CrossRiver**Rail**

Appendix E
Climate Change

Cross River Rail

APPENDIX E
Climate Change

JULY 2011

Appendix E-1 Risk Assessment

Appendix E-1 Climate change risk assessment for the Project

Environmental Variable Category	Climate Variable	Description of risk	Consequence	Likelihood	Risk without mitigation	Risk Mitigation Strategy (mitigation/adaptation options)
Atmosphere	Physical and chemical properties of the atmosphere	Increased temperatures results in passenger demand exceeding the capacity of Cross River Rail, leading to potential delays and/or passenger dissatisfaction with services	Major	Likely	High	Ongoing monitoring of passenger growth and respond with additional infrastructure as required
Atmosphere	Physical and chemical properties of the atmosphere	Reduced efficiency of “at surface” mechanical and electrical systems	Minor	Likely	High	Asset management plan to ensure that climate change impacts on the efficiency of mechanical and electrical systems are considered when upgrading equipment.
Multiple variable categories	Multiple variables	Increased cost of power due to supply cost	Minor	Likely	High	Implement power demand management measures Select energy efficient technologies
Atmosphere and Water	Multiple variables	Increased temperatures and rainfall events result in an increased demand for service (eg air conditioning, shelter while travelling instead of walking) which causes power supply overload resulting in damage to assets	Major	Likely	High	Asset owner to undertake strategic planning with respect to power supply. Asset management plan to ensure electrical equipment is upgraded over time.
Atmosphere and Water	Multiple variables	Damage to upstream power supply	Moderate	Possible	High	Update emergency response plan with climate change considerations. Work with power suppliers (Energex) to ensure transport services are prioritised in the event of power shortages, with prioritisation of essential services, for example, emergency exits and lighting
Multiple variable categories	Multiple variables	Carbon price impact on operating costs and service demand	Minor	Almost Certain	High	Maximise efficiency of operations.

Environmental Variable Category	Climate Variable	Description of risk	Consequence	Likelihood	Risk without mitigation	Risk Mitigation Strategy (mitigation/adaptation options)
Water	Sea Water (inundation) Rainfall and runoff	Inundation of underground stations results in major flood event	Severe	Rare	High	Development and implementation of appropriate emergency response plan Note – floodgates developed in reference design for stormwater events also help to mitigate against this risk
Atmosphere	Physical and chemical properties of the atmosphere	Surface track buckling from heat	Moderate	Possible	Medium	Design and build tracks in accordance with design standards for a warm climate. Upgrade existing track maintenance plans to ensure tracks are kept in good working order.
Atmosphere	Physical and chemical properties of the atmosphere	Rolling stock overheating (mechanical/electrical)	Moderate	Unlikely	Medium	Asset management plan to ensure climate factors are considered when upgrading rolling stock.
Atmosphere	Physical and chemical properties of the atmosphere	Passenger comfort at stations is impaired and will differ depending on underground and surface stations	Moderate	Unlikely	Medium	Station design to consider heat load and include appropriate cooling measures. Asset management plan to ensure climate factors are considered for both underground and surface stations
Atmosphere	Physical and chemical properties of the atmosphere	Passenger comfort on trains is impaired (extreme heat events, air conditioning fails)	Moderate	Unlikely	Medium	Asset management plan to ensure climate factors are considered when upgrading rolling stock.
Multiple variable categories	Multiple categories	Increased train loads overload the power supply	Moderate	Unlikely	Medium	Develop and implement station management plans to address the potential for power failures. Develop effective community and stakeholder communication protocols to address community complaints during power outages.
Multiple variable categories	Multiple categories	Accelerated deterioration of infrastructure (eg deterioration of station buildings, tracks buckling, bridges over tracks warping/rusting)	Minor	Possible	Medium	Asset management program to account for potentially accelerated deterioration of infrastructure due to climate change

Environmental Variable Category	Climate Variable	Description of risk	Consequence	Likelihood	Risk without mitigation	Risk Mitigation Strategy (mitigation/adaptation options)
Multiple variable categories	Multiple categories	Accelerated deterioration of rolling stock (eg rust, hail-related damage)	Minor	Possible	Medium	Asset management plan to ensure climate factors are considered when upgrading rolling stock.
Water Soils	Sea water/inundation Rainfall and runoff Soil quality and health	Increased groundwater intrusion into tunnel and shafts, due to increased rainfall infiltrating the water table	Minor	Possible	Medium	Pumping system design to consider demands of potential groundwater intrusion including potential changes in intrusion rates due to climate change factors
Water	Rainfall and runoff Inundation	Inundation of underground station entry points - stormwater event	Moderate	Unlikely	Medium	Development and implementation of appropriate emergency response plan. Implement localised flood mitigation measures. (Note: design components identified early on in the reference design phase has incorporated measures to manage stormwater inflows
Water	Rainfall and runoff Inundation	Reduced flood immunity at critical infrastructure points e.g. Mayne and Clapham (refer **Chapter 13 Surface Water**)	Minor	Possible	Medium	Climate change factors to be considered in determining flood immunity of critical infrastructure
Atmosphere	Wind	Damage to stations and above ground structures	Moderate	Unlikely	Medium	Station design and above ground structures to withstand higher wind loads anticipated from climate change effects
Atmosphere Water	Physical and chemical properties of the atmosphere Solar radiation Wind Lightning Hail Rainfall and runoff	Increased failure of control systems from heat and storms	Minor	Unlikely	Low	Low risk. No mitigation measures proposed.

Environmental Variable Category	Climate Variable	Description of risk	Consequence	Likelihood	Risk without mitigation	Risk Mitigation Strategy (mitigation/adaptation options)
Multiple variable categories	Multiple variables	Passenger demand placed on the rail infrastructure can increase the cost of power required to service the increased demand	Minor	Unlikely	Low	Low risk. No mitigation measures proposed.
Water Soils	Rainfall and runoff Inundation Soil quality and health	Changes in groundwater levels impacting on surface tracks (eg buckling)	Minor	Unlikely	Low	Low risk. No mitigation measures proposed.
Water Soils	Rainfall and runoff Inundation Soil quality and health	Groundwater change impacts to infrastructure in transition areas (eg Oxidation of ASS)	Minor	Rare	Low	Low risk. No mitigation measures proposed. Considered in **Chapter 7 – Soils, topography and geomorphology**).
Water Soils	Rainfall and runoff Inundation Soil quality and health	Increased rainfall infiltrating to groundwater and mobilising contaminants through groundwater	Minor	Unlikely	Low	Low risk. No mitigation measures proposed. Refer **Chapter 13 Surface Water and Chapter 12 Groundwater**).
Water Soils	Rainfall and runoff Inundation Soil quality and health	Climate change –related damage to underground external infrastructure impacting on Project e.g. Water mains bursting impact on surface or sub-surface infrastructure	Minor	Unlikely	Low	Low risk. No mitigation measures proposed.
Water	Inundation Rainfall and runoff	Track washout	Minor	Unlikely	Low	Low risk. No mitigation measures proposed. Refer **Chapter 4 Project Description**).

Appendix E-2 Sustainability Framework

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Status	
	Adopted in design
	Ongoing
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Category	No.	Theme	Goals/objectives	Indicator	Implementation	Design (D), construction (C), operation (O)	Ownership	Status	Action/Comment
Environment	1	Energy	Provide a focus on reducing energy demand and identifying opportunities to utilise renewable energy supply. Design facilities that minimise lifecycle energy consumption	1.1 Monitor energy use	Undertake energy audit in 1st year of operation and develop an energy efficiency plan	O	Detailed designer and eventual operator		This action should be followed through the project as a key action
				1.2 All designs reviewed for energy efficiency	Investigate additional energy efficiency measures, including opportunities to improve air conditioning efficiency	D	Detailed designer		This requirement should be considered further in detailed design
					Single track tunnels for the river crossing allow it to be as high as possible without compromising feasibility. This improves the gradient and allows for higher stations at the tunnel ends, reducing vertical station depth	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
					Pressure changes, physical separation (i.e. screening doors) and targeted cooling have been used to improve air-conditioning efficiency	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
				1.3 All construction operations reviewed for energy efficiency	Investigate energy efficiency measures to be incorporated into the construction phase activities	D, C	Detailed designer		To be progressed through detailed design and construction phases
				1.4 Renewable energy to be used in the operational phase of the project.	Investigate feasible renewable energy alternatives to determine their suitability for implementation during construction and operation of the Project	D, O	Detailed designer, Construction contractor and eventual operator		To be progressed through detailed design and construction phases and implemented during operation
		2 Water	Incorporate water reduction/efficiency measures into the project. Minimise the use of potable water in the construction phase. Protect the quality of existing resources and reduce the risk of flooding.	2.1 Reduce use of potable water during the construction and operation phase	Assess the potential for increasing greywater and stormwater use	D, C, O	Detailed designer		To be progressed through detailed design, construction and operational phases
				2.2 Project designed to improve flood immunity of existing infrastructure and all new infrastructure is designed to best practice standards	The project design is able to achieve flood immunity during a 1:10000 year flood event, including climate change allowance	D	EIS Team		As part of the EIS, mesures to be capture for inclusion in project approval
				2.3 No degradation of baseline groundwater or surface water quality	Waterproofing and water treatment proposed for Woolloongabba station to avoid movement of contaminated groundwater (due to past industrial uses on the site)	D	Detailed designer to incorporate into final design		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
					Use of prefabricated segments for tunnel boring machine avoids water leakage and assists with pumping	D	Detailed designer to incorporate into final design		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
				2.4 All designs reviewed for water efficiency measures	Investigate water efficiency measures and review all designs in order to incorporate	D	Detailed designer		To be progressed through detailed design and construction phases
		3 Materials	Apply the proximity principle with regards to sourcing materials. Use sustainably source materials where possible. Design to minimise material use	3.1 Maximise materials sourced within close proximity to the project	Use supply contracts to source materials as close as possible to the project	C	Construction contractor		To be progressed through detailed design and construction phases

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			minimise material use.	3.2 Maximise the amount of materials sourced from a sustainability accredited supplier	Use supply contracts to source sustainably accredited materials	C	Construction contractor		To be progressed through detailed design and construction phases
					Develop a sustainability procurement strategy	D, C	Detailed designer and Construction contractor		To be progressed through detailed design and occur prior to procurement
				3.3 Minimise material use	Cross section of caverns and box stations are lower than typical for this design	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
					Prefabricated segments used where possible	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
	4	Waste	Implement effective waste management beyond regulatory compliance by applying the principles of the waste management hierarchy (reduce, reuse and recycle).	4.1 All waste streams identified	Identify waste streams	D	EIS Team		Identify waste streams as part of the EIS for the Project
				4.2 Instigate a programme to implement the waste management hierarchy during detailed design and construction	Implement the waste management hierarchy	D, C	Construction contractor		To be followed through to the construction phase
				4.3 All opportunities to minimise spoil explored	Explore opportunities to minimise spoil	D	Detailed designer		Spoil disposal via rail is an option to be explored. Such a strategy would lend itself to the sites at the northern and [illegible]
				4.4 All opportunities for fill re-use explored	Explore opportunities for fill re-use	D	Detailed designer		To be pursued through detailed design and construction
					Contaminated land remediation of station sites at Woolloongabba and Roma Street sites to improve land potential	D, C	Construction contractor or specialist sub-contractor		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
	5	Biodiversity	Facilities to be designed, constructed and operated in such a way as to minimise impact on existing biodiversity values and to enhance biodiversity values where possible	5.1 All native fauna spotted during construction is protected	Implement all fauna protection measures presented in the EIS	D, C	Detailed designer, Construction contractor		Ongoing action to be followed through during detailed design and construction
				5.2 All rehabilitation areas are to use native, endemic plants, where possible	Identify suitable locations for revegetation of native vegetation that is cleared	D, C	Detailed designer, Construction contractor		Ongoing action to be followed through during detailed design and construction
					Implement all vegetation mitigation measures presented in the EIS	D, C, O	Detailed designer, Construction contractor and eventual operator		Ongoing action to be followed through during detailed design, construction and operation

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Category	No.	Theme	Goals/objectives	Indicator	Implementation	Design (D), construction (C), operation (O)	Ownership	Status	Action/Comment
					Biodiversity values incorporated into landscape design and urban design	D, C, O	Detailed designer, Construction contractor and eventual operator		Ongoing action to be followed through during detailed design, construction and operation
				5.3 Impacts to existing significant parks/vegetation are avoided where possible or minimised	Implement all vegetation mitigation measures presented in the EIS	D, C, O	Detailed designer, Construction contractor and eventual operator		Outcomes to be monitored throughout detailed design, construction and operation
Social	6	Built Environment	Maintain and where possible enhance the quality of the built environment through the promotion of high quality urban design which is in keeping with the subtropical urban form	6.1 All design in keeping with neighbourhood plans	Review neighbourhood plans and incorporate features into the design	D	Detailed designer		Ongoing action to be followed through during detailed design, construction and operation
				6.2 All opportunities for community involvement in the design of public spaces explored	Identify opportunities for community involvement in the design of public open spaces (at station entrances)	D	Detailed designer		Ongoing action to be followed through during detailed design, construction and operation
					Green Way' between Roma Street and Albert Street which includes neighbourhood improvements and street widening	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
	7	Infrastructure and services	Integrate facilities with existing transport nodes and other infrastructure to maximise efficiency in travel and patronage.	7.1 All connections to existing transport nodes maximised	A link from the rail network to the Albert Street end of the city which is currently absent is to be provided	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
					Opportunity to upgrade the bus station at Woolloongabba is not constrained by the design	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
					Enhanced interconnectivity with other transport modes (i.e. bus and cycling) at Boggo Road, Roma Street and Woolloongabba	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
					Explore opportunities for integrated timetabling to achieve best possible interconnectivity for passengers	D, O	Eventual operator		To be followed up prior to commencement of operation of the Project by the eventual operator
				7.2 No existing transport connections severed	Implement all transport impact measures presented in the EIS	D, C	Detailed designer		Commitments made in the Traffic and Transport EIS chapter to be followed through during detailed design, construction and operation

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				7.3 No impacts to existing services	Implement all services impact measures presented in the EIS	D, C, O	Detailed designer, Construction contractor and Operator		Commitments made in the Traffic and Transport EIS chapter to be followed through during detailed design, construction and operation
				7.4 No additional community severance	Implement all community severance measures presented in the EIS	D, C, O	Detailed designer, Construction contractor Consultation Manager		Commitments made in the Traffic and Transport EIS chapter to be followed through during detailed design, construction and operation
	8	Health, wellbeing and happiness	Improve health and wellbeing and contribute towards achieving a healthy environment for all users of the Cross River Rail Network	8.1 Increase the percentage of passengers who walk or cycle to reach a station on the Cross River Rail Network	Undertake a survey of passenger travel behaviours to determine the number of passengers likely to walk and/or cycle	O	Eventual operator		Operator to undertake survey of passenger travel behaviours
					Design the stations to include an adequate number of secure cycle bays	D	Detailed designer		To be incorporated into design and fed into operation
					Investigate creating a link from the train stations to the existing cycle network and pedestrian network	D	Detailed designer		To be incorporated into design and fed into operation
					Roma Street station designed to make interchanges easy and quick which includes a second entry allowing potential access from the proposed CBD connection footbridge to Roma Street Parklands, George Street and Kurilpa Bridge	D	Detailed designer		Incorporated in reference design. Any future design changes must avoid impacting this outcome
				8.2 Passenger comfort considered in all station design	Investigate all feasible opportunities for promoting passenger comfort	D	Detailed designer		Incorporated in reference design. Any future design changes must avoid impacting this outcome
					As far as technically feasible, vertical station depth has been reduced, improving passenger access to the Cross River Rail Network	D	Detailed designer		Incorporated in reference design. Any future design changes must avoid impacting this outcome
				8.3 Zero station closures attributable to pedestrian overcrowding	Woolloongabba station designed to cope with 20,000 passengers an hour after events at the 'Gabba	D	Detailed designer		Incorporated in reference design. Any future design changes must avoid impacting this outcome
	9	Land use	Ensure infrastructure compatibility with existing land uses and further enhance their viability where possible	9.1 Existing rail corridors utilised as a preference in all feasible instances	Rail tunnel length has been extended to the existing Industrial area to ensure train surfacing occurs in the most appropriate location, where a future TOD may be developed	D	Detailed designer		Incorporated in reference design. Any future design changes must avoid impacting on this outcome
					Clapham rail yards are proposed to be used for stabling	D	Detailed designer		Incorporated in reference design. Any future design changes must avoid impacting on this outcome
					Opportunity to use trains for removal of spoil from portal locations close to existing rail sidings	D, C	Detailed designer		Continue to monitor the outcome of this option during detailed design

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Category	No.	Theme	Goals/objectives	Indicator	Implementation	Design (D), construction (C), operation (O)	Ownership	Status	Action/Comment
				9.2 Investigate all commercial opportunity potential at train stations	New station facilities at Yeerongpilly	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting this outcome
					Capacity for future commercial and development opportunities at all stations	D, O	Detailed designer, operator		This is likely to be a continuing opportunity for the project and should be progressed through to operation
					Albert Street, Woolloongabba and Boggo Road stations designed to support future high rise development at station surface	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
				9.3 Avoid all nuisance related impacts (i.e. noise, air quality, traffic, access etc) to neighbouring properties during the construction phase	Implement all nuisance avoidance measures presented in the EIS	D, C, O	Detailed designer, Construction contractor and Operator		Implement measures recommended in the EIS and undertake appropriate monitoring programs as required
	10	Heritage and culture	Design facilities to minimise impact on existing cultural heritage values and enhance cultural heritage values where possible	10.1 Zero adverse impacts on archaeological artefacts discovered	Ensure site supervision to minimise risk of damage to archaeological artefacts that maybe present within the project area	C	Construction contractor		Implement measures recommended in the EIS and undertake appropriate monitoring programs as required
					Implement all archaeological artefact protection measures presented in the EIS	D, C, O	Detailed designer, Construction contractor and Operator		All measures to be followed through to the detailed design, construction and operation phases
				10.2 Minimise adverse impacts on heritage listed buildings/structures/sites	Protection of any heritage listed buildings/structures whilst work is being undertaken in the vicinity	C	Construction contractor		All measures to be followed through to the detailed design, construction and operation phases
					Implement all protection measures presented in the EIS relevant to heritage listed buildings / structures / sites	C	Construction contractor		Requirements should be included in the contract documents
	11	Safety, security and social inclusion	Increase safety and security through design that promotes natural surveillance and reduces anti-social activity. Promote social inclusion through improved transport services.	11.1 A per annum decrease in reported crime at existing stations or on the Cross River Rail Network	Implement site security measures at stations such as fencing, locked gates, warning signs, CCTV and security guards after hours	D, O	Detailed designer and operator		Detailed designer to ensure that appropriate site safety measures are included in the design. These measures to be followed through to operation
					Provide wide entrances to stations in order to increase natural surveillance	D	Detailed designer		Ongoing action to be followed through during detailed design
					Include CCTV on the trains to act as a crime deterrent	O	Operator		To be the responsibility of the eventual operator

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Category	No.	Theme	Goals/objectives		Indicator	Implementation	Design (D), construction (C), operation (O)	Ownership	Status	Action/Comment
				11.2	All opportunities for incorporating CPTED into the Project have been explored	Investigate CPTED opportunities to incorporate into station designs	D, O	Detailed designer and operator		Detailed designer to ensure that appropriate CPTED measures are included in the design. These measures to be followed through to operation
				11.3	All opportunities for improving pedestrian access have been explored	Underground pedestrian access across Alice Street improves access to the Botanical Gardens, particularly for students at QUT	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
				11.4	Increase in capacity of the rail network and every station to include means of access for persons of reduced mobility	Upgrade of existing Rocklea and Moorooka stations to make them compliant with the *Disability Discrimination Act 1992*	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
						Access to stations for all has been enabled through the use of lifts and elevators	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting on this outcome
	12	Climate change and adaptation	Minimise contributions towards climate change by reducing greenhouse gas emissions. Incorporate latest climate change scenarios into the design of the project	12.1	Aim to reduce CO2 emissions as per the mesures identified in the EIS	Undertake a greenhouse gas (GHG) emissions inventory in line with the GHG protocol for all stages of the project	D, C, O	EIS Team		Incorporated in EIS, which also described potential for greenhouse gas abatement measures
						Prepare and implement a carbon management plan for the operational phase of the Cross River Rail	D,O	Detailed designer		Proposals to further offset greenhouse gas emissions through indirect means to be further considered at detailed design stage
						Seek accreditation for the carbon management plan	D,C,O	Detailed designer		Accreditation for the proposed carbon management plan to be considered at detailed design stage
				12.2	All Cross River Rail infrastructure to accommodate the 2100 0.8m sea level rise scenario into design	Design all Cross River Rail Network infrastructure to meet the 0.8 m sea level rise scenario	D	Detailed designer		Incorporated into EIS to inform future detailed design phase
						Track elevation at Mayne Yard is in response to floodplain modelling	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting onthis outcome
				12.3	Future proof the Cross River Rail to all other predicted impacts of climate change	Undertake detailed climate change risk assessment to identify risks and risk management options	EIS	EIS Team		Incorporated into EIS to inform future detailed design phase
						Explore contingencies for power outages, including loss of grid power	D, C	Detailed designer and Construction contractor		Power outages during construction will be covered by generators on site.

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					Underground network can help prevent impact from extreme heat	D	Detailed designer		Incorporated in reference design. Any future design changes to avoid impacting onthis outcome
Economic	13	Local economy	Contribute towards economic growth of Brisbane through improvements in the public transport network and accessibility to areas with mixed land uses	13.1 Number of jobs created as a direct result of the scheme	Use local workforce where possible*	C	Construction contractor		To be included as a requirement of the EIS and followed through for Construction contractor consideration
					Develop and implement a local procurement policy for goods and services	D, C	Detailed designer and Construction contractor		Ongoing requirement to be followed through detailed design and construction
				13.2 Increase in passenger numbers for access to employment, retail etc	Undertake passenger forecast modelling to determine demand and patronage for the project	D	Detailed designer		This requirement to be undertaken during detailed design
					To generate economic benefits for the local community, new station facilities at Yeerongpilly to improve links and access between future Transit Oriented Development and industrial areas#	D, C, O	Detailed designer		Incorporated in reference design. New station provided at Yeerongpilly will provide improved access to the future TOD and industrial areas.
					Investigate and devise ways to increase the number of passengers using the Cross River Rail i.e. through provision of future commercial and development opportunities at stations (particularly at Albert Street, Woolloongabba and Boggo Road stations to enable future high rise development at station surface)	O	Eventual operator		Explore opportunities to enhance contribution to economic growth, improve the public transport network and increase accessibility to areas with mixed land uses
	14	Financial performance	Design a project which provides best value for money and is commercially viable	14.1 Project is profitable and provides wider economic gains for the region	Undertake economic appraisal of the project	O	Eventual operator		To be factored into the operation of the project and implemented as part of project delivery

Table Notes

* = Indicators to determine the success with using a local workforce for the project should use the following:
^ Labour market composition
^ Professional spread

= Indicators to determine the success of generating economic opportunities for the Project should use the following:
^ New business registry counts
^ Density indicators (% medium - high density living)
^ Outside gains for other communities