

Summary

A joint venture between Wesfarmers Sugar Company Pty Ltd (Wesfarmers) and Marubeni Corporation (Marubeni) was awarded an exclusive mandate in April 1998 by the Western Australian and Northern Territory Governments to investigate the feasibility of development of an area of land adjoining the existing Ord River Irrigation Area (ORIA).

The proposal being considered by Wesfarmers and Marubeni involves the potential establishment of a raw-sugar industry. The industry may involve the development of farmland for the purposes of growing sugarcane, the development of a sugar mill, and the development of storage facilities at the port of Wyndham. In parallel with the feasibility study being conducted by Wesfarmers and Marubeni, the Water Corporation of Western Australia (Water Corporation) is investigating the feasibility of development of the irrigation infrastructure required to service the farmland.

Neither of the abovementioned feasibility studies is complete, and at this stage no commitment, conditional or otherwise, has been made to proceed with the proposed development.

A key element of the feasibility studies is the acceptance or otherwise of the proposed development from an environmental perspective. For this reason, the proposal has been submitted for formal environmental review prior to the conclusion of the feasibility studies.

Due to the importance of water related issues to the environment, and the integrated nature of the proposed sugar industry and the irrigation infrastructure, Wesfarmers–Marubeni and the Water Corporation have undertaken to be the Co-proponents of a single and joint environmental assessment of the proposed development.

1 PROJECT OBJECTIVES

Development Preliminaries

Despite the completion of the Ord River Dam in 1972, the Ord River Irrigation Area (ORIA) has not yet been developed to its full potential. In 1994, the Western Australian Government decided to investigate the extension of the scheme and, as part of the fully developed scheme would lie within the Northern Territory, an agreement was reached between the Western Australian Government and the Northern Territory Government (the Governments) to jointly pursue the development. The extension to the existing scheme is known as ORIA Stage 2.

Throughout 1995 and 1996, the Governments commissioned various preliminary studies in relation to the expansion of the ORIA, with a view to private sector involvement. A call for expressions of interest in 1997 stimulated great interest from the private sector, and resulted in the submission of a number of detailed proposals from local and overseas-based organisations. In 1998, a joint venture between Wesfarmers and Marubeni was awarded an exclusive mandate by the Governments to investigate the feasibility of development of a portion of ORIA Stage 2 known as the M2 Development Area.

Scope of the Project

The proposed Project involves the development of an export-based raw-sugar industry on the Weaber, Keep River and Knox Creek plains in Western Australia and the Northern Territory. Key features of the Project are:

- sugarcane plantation development by Wesfarmers-Marubeni of approximately 29,000 hectares with potential for future 'sell-down' to independent farmers as smaller farms;
- the development of a raw-sugar mill by Wesfarmers-Marubeni with a capacity of approximately 400,000 tonnes per annum of raw-sugar and 160,000 tonnes per annum of molasses;
- the development by Wesfarmers-Marubeni of raw-sugar and molasses storage and handling facilities at Wyndham port;
- the sale of some 3,000 hectares of land by Wesfarmers-Marubeni to independent farmers on an unconditional basis with respect to the types of crops that may be grown. The commitments made in this report would also apply to this land;
- the development of irrigation, drainage and flood protection infrastructure by the Water Corporation;
- the establishment and management of over 40,000 hectares of land for conservation purposes.

Following development, the Project Area would therefore include approximately 32,000 hectares of land developed for farms, development of a further 3,000 hectares of land for infrastructure, and over 40,000 hectares of land managed for conservation. Farm areas would be developed on the heavy clay soils (black soils), while the land managed for conservation would include those areas that contain flora and fauna of conservation

significance on the black-soil and other areas, including riparian and rocky areas, within and around the farmland.

Major issues

The Project represents a significant opportunity for regional development in Australia and, in particular, in the East Kimberley. Due to the scale of the proposed development, a range of issues has had to be addressed during project planning. These issues include:

- the relationship of the Project to existing developments in the ORIA;
- potential changes to the hydrology of the Keep River;
- sustainable groundwater management;
- the conservation of the biological diversity of the region;
- changes in land use and compatibility with traditional uses by native title holders and claimants;
- Australia's targets for limiting greenhouse gas emissions under the Kyoto Protocol;
- the effect of the Project on mosquito-borne diseases in the region;
- the social implications of the consequential expansion of Kununurra;
- environmental management, including cross-border issues and conservation management.

The growing of sugarcane and its subsequent milling to produce raw sugar and molasses are operations that have been practised in Australia for many years. The Project offers the opportunity to incorporate recent advances in agricultural technology and productivity that would lead to improved management of off-farm impacts and water conservation.

This Environmental Review and Management Programme/draft Environmental Impact Statement (ERMP/draft EIS) demonstrates how the predicted biophysical and social environmental issues arising from the Project would be managed.

History of development

Development of the ORIA was originally planned to proceed in two stages. Stage 1 of the development was completed by 1966: this involved construction of the Kununurra Diversion Dam to form Lake Kununurra, as well as irrigation infrastructure and associated works, and the township of Kununurra.

The second stage of the ORIA has only been partially completed. Completed works include construction of the Ord River Dam - about 50 kilometres upstream from Kununurra - to provide a major storage reservoir called Lake Argyle. The Ord River Dam was officially opened in 1972.

In 1994 the height of the spillway in the Ord River Dam was raised as part of the works associated with the installation of a hydroelectric power station. The Ord River Dam is capable of supplying the water requirements for all ORIA Stage 2, the hydroelectric power station and the existing irrigation area.

The approvals process

A Memorandum of Understanding was signed on 19 April 1995 by the Chief Minister of the Northern Territory and the Premier of Western Australia in response to the desire of both their Governments to complete the ORIA. The Memorandum of Understanding provides a framework for sharing information from studies into the scheme and for planning by agencies of the two Governments and by the private sector.

The Governments of Western Australia and the Northern Territory have agreed that the Project should be subjected to joint environmental assessment and that the level of the assessment would be an ERMP in Western Australia and an EIS in the Northern Territory. Guidelines for the ERMP/draft EIS were finalised in July 1999.

The ERMP/draft EIS is available for comment by the public and by Government departments and agencies for a period of ten weeks. During this time members of the public are invited to forward comments on any aspect of the proposal to the Western Australian Environmental Protection Authority (EPA).

The EPA will prepare a summary of the public submissions for comment by Wesfarmers-Marubeni and the Water Corporation. Following receipt of these comments the relevant State and Territory Government departments and agencies will assess the proposal and publish the results in assessment reports.

In Western Australia, the ERMP and subsequent advice from the EPA will be considered by the Western Australian Minister for the Environment when making a decision in relation to the proposal. In the Northern Territory, the EIS will form the basis for recommendations that the Minister for Lands, Planning and Environment may make to the Northern Territory Cabinet on the Project.

Scope and structure of the report

The scope of the ERMP/draft EIS covers the environmental implications of the Project in response to the ERMP/draft EIS guidelines issued by the State and Territory Governments.

The ERMP/draft EIS does not visit issues associated with the construction and operation of the existing irrigation scheme (ORIA Stage 1). However, observations of past and current experiences in relation to ORIA Stage 1 have been utilised in the design and planning of the Project so as to improve the environmental performance. The ERMP/draft EIS also does not include issues associated with the water resource allocation from the Ord River as there is already an assessment of this issue being undertaken by the Water and Rivers Commission of Western Australia and the EPA.

Two key considerations have shaped the structure of the ERMP/draft EIS: the need to describe the scale and physical characteristics of the Project in the most effective way, and the need to examine those environmental factors that have been identified as being the most relevant in assessing the environmental impacts of the Project.

2 THE EXISTING ORD RIVER IRRIGATION AREA

ORIA Stage 1 comprises a gross area of 14,000 hectares of land developed for irrigated agriculture on the Ivanhoe Plain and the Packsaddle Plain. About 11,500 hectares of this area are cropped, with the balance devoted to irrigation, drainage and road infrastructure, and on-farm development. Agricultural activities include broad-acre cropping of the cracking clay (black-soil) areas with sugarcane, chick pea, pasture, melons and seed crops, and tree crops such as bananas and mangoes on the loam and sandy soils.

Early development of ORIA Stage 1 was beset with problems associated with control of pests which had a detrimental effect on farm economics. Current farming activities have benefited from the experience gained during those difficult early years to the extent that they are now profitable. As a consequence, there is now a shortage of developed irrigation farmland in the region.

Environmental issues and their management

ORIA Stage 1 has been operated continuously for the purpose of irrigated agriculture since 1963. Over that period, a wide range of commercial crops has been grown and farm management practices has evolved in response to the new crops, improved knowledge of local conditions, and improvements in agricultural practices generally.

The ongoing practice of irrigated agricultural in ORIA Stage 1 provides evidence that the environmental impacts are manageable in key areas such as pesticide and chemical usage, and the containment of groundwater, salinity, sedimentation and weed infestation.

One of the major changes in agricultural practices has been in the use of pesticides and chemicals. Current practices are profoundly different from those of the early development period of ORIA Stage 1, when the use of agricultural chemicals was extensive. The current use of chemicals has been tempered by lessons learnt from past practices, a shift in the mix of crops towards crops which are less reliant on chemicals, and the implementation of an integrated pest management strategy. However, the integrated strategy has reduced but not eliminated the continued application of a variety of agricultural chemicals deemed necessary to maintain the agricultural and commercial viability of ORIA Stage 1.

Large areas of sugarcane have been grown in ORIA Stage 1 in recent years. Sugarcane has a low requirement for chemicals compared with other broad-acre crops, and this has reduced the risks associated with off-farm impacts.

In common with other irrigated agricultural schemes, groundwater levels have risen over a significant proportion of the area covered by ORIA Stage 1. However, it is noted that after more than thirty years of irrigation, in only two localised areas is groundwater now less than 2 metres from the surface. Groundwater levels have not affected land use in ORIA Stage 1 to date and groundwater remedial measures have not been required. The monitoring data also show that no areas in ORIA Stage 1 have been affected by salinity, and groundwater salinity levels are generally within the range tolerated by most crop species.

Nevertheless, groundwater levels in ORIA Stage 1 may require management at some point in the future. Various options are available to provide such management, including extraction of groundwater from permeable gravel beds via dewatering bores, installation of subsurface drains, tree planting and improved farm drainage systems.

Drainage waters from ORIA Stage 1 containing varying quantities of sediment, nutrients and farm chemicals are discharged into the Ord River. As expected, measured nutrient levels downstream of the drain discharges are above natural levels. However, the low natural level of nutrients in the Ord River and the significant dilution provided from river flows obviate the occurrence of water quality problems in the lower Ord River.

A number of chemicals detected by water quality monitoring are no longer in use in ORIA Stage 1, including dieldrin, chlordane, heptachlor and DDT. While levels of these chemicals in the drains are currently above guidelines applicable to receiving waters, their concentration should continue to reduce with time.

The Ord River is currently free of any introduced aquatic weeds. However, the control in water levels brought about by the irrigation scheme infrastructure has led to proliferation of a *Typha* species (cumbungi) in Lake Kununurra and along the banks of the lower Ord River. This growth reduces access to the water's edge, interferes with navigation, and restricts the ability of farmers to pump directly from Lake Kununurra.

ORIA Stage 1 was developed before environmental legislation existed in Western Australia. As a consequence, no single environmental management plan was developed for ORIA Stage 1 in its entirety, and no holistic plan exists at the present time. Environmental management in ORIA Stage 1 currently relies upon the compliance of all individuals, groups and agencies with laws and statutes that apply to prevent pollution and degradation of land. This approach is common for broad-acre agricultural activities throughout Australia.

The local community has taken the initiative in preparing a Land and Water Management Plan to address the environmental issues and ensure long-term sustainability of ORIA Stage 1. The Land and Water Management Plan is to address the potential impacts, both environmental and economic, of uses of the land and water resources of ORIA Stage 1. The output from the Land and Water Management Plan is to be a framework for the implementation of appropriate environmental management practices and will result in an increased awareness and understanding of environmental issues by farmers and the wider community.

Implications for the Project Area

There are a range of opinions on the status of the environment in and surrounding ORIA Stage 1. Some argue that environmental issues are being managed in a pragmatic fashion, whilst others take the view that existing environmental issues should be resolved completely prior to any expansion of ORIA Stage 1 and/or development of ORIA Stage 2 (including the Project Area).

It is the view of Wesfarmers-Marubeni and the Water Corporation that development of the Project Area can be managed in an environmentally sustainable manner. However, it

is only natural that any expansion should take into account environmental issues that have become apparent during the implementation of ORIA Stage 1.

Experience from ORIA Stage 1, and from other irrigation areas around Australia, has shown that on-farm management of irrigation and stormwater is required in order to manage the off-farm impacts of pesticides and other agricultural chemicals. For this reason, current best-practice on-farm water management measures are proposed for the Project.

All farm units in the Project Area would be developed with tailwater return systems capable of collecting and returning all irrigation water runoff to each farm. The tailwater return systems have been designed in such a way as to perform the function of first-flush stormwater collection systems, with that stormwater to be retained on-farm for use as irrigation water. That is to say, that the tailwater return systems have been designed with the capacity to collect the initial farm runoff from rainfall events.

Recent advances in pesticide use and management in ORIA Stage 1 would be adopted and, wherever possible, enhanced in the Project Area.

In addition, the above management measures would be supported by a comprehensive monitoring programme for pesticides and chemicals in the receiving environment. The monitoring programme would be undertaken as part of the environmental management framework for the Project Area, and the results may be used to modify proposed on-farm practices if necessary.

A proactive groundwater management strategy is proposed as part of the Project. This strategy would manage groundwater levels from project inception to ensure the sustainability of irrigated agriculture on the Project Area.

An important lesson learned from the experiences with ORIA Stage 1 is that clear responsibility for groundwater management would be required, together with the allocation of responsibility for the funding of groundwater control measures. The Project has an advantage over ORIA Stage 1 in that current expectations with regard to environmental management can be incorporated into development plans from the outset. An environmental management framework would be established at project inception to ensure that environmental management responsibilities are clearly identified and appropriately implemented and funded as part of the Project.

The proposed environmental management framework has been developed in accordance with the concept of audited self-management. However, the proposed framework does allow for a high level of community input and regulatory authority review.

3 DESCRIPTION OF THE PROJECT

The proposed Project involves the development of an export-based raw-sugar industry on the Weaber Plain, the Keep River Plain and the Knox Creek Plain. The development would include approximately 29,000 hectares of sugarcane plantations, the necessary irrigation infrastructure to service the farmland, a 400,000 tonnes per annum raw-sugar mill, and storage and handling facilities at Wyndham port. A further 3,000 hectares would be made available for sale to independent farmers on which to grow crops of their choice; these crops may or may not include sugarcane.

Various alternative development scenarios were considered by Wesfarmers-Marubeni during preparation of the Project proposal. These included the potential development of part or all of the Project Area for the cultivation of crops other than sugarcane. However, it is the view of Wesfarmers-Marubeni that the proposed development scenario is the most robust of all the options, from an agronomic, economic, community and environmental perspective.

The Project would essentially be independent of other irrigation developments in the region, and require the development of purpose-built irrigation infrastructure for the distribution of water from the existing dams. ORIA Stage 1 is served by the M1 Channel. The Project Area would be serviced by the proposed M2 Channel, which would be aligned with the M1 Channel for the first 23 kilometres of its length from the off-take at Lake Kununurra. The M2 Channel would have a stand-alone management and operation system.

The development schedule would be staged to maximise the delivery of cane to the sugar mill in the early years. Farm development would be substantially complete by 2003 and the first cane would be harvested for processing by the mill in the same year. Full cane production should be achieved in 2005.

Farm development and operation

Initially, some 29,000 hectares of the total irrigable area would be developed and owned by Wesfarmers-Marubeni and operated as a sugarcane plantation. The plantation would be designed to facilitate the operation of large-scale farm equipment to optimise economies of scale.

Farm development would commence with the clearing of vegetation. Survey and land-leveling activities, which would optimise the cut-and-fill balance, would follow the land clearing. Farm development would then proceed with the construction of access roads, head ditches, tailwater return systems and stormwater drainage outlets.

Ground preparation prior to planting would generally involve spraying with a herbicide for the control of weeds, followed by cultivation to disturb any compaction from the previous construction activities.

The Project would utilise modern cane-planting machines that combine the planting operations in one pass-furrow-forming, fertiliser application, placement of the cane billets or stalks in the furrow, closing of the furrow and pressing of the soil on to the cane 'set'. It is envisaged that planting of new sugarcane crops would only be required every three to four years. In the intervening years, ratoon crops would be grown from the regrowth from the plant rootstock remaining following harvesting.

Sugarcane harvesting operations would be similar to methods used in ORIA Stage 1. All cane-harvesting operations would take place during the dry season (April to November), and would be scheduled to provide a continuous supply of cane to the raw-sugar mill.

Sugarcane harvesting would involve burning of the crop immediately prior to harvest. Burning is considered necessary to reduce the amount of trash associated with the cane at harvest, and it is also considered beneficial in the control of pests.

As is common practice throughout Australia, farm owners would be responsible for the day-to-day management of farm operations. However, certain constraints to management practices would apply to farms within the Project Area. These would include the timing of the harvest to maintain mill throughput, and the honouring of environmental commitments made in this ERMP/draft EIS and any environmental conditions that may apply to the Project.

On-farm water management

All farms in the Project Area would be developed with irrigation tailwater management systems. Irrigation tailwater is the water leaving the end of the furrows during watering and is unavoidable if uniform water application to the crop is desired. The tailwater management system proposed for use in the Project Area would consist of tailwater ditches, tailwater dams, and tailwater return pumps and pipelines that would return irrigation tailwater to the farm irrigation system for application to the crop.

Rainfall runoff from the cropped areas would also be collected by the tailwater collection system. The tailwater storage dams have been designed to act as first-flush collection systems for stormwater. First-flush stormwater is likely to contain higher concentrations of organic matter, fertiliser and other farm chemicals than stormwater arising later in the rainfall event or from subsequent rainfall events.

The first-flush stormwater would be retained in the tailwater management system for subsequent use as irrigation water. The remainder would discharge to the drainage infrastructure, which in turn would drain to the Keep River or to Sandy Creek.

Farm chemicals and their use

The predominant crop grown on the Project Area would be sugarcane. Experience with this crop in ORIA Stage 1 has shown that it has a low requirement for pesticides. The primary means of managing diseases in sugarcane is to plant with varieties known to be naturally resistant to such diseases.

The likely fertiliser requirements for sugarcane grown in the Project Area, based on experience in ORIA

Stage 1, are urea and diammonium phosphate. Weed control would also be required, and this would be provided by a combination of mechanical tillage of the soil and application of pre-emergent and post-emergent herbicides.

Farm chemical and fertiliser requirements for crops other than sugarcane would be similar to the range of agricultural chemicals currently used in ORIA Stage 1. Also in accordance with current practice in ORIA

Stage 1, application of farm fertilisers and chemicals would involve direct application of fertiliser to the seed bed and tractor-drawn boom-spraying and aerial-spraying in the case of herbicides and pesticides. Management regimes of chemical and fertiliser use, in terms of type, timing and method of application, would be incorporated into the Environmental Management Plan (EMP) to be developed for the Project Area.

Irrigation, drainage and flood protection infrastructure

The Water Corporation would be responsible for providing the off-farm irrigation, drainage and flood protection infrastructure required by the Project.

The proposed M2 Channel and other smaller supply channels would be open excavations with sloping sides. Compacted clay channel-lining would be provided where channel excavation is required to be constructed in more permeable soils. This lining would be at least half a metre thick over the bed and the lower 1 to 2 metres of the channel batters.

Three balancing storage dams are proposed to facilitate operation of the irrigation supply system, particularly in meeting peak demand or in providing buffer storage at times other than normal operating conditions. These balancing storage dams would consist of a clay-lined perimeter embankment with an internal lining of stone riprap to prevent erosion from wave action. They would also include entry and exit structures with remote controlled gates.

The control system for the irrigation infrastructure would be based upon a modern remote control system designed to maximise efficiency of water distribution while minimising operating costs.

The drainage system for the Project would comprise a variety of open, excavated drains that would convey stormwater runoff from developed farm areas to natural drainage features. These open drains would be located along low points in such a way that they service each farm unit.

Hillside drains would be provided at the perimeters of developed farmland to divert stormwater runoff from adjacent catchments. These structures would be embankments less than 3 metres in height, combined with limited excavation to ensure continuous longitudinal drainage.

Farmland adjacent to significant waterways would be protected from flooding by levees. Flood protection levees would be earth embankments generally 1 to 3 metres in height, with 2:1 side slopes and a 4 metre crest width.

Sugar-milling

The proposed raw-sugar mill has been sized to have a crushing capacity of about 750 tonnes of cane per hour, enabling an annual sugarcane crush of approximately 3.2 million tonnes.

Sugarcane delivered to the mill would be weighed, shredded and then fed to a crushing mill to maximise juice extraction.

Processing of the juice would involve heating, clarification and concentration of the sugar by evaporation of water in the presence of a slurry of seed crystals. After a period of crystal growth, the molasses would be separated from the raw-sugar crystals by centrifuging, and recycled for further recovery of sugar. The raw-sugar crystals would then be dried and stored in bins. The syrup from which it is uneconomic to extract further sugar (molasses) would also be stored in bins.

Cane fibre ('bagasse') from the crushing mill would be burnt in the boiler as fuel for the generation of steam. Ash from the boiler, comprising the unburned residue of bagasse, would be spread over the canefield to act as a soil conditioner and fertiliser.

Atmospheric emissions from the raw-sugar mill would consist of water vapour from the process equipment and the normal products of combustion from the bagasse and fuel-oil-fired boiler. Prior to any atmospheric discharge, the emissions would be passed through an emission cleaning system to ensure compliance with all relevant regulations.

Liquid discharges from the mill would predominantly consist of cooling water and relatively small quantities of process effluent that would be treated in a biological treatment plant, combining activated sludge and anaerobic processes. The treated effluent may be used as irrigation water on the canefields adjacent to the mill.

Materials handling and transport

Transport of cane would be carried out using purpose-designed road transport vehicles with a payload of approximately 100 tonnes. For the long-term sugarcane supply to the mill of 3.2 million tonnes per annum, approximately eight trucks would arrive at the mill every hour over a 24-hour period, seven days a week for seven months of the year.

Raw-sugar and molasses transport from the mill to the port of Wyndham would be carried out over the processing season in purpose-built road transport vehicles with a payload of up to 90 tonnes. Approximately thirty vehicle movements per day are anticipated for product transport from the Project Area. Transport from the Project Area to Wyndham would be via the existing Kununurra-Wyndham road.

The main product storage facilities would be developed adjacent to the Wyndham wharf, with a nominal capacity of 180,000 tonnes for raw sugar and 75,000 tonnes for molasses. Development of these storage facilities would require the reclamation of a portion of an unvegetated mud flat adjacent to the southern section of the Wyndham wharf access road.

Shipment sizes from the port of Wyndham are currently constrained to approximately 20,000 tonnes. On this basis, at full production, twenty-eight shipments would be required annually, meaning that shipments would leave Wyndham on average every thirteen days.

4 PHYSICAL ENVIRONMENT

The climate of the Project Area is typical of the Kimberley region, with two dominant seasons - a wet and a dry. The wet (monsoon or cyclone) season usually extends from November to April, while the dry season occurs from May to October.

The average annual rainfall at Kununurra is 776 millimetres, with around 90% falling during the wet season. Net evaporation rates are high, approximately 2,000 millimetres per annum. During most months, evaporation exceeds precipitation.

The area that would be developed for farmland is confined to three fluvial plains: the Weaber Plain, the Keep River Plain and the Knox Creek Plain. The Weaber and Knox Creek plains form wide and generally flat valleys at an elevation of approximately 25

metres Australian Height Datum (AHD). The Keep River Plain, located adjacent to the lower reaches of the Keep River, has an elevation varying from about 20 metres AHD in the south-west to about 10 metres AHD in the north-west.

Soil surveys indicate that cracking clay soils, known as Cununurra and Aquitaine clays, are dominant within the Project Area. Cracking clay soils are often described as black soils or vertisols. They exhibit significant shrinking and swelling properties which result in deep, open desiccation cracks during the dry season.

The landforms within the Project Area would be modified from the existing primarily natural state of flat, open grasslands and savanna, to a highly managed agricultural landscape. The drainage patterns of the plains would be modified to provide a more consistent gradient and to facilitate optimum water application and farm drainage. In addition, a formal drainage system would be developed within and around the Project Area.

Despite thirty years of irrigated agriculture, ORIA Stage 1 has neither salinity problems nor problems associated with sodic soils (sodicity). However, if not managed appropriately, the cracking clay soils may be susceptible to sodicity as a result of the bicarbonate present in the irrigation water. Sodicity issues would be managed in the Project Area through focused management of irrigation practices. Numerical modelling has shown that the irrigation practices proposed for the Project would result in an average leaching rate to groundwater of about 100 millimetres per annum. The data available from ORIA Stage 1 indicate that this leaching rate would be sufficient to avoid adverse levels of subsoil sodicity.

Long-term monitoring would be undertaken to ascertain any changes to surface and subsoil salinity and sodicity resulting from the proposed irrigation practices. Alternative management measures would be investigated and trialled if the monitoring were to detect subsoil sodicity levels sufficient to threaten the long-term sustainability of irrigated agriculture within the Project Area.

5 SURFACE WATER

As with ORIA Stage 1, releases of water from Lake Argyle, flowing via the Ord River and Lake Kununurra, would be the source of irrigation water for the Project Area. However, unlike ORIA Stage 1, the entire Project Area would be contained within the lower reaches of the Keep River and Sandy Creek catchments; therefore, no drainage flows from the Project Area would re-enter the Ord River.

The Water and Rivers Commission is the authority in Western Australia responsible for managing the allocation of water resources so that water is used efficiently within sustainable limits and to ensure that the needs of people, industry and the environment are balanced. The Water and Rivers Commission recently prepared a Draft Interim Water Allocation Plan for the Ord River for public comment and review by the EPA.

In the Draft Interim Water Allocation Plan, the Water and Rivers Commission noted that an allocation of 1,235 gigalitres per annum from the Ord System for irrigation purposes was sustainable (1 gigalitre equals

1 million cubic metres). The Water and Rivers Commission has proposed that the allocation for irrigation purposes would allow sufficient water for other uses, such as hydropower and mining activities, as well as for necessary environmental flows. The water allocated for all uses, including adequate environmental flows, approximates the net annual inflow into the Ord River Dam (net annual inflow equals inflow from streams and rainfall less evaporation losses).

The allocation to irrigation includes the projected water requirements of ORIA Stage 1 and ORIA Stage 2, including the Project Area. The estimated water consumption for irrigation purposes in the Project Area is consistent with the irrigation allocation in the Draft Interim Water Allocation Plan.

The hydrology of the lower reaches of the Keep River would be affected by containment of flood waters within flood protection levees and by land and drainage modification within the Project Area. That is to say, that the natural flooding over wide areas of the adjacent plains, which currently occurs during the wet season, would be curtailed in certain locations by the proposed flood protection levees. Hydrology models were used to optimise the proposed location of the flood protection levees with respect to minimisation of increases in peak flood levels and velocity.

Through the design process, it is considered possible to contain the predicted flood levels to a naturally occurring range, although peak flood levels at the higher end of the range may occur more frequently.

In regard to water velocity, the hydrology models predict minor or no increases in peak average flow velocity at most locations. One exception is in the lower reaches of Border Creek; however, erosion problems are not anticipated to result due to the rocky nature of the substrate at this location.

The provision of formalised drainage infrastructure would alter the rainfall runoff characteristics from the Project Area. If the proposed development were to proceed, there would be a net increase in the average flow in the lower reaches of the Keep River. This increase would be within the natural variability of surface-water flows due to the variable nature of rainfall in the region.

The capture and reuse of tailwater within the farms are expected to virtually eliminate discharges (arising from normal irrigation operations) from farming areas to surrounding natural drainage features during the dry season. This is consistent with the existing natural conditions where negligible surface runoff occurs during the dry season.

The water management measures for the proposed development would represent an application of current best-practice techniques in the ORIA. An analysis of the potential for elevated nutrient levels in receiving waters as a result of the proposed development was completed by comparing nutrient levels in drains from ORIA Stage 1 with recorded nutrient levels in the Keep River. The comparison indicated a low potential for environmental impact as concentrations of nutrients in ORIA Stage 1 drains are similar to natural levels of nutrients in the Keep River.

The majority of the Project Area would be devoted to the cultivation of sugarcane. Sugarcane has a relatively low requirement for pesticides, and no requirement for endosulfan. It is anticipated that the low requirement for pesticides, coupled with the

proposed water management measures, would mitigate any environmental impact on the receiving aquatic environment.

At this stage, the types of crops to be grown on the land made available to independent farmers is unknown. As a consequence, a precautionary approach is to be adopted with respect to the use of pesticides in the Project Area. For example, interim restrictions would be imposed on any use of endosulfan in the Project Area. The interim restrictions would require any application of endosulfan to receive prior approval from the Environmental Management Entity (EME) that would be established in conjunction with the Project. The interim restrictions would include monitoring of farm drains, tailwater return systems and drainage flows to confirm the effectiveness of the proposed management measures.

6 GROUNDWATER

The groundwater environment beneath the Project Area is considered currently to be in equilibrium, with groundwater levels reflecting a balance between geological formation and recharge from the surface. Development of the Project Area for broad-acre flood irrigation would change the hydrological cycles on the land and result in a change in the rate of groundwater recharge and, hence, a change in groundwater levels. These changes are expected to result in an increased rate of water infiltration (known as accessions) to underlying aquifers and a consequent rise in groundwater levels.

Management of accessions to groundwater

Accessions to groundwater could be expected from the irrigation infrastructure and the irrigated farmland. Best-practice standards, in both the construction and the operational phases of the Project, would be implemented to manage accessions to groundwater.

The proposed methods for management of accessions to groundwater from the proposed irrigation infrastructure are as follows:

- Irrigation channels would be constructed with clay lining so that the rate of infiltration would be less than 2 millimetres per day.
- Balancing storage dams would be sited in areas where the dominant surface soils are of Aquitaine clay. (Aquitaine clay is the least permeable soil type occurring in the Project Area.)
- Drainage channels would be designed to be broad and shallow to take advantage of the naturally occurring soil conditions; these consist of lower permeability clays nearer the surface, overlying soils of increasing permeability with depth.

The proposed management measures represent current best-practice construction standards for irrigation infrastructure. In addition, modern quality assurance procedures would be adopted during construction to ensure that the design intent is achieved in practice.

Sugarcane has a relatively high irrigation water requirement. Nearly all of this demand is needed to offset crop evapotranspiration, and irrigation schedules developed to satisfy

this requirement only would eliminate accessions to groundwater. However, there are a number of reasons why it is neither practical nor desirable to eliminate all accessions to groundwater. For example, some accessions to groundwater would be required to remove salts from the root zone of the crop that would otherwise accumulate from the consistent application of irrigation water, even for the low-salinity water sourced from Lake Kununurra. Also, some leaching of water through the soil profile would be desirable as a means of managing potential sodicity effects within the soils of the Project Area.

The proposed groundwater management strategy would involve the direct control of groundwater levels by the long-term use of dewatering bores and, to a lesser extent, field drains.

Dewatering bores would extract groundwater from the permeable palaeochannels that underlie much of the Project Area. The optimal locations for the dewatering bores would be determined following further field investigations. Current planning assumes that the dewatering bores would be uniformly spread over areas underlain by palaeochannels or other permeable strata, with minor variations in location made to accommodate infrastructure and farm unit boundaries.

In less permeable areas, it is considered likely that field drains would be more effective than dewatering bores. Field drains would consist of a series of perforated pipes laid below the surface and would allow the entry and collection of groundwater.

The results of the groundwater modelling undertaken for the Project indicate that dewatering bores and field drains would only need to be operated after ten years of cropping; even after that time their installation could be phased in over a number of years. Any collected groundwater would be variable in time both in terms of quantity and quality, with the latter initially being highly dependent upon existing groundwater quality.

Collected groundwater would initially be utilised as irrigation water, following dilution in the irrigation channels with water sourced from Lake Kununurra.

In some areas the quality and quantity of the extracted groundwater would be such as would allow this practice to occur in the long term. However, project planning is currently based upon the conservative assumption that, in the long term, all extracted groundwater would be collected by a network of buried pipelines for subsequent discharge to the estuarine (tidal) sections of the Keep River and Sandy Creek.

Black soils have been observed in other irrigation areas in Australia as being effective in preventing the migration of pesticides from the surface to groundwater. Also, black soils typical of the Project Area are known to be highly effective in binding phosphorus, a key element of fertilisers. Hence, significantly elevated levels of phosphorous are not anticipated in the groundwaters beneath the Project Area.

The migration of nitrogen to groundwater is known to be less affected by soil conditions. The predicted groundwater nitrate levels in the Project Area would be about twice the naturally occurring levels, yet the level is still sufficiently low as not to restrict any future beneficial uses of the groundwater.

Existing environment - terrestrial vegetation and flora

The Project Area lies within the Victoria-Bonaparte Biogeographic Region, which adjoins the lower part of the Joseph Bonaparte Gulf and is about 73,000 square kilometres in extent. This biogeographic region exhibits a diversity of landforms and vegetation types, including red earth and black-soil (cracking clay) plains, plateaux, ranges of sandstone, open savanna and tall grassland.

European occupation of the Kimberley region has historically been sparse and, as a consequence, biological studies have been relatively limited. Detailed vegetation and flora surveys within the Project Area have recently been conducted in relation to the proposed development. Prior to these comprehensive surveys, no detailed flora surveys had been conducted on the black-soil plains within the Project Area.

The following discussion summarises the terrestrial flora currently existing within the Project Area. A comprehensive conservation strategy is proposed for the Project Area, which would be implemented if the proposed development were to proceed. A summary of the strategy is outlined in Section 10.

Vegetation in and adjacent to the Project Area

The Western Australian portion of the Project Area was described by Beard (1979) as 'grassland with sparse bauhinia (*Bauhinia cunninghamii*) and coolibah (*Eucalyptus microtheca*) on cracking clay soil'. In 1990 Beard further expanded the description of the black-soil plains of the Ivanhoe Land System, describing it as treeless, or with low trees 3-6 metres high, including *Eucalyptus microtheca* (coolibah), *Bauhinia cunninghamii* (bauhinia), *Acacia suberosa* (corky bark wattle), *Terminalia* spp. and *Excoecaria parvifolia* (guttapercha tree). Shrubs include *Acacia farnesiana* (mimosa bush) and sparse *Carissa lanceolata* (conkerberry). The typical ground layer is a community of tall, perennial grasses reaching 2 metres and more in height. Common grass species include *Dichanthium tenuiculm* (blue grass), *Dichanthium fecundum*, *Sorghum plumosum* (plume sorghum), *Sorghum timorense*, *Eulalia fulva* (silky browntop), *Ophiuros exaltatus* (canegrass) and *Astrebla squarrosa* (bull mitchell grass).

The portion of the Project Area within the Northern Territory, mapped by Wilson et al. (1990), consists largely of *Chrysopogon fallax* (golden beard grass) and *Dichanthium fecundum* (blue grass) grassland.

Compared with other black-soil plains in the Victoria-Bonaparte Biogeographic Region at Auvergne Station, the Project Area has a predominance of *Sorghum timorense*, *Acacia* cf. *bidwillii* and *Themeda triandra*, and a scarcity of *Sorghum bulbosum*. The Project Area also has a greater diversity and possibly

a higher biomass of plant species than the Auvergne region, but the same dominant species are present in each region.

Based on information from field surveys, a total of seventy-two vegetation communities within seventeen major groups has been recognised within the Project Area.

The major vegetation associations of particular conservation significance within the region are vine thickets and rainforest (Beard 1990). Rainforest was not recorded within the Project Area. An area along the middle reaches of the Keep River was recorded as a vine thicket, but was considered degraded due to the long history of pastoral activity.

Flora of the Project Area

Data provided by the Western Australian Herbarium and the Parks and Wildlife Commission of the Northern Territory show that 307 taxa of plants from eighty families were previously recorded within the Ord River area. The most numerous families are Poaceae (grasses), Myrtaceae (eucalypts and paperbarks), Cyperaceae (sedges and rushes), Mimosaceae (wattles), Asteraceae (daisies), Papilionaceae (peas) and Combretaceae (*Terminalia* spp.).

The field surveys of the Project Area recorded 682 taxa from eighty-seven families, twenty-six of which were represented by a single taxon. Two hundred and seventy-six genera were recorded, with 138 of these represented by a single taxon. The number of plant taxa recorded for the Project Area was doubled by the field surveys.

Western Australia and the Northern Territory have different requirements for the conservation of flora. Within Western Australia, rare plant species are protected by the Wildlife Conservation Act 1950. The Act is administered by the Department of Conservation and Land Management (CALM) and prohibits the taking of any Declared Rare Flora on any lands anywhere in Western Australia without the written consent of the Minister for the Environment. CALM also maintains a supplementary listing of rare flora species referred to as 'Priority Flora'.

Rare flora in the Northern Territory is protected by the Parks and Wildlife Act 1993. This Act includes a schedule of protected plants (and animals) and a supplementary list of flora species.

Sixteen taxa known to occur within the Project Area have been listed by either the Western Australian or the Northern Territory Governments as threatened, rare or poorly known. An additional three taxa are listed by the Northern Territory as restricted in Central Australia but common throughout the remainder of the Territory. Fourteen taxa considered to be rare within the Northern Territory were recorded within the Northern Territory portion of the Project Area, two of which are classed as Priority Flora in Western Australia. Four taxa of priority status were recorded in Western Australia: two were considered to be restricted to Western Australia and two were threatened in the Northern Territory.

Of the rare and priority species of conservation significance recorded in the Project Area, fourteen species are not exclusive to the Kimberley region, and occur in other regions of Western Australia, the Northern Territory and Queensland, with some also occurring in tropical Africa and Asia.

Introduced flora

Eighteen introduced plants were recorded in the Project Area. Seven of the introduced plants have been declared noxious weeds under the Agriculture and Related Resources

Act 1976, in Western Australia, and the Northern Territory Noxious Weeds Act 1978, in the Northern Territory. None of the noxious weeds are listed in the National Weeds Strategy (Agriculture and Resource Management Council of Australia and New Zealand et. al. 1999).

The black cracking clay soil areas of the Project Area have not been significantly affected by weed invasion.

8 EXISTING ENVIRONMENT – TERRESTRIAL FAUNA

The Project Area falls within the Torresian Zoogeographic Region, which encompasses the humid tropical and subtropical areas of northern Australia. This region incorporates the Kimberley region of Western Australia, much of the 'Top End' of the Northern Territory, and northern Queensland.

Most of the fauna encountered within the Project Area is adapted to the wet-dry tropical environment and has Torresian distributions. However, the distribution of some species is more wide-ranging, and some have strong affinities with the Eyrean Biogeographic Region (semi-arid to arid areas). Other fauna, in particular birds, may be even more wide-ranging, with distributions throughout Australia or overseas; these include trans-equatorial migratory species.

The following discussion summarises the terrestrial fauna currently found within the Project Area. Proposed conservation initiatives in relation to terrestrial fauna are outlined in Section 10.

Fauna habitats of the Project Area

Fauna habitats are closely aligned with landforms and associated vegetation. Seven fauna habitats have been recognised in the Project Area. Three of these habitats are widespread and broadly categorised as savanna woodland (grassland, eucalypt woodland and Bauhinia woodland), while the remaining four (riverine woodland, vine thicket, wetland and rock outcrops) are more restricted and provide more specialised habitats.

The majority of habitats encountered in the Project Area are savanna woodland, which occurs on the black-soil or red-soil plains. Three subtypes may be distinguished: the grassland habitat is typically found on soils inundated in the wet season and subject to cracking in the dry season; eucalypt woodland is a grassland with a few shrubs and emergent trees, dominated by *Eucalyptus* spp. and *Corymbia* spp.; and Bauhinia woodland is a grassland with a few shrubs and emergent trees, dominated by *Bauhinia cunninghamii*.

The riverine woodland adjoining the Project Area is a localised but relatively important habitat, with an abundance and diversity of species. It occurs along the margins of the Keep River, Knox Creek, Sandy Creek and on the levees adjacent to them, and is subject to inundation during the wet season.

Vine thickets occur in small localised patches within the riparian areas of the Keep River in the Project Area, and consist of a variety of tree and vine species.

Wetlands in and adjacent to the Project Area include billabongs, permanently inundated areas, and artificial water storage areas (e.g. dams and tanks). These areas provide a diverse array of ecological niches which support a range of vertebrate and invertebrate fauna species.

Several rock outcrops occur throughout the Project Area. Rock crevices, loose rocks and small caves provide numerous niches for specialist saxicoline (rock-inhabiting) fauna species. Rock crevices may be utilised by geckos, while caves may be used as roosts for bats, or as shelter for a range of fauna.

Vertebrate fauna

Literature searches indicate that the Project Area may support as many as 240 bird, fifty-five native and eight introduced mammal, 102 reptile and twenty-seven frog species.

Based on all surveys of the Project Area, nine mammal families have been recorded, comprising twenty-eight native mammal species; these are *Dasyuridae* (carnivorous marsupials - three species), *Macropodidae* (kangaroos and wallabies - four species), *Pteropidae* (fruit bats - two species), *Vespertilionidae* (true bats - nine species), *Megadermatidae* (ghost bats - one species), *Hipposideridae* (horseshoe bats - two species), *Emballonuridae* (sheath-tail bats - two species), *Molossidae* (freetail bats - one species) and *Muridae* (rats and mice - four species).

The total number of bird species recorded for the Project Area is 166. During the dry season when water is scarce, the wetland and riverine woodland habitats provide valuable refuges for birds. This is reflected by the highest levels of species richness being recorded in these areas (sixty-three and forty-one species respectively). By contrast, the grassland offers few dry-season habitats and consequently had the lowest species richness.

During the wet season the widespread abundance of water allows for the dispersal of many bird species. During this period, structurally diverse habitats (vine thicket, eucalypt woodland and rock outcrop) have recorded the highest species richness (thirty-five, twenty-nine and twenty-eight bird species respectively). Grassland habitat has recorded the lowest species richness (fifteen bird species), presumably due to the limited number of ecological niches available in this habitat.

The total number of reptile species recorded to date for the Project Area is forty-five while the total number of frog species recorded to date is twenty.

Groundwater and cave fauna

Stygofauna are fauna (usually invertebrate) that exclusively live in subterranean habitats, principally caves. One species of stygofauna has been found in the palaeochannels of the Project Area as well as in groundwater of ORIA Stage 1.

Bats also commonly inhabit caves, especially during breeding and daylight hours. A total of seventeen species of bats has been recorded from the Project Area, of which five species frequent caves and other rock outcrops. However, bats forage over extensive

ranges, and any caves or dense vegetation in the vicinity of the Project Area could be utilised by bats.

Rare and protected fauna

Seventeen vertebrate species considered rare and protected under Commonwealth and State legislation could be expected within the Project Area. These include one mammal, eleven birds, two reptiles and three frogs, including the previously presumed extinct frog species, flat-headed frog, which was recently found at Cockatoo Lagoon in the Keep River National Park.

Two species recorded in the Project Area are listed under the Commonwealth Endangered Species Protection Act 1992: Derby white-browed robin (*Poecilodryas superciliosa*) is classified as endangered, and ghost bat (*Macroderma gigas*) is classified as vulnerable.

Black bittern (*Ixobrychus flavicollis gouldi*) is listed as Schedule 1 species under the Western Australian Wildlife Conservation Act 1950. An additional four species recorded within the Project Area are listed under Schedule 4 of the Act: peregrine falcon (*Falco peregrinus*), radjah shelduck (*Tadorna radja*), freshwater crocodile (*Crocodylus johnstoni*) and saltwater crocodile (*Crocodylus porosus*).

Ghost bat (*Macroderma gigas*), zitting cisticola (*Cisticola juncidis*) and wailing frog (*Cyclorana vagitus*) are listed under Schedule 7 in the Northern Territory.

Flat-headed frog (*Limnodynastes depressus*) is classed as a critically vulnerable species in the Northern Territory. Two recently described lizard subspecies - *Ctenotus rimicola rimicola* and *Ctenotus rimicola campestris* - were rated by the taxonomists Horner and Fisher (1998) as 'rare or insufficiently known' in both Western Australia and the Northern Territory.

An additional thirteen species of birds listed under the China-Australia Migratory Bird Agreement (CAMBA) were recorded in the Project Area.

Introduced species

Three introduced species - naturalised dingo (*Canis lupus dingo*), cat (*Felis catus*) and donkey (*Equus asinus*) - were recorded in the Project Area. Native rat (*Rattus villisissimus*) is present in the Project Area and occasionally reaches plague proportions in ORIA

Stage 1. Introduced rodents, such as house mouse (*Mus musculus*) and black rat (*Rattus rattus*), are expected to occur within the Project Area. Other mammals expected to occur are horse (*Equus caballus*) and feral pig (*Sus scrofa*). Cattle (*Bos indicus*) are widespread across the Project Area due to pastoral activities.

Existing environment aquatic flora and fauna

The proposed conservation strategy for the Project would ensure that all rivers, streams and natural wetlands in the Project Area are contained within conservation areas, and are isolated from land development.

Throughout the Project Area the vegetation fringing the creeks, rivers and other watercourses is dominated by *Barringtonia acutangula* (freshwater mangrove), *Melaleuca*

argentea (paperbark), *Pandanus spiralis* (screw palm), *Carthorium umbellatum*, *Acacia colei* (wattle) and *Eucalyptus* species, including *Eucalyptus camaldulensis* and *Excoecaria parvifolia* (guttapercha tree). These species are mainly associated with fresh or slightly brackish water. Scattered mangroves occur along the northern reaches of the Keep River within the Project Area; however, extensive mangrove woodlands exist nearby in the estuarine portion of the Keep River, and outside the Project Area.

Aquatic vegetation and flora

The records of the Western Australian Herbarium were used to determine which aquatic species were likely to occur in the Project Area. In addition, during the fauna study of the Keep River by Larson (1999), opportunistic recordings of aquatic plants were made.

Larson (1999) recorded the aquatic vegetation in the pools along the Keep River near the southern boundary of the Project Area as comprising:

- mixed grasses, Nardoo (*Marsilea* sp.) and algae *Chara* spp. and *Enteromorpha* spp. in the water;;
- spikerush (*Eleocharis* spp.) and taro (*Colocasia esculenta*) in the soil at the water edge.

At Alligator Hole and Milligan Lagoon, Larson (1999) recorded *Nymphaea macrosperma* and *Nymphaea violacea* (waterlilies), *Nymphoides indica*, *Najas tenuifolia* (water nymph), *Utricularia australis* (bladderwort), *Hydrilla verticillata* (water thyme) and *Chara* spp.

No rare or priority flora was recorded from the aquatic environment.

Aquatic fauna

A survey of aquatic fauna in and near the Project Area was undertaken in October 1998 (Larson 1999). Seventeen sites were sampled along the Keep River and Sandy Creek.

The survey recorded five mammal, ninety-three bird, thirteen reptile, eleven frog and thirty-five fish species. The survey results showed that the aquatic invertebrates comprise assemblages typical of Northern Territory rivers, creeks and billabongs. Insects and molluscs were found to be common in most waterbodies and some insects were locally common.

No feral fish were recorded. Two species of sawfish have been recorded in the Keep River - dwarf sawfish (*Pristis clavata*) and freshwater sawfish (*Pristis microdon*). Dwarf sawfish is coastal in distribution but can travel long distances up rivers into fresh water. Its conservation status is unknown but it may only occur in northern Australia. Freshwater sawfish is listed as 'vulnerable' under the Commonwealth Endangered Species Act 1992. Freshwater sawfish is usually found in fresh water and in the upper reaches of estuaries, and may be isolated in small billabongs for several years until floodwaters enable it to return to the estuary. Freshwater sawfish has been recorded from several rivers in Western Australia, the Northern Territory and at Cape York in Queensland.

Introduced flora and feral fauna

No introduced species of plants and animals were recorded from the aquatic environment.

10 BIOLOGICAL ENVIRONMENT – IMPACT MANAGEMENT

A comprehensive conservation strategy has been proposed as an integral feature of the development of the Project Area. It is the view of Wesfarmers-Marubeni and the Water Corporation that the proposed strategy conforms with commitments made in relation to conservation by the Commonwealth, State and Territory Governments. A key element of the strategy is the establishment of some 40,000 hectares of conservation reserve within the Project Area. This would include representative areas of the vegetation associations, faunal habitats and major soil types found in the Project Area. Furthermore, an EME would be formed to implement the conservation strategy and the strategy would be formalised in an EMP.

Existing and proposed reserves in the Victoria-Bonaparte Biogeographic Region

The Victoria-Bonaparte Biogeographic Region has a total area of 72,970 square kilometres, approximately 73% of which is in the Northern Territory and 27% in Western Australia. The area set aside in conservation reserves in the Northern Territory is 6,846 square kilometres (approximately 13%); in Western Australia, the area in conservation reserves is 2,443 square kilometres (also approximately 13%). The conservation reserves in Western Australia include Lake Argyle and Lake Kununurra. Each lake was formed as a result of the ORIA development and each has since become listed under the Ramsar Convention as valuable habitat for aquatic birds, including migratory birds.

As signatories to the National Strategy for the Conservation of Australia's Biological Diversity, the Western Australian, Northern Territory and Commonwealth Governments are committed to the establishment of a comprehensive and representative system of ecologically viable protected areas. Following development, the Project Area would include undeveloped areas that would be managed for conservation. These proposed conservation areas would provide an important contribution to the national conservation estate.

The Governments of Western Australia and the Northern Territory continually review their systems of conservation reserves. The proposed development would provide significant opportunities for the State and Territory Governments to increase conservation areas, particularly as these initiatives could be completed in parallel with the excision of the Project Area from existing pastoral leases. For example, the Northern Territory Government is considering a significant expansion of the Keep River National Park which may increase the conserved area in the Victoria-Bonaparte Biogeographic Region by approximately 220,000 hectares.

Conservation within the Project Area

The key environmental and conservation management objective in relation to the proposed development is the management of a world-class broad-scale agricultural development, with integral conservation areas, in accordance with Australia's environmentally sustainable development and biodiversity policies. Conservation management would take into account issues such as indigenous habitats and species, traditional land uses, community involvement, water and land pollution, construction and operational activities, and pest species.

The objectives of conservation management would be to:

- minimise environmental disturbance consistent with development requirements;
- maintain and not degrade the biological integrity and diversity in the Project Area and adjacent regions/areas;
- manage conservation areas to the satisfaction of the community and government agencies.

The priorities for environmental management of the Project Area are to:

- protect scheduled and other significant species, including those protected under international agreements;
- preserve site or habitat-specific areas;
- sustain biological diversity in terms of species richness criteria;
- conserve genetic resources;
- control erosion.

These priorities have been considered in the context of representation of scheduled species and suitable habitats in conservation reserves in the East Kimberley and the adjacent parts of the Northern Territory.

A key element of the conservation strategy is the retention of representative associations and habitats of the Project Area within distinct conservation areas. For example, all rock outcrops and watercourses, including wetlands and billabongs with environmental and cultural significance, would be conserved. To maintain the effectiveness of these areas as fauna habitats, a system of corridors would provide links to adjacent areas of the surrounding Cockatoo Land System.

All the major soil types that occur in the Project Area would be represented within the conservation areas, although some of the minor soil types represented in small areas would not be protected. Farm development would focus on the cracking clay black-soil areas comprising Cununurra and Aquitaine clays. A minimum of 24% and 15% respectively of these soils would be conserved in the Project Area.

All undeveloped land within the Project Area would be managed for conservation. Most of this conservation area would be located around the perimeter of the Project Area, thereby providing an important physical link with undeveloped areas. In the Northern Territory this would include the proposed extension of the Keep River National Park and, in Western Australia, the Point Spring Nature Reserve.

Four of the seventy-two recognised vegetation associations would not be conserved to some extent in the Project Area. However, the combined extent of these associations is 133 hectares and represents only 0.4% of the proposed development area. Twelve vegetation associations only occur in the proposed conservation area and therefore would not be affected by development. Of the remaining fifty-six vegetation associations only one would not have at least 10% represented in the conservation area.

Two currently unreserved or poorly reserved vegetation associations in the Victoria-Bonaparte Biogeographic Region in the Northern Territory - *Melaleuca minutifolia* low woodland and *Xerochloa* grasslands - would be included in the proposed conservation areas. The conservation of these two vegetation associations within the Project Area would significantly increase the size and comprehensiveness of their conserved area within the biogeographic region.

The only association of restricted distribution in the Project Area is an *Echinochloa kimberleyensis* dominated swamp near the foothills of the Weaber Range. This swamp would be included within the proposed conservation area and would be protected.

No threatened communities covered by the Endangered Species Protection Act 1992 occur in the Project Area.

All the identified fauna habitats would be represented in the proposed conservation areas within the Project Area. All rare species of, and specially protected, fauna identified with the Project Area would have their usual habitat retained.

Assessment of potential impacts

The proposed development would take place predominantly on the black-soil plains. These cracking clays are typically dominated by savanna woodland, a homogeneous habitat consisting of *Bauhinia* woodland, eucalypt woodland and grassland. Habitats associated with black soils are widespread in the Kimberley and the Northern Territory.

Mammals

As with any sizeable land development, it is inevitable that individuals of some of the smaller species of mammals may be detrimentally affected during construction activities. Some may move, and survive, within the proposed conservation areas. Other individuals may be displaced and may later succumb to predators, stress or territorial conflicts during attempts to re-establish a home range. However, none would become locally extinct.

Clearing of the black-soil vegetation would reduce the foraging habitat for some terrestrial (arboreal) species and some bats, as well as remove some den and roost trees. However, the areas of natural vegetation preserved on the hills and along watercourses within the proposed conservation areas would minimise this particular impact.

Birds

Nesting sites and foraging areas for birds may unavoidably be impacted during construction activities, but it is envisaged that most individuals would be able to move into the adjoining proposed conservation areas. In ORIA Stage 1, some birds - including broilgas, magpie geese, radjah shelduck, parrots and finches - have benefited from the development of irrigated farms.

Reptiles

Some individuals may relocate to adjoining proposed conservation areas, but some may unavoidably be killed during construction activities. Based on existing information for

ORIA Stage 1, most of the reptile species would not be adversely affected and it is considered likely that some may benefit from the establishment of the irrigation system.

Frogs

It is anticipated that most, if not all, species of frogs would continue to live and possibly thrive in the irrigated areas. Those with specialist habitat niches - such as Copland's rock frog, which is restricted to the rock outcrops - would probably not be affected by the proposed development.

Fish and aquatic biota

The proposed conservation areas would include all significant waterways, billabongs and wetlands, and their associated riparian vegetation. Direct impacts upon the habitats of fish and other aquatic biota would therefore be avoided, except in two localised areas associated with the road crossings of the Keep River and Knox Creek.

The predicted changes to the hydrology of the Keep River and Sandy Creek from proposed development are not expected to result in any significant impacts on fish and other aquatic biota in these two watercourses. The altered flow regime may cause some localised erosion, but this should stabilise with time. The differential effect of the increased average flows would be greater in drier years and, at these times, the additional flows that would occur earlier and later in the wet season would benefit an environment that would otherwise be under stress.

Stygofauna

The predicted changes to the groundwater environment of the Project Area would include a rise in groundwater levels; therefore, existing habitats would remain flooded. Only minor changes to groundwater quality arising from the use of farm chemicals are predicted.

No significant changes to groundwater quality arising from the use of farm chemicals are predicted to occur.

Taking the above predictions into account, it would appear that the potential for impact on the stygofauna of the Project Area is very low. The continued presence of stygofauna in groundwater beneath ORIA Stage 1, which has been used for irrigated agriculture for over thirty years, would support this conclusion.

Existing conservation reserves

The Keep River National Park is approximately

6 kilometres south of the Project Area. Being upstream of the Project Area, it is unlikely that the Keep River National Park would suffer any significant direct detrimental impact as a result of the proposed development.

Point Spring Nature Reserve, less than a kilometre north of the Weaber Plain portion of the Project Area, protects a permanent spring, remnant rainforest and a small wetland at

the base of the Weaber Range. The Point Spring Nature Reserve is a Class A reserve for the conservation of flora and fauna. This reserve includes small areas of black soil and sandy alluvium. Point Spring is in a separate groundwater system to the adjacent alluvial plains and, as a consequence, would be isolated from any changes in the water table in the Project Area. However, its close proximity to the Project Area has necessitated the implementation of special management and design considerations, with particular reference to anticipated higher flood water levels and flow velocities. A buffer zone has been incorporated into the design of the proposed development to insulate Point Spring Nature Reserve from these effects.

All other conservation reserves in the region would be sufficiently removed from the Project Area so as not to be affected by the Project.

Environmental management

An EMP would be prepared prior to development to guide planners and mitigate any potential environmental impact associated with the proposed development. The EMP, which would be made available for public comment prior to finalisation, would consider both construction and operation activities.

The EME that would be established in conjunction with the proposed development would be responsible for ensuring implementation of the EMP.

There is potential for the Miriwung and Gajerrong people to be involved in the development of the EMP and operations of the EME. Wesfarmers-Marubeni and the Water Corporation consider that the management of the biodiversity issue would be enhanced by the input of Miriwung and Gajerrong people.

Permanent monitoring sites for flora, fauna and biodiversity would be established in conservation areas, along ecological corridors and in selected sites in the Project Area. Monitoring would be undertaken on a regular basis with the monitoring parameters clearly defined following consultation with the staff of CALM and the Parks and Wildlife Commission of the Northern Territory.

To limit any potential for overclearing, all areas designated for construction works would be clearly marked on development maps, and on the ground prior to commencement of works. Vegetation clearance would also be staged so that areas would be cleared only as required.

All contractors and consultants would be required to participate in a formal environmental and cultural heritage induction programme on the importance of the natural and social environment.

Advice would be sought from CALM and the Parks and Wildlife Commission of the Northern Territory in the preparation of a Fire Management Plan for the Project Area, including the proposed conservation areas. This plan would take into account community assets, environmental values, fire frequency and season, and the impact that fire could have on human life.

Various mechanisms would be used to control the introduction of weeds to the Project Area. Mandatory interstate quarantine would be maintained to control weeds from other

areas. During construction, all construction machinery would be cleaned of soil and other organic debris prior to being transported to and from the Project Area.

Once construction and development works are complete, each farmer would be responsible for the recognition and control of weeds on their property.

The EME would oversee the environmental management of the Project Area, including the identification of weeds in the Project Area, and provision of advice and assistance about control/eradication.

A strategy for public access through the conservation areas would be developed. Areas in and around the Project Area are currently utilised for recreational and, in the case of Miriung and Gajerrong people, cultural purposes; however, with improved access, the incidence of human impact could increase as a result of the proposed development. Signage about the Project Area and surrounds, and defined roads or tracks to the more popular areas, should assist with management. At popular areas (e.g. Keep River) camping grounds complete with composting toilets would need to be established.

Rehabilitation of any sites disturbed during the proposed development would be undertaken progressively. Areas disturbed during development of the infrastructure would be rehabilitated as each stage of the work is completed, particularly those drainage channels designated as conservation-vegetation corridors.

Where possible, topsoil would be utilised immediately or removed and stockpiled for later use on disturbed areas. Once the development was complete, the topsoil would be spread over the disturbed areas, allowing seeds and root stock stored in the soil to germinate and become established. Active reseeding of some areas would also take place.

A seed collection programme would be undertaken before vegetation is cleared. A seed mix appropriate to the area to be rehabilitated would be prepared and scattered over the disturbed areas. Alternatively, seedlings could be germinated and planted out at the commencement of the wet season. Only seeds of plant species endemic to the Project Area would be used in revegetation projects.

11 LAND USE

Grazing of cattle for beef production is a major local industry and more than half of the Kununurra-Wyndham area is used for pastoral activities. The Project Area has been utilised for pastoral activities for approximately one hundred years. Pastoral leases associated with Ivanhoe Station in Western Australia, and Legune and Spirit Hills stations in the Northern Territory, cover most of the Project Area.

Leasehold improvements made in the Project Area include fencing, holding yards, gates, groundwater bores, tanks, small dams and aircraft landing strips.

A number of rubbish dumps also exist and some areas have been quarried to provide road construction materials.

A limited amount of mining exploration occurs in the region. In the recent past, exploration for alluvial diamonds was conducted in the west Ivanhoe area. Deposits of lead, zinc and silver are known to exist at Sorby Hills, north-east of the Pincombe Range, but as yet the deposit has not proved sufficiently attractive for commercial development. The Weaber Gas Field, situated at the southern end of the Keep River Plain, is not commercially exploited at the present time.

A Kununurra-Wyndham Area Development Strategy is being developed by the Ministry for Planning and the Kimberley Development Commission with assistance from the Shire of Wyndham-East Kimberley and the Department of Lands, Planning and Environment. The aim of the strategy is to assess the regional planning implications arising from potential future development of the Project Area and other regional developments.

Land tenure within the Project Area

The Project Area is impacted by native title and land rights claims in Western Australia and the Northern Territory. The approach taken by Wesfarmers-Marubeni and the Water Corporation with respect to native title and land rights issues in the Project Area is for resolution of land issues by way of a negotiated settlement with Miriuwung and Gajerrong people.

The preferred land tenure for the various portions of the Project Area would vary depending upon the intended use. Wesfarmers-Marubeni would seek freehold title on land proposed for farms, the sugar mill, and the construction camp. The Water Corporation would seek freehold title on land to be developed for the purposes of irrigation infrastructure. It is envisaged that land required for public roads, communication sites and associated infrastructure would be special-purpose reserves vested in Government.

A feature of the proposed development would be the establishment of conservation areas within the farmed area, and around the perimeter of the farmed area. These conservation areas would be established to ensure that significant habitats and cultural heritage sites are protected and maintained. The proposed conservation areas would be managed by the EME.

It is envisaged that access to the portion of the Keep River within the proposed conservation area would remain open, and designated recreation sites for fishing and picnicking purposes would be established. Access to the remainder of the proposed conservation area may be restricted, where considered appropriate, to control erosion and weeds as well as to protect the regeneration of the flora and fauna habitats.

Land-use impacts and mitigation measures

Pastoral activities would be inconsistent with the proposed broad-acre agriculture, and displacement and severance of pastoral activities would be an unavoidable consequence of the Project proceeding. Pastoral activities within the Project Area would progressively be scaled down; however, the areas involved would be relatively small in comparison

with the existing pastoral leases. The boundary of the Project Area would be fenced, where appropriate, to prevent ingress of cattle.

Development of roads would lead to improved access between Kununurra and the Project Area. However, it is recognised that road development may also have perceived negative impacts resulting from an increase in human impact in and around the Project Area. Project development would include road signage to limit human movement where considered appropriate.

Northern Australia has become an increasingly popular holiday destination for Australian and international tourists because of the region's scenic beauty, unique landforms, and relaxed and distinctively Australian lifestyle. Tourism is to some extent a seasonal industry, with an estimated 60% of tourists arriving between April and November when temperatures are relatively low. It is likely that regional tourism and recreation area usage will continue to increase whether or not the Project proceeds. However, it is anticipated that improved infrastructure and services such as roads and accommodation that would result from the proposed development would lead to increased tourist numbers and to longer sojourns.

12 ISSUES SPECIFIC TO MIRIUWUNG AND GAJERRONG PEOPLE

The land encompassing the Ord and Keep rivers, including the Project Area, is of traditional and current significance to Miriuwung and Gajerrong people.

Historical overview

The introduction of the pastoral industry in the East Kimberley resulted in a diminished opportunity for Aboriginal people to maintain their traditional lifestyle. Many Aboriginal people worked on the pastoral stations and were still able to practise their traditional lifestyle, conduct ceremonies, hunt and to visit country on weekends and during the wet season. However, the advent of equal wages for Aboriginal people in 1969 in the pastoral industry dramatically decreased Aboriginal employment. This in turn resulted in the relocation of Aboriginal people from the pastoral stations into towns such as Wyndham and the newly established Kununurra.

The early development of the ORIA Scheme occurred at a time when there was no legal requirement to formally consult with, or consider, Aboriginal issues. In recent years, Aboriginal people have actively sought to have their traditional rights recognised, to participate in the economic development process, and to share in the benefits of economic development.

Consultation with Miriuwung and Gajerrong people

Consultation with Miriuwung and Gajerrong people in relation to the potential ORIA Stage 2 developments began in 1995.

The Western Australian Government undertook consultations with Miriuwung and Gajerrong people from 1995 to 1998. Since 1998, Wesfarmers-Marubeni and the Water Corporation have taken over the lead role in consultation with respect to the Project Area, after being awarded an exclusive mandate in April 1998 to investigate the viability of the development of the Project Area.

Wesfarmers-Marubeni and the Water Corporation recognise the need to establish a working relationship with the Aboriginal community. Extensive consultation is ongoing with Miriuwung and Gajerrong people, as well as with the Aboriginal representative bodies - the Aboriginal Legal Service, the Kimberley Land Council and the Northern Land Council.

Wesfarmers-Marubeni and the Water Corporation have established a community relations team of three staff to facilitate ongoing communication with Miriuwung and Gajerrong people in relation to the proposed development. Two members of the team reside permanently in Kununurra.

Native title and land claims

Miriuwung and Gajerrong people lodged three native title claims over a significant portion of the East Kimberley in Western Australia and the Northern Territory, in 1994 and 1995. The claims cover the entire Project Area.

Unlike Western Australia, the Northern Territory has an additional legislative procedure by which Aboriginal people can claim land - the Aboriginal Land Rights (Northern Territory) Act 1976 (ALRA). In 1997, the Legune Area Land Claim was lodged on behalf of Miriuwung and Gajerrong people, and this claim affects the portion of the Project Area within the Spirit Hills Pastoral Lease.

In 1998, the Federal Court of Australia determined that Miriuwung and Gajerrong people hold native title rights to an area of land the subject of the first of the three native title claims. The determination area covers approximately 7,900 square kilometres and includes the Ord River, Lake Argyle and approximately 100 square kilometres of the Project Area.

For land which is the subject of a native title determination or land which is the subject of a native title claim, the native title holders and claimants may voluntarily surrender their native title rights and interests by way of a negotiated settlement. Such a negotiated settlement is known as an Indigenous Land Use Agreement (ILUA). Typically, parties to an ILUA can include Aboriginal native title holders and claimants, Aboriginal representative bodies, project proponents and Governments. Mutually agreed benefits packages for the native title holders and claimants are a key element of any ILUA, in return for the voluntary surrender of native title rights and interests over the land, thereby enabling development to occur.

The proposed development could not occur until all native title issues over the Project Area are resolved. The preferred approach of Wesfarmers-Marubeni and the Water Corporation is to resolve all native title issues in relation to the Project Area by concluding an ILUA with Miriuwung and Gajerrong people. Resolution of the native title issues by way of an ILUA is considered to be the most equitable way of securing access to land in the Project Area, and the most pragmatic approach to a timely resolution of the issues.

Cultural heritage

Miriuwung and Gajerrong people have strong social and cultural links to each other and to their traditional land.

There have been a number of cultural heritage assessments undertaken in the broader region both by independent consultants and by Government officers. However, to date, there has been no comprehensive ethnographic or archaeological assessment of the Western Australian portion of the Project Area, encompassing the Weaber and the Knox Creek plains. There has, however, been a comprehensive ethnographic assessment (sacred site survey) of the Northern Territory portion of the proposed farmland by the Aboriginal Areas Protection Authority. Also, a comprehensive archaeological assessment has been undertaken of the same land by the Department of Lands, Planning and Environment.

Cultural heritage sites are protected by State, Territory and Commonwealth legislation. Wesfarmers-Marubeni and the Water Corporation are committed to ensuring compliance with relevant State, Territory and Commonwealth heritage legislation, as well as to meeting the expectations of Miriuwung and Gajerrong people in respect to the protection of cultural heritage.

In 1998 and 1999, Wesfarmers-Marubeni and the Water Corporation formally consulted the relevant Western Australian, Northern Territory and Commonwealth Government departments with respect to the location, spatial dimensions and significance of known cultural heritage sites within the Project Area. The available information on cultural heritage sites provided by the various Government agencies was overlaid on topographic plans of the Project Area.

The proposed project design, including the farmland, the irrigation channels, drains and roads as well as the potential sugar mill sites, was superimposed on the plans to ascertain whether any known cultural heritage sites would be affected by the initial design. This exercise revealed that five ethnographic sites may potentially be affected, and the proposed design was modified to ensure that these sites would not be disturbed.

A predictive model has indicated that land units classified as having moderate archaeological sensitivity could be expected on 4% of the land. Land units classified as having high to very high archaeological sensitivity could be expected on 4% of the land; however, this land would not be developed for agricultural purposes. The remaining 92% of the land could be expected to be of low archaeological significance and would be unlikely to contain significant archaeological sites. The predictive model was validated during the archaeological assessment undertaken within the Project Area in October 1998.

Due to time constraints, a single cultural heritage assessment of the entire Project Area was not completed in the 1998 dry season. However, time permitted the completion of an assessment of cultural heritage issues with respect to a programme of investigatory geotechnical works. The assessment was co-ordinated by the Kimberley Land Council and the Northern Land Council, and was completed on:

- a 50 metre wide corridor approximately 400 kilometres length within which proposed irrigation channels, drains, levees and roads would be located;
- six potential sugar mill sites.

As a result of the assessment, the proposed alignment of the M2 Channel adjacent to Cave Springs has been re-designed, and four of the original six potential sugar mill sites have been discarded from further consideration.

A further cultural heritage assessment would be required within and around the Project Area prior to the commencement of the proposed development.

It is proposed that the findings of the cultural heritage assessments would support the development of a Cultural Heritage Management Plan, which would define how the cultural heritage values within the Project Area would be protected and managed for the life of the Project.

Aboriginal social impact

Over the last twenty-five years there have been a number of studies into the social and economic impact on Aboriginal people in the East Kimberley region as a result of pastoral, agricultural and mining development. Significant studies completed to date have been commissioned by the Kimberley Land Council and the State and Commonwealth Governments.

Research has found that Aboriginal people in the region had experienced a series of significant changes in the 1960s and early 1970s. These changes have included the introduction of equal wages, the increased reliance on capital intensive investment in the pastoral industry, and the establishment of ORIA Stage 1. All the changes have led to some dislocation of Aboriginal communities and consequent social disruption.

The Kimberley Land Council has noted potential economic opportunities for Aboriginal people in relation to the proposed development. In July 1998, over 300 people attended a conference, co-ordinated by the Kimberley Land Council, entitled 'The Kimberley - Our Place, Our Future'. In the conference proceedings, it was stated that 'major opportunities in the region include the expansion of tourism, the full development of the Ord River irrigation area, the expansion of pearling, and the development of a capacity to process meat'.

Wesfarmers-Marubeni and the Water Corporation are to address Aboriginal social impact issues through the completion of an Aboriginal Socio-Economic Impact Assessment (ASEIA) in relation to the Project. Completion of an ASEIA is not a legal requirement for Wesfarmers-Marubeni and the Water Corporation; however, it is considered likely that completion of an ASEIA would provide a valuable insight into the social and economic expectations, and any concerns, held by Miriuwung and Gajerrong people in relation to the proposed development. As a consequence, it is likely that completion of an ASEIA would assist all parties in the negotiation and settlement of an ILUA.

The aim of the ASEIA is to provide sufficient information about the proposed development to Miriuwung and Gajerrong people to enable them to identify and assess

any potential resultant impact. The objective of the ASEIA is to ensure that any potential impact from the proposed development is assessed with respect to:

- a Miriwung and Gajerrong understanding of country, the use of land and access to culturally important areas and landscapes in and around the proposed development;
- any impact on the ability of Miriwung and Gajerrong people to live in accordance with their own values, traditions and aspirations;
- any impact on community structures and vitality, and economic vitality;
- historical and current responses to previous developments in the region;
- the preferred outcomes of Miriwung and Gajerrong people regarding the proposed development;
- the maximisation of potential positive impacts and the mitigation of any potential negative impacts.

13 AIR QUALITY AND NOISE

Dust

It is inevitable that dust would be generated during construction, predominantly from the earthworks associated with the development of farm blocks, service roads, irrigation channels and drains.

The impact of dust on the local community from construction activities would be mitigated by the remoteness of the Project Area from existing residences. An exception relates to the proximity of a section of the proposed M2 Channel, which in some areas is within 300 metres of permanent residences. These residences are located south of the M2 Channel alignment and, therefore, would be predominantly upwind of the construction activity.

Smoke and ash

Existing growers in ORIA Stage 1 have adopted cane-burning prior to harvest, and this practice is considered the preferred method for the Project. Occasional complaints associated with smoke and cane ash fallout have been lodged with local Government regulatory agencies. Changing production practices to green-cane harvesting (which does not involve cane-burning prior to harvest) in ORIA Stage 1 has been investigated in the past and not adopted for a variety of reasons, including the subsequent difficulties that may be experienced in relation to flood irrigation of the crop.

The remoteness of the Project Area from existing communities - some 30 kilometres north-east of Kununurra - would mitigate any potential effects arising from cane-burning.

The sugar mill would primarily be powered by energy from the burning of bagasse in a boiler. Emissions to the atmosphere would consist of the normal products of combustion

from the boiler chimney and the water vapour from cooling towers and steam safety valves.

It is envisaged that the boiler would be operated continuously during the crop harvesting season.

Prior to discharge from the boiler chimney the gases would be passed through a scrubber to ensure that particulate levels conform with relevant emissions guidelines.

Greenhouse gas emissions

It is estimated that the proposed development would result in a net decrease in Australian greenhouse gas emissions. The reduction, whilst not significant on a global scale, would be consistent with commitments made by the Commonwealth Government under the Kyoto Protocol in 1997.

Project development would entail removal of approximately 35,000 hectares of the existing vegetation cover of grass and sparse trees, and replacement of much of that area with agricultural farmland. The principal crop would be sugarcane, a perennial grass that would be grown on most of the farm area. The amount of carbon stored in the Project Area in both the existing and the proposed scenarios would vary seasonally. However, it is estimated that the minimum carbon stored would increase following development, from about 19,500 tonnes to about 670,000 tonnes at full development. Most of the increase would be from the growth of sugarcane during the dry season following progressive harvesting of the crop. The estimate includes the effects of burning of the sugarcane prior to harvest, and includes the carbon content in the raw sugar and molasses that would be in storage at the end of the dry season.

It is estimated that the proposed development would result in a net reduction of the level of carbon dioxide (a greenhouse gas) in the atmosphere, through the storage of carbon dioxide as carbon within the sugarcane once the Project has reached full production. The estimates indicate that the magnitude of the reduction on an ongoing basis would be approximately 160,000 tonnes per annum of carbon dioxide equivalent carbon.

Noise

The Project Area is currently typical of isolated rural areas with respect to a general absence of development and low ambient noise levels.

Noise would be generated during construction from large earth-moving machinery associated with earthworks, land-clearing and levelling. Noise would also be generated at construction sites (e.g. at the sugar mill) and from general vehicle movements. The main noise-generating activity of the Project, such as noise created at the sugar mill and as part of farming and transportation operations, would occur at distances of 30-80 kilometres from Kununurra and, under these circumstances, would have negligible effect on existing residences.

Construction work associated with the proposed M2 Channel may at times be within 300 metres of existing residences. Management measures, such as controlling the hours of

construction activities, would be adopted to mitigate any potential adverse impacts on these residences.

14 PUBLIC HEALTH

Mosquito-borne diseases

The flavivirus that causes Murray Valley or Australian encephalitis, and the alphavirus that causes Ross River fever, are the two most important pathogenic arboviruses causing human disease in Australia. The mosquito *Culex annulirostris* is an important vector in the transmission of both the Murray Valley encephalitis and the Ross River virus. *Culex annulirostris* breeds in fresh water and is the predominant species of mosquito found in the Ord River area.

Australian encephalitis is potentially fatal. The Murray Valley encephalitis virus is recognised as the main aetiological agent of Australian encephalitis, although a few cases are caused by the closely related Kunjin virus.

The disease caused by Ross River virus is much more common than Australian encephalitis. Although, it is debilitating, it is fortunately not fatal to its victims. However, the symptoms can persist for many months or even years. Ross River virus is one of the most frequently isolated arboviruses in Australia and has been obtained from more than thirty species of mosquito in six genera. Recently, the north-east Kimberley region was identified as having the highest case attack rate of Ross River virus in Australia.

Since 1972 the Arbovirus Surveillance Laboratory at the University of Western Australia has been monitoring mosquito populations in the Kimberley region. In 1981 the first sentinel chicken surveillance flock was established and by 1989 the number of flocks had increased to twenty-four throughout the Kimberley, Pilbara and Gascoyne regions. Similar sentinel programmes were established in 1992 in the Northern Territory. These programmes have shown that Murray Valley encephalitis virus is enzootic (always present) in several areas of the Kimberley, particularly in the Ord River area.

Management action would be taken in conjunction with the proposed development to reduce the risk of increased infection with arboviruses. These actions would concentrate upon the following activities:

- designing and operating the Project so as to reduce the potential for increased mosquito-breeding activity;
- designing education programmes for the Project's construction and operational workforce on measures that could be taken to reduce their personal risk of infection;
- extending the existing monitoring programmes to cover the Project Area.

Farm chemicals in the environment

Development of land for farming purposes is generally associated with an increased use of agricultural chemicals. In some instances the use of farm chemicals has led to conflicts with adjacent land users, particularly if there have been any concerns regarding possible health effects on the surrounding community from exposure to the chemicals.

The public health issues associated with the use of agricultural chemicals in the Project Area would be mitigated by the absence of other intensive land uses nearby and by the dominance of sugarcane cultivation, which has minimal chemical requirements for successful growth. However, management measures are proposed in relation to the issue of farm chemicals and the environment.

Commonwealth, Territory and State Governments, and industry regulations in relation to the handling and use of agricultural chemicals would be implemented throughout the Project Area to reduce any risk to public health. Management measures to minimise potential health impacts outside the Project Area would focus on reducing chemical use and controlling the main transport mechanisms.

Wherever possible, any application of chemicals within the Project Area would be from tractor-drawn boom-sprays. The proposed technology would result in relatively large spray droplets being released close to the ground in order to minimise potential for spray drift. For any aerial-spraying, only operators who have successfully undertaken the pilot accreditation programme of the Aerial Agricultural Association of Australia would be utilised, and the timing and manner of application would be carefully chosen to minimise spray drift.

The risk of transporting chemicals from the Project Area in surface water to adjacent areas would be minimised through the on-farm water management systems. Similarly, the low chemical requirements for sugarcane cultivation, combined with the prevalence of heavy soils which are known to impede the transport of chemicals through the soil, suggest that contamination of groundwater in the Project Area by agricultural chemicals is unlikely. Nonetheless, as an additional precaution, groundwater supplies would be monitored on a regular basis for all chemicals used in the Project Area to ensure compliance with relevant criteria.

15 COMMUNITY ISSUES

Existing social environment

The nearest population centres to the Project Area are the towns of Kununurra (approximately 30 kilometres south-west of the easternmost extremity of the Project Area) and Wyndham (approximately 100 kilometres west of Kununurra). Both towns are in the Shire of Wyndham-East Kimberley, within the Kimberley region of Western Australia. The nearest population centres in the Northern Territory are the settlement of Timber Creek and the town of Katherine, respectively around 220 kilometres and 510 kilometres east of Kununurra.

In 1996, the Kimberley region had an estimated population of around 25,000, which is approximately 1.5% of Western Australia's population. Three-quarters of the Kimberley population reside in urban centres. The remaining one-quarter is spread throughout twenty relatively large and sixty smaller Aboriginal communities, 100 pastoral stations, seven mining sites and in the farm area of ORIA Stage 1.

About one-quarter of the Aboriginal population of Western Australia lives in the Kimberley region, and Aboriginal people comprise about 34% of the total population of the Shire of Wyndham-East Kimberley.

The Aboriginal and non-Aboriginal populations display very different demographic and settlement trends.

The Aboriginal population is demographically stable, relatively young (40% under fifteen years of age), and has a well-balanced gender ratio. By comparison the non-Aboriginal population is more transient, is 56% male, and has a higher representation of persons aged between twenty-five and fifty-four years.

A comparison of socio-economic indicators shows that, in 1996, Kununurra was more affluent than the Kimberley as a whole, and that Kununurra had a lower unemployment rate than the Western Australian average.

Existing regional economy

The dominant industries in the Kimberley region are mining, aquaculture and fishing, tourism, irrigated agriculture and pastoralism. Whilst mining dominates in terms of gross domestic value, the fly-in/fly-out component of some of the operations has limited the regional economic flow-on effect.

The pastoral industry and irrigated agricultural operations are the two major activities contributing to agricultural production in the region. Irrigated agricultural production has increased significantly in recent years; it is based predominantly on horticultural and broad-acre crops grown in the ORIA near Kununurra and also includes smaller agricultural holdings near Broome and Derby. The pastoral industry is based on rangeland production of beef cattle, which are predominately exported live from the region.

Tourism has become a major industry in the Kimberley with the region's scenic beauty and unique landforms being important drawcards for tourists.

Workforce and population projections

The estimated direct workforce required for the proposed development would be approximately 550 full-time equivalent positions. This estimate includes employment on the corporate and independent farms, in the sugar mill, in harvest and transport operations, in water supply operations, in environmental management, and in management and administration.

Project planning is based upon an estimated indirect workforce of seventy-five people and an induced workforce of 200. Indirect employment refers to jobs in businesses supplying goods and services to the agriculture sector. Induced employment refers to

jobs created by the personal consumption and associated activities of people employed directly and indirectly in the agriculture sector.

It is anticipated that the numbers of construction personnel would range from 250 to 650 per annum over a three-year period. Whilst many construction workers would be sourced locally, it is anticipated that the majority would originate from outside the Kimberley region and would be accommodated in a self-contained construction camp in the centre of the Project Area.

The construction camp would initially be developed to accommodate approximately 650 construction workers at any one time, all with 'single' status. At the completion of construction, the construction camp may be reconfigured, to yield in approximately 200 single accommodation units that could be used by seasonal workers during the operational phase of the Project.

The estimates of net population increase in Kununurra range from 1,397 persons to 1,954 persons. The range in the estimate results from some uncertainty regarding the anticipated level of employment of people currently living in Kununurra but who are currently unemployed.

Social impact assessment

The Kununurra-Wyndham Area Development Strategy (KWADS) is in the final stages of preparation by the Ministry for Planning and the Kimberley Development Commission. KWADS is intended to provide direction for the long-term use and management of land in the Kununurra-Wyndham area. It will also promote further co-ordination of activities and initiatives of community, private enterprise and Government agencies with responsibilities in the area.

Of importance to the Project is that the KWADS is to consider the land-use planning and infrastructure needs of the Kununurra-Wyndham area in the context of further development of ORIA Stage 2, including the proposed development of the Project Area. KWADS should provide a sound basis for statutory authorities to plan the long-term provision of services in the area, including any significant expansion of Kununurra.

There may be a need for between 500 and 700 new dwellings to be constructed as a result of the proposed development. The 200 single units that may remain operational in the construction camp following the end of project construction activities may meet part of this requirement. It is envisaged that the remainder of the Project's accommodation requirements would be serviced by the township of Kununurra. Sufficient residential lots in the undeveloped portion of the existing Lakeside subdivision and the proposed Hidden Valley subdivision are available for the building of over 600 additional houses and flats, which would be sufficient to meet the accommodation requirements associated with the proposed development.

The central hospital facility in the East Kimberley is the Kununurra Hospital, which has twenty-six beds and an existing average demand of around twenty-two beds. The influence of the proposed development and other ORIA Stage 2 developments has been factored into the planning requirements of the Kununurra Hospital. Plans exist to add

another ten beds to the hospital to accommodate any increase in demand for hospital services from anticipated growth.

It is likely that the East Kimberley Aboriginal Medical Service may be required to service a larger patient load due to a significant increase in the non-Aboriginal population in Kununurra. Currently, more than 30% of the patients using the service are non-Aboriginal. Increased resource allocations or changed policies on access to the clinic in Kununurra may be required to maintain the current level of provision of medical services to Aboriginal patients.

Kununurra has two schools: Kununurra District High School (pre-primary to Year 12) and St Joseph's Catholic Primary School, which mainly caters for Aboriginal students of pre-primary and primary age. Currently there is no senior high school in either Kununurra or Wyndham. The anticipated population growth and projected increase in enrolments may necessitate development of another combined pre-school and primary school. The population growth may also precipitate an upgrade of the Kununurra District High School to a senior high school, an initiative that would be welcomed by the local community.

Given the importance of the local waterways for both recreational and lifestyle purposes, the maintenance of access to the waterways is an important social impact issue. This is particularly true for the local Aboriginal community for whom access to the riverbanks and the water is of socio-cultural importance. The Project has been designed in such a way that access to the Keep River would be maintained. The proposed development would have no impact on access to the Ord River.

As the majority of construction personnel would be accommodated in a construction camp at the centre of the Project Area, the social impact of this workforce on the people and facilities of Kununurra is expected to be minimal. A high standard of amenities would be provided at the construction camp, including recreation and entertainment facilities, thereby limiting the need for construction workers to travel to Kununurra on a daily basis. However, it is likely that during the construction phase, additional custom would be generated for local businesses.

Community consultation

Significant community consultation has been undertaken in relation to the proposed development.

Community consultation relating to the Project commenced in 1996 on behalf of the Department of Resources Development and continued in 1998-99, during preparation of the ERMP/draft EIS. These consultation activities have included the use of a range of media outlets, brochures, public displays and meetings, and direct consultations.

A resident community relations team was established by Wesfarmers-Marubeni and the Water Corporation in Kununurra in mid-1998. The role of the team is to keep the local community informed on issues arising from the development of the Project on a regular basis. This team is supported by regular visits by other staff of Wesfarmers-Marubeni and the Water Corporation and their consultants.

Consultation with local Aboriginal people has been extensive during 1998-99 and is ongoing. This consultation has been facilitated by the community relations team, and has included regular presentations given to the local community.

Environmental management framework

The need for an environmental management framework

The proposed development has a number of distinctive characteristics relevant to ongoing environmental management. These include:

- a Project Area that is relatively large and would include related but discrete activities such as the supply of irrigation water, farming and processing;
- a farmed area which would be predominantly developed and operated by Wesfarmers-Marubeni in the initial phase but perhaps sold down in part or whole to independent farmers in the future;
- a Project Area that straddles the border between Western Australia and the Northern Territory, which may induce cross border issues with respect to environmental compliance legislation;
- the legal recognition of Miriuwung and Gajerrong native title rights over a portion of the Project Area and the existence of native title claims over the balance of the Project Area;
- high community expectations with regard to environmental management.

To address these characteristics Wesfarmers-Marubeni and the Water Corporation consider it appropriate that an environmental management framework should be developed for utilisation throughout the construction and operational phases of the proposed development. Key elements of such a framework should:

- be structured to suit the proposed development and be site specific;
- clearly and transparently articulate environmental responsibilities and accountability;
- accommodate the need for ongoing environmental monitoring and reporting;
- be appropriately resourced over the long term.

Relevant legislative issues

As the Project Area straddles the border between Western Australia and the Northern Territory, the proposed development would be subject to a range of State and Territory legislation. Similarities and differences currently exist with respect to relevant State and Territory legislation applicable to the proposed development. For example, the portion of the proposed development within Western Australia would currently be subject to the Environmental Protection Act 1986, and the portion within the Territory would be subject to the Environmental Assessment Act 1994. Whilst the effect of each Act is substantially similar, differences exist which could give rise to complications during the development and operational phases of the Project.

To address any potential complications which may arise from legislative issues, the State and Territory Governments have undertaken to form a Ministerial Council. The Ministerial Council is to comprise a Minister from each of the State and Territory Governments, and would oversee the recommendation and adoption of appropriate legislation to be applicable over the Project Area.

The development of an environmental management framework

To assist in the conceptual development of an environmental management framework for the Project Area, a review of environmental frameworks currently being implemented in a number of irrigation areas throughout Australia has been completed. It was noted that most of the environmental management frameworks currently operational in Australia have been developed to 'retrofit' existing operations. Furthermore, the industry being retrofitted was often characterised by a relatively large number of participants, ranging from small-scale operators to government agencies. As a consequence, and to balance existing and often competing interests, the environmental frameworks were relatively complex and involved significant government intervention.

In contrast to many existing irrigation schemes, the proposed development is to be characterised by the involvement of three large and reputable organisations - Wesfarmers, Marubeni and the Water Corporation - rather than a relatively large number of small-scale operators. This factor has been taken into consideration in the development of a conceptual framework for environmental management, in addition to the analysis of existing environmental frameworks in operation in Australia, and the distinctive characteristics of the proposed development.

It is the view of Wesfarmers-Marubeni and the Water Corporation that the nature of the proposed development, including the proposed industry structure, and the perceived key elements of an effective environmental management framework lend themselves to industry self-management.

Outline of the proposed environmental management framework

The proposed development would comprise three core industry activities:

- the development and operation of irrigated farmland, predominantly for the purpose of growing sugarcane;
- the development and operation of a raw-sugar mill;
- the development and operation of irrigation and drainage infrastructure.

It is envisaged that any environmental conditions laid down by the Minister for the Environment would be assigned to the owners of the respective key assets, and it would follow that each of the asset owners would have environmental responsibilities and obligations under the relevant environmental management.

Due to the interrelated nature of the core industry activities, Wesfarmers-Marubeni and the Water Corporation propose that an entity be established to shoulder the operational aspects of ongoing environmental management in relation to the proposed development on behalf of the industry participants.

The proposed entity, or EME, would be owned by the industry participants, and would provide environmental management services to the owners. Key features of the proposed EME would be as follows:

- The EME would be wholly owned by the industry participants, including all three core industry participants.
- The key objective of the EME would be the management of environmental issues within the entire Project Area, on behalf of the industry participants.
- The EME would be responsible for aspects such as ongoing monitoring, analysis, and reporting on behalf of industry within the proposed development - but legal responsibility for environmental compliance would rest with the individual asset owners.
- The EME would be the focal point for community input in relation to environmental issues in relation to the proposed development.
- The EME would be resourced by the industry participants within the proposed development.

An important aspect of the environmental management framework is the implication, if any, of future transfer of asset ownership. It is envisaged responsibility for legal and statutory environmental compliance would rest with the relevant individual asset owners. Assignment of an interest in any asset, in part or whole, would involve the transfer of legal or statutory environmental compliance responsibility to the new owner. It is also planned that shareholder rights and obligations with respect to the EME would be assigned to the asset, and flow with any asset transfer.

Table of Environmental Factors Relevant to the Project

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
Biophysical						
Biodiversity	Ecosystems	To maintain biological diversity meaning the different plants and animals and the ecosystems they form, at the levels of genetic diversity. Species diversity and ecosystem diversity	The Project is located within the Victoria–Bonaparte Biogeographic Region. This biogeographic region extends over 72,972 km ² and includes land in the Northern Territory and Western Australia. Approximately 13% of this biogeographic region are currently in conservation reserves. The Project Area would extend over 75,760 hectares of land currently used for pastoral purposes, and include approximately 34,800 hectares that would be developed for irrigated agriculture and infrastructure, and 40,960 hectares that would be managed for conservation. The proposed development would take place predominately on the black-soil plains. These cracking clays are typically dominated by savanna woodland, a homogenous habitat consisting of Bauhinia woodland, eucalypt woodland and grassland. Habitats associated with black soils are widespread in the Kimberley and the Northern Territory. The Project Area would also include riparian vegetation and habitats (riverine woodland and vine thicket) associated with watercourses, billabongs and wetlands, and large areas of rock outcrops. Habitats associated with riparian areas and rock outcrops are also widespread in the Kimberley and the Northern Territory.	Clearing of approximately 34,800 hectares of vegetation predominantly associated with cracking clays of the black soil plains within the Project Area. The remainder of the Project Area would be managed for conservation. The ERMP/EIS identifies the opportunities for land adjacent to the Project Area, currently used for pastoral purposes, to be added to the conservation estate by Government as a consequence of the Project proceeding.	The project development plan contains features to mitigate the consequences of vegetation clearing and to ensure maintenance of biodiversity in the region. These features include: <ul style="list-style-type: none"> the provision of dedicated conservation areas within the Project Area; the maintenance of riparian vegetation along watercourses and permanent waterbodies, including provision of buffer zones between these and development areas. the provision of corridors for the movement of fauna, between areas set aside for conservation and the surrounding undeveloped country. the provision of a buffer zone nominally 1,500 m wide around the farm areas. the active management of all conservation areas, buffer zones and, wherever possible, infrastructure corridors for the purpose of conservation. As a minimum, management of the areas would include removal of stock, control of access, monitoring and control for weeds and introduced species, and monitoring of environmental and ecological parameters. 	The proposed conservation areas contain vegetation assemblages that are representative of those found in the Project Area, as well as flora and fauna identified as having regional conservation significance. Black soil plains, the predominant soil type targeted for development, would have approximately 25% of its extent in the Project Area retained and managed for conservation. The EPA’s objectives can be met by conserving and managing viable ecosystems <i>in-situ</i> . Implementation of opportunities to add to the conservation estate would significantly enhance the maintenance of biodiversity within the Victoria–Bonaparte Biogeographic Region.
Terrestrial flora	Vegetation communities	Maintain the species diversity, geographic distribution and productivity of vegetation communities.	A total of seventy-two vegetation communities within seventeen major groups are recognised for the Project Area. The Keep River Plain has extensive areas of grassland with no, or only a few, scattered trees, which include <i>Eucalyptus microtheca</i> , <i>Corymbia bella</i> , <i>Excoecaria parvifolia</i> , <i>Acacia ditricha</i> and <i>Bauhinia cunninghamii</i> . The vegetation of the Knox Creek Plain is predominantly grassland with emergent to dense low trees dominated by <i>Eucalyptus microtheca</i> , <i>Excoecaria parvifolia</i> , <i>Atalaya hemiglauca</i> and <i>Bauhinia cunninghamii</i> . The Weaber Plain is a grassland with emergent trees dominated by <i>Eucalyptus microtheca</i> , <i>Excoecaria parvifolia</i> and <i>Terminalia obovata</i> subsp. <i>volucris</i> . Sections of the Weaber Plain retain water for longer periods and have grassland species associated with wetter areas (e.g. <i>Oryza australiensis</i> and <i>Ophiuros exaltatus</i>). The only association of restricted distribution in the Project Area is a <i>Echinochloa kimberleyensis</i> dominated swamp near the foothills of the Weaber Range. No threatened communities covered by the <i>Endangered Species Protection Act 1992</i> occur in the area. Two currently unreserved or poorly reserved vegetation associations in the Victoria–Bonaparte Biogeographic Region in the Northern Territory— <i>melaleuca minutifolia</i> low woodland and <i>Xerochloa</i> grasslands occur in the Project Area.	The proposed development would require clearing of approximately 34,800 hectares of predominately black-soil plains. These cracking clays are typically dominated by savanna woodland, a homogenous habitat consisting of Bauhinia woodland, eucalypt woodland and grassland. Approximately 40,960 hectares of land within the Project Area, comprising black soil plains and all of the riparian areas and rock outcrops would be managed for conservation. Grazing pressure from stock would be removed from the conservation areas. These areas would also be monitored and managed for weeds. The <i>Echinochloa kimberleyensis</i> dominated swamp and the <i>Xerochloa</i> grasslands that occur within the Project Area would be located entirely within areas to be conserved. Approximately 293 hectares of <i>melaleuca minutifolia</i> low woodland would be subject to development while approximately 262 hectares would be located within conservation areas within the Project Area.	The environmental management proposed for this factor is described above under the factor of biodiversity.	The EPA’s objectives can be met with the project development plan by conserving and managing viable representative areas of vegetation communities that occur in the Project Area. All of the vegetation communities associated with riparian areas, including the <i>Echinochloa kimberleyensis</i> swamp near the foothills of the Weaber Range, and rock outcrops would be conserved to their full extent in the Project Area. The area of <i>melaleuca minutifolia</i> low woodland and <i>Xerochloa</i> grasslands conserved in the Northern Territory would increase. The biodiversity and health of vegetation associations in the conservation areas should improve with removal of cattle and management for conservation.
	Declared Rare and Priority Flora	Protect Declared Rare and Priority Flora, consistent with the provisions of the WA Wildlife Conservation Act 1950 and other relevant State, Northern Territory and Commonwealth legislation.	The Project Area is known to contain no Declared Rare Flora and 4 Priority Flora listed by the Western Australia Government and thirteen 3r flora and one insufficiently known nationally flora listed by the Northern Territory Governments. The Northern Territory list includes three taxa listed as being restricted in Central Australia but common throughout the remainder of the Territory. One taxon located in the Project Area—a grass (<i>Lepturus</i> sp. Mataranka ST Blake 17154)—is also listed by the Australian New Zealand Environment and Conservation Council Flora List as being endangered (Environment Australia 1999). Only four of the listed taxa have been recorded as only	Reduction in size of ecosystems for those species that occur on cracking clay soils. Approximately 25% of the cracking clay soils in the Project Area would be retained and managed for conservation. Grazing pressure from stock would be removed from the conservation areas. These areas would also be monitored and managed for weeds. The area known for the species <i>Lepturus</i> sp. Mataranka would be included in a conservation area.	The environmental management proposed for this factor is described above under the factor of biodiversity	The EPA’s objectives can be met with the project development plan.

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
			occurring on cracking clay soils. Another seven taxa are known to occur on cracking clay soils as well as other soils while eight taxa have not been recorded on cracking clay soils.			
Estuarine flora	Estuarine flora	Maintain the ecological function, abundance, species diversity and geographic distribution of estuarine and marine flora.	A number of species of mangrove are known to occur along the Keep River: <i>Avicennia marina</i> (white mangrove), <i>Bruguiera exaristata</i> (ribbed-fruited orange mangrove), <i>Ceriops tagal</i> var. <i>australis</i> (yellow mangrove), <i>Rhizophora stylosa</i> (red mangrove) and <i>Xylocarpus moluccensis</i> (cedar mangrove). However, only seedlings of <i>Avicennia marina</i> were located by survey along the Keep River within the Project Area. Mudflats occur downstream of the Project Area and at the Mouth of the Keep River.	All estuarine flora is located well outside of the area proposed for development, hence direct impact would not occur. Estuarine flora within the Project Area would be retained and managed for conservation. Potential exists for secondary impacts from changes to the hydrology (quantity and quality) of the Keep River. This potential is low, commensurate with the low level of impact predicted for the river's hydrology.	The environmental management for this factor would involve: <ul style="list-style-type: none"> measures described above under the factor of biodiversity; measures described below under the factor of surface water quality. 	No impact on estuarine flora is predicted, hence the EPA's objective can be met with the project development plan.
Terrestrial fauna	Terrestrial fauna	Maintain the abundance of species diversity and geographical distribution of terrestrial fauna.	The fauna habitats of the Project Area comprises rock outcrop (6%), woodland (76%), grassland (5%), riverine woodland (8%), wetland (0.1%) and mudflats (5%). Surveys of the Project Area have recorded twenty-eight species of native mammals; two species of introduced mammals, 159 species of birds, forty-five species of reptiles and twenty species of frogs. Analysis of species composition for the habitat types results in the following conclusions: rock outcrops and wetland habitats show a distinct difference for mammals to other habitat types which can all be considered to be similar; the composition of birds between habitats varies little during the dry season. The results also indicate that bird assemblages may be more habitat specific during the wet season; rock outcrop habitat showed the strongest grouping for reptiles and frogs but there was only limited separation between all habitats.	The proposed development would require clearing of approximately 34,800 hectares of predominately black soil plains. These cracking clays are typically dominated by savanna woodland, and homogenous habitat consisting of Bauhinia woodland, eucalypt woodland and grassland. Approximately 40,960 hectares of land within the Project Area, comprising black soil plains and all of the riparian areas and rock outcrops would be managed for conservation.	The environmental management proposed for this factor is described above under the factor of biodiversity.	The proposed conservation areas contain fauna habitats that are representative of those found in the Project Area. Black soil plain, the predominant soil type targeted for development would have approximately 25% of its extent in the Project Area retained and managed for conservation. Habitat types that have been shown to have the strongest groupings for terrestrial fauna rock outcrops and wetlands would have the full extent in the Project Area retained for conservation. The EPA's objective can therefore be met.
	Specially protected (threatened) fauna	Protected Specially protected (Threatened) Fauna, consistent with the provisions of the WA Wildlife Conservation Act 1950 and other relevant State, Northern Territory and Commonwealth legislation.	A total of fifty-four vertebrate species considered rare or protected under Commonwealth and State legislation or listed in international treaties could be expected to be found in the Project Area. These include six mammals, forty-one birds, four reptiles and three frogs. Only nine of these species have actually been recorded within the Project Area: <ul style="list-style-type: none"> Under the <i>Commonwealth Endangered Species Protection Act 1992</i> are listed Derby white-browed robin (<i>Poecilodryas superciliosa</i>) which is classified as endangered, and ghost bat (<i>Macroderma gigas</i>) which is considered vulnerable. Black bittern (<i>Ixobrychus flavicollis gouldi</i>) is listed as Schedule 1 under the Western Australian Wildlife Conservation Act 1950, while under Schedule 4 are listed peregrine falcon (<i>Falco peregrinus</i>), radjah shelduck (<i>Tadorna radja</i>), freshwater crocodile (<i>Crocodylus johnstoni</i>) and saltwater crocodile (<i>Crocodylus porosus</i>). Ghost bat (<i>Macroderma gigas</i>), zitting cisticola (<i>Cisticola juncidis</i>) and wailing frog (<i>Cyclorana vagitus</i>) are listed under Schedule 7 of the <i>Parks and Wildlife Conservation Act 1993</i>. 	The proposed development would require clearing of approximately 34,800 hectares of predominately black soil plains. These cracking clays are typically dominated by savanna woodland, a homogenous habitat consisting of Bauhinia woodland, eucalypt woodland and grassland. Approximately 40,960 hectares of land within the Project Area, comprising black soil plains and all of the riparian areas and rock outcrops would be managed for conservation.	The environmental management proposed for this factor is described above under the factor of biodiversity.	All the fauna habitat types of the Project Area would be represented in conservation areas. Habitats considered to include site-specific species would have all of their habitat conserved. Rare and specially protected fauna that could occur within the Project Area would have at least 42% of their habitat conserved. The project development plan can fulfill the provision of the Wildlife Conservation Act 1950; hence the EPA's objective can be met.
	Subterranean fauna	Maintain the abundance, species diversity and geographical distribution of subterranean species.	Little is known of the subterranean fauna of the Project Area. Limited sampling of a paleochannel beneath the Weaber Plain has indicated the presence of at least one species of bathynellid syncarid Crustacea. Similar fauna has been sampled from groundwater beneath ORIA Stage One, although it is unknown if the fauna from both areas is the same.	Project development would cause a change in the hydrogeological environment of the Project Area. This change would predominantly comprise an increase in groundwater and localised changes in groundwater quality. Groundwater salinity is expected to remain	The environmental management proposal for this factor is described below under the factor Groundwater quantity.	Potential impacts would appear to be restricted to changes in distribution reflecting localised changes in groundwater quality.

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
				within the natural range for groundwater in the Project Area and significant changes to groundwater quality arising from the use of farm chemicals are not predicted to occur. Existing stygofauna habitats would remain flooded.		
Aquatic fauna	Aquatic fauna	Maintain the ecological function, abundance, species diversity and geographic distribution of aquatic fauna.	A survey of the Keep River and Sandy Creek recorded five mammals, ninety-three birds, thirteen reptiles, eleven frogs and thirty-five fish species. The survey results indicated that the aquatic invertebrates comprise assemblages typical of Northern Territory rivers, creeks and billabongs. Insects and molluscs are common in most waterbodies and some insects are locally common. Two species of sawfish have been recorded in the Keep River—dwarf sawfish (<i>Pristis clavata</i>) and freshwater sawfish (<i>Pristis microdon</i>). Dwarf sawfish is coastal in distribution but can travel long distances up rivers into fresh water. Its conservation status is unknown but it may only occur in northern Australia. Freshwater sawfish is listed as 'Endangered' in the IUCN's Red List, and as 'Potentially threatened' in the 1998 Australian Society for Fish Biology's Threatened Fish List. It is usually located in fresh water and in the upper reaches of estuaries, and may be isolated in small billabongs for several years until floods release it back into the estuary. It has been recorded from several rivers in Western Australia, the Northern Territory and at Cape York in Queensland.	The proposed conservation areas would include all significant waterways, billabongs and wetlands, and their associated riparian vegetation. Direct impacts upon the habitats of fish and other aquatic biota would therefore be avoided, except in two localised areas associated with the road crossings of the Keep River and Knox Creek. Predicted changes to the hydrology of the Keep River and Sandy Creek from proposed development would be contained to the lower reaches of these watercourses and would involve: <ul style="list-style-type: none"> an insignificant change in water quality; a minor increase in peak flood velocities and an increase in the occurrence of peak flood levels; An increase in average flows during the wet season, and infrequent and minor releases of good quality water during the dry season.	The environmental management proposed for this factor is described below under the factor of Surface water quality.	The predicted changes are not expected to result in any significant impacts on fish and other aquatic biota in the Keep River and Sandy Creek. The altered flow regime may cause some localised erosion, but this would be monitored and managed to stabilise with time. The differential effect of the increased average flows would be greater in drier years and, at these times, the additional flows that would occur earlier and later in the wet season would benefit an environment that would otherwise be under stress.
Wetlands	Wetlands	To protect the environmental values and maintain or enhance key ecological functions of the wetlands.	A total of twenty-eight natural and one man-made wetlands have been identified in the Project Area. Most of these are associated with watercourses or are located at the base of rock outcrops. Throughout the Project Area the vegetation fringing the creeks, rivers and other watercourses is dominated by <i>Barringtonia acutangula</i> (freshwater mangrove), <i>Melaleuca argentea</i> (paperbark), <i>Pandanus spiralis</i> (screw palm), <i>Carthorium umbellatum</i> , <i>Acacia coleii</i> (wattle) and <i>Eucalyptus</i> spp., including <i>Eucalyptus camaldulensis</i> and <i>Excoecaria parvifolia</i> (guttapercha tree). These species are mainly associated with fresh or slightly brackish water. Scattered mangroves occur along the northern reaches of the Keep River within the Project Area, but extensive mangrove woodlands are located further downstream and outside the Project Area.	All of the natural wetlands in the Project Area would be retained and managed for conservation. Direct impacts would therefore not occur to these wetlands. Secondary impacts associated with changes in surface water and groundwater hydrology are possible.	The environmental management proposed for this factor would include: <ul style="list-style-type: none"> inclusion of all natural wetlands and watercourses in the conservation area as described above under the factor of Biodiversity; the management of groundwater levels as described below under the factor of Groundwater quality; the strategic positioning of flood protection levees to minimise the changes to the hydrology of Keep River and its tributaries; the implementation of on-farm water management measures as described below under the factor of surface water quality. 	Minimal impact is predicted on the environmental values and functions of natural wetlands. These values and functions would be enhanced by removal of stock and management of weeds and access. The man-made wetland would be developed.
	Watercourses	Maintain the integrity, functions and environmental values of watercourses.	All of the watercourses in the Project Area only flow during the wet season. During the dry season the stream inverts are dry with the exception of localised rocky pools and the tidal sections of the Keep River and Sandy Creek. The riparian vegetation is described above under the factor of Wetlands.	Potential impacts arise from the construction of flood protection levees, which would increase the magnitude of frequently occurring floods, possibly leading to increases in erosion. Farm development would also increase the average annual volume of run-off reaching the Keep River. Rises in groundwater levels may cause some induced base flow in the lower reaches of the Keep River and Sandy Creek.	Hydrology models have been used to strategically locate flood protection levees so as to minimise increases in flood heights and velocities for frequently occurring floods. All riparian areas would be retained and managed for conservation. Management would include monitoring for erosion and remediation measures as appropriate. Monitoring would also include the effects on riparian vegetation of any groundwater induced stream flow. Groundwater management using dewatering bores would be implemented' as required.	Peak flood levels from frequently occurring floods would be restricted to less frequently occurring levels. Minor increases in peak flood velocity are predicted at some locations and where the substrates are not rock, the increased velocities are within ranges that do not generally cause erosion. Levees have been positioned to avoid frequent inundation of Point Spring Nature Reserve.
	Groundwater quantity	Maintain groundwater so that existing and potential uses, including ecosystem maintenance are protected.	Groundwater flow occurs in paleochannels beneath each of the three plains that could be developed. Beneath the Weaber Plain the groundwater flow is generally west to east while under the Knox Creek and Keep River plains the general direction of groundwater flow is to the north. Groundwater levels are generally approximately 20 m below the surface of the Weaber Plain, 10–15 m below the surface of the Knox Creek Plain and 5–10 m below the surface of the Keep River Plain.	Groundwater level rise due to increased accessions from the surface.	A proactive groundwater management strategy is proposed as part of the Project. This strategy seeks to manage groundwater levels from project inception to ensure the sustainability of irrigated agriculture on the Project Area. Engineering design standards would comply with current best practice for all irrigation channels and regulating storage's intended to convey or store water for prolonged periods. Crop watering strategies that maximise the water uptake by crops and minimise the water loss to groundwater would be	Groundwater levels are predicted to rise but be controlled in the long term to greater than 5 m from the surface over most of the Project Area.

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
					utilised. Groundwater levels would be controlled via the utilisation of bores and subsoil drains. A comprehensive monitoring programme for groundwater levels and quality would be implemented and the collected data used to modify management practices as necessary.	
	Surfacewater quantity	Maintain surface water so that existing and potential uses, including ecosystem maintenance are protected.	All of the watercourses in the Project Area only flow during the wet season. During the dry season the stream inverts are dry with the exception of localised rocky pools and the tidal sections of the Keep River and Sandy Creek.	Increase in wet season flows of the Keep River and Sandy Creek due to provision improved drainage to the project development area.	The environmental management prepared for this factor is described below under the factor of surface water quality.	The net result of the Project would be an increase in the volume of run-off reaching streams and rivers over the wet season. On average, an annual flow increase of about 20% in the lower reaches of the Keep River is predicted. The timing of runoff flows leaving the Project Area would also change following development due to the cropped areas entering the wet season in a moist state and the improved efficiency of the drainage infrastructure. The magnitude of this change would vary, however, it is probable that in some seasons the runoff from the cropped areas would occur around one month earlier than is currently the case.
	Mosquitoes and disease vectors	Mosquito numbers on-site should not adversely affect the health, welfare and amenity of future residents; and Ensure the breeding of mosquitoes is controlled to the satisfaction of the Health Department without adversely affecting other flora and fauna.	The flavivirus, which causes Murray Valley encephalitis, and the alphavirus, which causes Ross River virus, are the two most important pathogenic arboviruses causing human disease in Australia. Both are enzootic (always present) in the east Kimberley. Barmah forest virus has also been recorded in the Ord River area. The mosquito <i>Culex annulirostris</i> is an important vector of both the Murray Valley encephalitis virus and the Ross River virus. <i>Culex annulirostris</i> breeds in fresh water and is the predominant species of mosquito found in the Ord River area. The numbers of mosquitoes vary widely from year to year but the highest numbers correspond to years with heavy wet season rainfall.	An increase in the number of mosquito related diseases due to a combination of: <ul style="list-style-type: none"> an increase in the number of residents in the region; possible increase in mosquito populations. 	Management action would be taken as part of the Project to reduce the risk of increased infection with arboviruses. These actions would concentrate upon the following activities: <ul style="list-style-type: none"> designing and operating the Project so as to reduce the potential for increased mosquito-breeding activity; implementing education programmes for the Project's construction and operational workforce on measures that could be taken to reduce their personal risk of infection; extending the existing monitoring programmes to cover the Project Area. 	A potential increase in the number of mosquito related diseases.
Land	Hydrology	Establish stable, sustainable landform consistent with surroundings.	The Project Area generally comprises fine-textured fluvial plains of the Ivanhoe Land System that are flat to gently undulating, with localised variation in topography and soil types. Surrounding the Project Area are the following landforms: <ul style="list-style-type: none"> the Cockatoo Land System, made up of gently undulating plains on sandstone and calcareous sandstone, or deep sands; rugged hilly country with ridges, hogbacks, cuestas and structural plateaux of the sandstone, calcareous sandstone and conglomerate rock outcrops of the Weaber Land System, or of the sandstone, siltstone and shale rock outcrops and skeletal soils of the Pinkerton Land System; gently sloping alluvium with leached yellowish loamy and sandy soils of the Angallari Land System and undulating plains on dolomite and shale, leached loamy soils with moderate limestone outcrop of the Dinnabung Land System; estuarine alluvium cracking clay and solonchic soils of the Legume Land System; estuarine alluvial plains, saline soils and bare mud of the Carpentaria Land System. 	Erosion from areas disturbed by construction activities.	Soil erosion in the Project Area would be controlled by a combination of the following management strategies: <ul style="list-style-type: none"> controlling drainage by providing levee banks to prevent floodwaters entering the developed area; grading land on farms to gentle slopes to minimise stormwater runoff velocities; sizing and designing receiving drains to accommodate anticipated flow regimes; providing buffer zones on both sides of watercourses to allow riparian vegetation to continue to stabilise soils in these areas; rehabilitating disturbed areas: <ul style="list-style-type: none"> as soon as possible following disturbance during construction; by formulating and implementing appropriate rehabilitation plans and programmes including topsoil stripping and stockpiling, land preparation, and reseedling to facilitate regeneration of disturbed areas; managing crops in such a way that crop cover of the soil is maximised, particularly during the wet season when highly erosive rainfall may occur. Monitoring and remediation of erosion would also occur as part of normal operations within the Project Area.	The landforms within the Project Area would be modified from the existing primarily natural state to become a highly managed agricultural landscape. The drainage patterns of the plains would be modified to provide a more consistent gradient and to facilitate optimum water application and drainage. In addition, a formal drainage system would be developed within and around the Project Area.

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
Pollution Management						
Air	Particulates and dust	Ensure that the dust levels generated by the proposal do not adversely impact welfare and amenity of surrounding land users or cause health problems by meeting statutory requirements and acceptable standards.	Ambient levels of dust in the Project Area are likely to be highly seasonal, with low levels during the wet season, increasing during the dry season as the cover of native vegetation becomes substantially less and wind strength increases. Movements of vehicles on unsealed roads and stock movements would be localised sources of dust.	Increased nuisance from dust, although the potential is very low due to the remoteness of the Project Area from existing residences.	The main issue associated with dust would be the protection of workers from excessive levels. Earth-moving contracts would be structured to require air-conditioned cabins on earth moving equipment and monitoring of dust levels associated with development activities. A dust-monitoring programme would be established as part of the EMP and administered throughout the construction and operational phases of the Project. Emissions from the sugar mill would be passed through a scrubber in order to reduce particulate emissions from that source to levels within national guideline levels.	Remoteness of the site should mitigate issues associated with nuisance dust.
	Chemical spray drift	Ensure that spray drift generated by chemicals used for the proposal does not adversely impact health, welfare and amenity of surrounding land users and the environment by meeting statutory requirements and acceptable standards.	Chemical sprays are currently not used in the Project Area. However, chemical sprays are currently used in ORIA Stage One, which is located closer to the residential area of Kununurra than the Project Area.	Existing residences are located well outside the expected range of spray drift from the Project Area. Entry of chemicals into the environment may occur via watercourses.	In order to minimise the potential for spray drift, the application of chemicals within the Project Area would, wherever possible, be from tractor-drawn boom-sprays utilising technology that results in relatively large spray droplets being released close to the ground. In other circumstances, for example when ground or crop conditions prevent tractor access, it may be necessary to utilise aerial spraying. In these instances only operators who have successfully undertaken the pilot accreditation programme of the Aerial Agricultural Association of Australia would be utilised, and the timing and manner of application would be carefully chosen to minimise spray drift. The provision of a nominal 1,500 m buffer zone around the farm areas would avoid future land use conflicts.	The use of agricultural chemicals within the Project Area would be minimal in relation to other agricultural industries in Australia. Sugarcane, the dominant crop proposed for the Project Area, has a low requirement for pesticides. Furthermore, the Project Area and its surrounds are characterised by sparse residential settlement. As a consequence of the above factors, the potential for detrimental impact to surrounding land users from the usage of agricultural chemicals in the Project Area is considered low.
	Greenhouse gases	Ensure that greenhouse gas emissions meet acceptable standards and requirements of Section 51 of the WA Environmental Protection Act 1986 (all reasonable and practicable measures are taken to minimise greenhouse gas discharge).	The Project Area has been assumed to be in equilibrium with respect to greenhouse gas emissions.	Clearing of native vegetation comprising savanna woodland and grasslands. However, most the Project Area would be developed for the cultivation of sugarcane, a perennial crop with a greater biomass per unit area than the existing vegetation.	Processing of sugar cane to produce raw sugar would utilise the bagasse bi-product as the primary source of fuel. Large scale farm machinery and trucks would be utilised to improve the efficiency of agricultural and transport operations with respect to fuel use.	A net increase is predicted in the amount of carbon sequestered in vegetation in the Project Area following development. In addition, the carbon sequestered in the raw sugar and molasses products would exceed the carbon released from the consumption of fuel by agricultural and transport operations. The Project Area is closer to intended markets in Asia than alternative producers, providing the potential for reductions in greenhouse gas emissions from the shipping of products.
Water	Groundwater quality	Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected.	Groundwater quality of the Project Area varies with location. Groundwater of the Weaber Plain has a salinity range of 70mg/L to 2,600mg/L TDS. The salinity of groundwater of the Knox Creek Plain is generally around 1,000mg/L but can range from 60mg/L to 20,800mg/L TDS. The groundwater salinity beneath the Keep River Plain varies greatly, ranging between 100mg/L to 51,000mg/L TDS. Surface expressions of groundwater at Cave Spring and Point Spring are from different aquifers to those beneath the Project Area. The groundwater of the Project Area is not known to support ecosystems, other than stygofauna.	Localised changes in groundwater salinity due to accessions from cropped areas and irrigation and drainage infrastructure. Potential migration of agricultural chemicals from the surface.	The focus of groundwater management would be on controlling groundwater levels as discussed above under the factor of Groundwater quantity. The black soil plains that would be the target for development are known to be highly effective in binding herbicides, pesticides and phosphorous and restricting their migration to groundwater. Monitoring of groundwater quality would be a component of the EMP.	In the long term the salinity of the groundwater would trend towards the salinity of all the accessions would trend combined, which are predicted to be less than 2,200mg/L TDS. Localised areas of lower salinity would still occur in areas where the predominant accessions would be from irrigation and drainage infrastructure. The predicted levels are within the range of naturally occurring levels. The black soils typical of the Project Area are known to be highly effective in binding phosphorus, and elevated levels of this nutrient are not anticipated in the groundwater beneath the Project Area. Nitrogen levels in groundwater are predicted to be in the range of 3.1–5.2 mg/L. Although the predicted levels are about twice the naturally occurring levels, they remain relatively low. For example, the drinking-water guideline value is 10 mg/L. Elevated levels of pesticides are not predicted for groundwater of the Project Area.

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
	Surface water quality	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected.	Monitoring of wet season flows in the Project Area has shown that these flows naturally contain high levels of suspended solids and often contain natural levels of nutrients phosphorus and nitrogen that exceed national guideline values for the protection of aquatic ecosystems.	Reduction in water quality from the migration of sediment, fertilisers and pesticides from the farm areas.	<p>All farm units within the Project Area would be developed with tailwater return systems capable of collecting and returning on-farm all irrigation water runoff. The tailwater return systems would be designed in such a way as to also perform the function of first-flush stormwater collection systems, with the collected stormwater also being returned on-farm for use as irrigation water.</p> <p>Recent advances achieved in pesticide use and management in ORIA Stage One would be adopted, and wherever possible enhanced, in the Project Area. As a minimum this would include:</p> <ul style="list-style-type: none"> • provision of buffers between farms and water courses; • the adoption of the integrated pest management strategy developed in ORIA Stage One where appropriate; • the adoption of the spray calendar developed each year for ORIA Stage One; • the adoption of AGWEST recommendations for on-farm management of endosulfan; • compulsory training for all farm staff who would be required to handle and spray chemicals; • compulsory accreditation of all commercial spray operators to a national standards system. <p>In addition, the above management measures would be supported by a comprehensive monitoring programme for pesticides and chemicals in the receiving environment.</p>	Levels of sediment and nutrients in surface waters are predicted to remain within the naturally occurring range. Levels of farm chemicals, including pesticides, are predicted to be within national guideline values for maintenance of aquatic ecosystems.
Social Surroundings						
Recreation	Recreation	Maintain or enhance recreational usage of the Project Area, consistent with plans developed by planning agencies.	There are no existing plans that have been developed by planning agencies for the land within the Project Area, apart from the Point Springs Nature Reserve managed by CALM. Limited access to the pastoral leases due to locked gates, poorly maintained roads and limited access points to the Keep River	Community access to the black soil plains would be limited to the Conservation Area due to the establishment of the farms. Community access to the Keep River would be improved due to maintained roads. Management of the land would be improved due to the establishment of an Environmental Management Entity. Safety to travelers would be enhanced due to an improved and maintained road system.	The Conservation Area would be managed by the Environmental Management Entity. Miriung and Gajerrong people would be invited to participate in management. Specific recreation areas including localities on the Keep River would be established and managed.	Increased visitation of the Project Area by local residents and tourists. Improved access to and management of recreational areas. Active involvement of Miriung and Gajerrong people in the management of their native title rights. Increased opportunity for recreation associated industries and employment. Increased opportunity for people to learn about the natural environment.
Culture and heritage	Aboriginal heritage and culture	Ensure the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	No active management of cultural heritage sites is presently undertaken by the State, Territory or Commonwealth heritage agencies. Limited opportunity for Miriung and Gajerrong people to presently be consulted or invited to be involved in the management of the cultural and biophysical environment.	Compliance with State, Territory and Commonwealth legislation as well as the rights of native titleholders would occur. Known cultural heritage sites would be located, recorded and protected. Cultural heritage sites would not be affected by the development of the infrastructure corridor or the Sugar Mill site. Miriung and Gajerrong people would have the opportunity to have input into the management of cultural heritage sites.	The Cultural Heritage Management Plan would be developed as part of the Environmental Management Plan to be administered by the Environmental Management Entity. Miriung and Gajerrong people would have the opportunity to be involved in the development of the Plan as well as the operation of the Environmental Management Entity. Cultural heritage sites would be managed using appropriate techniques agreed with the endorsement of Miriung and Gajerrong people, and the State, Territory and Commonwealth heritage agencies. Aboriginal Areas Protection Authority issued Authority Certificates for the NT portion of the Project Area.	Undertake an additional cultural heritage assessment of the land to be developed. Develop a Cultural Heritage Management Plan to ensure that sites are managed and protected, lessening any inadvertent damage. Involvement of Miriung and Gajerrong people in the management of cultural heritage sites. Increase community awareness regarding Aboriginal cultural heritage values in the area.
Social	Social surrounds	To maintain and protect the aesthetic, cultural, economic and social surroundings, where those surroundings affect or are affected by physical and biological changes.	Limited community understanding of the aesthetic, cultural, economic and social surroundings that will be affected.	Change from land containing pastoral activity to irrigated farmland. Establishment of new bodies of water would encourage an increase in fauna. Long-term environmental management would provide the opportunity for Miriung and Gajerrong people to be involved. Native title over the developed land may be extinguished while rights over the non-	The farmland would be managed by the individual owners. The undeveloped land contained within the Conservation area would be managed by the Environmental Management Entity. Miriung and Gajerrong people would have the opportunity to participate in management. A Cultural Heritage Management Plan would be developed detailing an agreed process for sustainable management. Conservation Reserves/National Park would be co-operatively managed by the NT and WA Governments with input from the	Establishment of the Environmental Management Entity. Development of the Environmental Management Plan that reflects the native title rights of Miriung and Gajerrong people. Development of a Cultural Heritage Management Plan. Conclusion of an Aboriginal Socio-Economic Impact Assessment of the impacts on Miriung

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
				<p>developed land would be maintained.</p> <p>Increase in land available for Conservation Reserve or National park as a direct result of the development of the Project.</p>	Miriuwung and Gajerrong people.	<p>and Gajerrong people.</p> <p>Maximise the positive impacts and minimise the negative impacts of the Project on Miriuwung and Gajerrong people.</p> <p>Settle an Indigenous Land Use Agreement to address and compensate Miriuwung and Gajerrong people for the extinguishment or impairment of native title rights.</p> <p>The ILUA would ensure the active involvement of Miriuwung and Gajerrong people in the management of the Conservation Reserve and the National Park.</p>
Cumulative Impact	None	None		<p>Increased allocation of water from the Ord River for other ORIA Stage 2 proposals resulting in less water being available for environmental flow.</p> <p>Increased clearing of native vegetation in the Victoria-Bonaparte Biogeographic region.</p>	The Water and Rivers Commission has commenced a process to allocate water from the Ord River that will address environmental needs and the combined effect of the Project and other development. This proposal is consistent with the Commission's Interim Water Allocation Plan. The proposal involves the conservation of unique and representative samples of vegetation species and communities within the Project Area.	A comparison of the results of biological survey shows that while there is a significant overlap in floristic composition between the Project Area and other ORIA Stage 2 development, the sites are clearly separated in biological terms. The strategy of conserving representative and reasonably sized viable portions of vegetation associations and fauna habitats should therefore be an effective means of mitigating combined regional vegetation clearance effects.

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
		ecosystem maintenance are protected.	and nitrogen that exceed national guideline values for the protection of aquatic ecosystems.		<p>return systems would be designed in such a way as to also perform the function of first-flush stormwater collection systems, with the collected stormwater also being returned on-farm for use as irrigation water.</p> <p>Recent advances achieved in pesticide use and management in ORIA Stage One would be adopted, and wherever possible enhanced, in the Project Area. As a minimum this would include:</p> <ul style="list-style-type: none"> • provision of buffers between farms and water courses; • the adoption of the integrated pest management strategy developed in ORIA Stage One where appropriate; • the adoption of the spray calendar developed each year for ORIA Stage One; • the adoption of AGWEST recommendations for on-farm management of endosulfan; • compulsory training for all farm staff who would be required to handle and spray chemicals; • compulsory accreditation of all commercial spray operators to a national standards system. <p>In addition, the above management measures would be supported by a comprehensive monitoring programme for pesticides and chemicals in the receiving environment.</p>	including pesticides, are predicted to be within national guideline values for maintenance of aquatic ecosystems.
Social Surroundings						
Recreation	Recreation	Maintain or enhance recreational usage of the Project Area, consistent with plans developed by planning agencies.	There are no existing plans that have been developed by planning agencies for the land within the Project Area, apart from the Point Springs Nature Reserve managed by CALM. Limited access to the pastoral leases due to locked gates, poorly maintained roads and limited access points to the Keep River	Community access to the black soil plains would be limited to the Conservation Area due to the establishment of the farms. Community access to the Keep River would be improved due to maintained roads. Management of the land would be improved due to the establishment of an Environmental Management Entity. Safety to travelers would be enhanced due to an improved and maintained road system.	The Conservation Area would be managed by the Environmental Management Entity. Miriuwung and Gajerrong people would be invited to participate in management. Specific recreation areas including localities on the Keep River would be established and managed.	Increased visitation of the Project Area by local residents and tourists. Improved access to and management of recreational areas. Active involvement of Miriuwung and Gajerrong people in the management of their native title rights. Increased opportunity for recreation associated industries and employment. Increased opportunity for people to learn about the <u>natural environment</u> .
Culture and heritage	Aboriginal heritage and culture	Ensure the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	No active management of cultural heritage sites is presently undertaken by the State, Territory or Commonwealth heritage agencies. Limited opportunity for Miriuwung and Gajerrong people to presently be consulted or invited to be involved in the management of the cultural and biophysical environment.	Compliance with State, Territory and Commonwealth legislation as well as the rights of native titleholders would occur. Known cultural heritage sites would be located, recorded and protected. Cultural heritage sites would not be affected by the development of the infrastructure corridor or the Sugar Mill site. Miriuwung and Gajerrong people would have the opportunity to have input into the management of cultural heritage sites.	The Cultural Heritage Management Plan would be developed as part of the Environmental Management Plan to be administered by the Environmental Management Entity. Miriuwung and Gajerrong people would have the opportunity to be involved in the development of the Plan as well as the operation of the Environmental Management Entity. Cultural heritage sites would be managed using appropriate techniques agreed with the endorsement of Miriuwung and Gajerrong people, and the State, Territory and Commonwealth heritage agencies. Aboriginal Areas Protection Authority issued Authority Certificates for the NT portion of the Project Area.	Undertake an additional cultural heritage assessment of the land to be developed. Develop a Cultural Heritage Management Plan to ensure that sites are managed and protected, lessening any inadvertent damage. Involvement of Miriuwung and Gajerrong people in the management of cultural heritage sites. Increase community awareness regarding Aboriginal cultural heritage values in the area.
Social	Social surrounds	To maintain and protect the aesthetic, cultural, economic and social surroundings, where those surroundings affect or are affected by physical and biological changes.	Limited community understanding of the aesthetic, cultural, economic and social surroundings that will be affected.	Change from land containing pastoral activity to irrigated farmland. Establishment of new bodies of water would encourage an increase in fauna. Long-term environmental management would provide the opportunity for Miriuwung and Gajerrong people to be involved. Native title over the developed land may be extinguished while rights over the non-developed land would be maintained. Increase in land available for Conservation Reserve or National park as a direct result of the	The farmland would be managed by the individual owners. The undeveloped land contained within the Conservation area would be managed by the Environmental Management Entity. Miriuwung and Gajerrong people would have the opportunity to participate in management. A Cultural Heritage Management Plan would be developed detailing an agreed process for sustainable management. Conservation Reserves/National Park would be co-operatively managed by the NT and WA Governments with input from the Miriuwung and Gajerrong people.	Establishment of the Environmental Management Entity. Development of the Environmental Management Plan that reflects the native title rights of Miriuwung and Gajerrong people. Development of a Cultural Heritage Management Plan. Conclusion of an Aboriginal Socio-Economic Impact Assessment of the impacts on Miriuwung and Gajerrong people. Maximise the positive impacts and minimise the <u>negative impacts of the Project on Miriuwung and</u>

Factor	Site Specific Factor	WA EPA objective	Existing Environment	Potential Impact	Environmental management	Predicted Outcome
				development of the Project.		Gajerrong people. Settle an Indigenous Land Use Agreement to address and compensate Miriuwung and Gajerrong people for the extinguishment or impairment of native title rights. The ILUA would ensure the active involvement of Miriuwung and Gajerrong people in the management of the Conservation Reserve and the National Park.
Cumulative Impact	None	None		Increased allocation of water from the Ord River for other ORIA Stage 2 proposals resulting in less water being available for environmental flow. Increased clearing of native vegetation in the Victoria-Bonaparte Biogeographic region.	The Water and Rivers Commission has commenced a process to allocate water from the Ord River that will address environmental needs and the combined effect of the Project and other development. This proposal is consistent with the Commission's Interim Water Allocation Plan. The proposal involves the conservation of unique and representative samples of vegetation species and communities within the Project Area.	A comparison of the results of biological survey shows that while there is a significant overlap in floristic composition between the Project Area and other ORIA Stage 2 development, the sites are clearly separated in biological terms. The strategy of conserving representative and reasonably sized viable portions of vegetation associations and fauna habitats should therefore be an effective means of mitigating combined regional vegetation clearance effects.