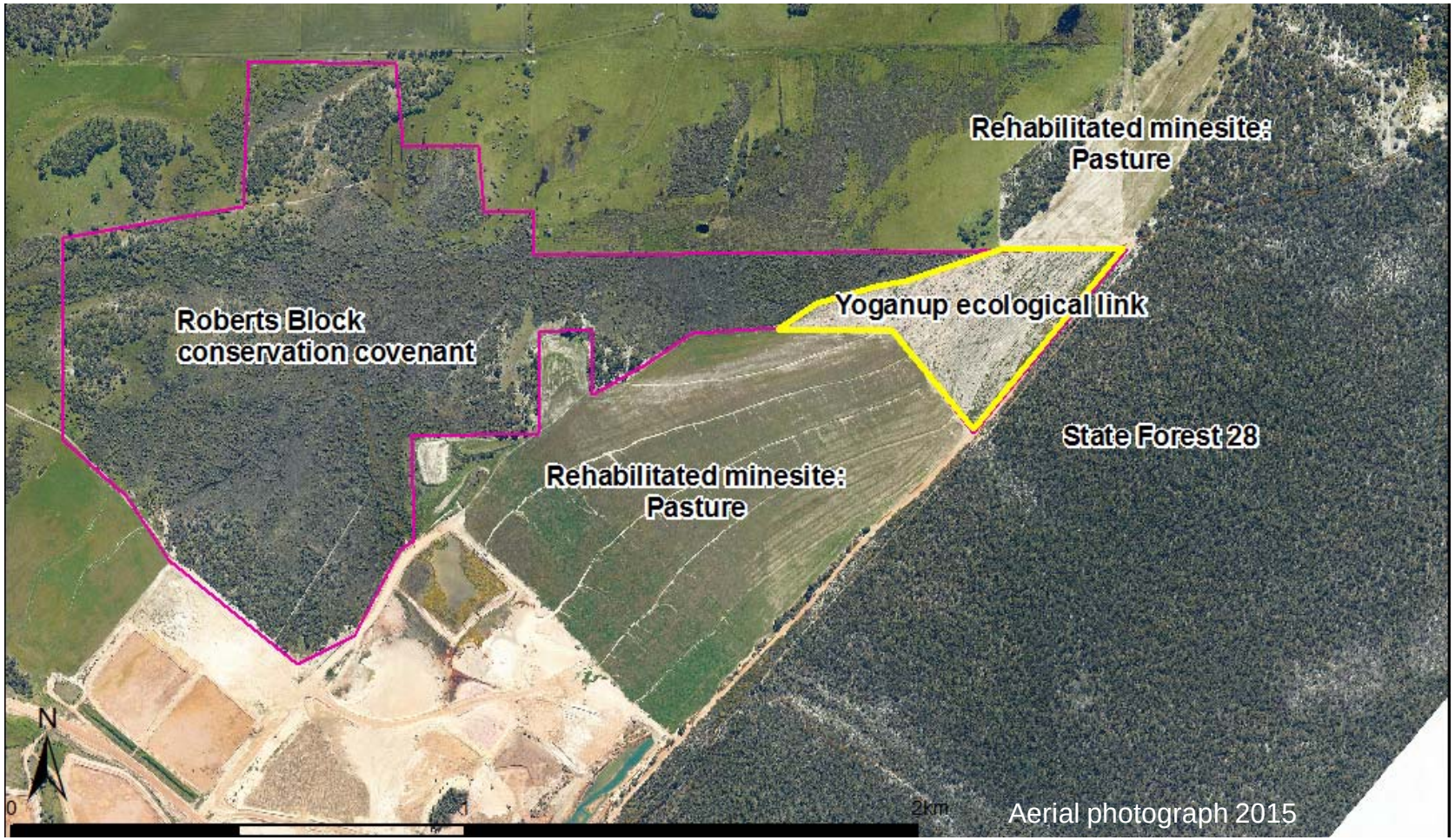
THE UNIVERSITY OF WESTERN AUSTRALIA

External Recognition

- External recognition of Iluka's sustainability focus
  - Western Australian Golden Gecko Award (1999)
  - Victorian Government via Strzelecki Award
    - Excellence in community engagement (2005)
    - Excellence in sustainable development (2009)
  - South Australian Premiers Awards
    - Social Inclusion (2013)
    - Environmental Excellence (2014)
    - Supporting Communities (2015)

Yoganup Ecological Link

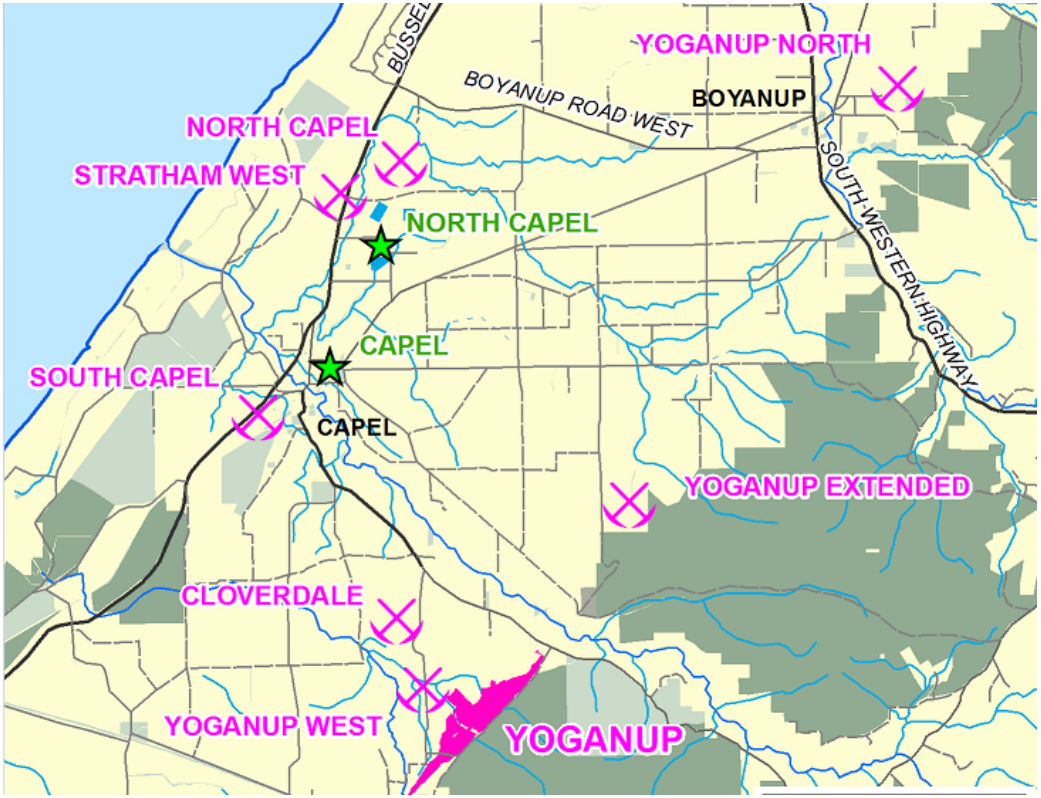
To create an ecological link between two significant areas of remnant vegetation using innovative rehabilitation techniques



Aerial photograph 2015

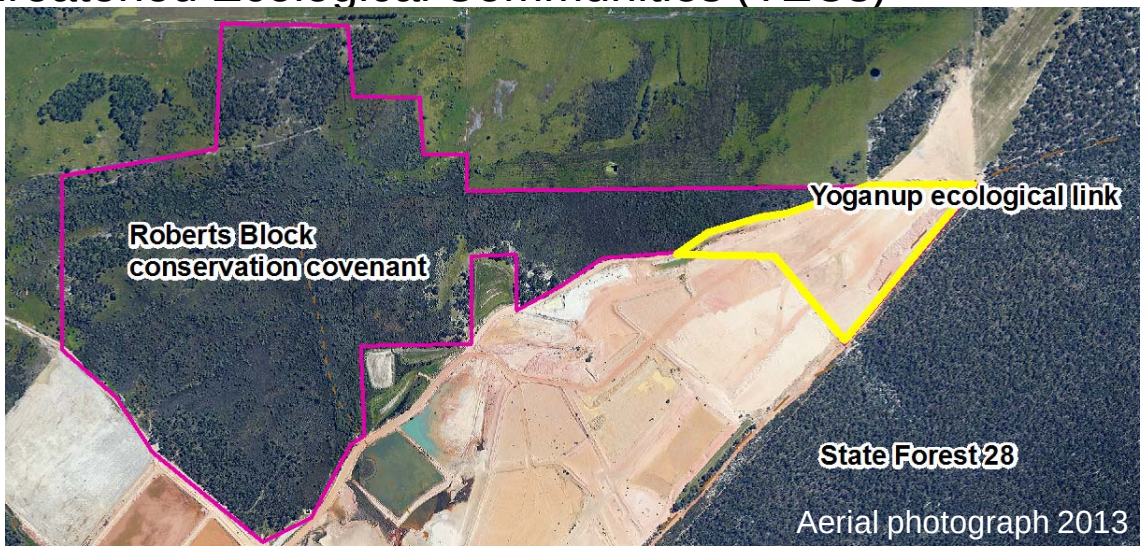
Project Location

- Yoganup site is located 10 km SE of Capel on the Whicher Scarp
- Before mining the area was agricultural with small pockets of remnant vegetation
- Mining occurred 1956–1975 and 1999–2008



Project History

- Original approvals for Yoganup: return site to pre-mining conditions, i.e. pasture
- In 2008, offsets for Tutunup South project agreed with WA and federal government
  - at Yoganup, place Roberts Block under Nature Conservation Covenant
  - link Roberts Block and State Forest 28 with native vegetation, 12 hectares
- This ensured the protection of an area of high conservation value
  - three Threatened Ecological Communities (TECs)



Aerial photograph 2013

Challenges

- Challenges to conventional revegetation practices of mined areas
  - no fresh topsoil containing organic matter and native seedbank (1960s mining)
  - post-mining landform was 8 m higher than final rehabilitation design
  - available soil resources consisted primarily of coarse sand tailings
    - poor water and nutrient retention qualities
  - a need to enhance the ecological value of link through a targeted suite of Whicher Scarp species
    - no digital herbarium for juvenile plants – identification was difficult

Removal of sand tails: 2013 to 2014

Process

Creation of a suitable soil profile to establish native vegetation

- Landform design and soil profile criteria developed; plan implemented
- ~500,000 m^3 sand tails removed and replaced with a combination of clay fines, overburden and subsoil
- Area ripped on contour at 1 m intervals
  - to enhance plant root penetration
  - to slow surface water run off and encourage infiltration


Removal of sand tails: 2013 to 2014


Replacement material:
combination of clay fines, overburden and subsoil

Process

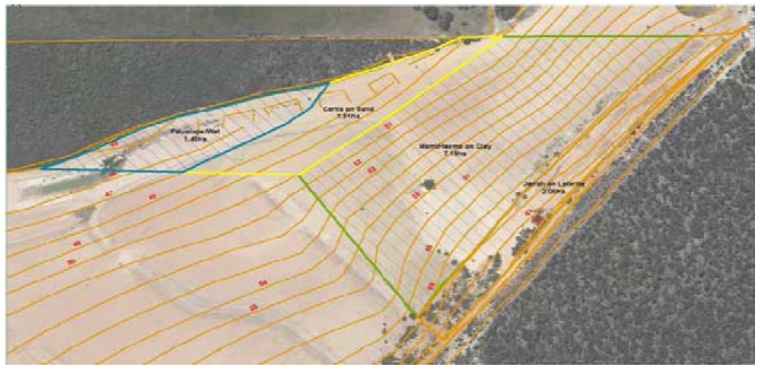
Creation of topsoil substitute

- Compost and mulch was sourced locally and mixed (10 mulch:1 compost)
- Mixture applied as 25 mm thick layer over 300 mm sand tailings
  - to ensure adequate nutrient availability
  - to improve moisture retention
  - to protect from wind erosion
- Recreated topsoil also included mineral fertiliser and microbial blend
  - to encourage successful plant establishment and growth

Process

Enhanced ecological value of link through a targeted suite of Whicher Scarp species

- Absence of formal completion criteria/standards for the link's vegetation
  - understanding reached with Department of Parks and Wildlife that the link would complement existing vegetation communities
- A larger suite of potential species for each soil/landscape unit was identified by grouping local plant communities with similar soil/landscape associations
  - species selection from four community types
    - Paluslope/wetland species
    - Cartis on sand species
    - Haematoxylon on clay
    - Jarrah on laterite



- Expect ecological succession to naturally refine community types over time

Process

Targeted species selection methods

- Review of known data on Whicher Scarp species
  - seed: optimal timing for collection, storage requirements, germinates per gram, dormancy mechanisms, pre-sowing treatment requirements
  - advanced propagation methods: cuttings, division, transplanting, tissue culture
- Literature reviews and consultation undertaken to confirm species list
  - Department of Parks and Wildlife
  - Botanic Gardens & Parks Authority
  - The University of Western Australia
  - native plant nurseries and individual specialists in the field
- Development of Whicher Scarp restoration digital herbarium

Process

Revegetation methods

- Recalcitrant species propagation commenced September 2013
- Seeding and planting commenced Winter 2014
- 107 seed species collected from 50 km provenance of the Whicher Scarp
- 22.9 kg of seed was sown over the four vegetation communities
- Smaller seed species were hand broadcast
- Larger seed species were drilled into soil via Legette spear method
- 22,369 plants of 100 species over four communities
- Infill planting of 20,626 seedlings in Winter 2015
- Weed control by hand due to threat of herbicide to native seedlings

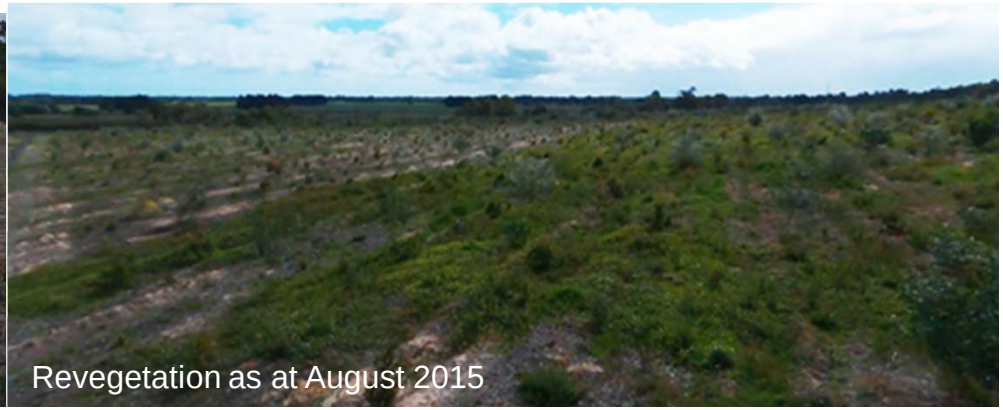
Legette spearing

Excellent Environmental Outcomes

Enhanced ecological link (at November 2015)

- 128 native species of the 132 species targeted were recorded and observed
- several species have reached flowering maturity and will be contributing to the soil seed bank


Progress seven months after planting (2014)


Revegetation as at August 2015

Commitment to Environmental Excellence

Enhanced biodiversity and improved rehabilitation outcomes

- Detailed planning and understanding of natural landforms and vegetation
- Investment in new and existing technology
- Scientific research
- Financial commitment
  - over $1.5 million was contributed towards establishing ecological link

Innovation

Iluka's commitment to develop innovative solutions ensured a beneficial and sustainable ecological link

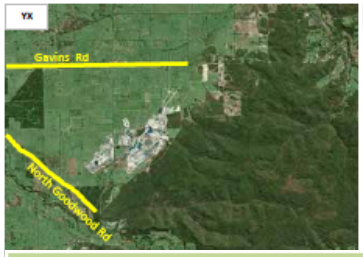
- Creation of enhanced soil profile by optimal use of available soils and mulch
- Development of Whicher Scarp restoration digital herbarium
  - Iluka is seeking to raise awareness and share the techniques for broader landform restoration use
    - resources industry, private and government organisations and community groups
  - available on Iluka's website www.iluka.com
  - increased knowledge base for restoration of Whicher Scarp communities
  - digital version with high resolution professional photography of species
  - sheets contain information on botanical descriptions, flowering times, seed collection timing, etc

Bossiaea pulchella FABACEAE

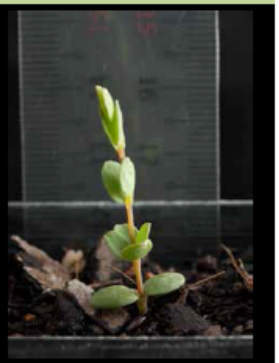
Name Derivation	Joseph de Bossieu de la Martiniere / Beautiful, small.
Plant Description	**SHRUB:** To 1.5m in height. **LEAVES:** Alternate, ovate to heart shaped, 3-9mm long and 3-6mm wide, the margin with minute and irregular rounded teeth, tip rounded to pointed. **FLOWERS:** Winter to Spring. Yellow and maroon to brown, Calyx 3-4mm long, the lobes shorter then the tube, with upper 2 cut off squarely, Petal standard 9-13mm, longer than the wings and keep petal. **POD:** Only seen immature, hairless.
Habitat	Rehab Veg Community; Haemotoxylon on Clay; Jarrah on Laterite; Cartis Whicher Location Map; Yoganup
Collection	

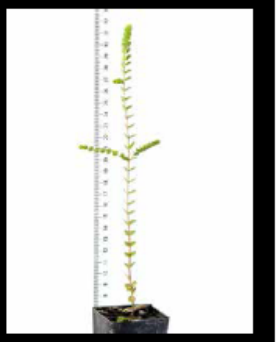
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flowers	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Collection	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Propagate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Propagation	Seeds per *Gram*	Germination per *Gram*	Germination %	Plant Density per *ha*	Treatment				
					Scarify	Hot Water	Heat	Smoke	Cuttings
	60	30	50	100	Y	Y			



Bossiaea pulchella FABACEAE





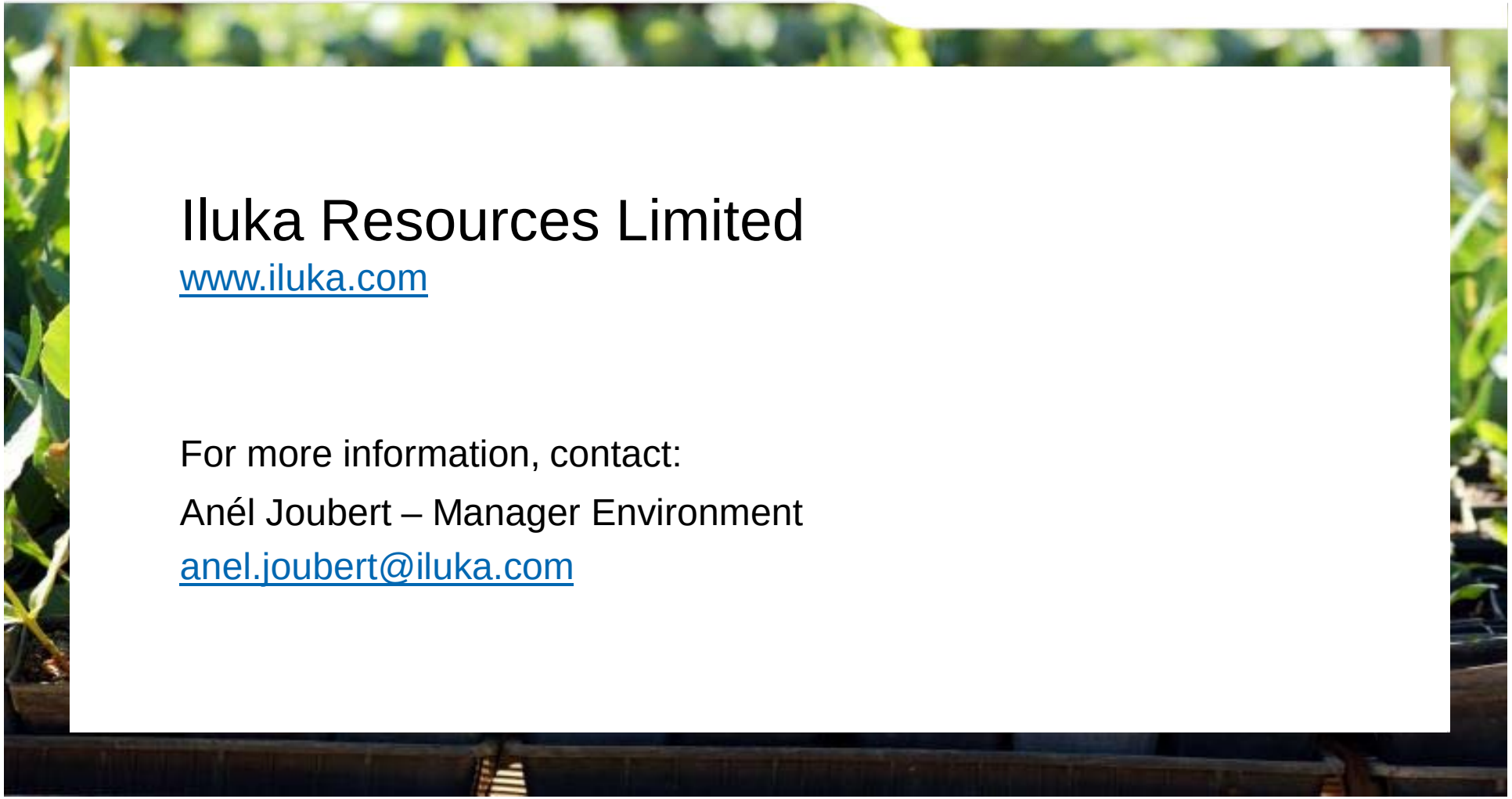
Community Engagement & Corporate Social Responsibility

- ~50 people were involved in the planning and implementation of the project:
  - Iluka personnel from rehabilitation, operations and planning departments
  - contract seed collectors and planters
  - earthmoving contractors
  - Parks and Wildlife officials
  - Botanic Garden & Parks Authority
  - The University of Western Australia
  - specialist consultants
  - neighbours

- Broad range of local companies and contractors were used
  - Karnup, Waroona, Boyanup, Vasse, Hithergreen, Busselton and Picton

Summary

- Rehabilitation of historically mined area to create a sustainable ecological link
- Development and implementation of rehabilitation techniques established new industry standards
  - creation of soil profile for native vegetation establishment
  - enhanced ecological value of the link through a targeted suite of Whicher Scarp species
  - development of Whicher Scarp restoration digital herbarium
- Rehabilitation methods and resources developed have broader application in landform restoration and conservation



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