

Appendix F

---

**Multi Criteria Analysis**

## Contents

F1	Multi Criteria Analysis
F1.1	Introduction
F1.2	Approach
F1.3	Non-cost Criteria
F1.4	Weightings
F1.5	Analysis
F1.6	Outcome
F1.7	Summary
F1.8	Next Step

## F1 Multi Criteria Analysis

### F1.1 Introduction

---

Phase 2 Terms of Reference require the development of evaluation criteria and an appropriate mechanism for scoring and weighting against these criteria. This will form part of the framework for comparison of the sites under investigation in Phase 2 studies.

A Multi Criteria Analysis (MCA) approach was determined to be the most appropriate approach making it possible to bring together a range of different criteria into a single assessment. This section discusses in more detail the application of this approach which covers the non-cost elements of the site scoring and ranking (see the Main Study Report for further details regarding the assimilation of the cost and non cost components).

### F1.2 Approach

---

In developing the MCA, agreement was obtained with QWC whereby technical (engineering) and cost factors would be quantified within the cost estimates, and that only environmental and social factors would be covered by the MCA which constitutes the non cost element component of site assessment.

The key components of the MCA include a set of evaluation criteria and measures for the evaluation of the proposed sites, and the weights which define the relative importance of the chosen criteria. A set of criteria was developed and a pairwise comparison approach used to determine the relative weighting of these criteria.

The non-cost criteria were broken down into criteria which could measure performance against objectives to minimise environmental impact and criteria which would measure performance against objectives to minimise social impact. A relatively uncomplicated approach to the determination of criteria was adopted. Choosing numerous criteria makes it difficult to ensure that the criteria chosen are relatively independent from one another and largely quantifiable in the measures adopted.

The environmental and social criteria aim to measure performance against a key set of objectives, helping to differentiate the sites and therefore assess their relative suitability for siting of a desalination plant. Where possible the criteria to meet these objectives have been chosen so that they can be assessed quantitatively. There are however two instances where the measures will need to be qualitative. These objectives and types of associated measures are to:

- Minimise impact on terrestrial and intertidal environments (Quantitative);
- Minimise impact on marine environment (Quantitative);
- Maximise compatibility with other uses (Quantitative);
- Minimise land related issues which have the potential to affect securing the site for use for a desalination plant (Quantitative);
- Minimise impact on Native Title (Qualitative);
- Minimise visual impact of the plant with the surrounding context (Qualitative).

It is possible to apply quantitative measures when assessing for some criteria. These criteria use calculations of areas or distances to determine quantitatively the likely impacts of construction of the plant, network pipeline corridors or intake and outfall on land and in the marine environment. Geographic Information Systems (GIS) were applied in the calculation of these criteria using publically available environmental and social datasets. Assumptions have been made with respect to the likely areas cleared for the construction of the network pipeline corridors or intake and outfall. These include:

- Construction of the network pipeline corridor will on average require a 40 m corridor cleared for not only the pipeline but lay down areas for construction, pumping stations and access roads.
- Construction of the intake and outfall will require on average a 50 m corridor to construct the intake and outfall which are larger in size than the network pipeline corridor
- Construction in the marine environment is significantly more difficult to assess given the difficulty in maintaining a corridor of works due to the movement of water and potential increased sedimentation which is likely to occur during construction. Marine works will also require the construction of auxiliary works such as a self elevating platform (SEP) and the combined affects of all of these has been assumed by applying an average corridor of 60 m for works in the marine environment.

Phase 3 works will look in more detail at the areas affected based on more detailed engineering and how these areas affected can either be avoided or minimised.

Appendix B has investigated options of tunnelling or sea bed laid for the intake and outfall at sites where this is considered practical. Where a sea bed laid option is considered possible it will form the base option for each site, but both have been assessed here. In the case of the sea bed laid option greater areas are likely to be affected due to the need to disrupt the surface on land and in the marine environment. To minimise environmental impact, tunnelling may ultimately be preferred and therefore is also investigated here. Tunnelling is the only option considered for Kawana and North Stradbroke Island, while all other sites have considered both Sea Bed Laid and Tunnelling.

In the case of Lytton and PoBC it should be noted that there is no difference in the non cost score based on the MCA approach adopted here (refer Section F1.6.1) between a sea bed laid and tunnelled method of construction for the intake and outfall. Therefore this report refers only the tunnelled option for Lytton and PoBC.

### F1.3 Non-cost Criteria

#### F1.3.1 Protected Area

For the purpose of the assessment, 'protected areas' comprise areas that are protected under state legislation through a formal National Park / Marine National Park designation.

This criterion captures the impact on protected areas through construction within the site footprint or corridors for intake/outfall or network pipelines. Currently no sites sit on a State Protected Area but sites may in the future be designated as a Protected Area. Some intake/outfall and network corridors when constructed using a sea bed laid option will require clearing within state protected areas and as such register an impact under this criterion.

The protected area criteria and associated measures are shown in Table 1.

**Table 1 Protected area evaluation criteria and measures**

Criteria	Unit	Measure	CONSTRAINT				
			Very Low	Low	Medium	High	Very High
			5	4	3	2	1
Protected area	ha	Protected area affected	0 – 2.5	2.5 - 5	>5 - 10	>10 - 20	>20

### F1.3.2 Remnant vegetation clearance

Remnant vegetation is defined through the *Vegetation Management Act 1999* as vegetation shown on a regional ecosystem or remnant map. The Queensland Herbarium section of the Environmental Protection Agency (EPA) is the lead agency which undertakes regional ecosystem survey and mapping of the state.

This criterion covers the area of Remnant vegetation cleared for each proposed option. The EPA sub-classifies the remnant vegetation as: Endangered, Of Concern and Not of Concern. However for the purposes of this exercise the MCA does not differentiate between the status of the remnant vegetation. More details of the types of remnant vegetation potentially affected can be found in Appendix A – Site Analysis. The measures of this criterion are shown in Table 2.

**Table 2 Remnant vegetation clearance evaluation criteria and measures**

Criteria	Unit	Measure	Constraint				
			Very Low 1	Low 2	Medium 3	High 4	Very High 5
Remnant vegetation clearance	Ha	Hectares removed	0-10	10 – 20	20 – 40	40 – 80	>80

### F1.3.3 Essential habitat

Essential habitat is mapped by the EPA and refers to vegetation where species of fauna classified as endangered, vulnerable, rare or near threatened species are known to occur. The clearing of this habitat type is regulated by the *Vegetation Management Act 1999* which aims to protect from loss of biodiversity.

This criterion covers the area of Essential Habitat likely to be cleared for each proposed site. Details of the evaluation criterion and measures for essential habitat clearance are shown in Table 3.

**Table 3 Essential Habitat clearance evaluation criteria and measures**

Criteria	Unit	Measure	Constraint				
			Very Low 1	Low 2	Medium 3	High 4	Very High 5
Essential Habitat	Ha	Hectares removed	0 - 10	10 – 20	20 – 40	40 – 80	>80

### F1.3.4 Ramsar wetlands

Ramsar wetlands refer to wetlands classified under the Ramsar Convention as wetlands of international significance. The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides the framework for managing Ramsar wetlands and any activities likely to affect the integrity of designated wetlands would be subject to assessment under a statutory environmental impact assessment and approval process. Applying this criterion not only incorporates the direct impact to the wetland but also accounts for impacts on migratory birds.

The criteria and measures for Ramsar wetland impact are shown in Table 4.

**Table 4 Evaluation Criteria and measures for area of Ramsar wetlands affected**

Criteria	Unit	Measure	Constraint				
			Very Low 1	Low 2	Medium 3	High 4	Very High 5
Significant wetland	Ha	Area of Ramsar wetlands affected	<5	5 – 10	10 – 20	20 – 40	>40

#### F1.3.5 Fish habitat

Fish Habitat Areas (FHA) declared through the *Fisheries Act 1994* aim to protect fish habitats and therefore fish numbers from physical disturbance arising from coastal development. FHAs often include seagrass areas. This criterion measures areas directly affected by the construction of the intake/outfall and network alignment pipes. It should be emphasised that the impact to FHAs will be greatest during the construction phase.

The effect on fish habitat from the brine is not factored into this criterion. The assumption is that the approval to proceed with the desalination plant at any of the sites is conditional on it demonstrating that dispersion of brine from the plant will have minimal impact on the surrounding marine ecosystems.

The evaluation criterion and measures for the assessment of impact on FHAs are shown in Table 5.

**Table 5 Evaluation criterion and measures for Declared Fish Habitat Areas**

Criteria	Unit	Measure	Constraint				
			Very Low 1	Low 2	Medium 3	High 4	Very High 5
Fish habitat	Ha	Areas affected	0 - 1	1 – 2.5	2.5 – 5	5 – 10	>10

#### F1.3.6 Existing sensitive land-uses

Proximity to local sensitive land uses is necessary to understand the social context and therefore social impact of a desalination plant at each of the proposed sites. To assess compatibility with surrounding uses this criterion measures proximity to sensitive land uses. Sensitive land uses cover areas including residential (includes nursing homes, etc); schools/child care centres and hospitals based on information provided by councils and Queensland Land Use Mapping datasets held by the Queensland Government. An area classified as having a sensitive land use will be one negatively affected by the desalination plant (e.g. Noise, odour, visual amenity). Two measures are required for this criterion to distinguish between the plant's impact and the pipelines' impact on sensitive land-uses: distance from desalination plant to nearest sensitive land use and length of corridor within 1km of existing sensitive land uses.

The evaluation criterion and measures for this criterion are shown in Table 6.

**Table 6 Evaluation criterion and measures for sensitive land uses affected**

Criteria	Unit	Measure	Constraint				
			Very Low 1	Low 2	Medium 3	High 4	Very High 5
Existing sensitive land uses	m	Distances from desalination plant to nearest sensitive land use	>5000	2000 – 5000	1000 – 1999	500 – 999	<500
	km	Length of corridor within 1 km of existing sensitive land uses	0 - 10	10 – 20	20 – 40	40 – 80	>80

#### F1.3.7 Land related issues

With the objective of minimising land related issues that have the potential to affect securing the site for use for a desalination plant a criterion was developed to encompass other likely third party interfaces relating to the sites. Land related issues may include mining leases, infrastructure agreements, etc

The measures for this criterion are based on the number of interfaces and agreements which would need to be negotiated to procure a site. Sites requiring numerous external agreements or leases would be likely to have either complex or extremely complex issues. A site with one lease of agreement is likely to result in moderate issues and sites affected by master plans are considered to have minimal issues. Sites with no external contractual agreements or relevant master plans are considered to have no issues. The focus of this criterion is based on the site footprint.

The evaluation criterion and measures for this criterion are shown in Table 7.

**Table 7 Evaluation criterion and measures for land related issues pertaining to the proposed sites**

Criteria	Unit	Measure	Constraint				
			Very Low 1	Low 2	Medium 3	High 4	Very High 5
Minimise land related issues		Assessment with supporting commentary	No issues	Minimal issues	Moderate issues	Complex issues	Extremely complex issues

#### F1.3.8 Native Title

With the objective to minimise impact on native title a criterion has been developed, which indicates whether the site is subject to any registered claims. Native title is administered through the *Native Title (Queensland) Act 1993* which dictates that land subject to native title requires an indigenous land use agreement. Responsibility for administering native title lies with the Native Title and Indigenous Land Services (NT&ILS) within the Department of Natural Resources and Water. Sites are measured against the criteria using either the tenure or the status of native title claim over the land and are therefore largely qualitative.

Qualitative measures have been developed which use either the land tenure or status of claim for evaluation. Land with a freehold tenure extinguishes native title and any land with a non freehold tenure can be subject to a claim. The measures also look at whether a claim on the land has a non registered, registered or determined native title claim upon it. The

information on which this criterion is based has been obtained from the National Native Title Register. The evaluation criterion and measures are shown in Table 8.

**Table 8 Evaluation criterion and measures for minimising impact on native title**

Criteria	Unit	Measure	Constraint				
			Very Low 1	Low 2	Medium 3	High 4	Very High 5
Native Title	-	Land type	Freehold tenure	No claim, non-freehold land	Not registered Native Title claim over non-freehold land	Registered Native Title claim over non-freehold land	Determined Native Title

#### F1.3.9 Visual impact

Based on the objective to minimise visual impact of the plant, a criterion for visual impact was developed. The visual impact has been assessed qualitatively, based on the visual elements surrounding the site and the likely visual fit of the plant taking into account this surrounding visual context and results are presented in detail in Appendix A. This is the second qualitative measure in the MCA. Table 9 shows the criteria used and the measures adopted.

**Table 9 Evaluation criterion and measures for assessment of visual impact**

Criteria	Unit	Measure	Constraint				
			Very Low 1	Low 2	Medium 3	High 4	Very High 5
Visual impact	-	Assessment with supporting commentary	Very low impact	Low impact	Moderate impact	High impact	Very high impact

#### F1.3.10 Other criteria

Other criteria listed below were considered, but were not included within the evaluation criteria because there was either insufficient information to create quantitative objective or informed subjective measures, or that the criterion was unlikely to be an important differentiator.

- Land tenure is not considered to be an important differentiator except in the case of the Native Title criteria;
- Based on information from the Cultural Heritage register, cultural heritage would not show a differentiation between the sites, although the desktop site analysis suggests that the cultural heritage sensitivity of some sites is not evident from the cultural heritage register search. Whilst it is considered there may be a differentiator based on a proper site cultural heritage survey, it was considered too difficult to assign a measure and site score with any degree of confidence and impartiality;
- While general Acid Sulfate Soils (ASS) risks are known, a more detailed analysis is required to determine the real extent of ASS related to a project at each site. Treatment for ASS is practical and creates an additional (although not significant) cost, which has been factored into the estimated pipeline costs and therefore has not been duplicated in the non-cost assessment;

- Dispersion and impact of the brine discharge has not been considered within the evaluation criteria. Acceptable environmental impact is assumed as a pre-requisite to project approvals and the costs of achieving this have been estimated as a consequence of the engineering required for the outfall to meet statutory requirements. Therefore this criterion has not been duplicated in the non-cost assessment.

#### F1.4 Weightings

A pairwise comparison method was agreed as the appropriate system for developing weightings for the non-cost criteria. In applying this methodology the decision maker is asked a series of questions to determine how important one particular criterion is relative to another. For the methodology utilised in this study, a value between 1 and 9 was used to rate the relative preference of a criterion over another, rather than a simple binary statement on which criteria was deemed more important. A score of 1 indicates the highest relative importance with a score of 9 indicating the lowest relative importance. Inversely a score of 1/9 indicates the relative insignificance of that particular criterion when measured against another. In the case of protected area and remnant vegetation a value of 3 was assigned indicating that a protected area status is significantly more important than remnant vegetation status. Conversely when remnant vegetation is compared with protected area it is assigned a score of 3/9 indicating a relative insignificance.

Further explaining the calculations underlying the calculation of weights, the values assigned for each criteria are summed and the relative contribution calculated. As an example refer the protected area column in Table 10 where all the values are added and total 3.48. In Table 11 the relative weight of 0.248 is then calculated (ie  $0.248 = 1 / 3.48$ ). To obtain the final weighting the weights across each criteria are then averaged.

A workshop was held on 13 October 2009, where the pairwise comparison was undertaken with input from QWC. The pairwise comparison resulted in the assignment of 31.4% of the weights to social criteria and 68.6% to the environmental criteria (see Table 10). The weights resulting from the pairwise comparison are shown in Table 11.

**Table 10 Application of pairwise comparison of criteria**

Criterion weight determination Inputs			Protected area	Remnant vegetation clearance	Essential Habitat	Significant wetland	Fish habitat	Existing sensitive land uses <sup>1</sup>	Minimise land related issues <sup>2</sup>	Native title	Visual Impact	
Environmental	Minimise impact on terrestrial and intertidal environment	Protected area	1	3	2	2	4	4	5	5	4	
		Remnant vegetation clearance	0.33333	1	0.2	0.2	0.2	0.5	1	0.2	0.25	
		Essential Habitat	0.5	5	1	1	2	3	4	2	1	
		Significant wetland	0.5	5	1	1	3	3	4	2	1	
Social	Minimise impact on the marine environment	Fish habitat	0.25	5	0.5	0.333	1	1	4	0.5	0.25	
		Maximise compatibility with other uses	Existing sensitive land uses <sup>1</sup>	0.25	2	0.333	0.333	1	1	3	1	0.5
		Minimise land related issues that have the potential to affect securing the site for use for a desalination plant.	Minimise land related issues <sup>2</sup>	0.2	1	0.25	0.25	0.25	0.333	1	0.25	0.33333
		Minimise impact on native title	Native title	0.2	0.5	0.5	0.5	2	1	4	1	2
		Minimise visual impact	Visual Impact	0.25	4	1	1	4	2	3	0.5	1
			3.48333	26.5	6.783	6.617	17.45	15.83	29	12.45	10.3333	

**Table 11 Resultant weights from pairwise comparison**

Criterion weight determination Inputs		Protected area	Remnant vegetation clearance	Essential Habitat	Significant wetland	Fish habitat	Existing sensitive land uses <sup>1</sup>	Minimise land related issues <sup>2</sup>	Native title	Visual Impact	weight
<b>Environmental</b>	Protected area	0.28708	0.113	0.295	0.302	0.229	0.253	0.1724	0.40161	0.3871	<b>0.271</b>
	Remnant vegetation clearance	0.09569	0.038	0.029	0.03	0.011	0.032	0.0345	0.01606	0.02419	<b>0.035</b>
	Essential Habitat	0.14354	0.189	0.147	0.151	0.115	0.189	0.1379	0.16064	0.09677	<b>0.148</b>
	Significant wetland	0.14354	0.189	0.147	0.151	0.172	0.189	0.1379	0.16064	0.09677	<b>0.154</b>
	Fish habitat	0.07177	0.189	0.074	0.05	0.057	0.063	0.1379	0.04016	0.02419	<b>0.079</b>
<b>Social</b>	Existing sensitive land uses <sup>1</sup>	0.07177	0.075	0.049	0.05	0.057	0.063	0.1034	0.08032	0.04839	<b>0.067</b>
	Minimise land related issues <sup>2</sup>	0.05742	0.038	0.037	0.038	0.014	0.021	0.0345	0.02008	0.03226	<b>0.032</b>
	Native title	0.05742	0.019	0.074	0.076	0.115	0.063	0.1379	0.08032	0.19355	<b>0.091</b>
	Visual Impact	0.07177	0.151	0.147	0.151	0.229	0.126	0.1034	0.04016	0.09677	<b>0.124</b>
		1	1	1	1	1	1	1	1	1	

## F1.5 Analysis

### F1.5.1 Criteria Statistics

In order to compare the sites and options, statistics were generated to measure the quantity of each evaluation criteria affected. Calculations were made with regards to either the area disturbed or distances affected by the desalination plant itself including the intake and outfall and the associated pipelines (for the 100 ML/d and 400 ML/d options). The statistics were calculated by analysing various datasets in GIS (see Table 12 and Table 13) for these statistics).

Separate statistics were generated for each site for tunnelling or sea bed laid option construction of the intake and outfall. The tunnelling option is considered to be less damaging environmentally given that there is no surface disruption to the vegetation.

**Table 12 Environmental and Social quantitative statistics for the 100ML/d scenario**

Principle	Objective	Criteria	Unit	Measure	A. Marcoola	A. Marcoola	B. Kawana	C. Bribie	C. Bribie	D. Lytton	E. N	F. S	F. S	G. BAC	H. Fisherman
					Sea Bed	Tunnelled	Tunnelled	Sea Bed	Tunnelled	Tunnelled	Stradbroke	Stradbroke	Tunnelled	Tunnelled	Tunnelled
Environmental	Minimise impact on terrestrial and intertidal environment	Protected area	ha	Protected area affected	6.5	0.0	0.0	5.0	0.9	0.0	0.0	17.6	0.0	0.0	0.0
		Remnant vegetation clearance	ha	Hectares removed	58.3	49.0	13.0	33.6	29.7	0.0	14.8	29.3	27.1	0.0	0.1
		Essential Habitat	ha	Hectares removed	20.7	11.4	8.8	32.4	28.5	0.0	5.5	19.5	18.1	0.0	0.0
		Significant wetland	ha	Area of RAMSAR wetlands affected	0.0	0.0	0.0	10.4	3.3	0.0	21.7	29.1	21.0	0.0	0.0
	Minimise impact on the marine environment	Fish habitat	ha	Area affected	0.1	0.1	0.0	0.1	0.1	0.0	11.0	13.0	13.0	0.0	0.0
Social	Maximise compatibility with other uses	Existing sensitive land uses <sup>1</sup>	m	Distance from desalination plant to nearest sensitive land	1200	1200	830	2200	2200	350	2100	1500	1500	3400	5700
			km	Length of corridor within 1 km of existing sensitive land uses.	85.0	85.0	66.4	52.6	52.6	10.9	14.3	16.9	16.9	9.6	18.4
	Minimise land related issues that have the potential to affect securing the site for use for a desalination plant.	Minimise land related issues <sup>2</sup>		Assessment with supporting commentary	Moderate Issues		Complex	Minimal Issues		No Issues	Moderate Issues	Moderate Issues		Moderate Issues	Moderate Issues
	Minimise impact on native title	Native title		Land Type	Freehold Tenure		Freehold Tenure	No Claim - Non Freehold		Freehold	Registered Native Title Claim	Non Registered		Freehold	Freehold
	Minimise visual impact	Visual impact		Assessment with supporting commentary	Moderate Impact		Moderate Impact	Moderate Impact		Very Low Impact	High Impact	High Impact		Low Impact	Very Low Impact

**Table 13 Environmental and Social quantitative statistics for the 400ML/d scenario**

Principle	Objective	Criteria	Unit	Measure	A. Marcoola	A. Marcoola	B. Kawana	C. Bribie	C. Bribie	D. Lytton	E. N	F. S	F. S	G. BAC	H. Fisherman
					Sea Bed	Tunnelled	Tunnelled	Sea Bed	Tunnelled	Tunnelled	Stradbroke	Stradbroke	Stradbroke	Tunnelled	Tunnelled
Environmental	Minimise impact on terrestrial and intertidal environment	Protected area	ha	Protected area affected	6.5	0.0	0.0	5.0	0.9	0.0	0.0	20.1	0.0	0.0	0.0
		Remnant vegetation clearance	ha	Hectares removed	58.3	49.0	39.0	34.4	30.5	11.7	56.8	90.9	88.7	11.7	11.7
		Essential Habitat	ha	Hectares removed	20.8	11.4	25.4	32.4	28.5	3.4	36.7	69.6	68.3	3.4	3.5
		Significant wetland	ha	Area of RAMSAR wetlands affected	0.0	0.0	0.0	10.4	3.3	0.0	21.7	47.1	39.0	0.0	0.0
	Minimise impact on the marine environment	Fish habitat	ha	Area affected	0.1	0.1	0.0	0.1	0.1	0.0	11.0	13.0	13.0	0.0	0.0
Social	Maximise compatibility with other uses	Existing sensitive land uses <sup>1</sup>	m	Distance from desalination plant to nearest sensitive land use.	860	860	720	2000	2000	350	2100	1500	1500	3100	5700
			km	Length of corridor within 1 km of existing sensitive land uses.	85.0	85.0	66.4	52.6	52.6	51.5	55.5	65.0	65.0	61.6	57.8
	Minimise land related issues that have the potential to affect securing the site for use for a desalination plant.	Minimise land related issues <sup>2</sup>		Assessment with supporting commentary	Moderate Issues		Complex	Minimal Issues		No Issues	Moderate Issues	Moderate Issues	Moderate Issues	Moderate Issues	Moderate Issues
	Minimise impact on native title	Native title		Land Type	Freehold Tenure		Freehold Tenure	No Claim - Non Freehold		Freehold	Registered Native Title Claim	Non Registered	Freehold	Freehold	
	Minimise visual impact	Visual impact		Assessment with supporting commentary	Moderate Impact		Moderate Impact	Moderate Impact		Very Low Impact	High Impact	High Impact	Low Impact	Very Low Impact	

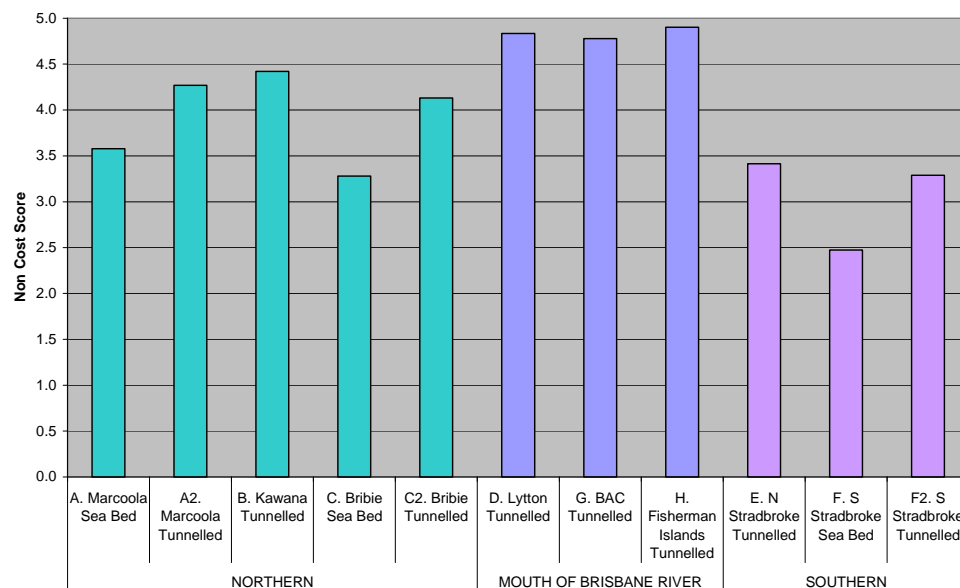
F1.6 Outcome

F1.6.1 100ML/d Scenario

**Table 14 Non-cost scores and ranking for baseline scenarios for 100ML/d option**

Region	Site	100 ML/d With Pipelines Non-Cost Score
NORTHERN	A. Marcoola Sea Bed	3.58
	A2. Marcoola Tunnelled	4.27
	B. Kawana Tunnelled	4.42
	C. Bribie Sea Bed	3.28
	C2. Bribie Tunnelled	4.13
MOUTH OF BRISBANE RIVER	D. Lytton Tunnelled	4.83
	G. BAC Tunnelled	4.78
	H. Fisherman Islands Tunnelled	4.90
SOUTHERN	E. N Stradbroke Tunnelled	3.41
	F. S Stradbroke Sea Bed	2.47
	F2. S Stradbroke Tunnelled	3.29

Applying the calculations generated in Table 12 and Table 13 to the MCA produces a non-cost score for each site as shown in Table 14 and Figure 1. These non-cost scores have been categorised based on the region (Northern, Mouth of the Brisbane River and Southern) within which the sites are located. Lower scores indicate reduced site suitability based on the non cost criteria, while higher scores indicate improved site suitability.



**Figure 1 Variation of non-cost scores for 100ML/d scenario**

The non-cost scores reveal that the sites at the mouth of the Brisbane River consistently score the highest based on the environmental and social criteria used here confirming that their industrial setting have limited environmental and social value. Out of the base

assumptions a 100 ML/d desalination plant at South Stradbroke scores significantly lower than other options. Even a tunnelling option here scores lower than at most other sites due to the high environmental value of the site and its surrounds.

#### F1.6.1.1 Southern Sites

The Stradbroke Island sites obtain scores on the lower end of the scale largely due to their environmental value. South Stradbroke in particular has the largest coverage of essential habitat and remnant vegetation and is a declared Ramsar wetland. This site which has previously been earmarked for protection through a conservation park declaration is a high value site. While North Stradbroke has a higher score than South Stradbroke it is still considered a high value site when compared with other sites being investigated. North Stradbroke is currently undergoing rehabilitation and it is expected that in the future its environmental value would be raised by the likely increase in remnant vegetation and essential habitat.

#### F1.6.1.2 Northern Sites

The three northern sites score similarly for the tunnelling option. There is however a marked difference between the tunnelling and sea bed laid option for Marcoola and Bribie Island where the impact of sea bed laid options results in these sites scoring comparably with sites on North and South Stradbroke Island. In the case of the tunnelling option there is very little differentiation amongst the three northern sites.

This indicates that the use of a sea bed laid option at these sites will result in damage to areas of high environmental value. A sea bed laid option will involve trenching through the seabed which could be highly disruptive during the construction phase in terms of sensitive habitat destruction. This is reflected in the non-cost scores which show that when compared with the tunnelled option at any site the sea bed laid option scores lower (increased environmental impact). Sea bed laid options will also be disruptive in terms of water quality and localised sedimentation which is likely to affect all sites and has not been specifically reflected in this assessment.

An inherent disadvantage of the northern sites is the fact that they require significant length of pipelines (approximately 105km for Marcoola, 82km for Kawana and 55km for Bribie Island) to connect to the proposed network connection node with no difference in lengths for the 100 ML/d and 400 ML/d options. The statistics show that Marcoola will incur the greatest loss of remnant vegetation with a large proportion of this due to the length of pipeline required to feed back into the water grid compared to other sites. A more detailed analysis of the integration point and pipeline route may further reduce the need for remnant vegetation clearance. A sensitivity analysis has been undertaken and is discussed in Section F1.6.3 which investigates the impact on non-cost scores of removing the pipeline component.

#### F1.6.1.3 Central Sites

As mentioned above the sites at the mouth of the Brisbane River consistently score highly due to their industrial setting. However given that they are situated on the Moreton Bay coastline, appropriate feed water quality and dispersion are key issues determining the location of the feed water intake and brine discharge outfall. Significant lengths (approximately 5 to 10km) of pipeline will be required to either collect feed water or discharge the brine. The location of the feed water intake and outfall has been largely determined by a separate dispersion modelling study (Refer Appendix I). The key objective of this modelling project was to inform the overall Phase 2 SEQ Regional Desalination Plant Siting Studies with the provision of a preliminary investigation of various brine discharge scenarios in the lower Brisbane River estuary and Moreton Bay. Specifically, the study was intended to assist in the determination of plant capacity at the potential Lytton site in terms of what level of brine discharge to the marine environment could be considered sustainable.

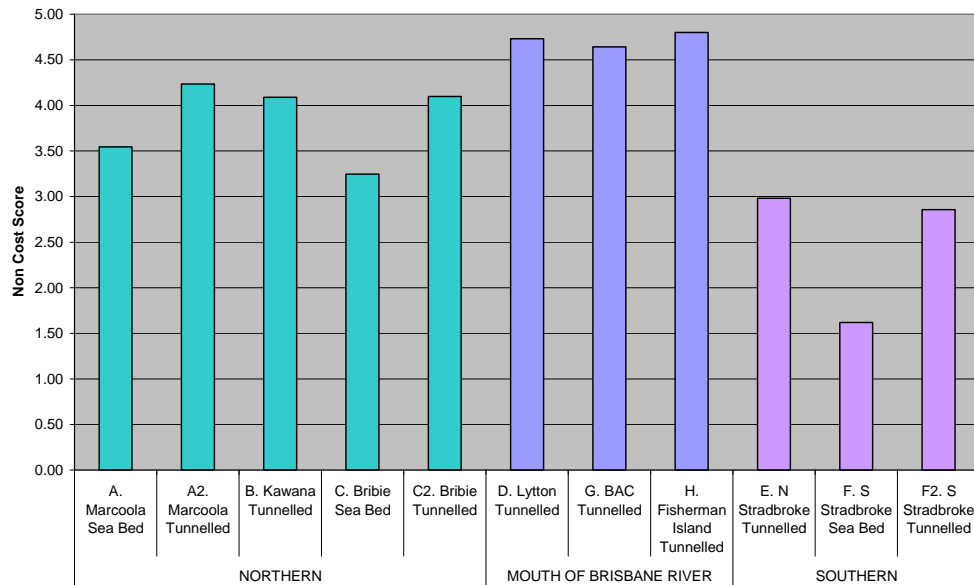
All three central sites will require an intake which extends to a point west of Mud Island. In the case of Lytton and Port of Brisbane there is the potential to trench (sea bed laid) the intake pipe while BAC will be limited to tunnelling due to the need to pass through a navigation channel and to avoid impacting the environmentally sensitive Bramble Bay. However, the non cost scores for Lytton and Port of Brisbane, will not differ between a trenched and tunnelled option unlike other sites. This is due to the fact that a trenched pipeline to the west of Mud Island will traverse through what is designated as 'General Use Zone', under *Marine Park (Moreton Bay) Zoning Plan, 2008*. The MCA only accounts for areas designated as 'Protected Zones' or 'Ramsar Wetlands', given the high level of restrictions in place for undertaking works in these zones.

#### F1.6.2 400 ML/d Scenario

Table 15 and Figure 2 show the results of a similar scoring exercise undertaken for a 400 ML/d scenario. The ability to undertake a future upgrade to 400 ML/d from 100 ML/d at any particular site is considered an important feature of the site. Some similar patterns of scoring are evident for the 400 ML/d scenario as for the 100 ML/d scenario. The central sites again score consistently higher than other sites being considered.

**Table 15 Non-cost scores and ranking for baseline scenarios for 400ML/d option**

	Site	400 ML/d With Pipelines Non-Cost Score
NORTHERN	A. Marcoola Sea Bed	3.54
	A2. Marcoola Tunnelled	4.23
	B. Kawana Tunnelled	4.09
	C. Bribie Sea Bed	3.25
	C2. Bribie Tunnelled	4.10
MOUTH OF BRISBANE RIVER	D. Lytton Tunnelled	4.73
	G. BAC Tunnelled	4.64
	H. Fisherman Island Tunnelled	4.80
SOUTHERN	E. N Stradbroke Tunnelled	2.98
	F. S Stradbroke Sea Bed	1.62
	F2. S Stradbroke Tunnelled	2.86



**Figure 2 Variation of non-cost scores for 400ML/d scenario**

#### F1.6.2.1 Southern Sites

For the 400ML/d scenario the southern sites score consistently lower than all other sites investigated. South Stradbroke for the sea bed laid option scores significantly lower than for other options reaffirming the environmental sensitivities associated the site. A sea bed laid option at South Stradbroke would require the construction of an intake and outfall through areas designated as 'Marine National Park' under the *Marine Park (Moreton Bay) Zoning Plan, 2008* which further lowers its score due to the high restrictive nature of undertaking works within such a zone.

#### F1.6.2.2 Northern Sites

Marcoola, Bribie Island and Kawana score fairly similarly for the tunnelled option. Kawana however becomes the least preferred of the northern sites for the 400 ML/d scenario. This is attributed to the high environmental sensitivity of the area which would be affected by additional land requirements with an expansion from 100 ML/d to 400 ML/d. The score however is not significantly lower than the other two northern sites is due to the fact that the analysis does not differentiate between the types of remnant vegetation to be cleared. The 400ML/d option at Kawana will necessitate the clearing of 17.4 ha of endangered remnant vegetation. If the analysis placed further emphasis on the endangered classification of the vegetation it is likely that the score for Kawana would be significantly lower when compared with the score for the other northern sites. Kawana is therefore considered the least suited for future expansion of the three northern sites.

In regards to the other two northern sites, Marcoola and Bribie Island both the 100 ML/d and 400 ML/d scenarios reveal a slight preference for Marcoola over Bribie, with both the sea bed laid and tunnelling options receiving a higher score at Marcoola.

#### F1.6.3 Sensitivity Testing

A sensitivity exercise has been undertaken to test the sensitivity of the output to two key variables:

- Impact of network pipeline corridors; and
- Impact of different weightings.

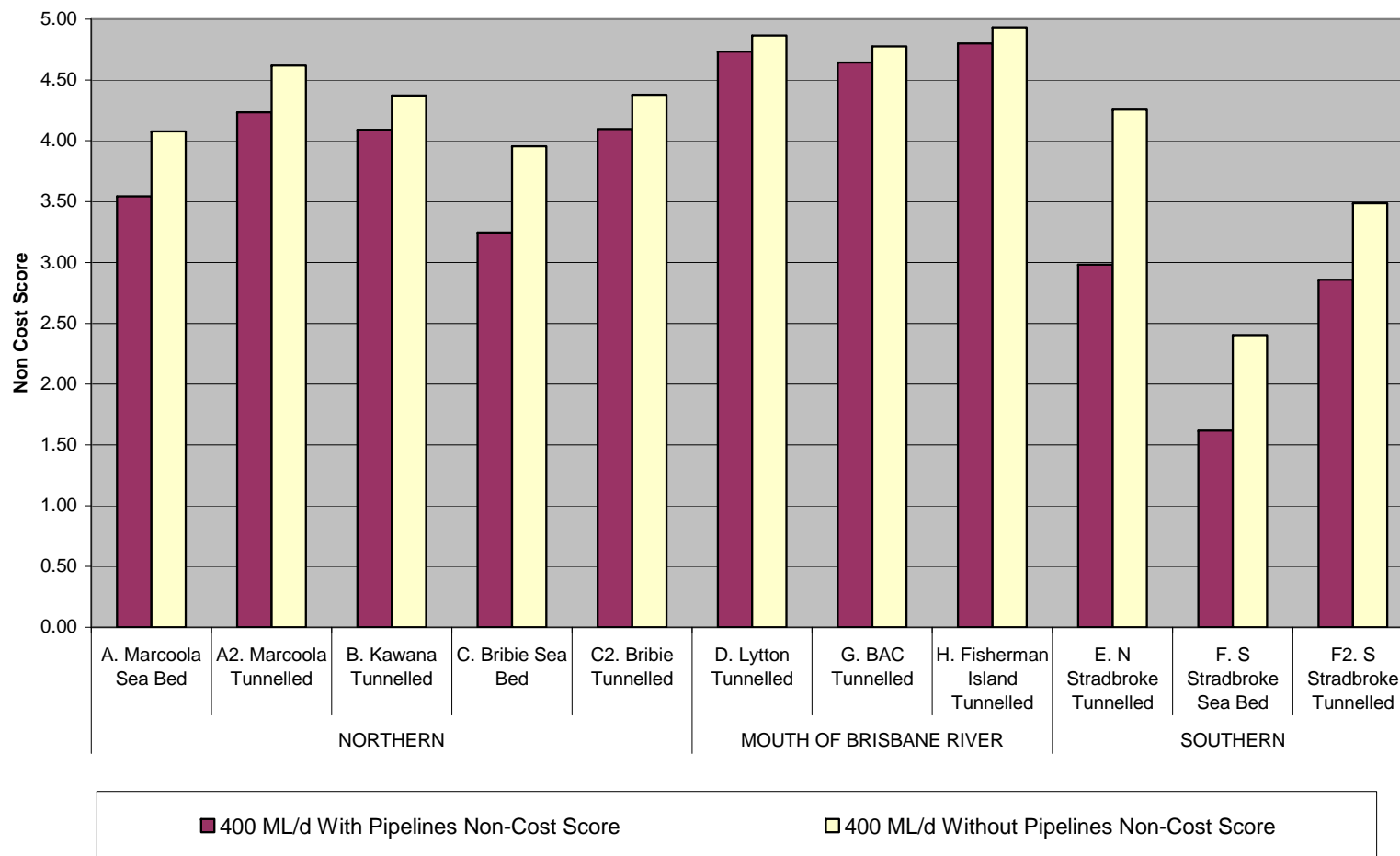
The network pipeline corridors chosen for this study have been selected with the aim of connecting the site with the connection node specified by QWC. The specification of the

network corridors has been selected using a broad desk based approach and will be the focus of further investigation for priority sites in Phase 3 of this study. It is likely that further investigation of both the connection node and connection corridors will reveal alternate options with lower impacts. The northern sites have significantly longer lengths of corridors compared to other sites which are an inherent disadvantage of the sites. Island sites will require a pipeline to be constructed across waterways to the mainland, with limited options available to avoid sensitive areas which surround the sites. This analysis considers the effect on the non cost score of removing the pipeline corridors on the mainland.

This sensitivity analysis has been undertaken for the 400 ML/d option for which all sites have an extended pipeline length allowing for a more unbiased comparison of the impact of the pipeline. The result of the sensitivity analysis comparing the non-cost scores for the 400 ML/d scenario with and without pipeline is shown in Figure 3. The removal of the pipeline generally results in changes to the environmental score and has also involved the removal of the criteria which looks at the proportion of the pipeline corridor close to sensitive uses. Overall removal of the pipeline scores illustrates the value of the site and surrounding area.

The results show that the southern sites are more sensitive to their associated pipeline corridors. While the sites themselves are known to be of high environmental value, the heightened sensitivity of the southern sites reveals the relative high value of their chosen pipeline corridors on the mainland. North Stradbroke is particularly sensitive to removal of the pipeline corridor indicating the environmental value of the chosen corridor on the mainland. A further investigation of the GIS mapping of essential habitat and remnant vegetation indicates that there are larger areas of such vegetation on the mainland in the south making it difficult to entirely avoid them. Therefore while some optimisation of the southern pipeline corridors will result in improved 'non cost scores' it is unlikely that it is going to result in the full removal of the non cost scores associated with the pipeline. In the case of South Stradbroke further optimisation of the pipeline does not preclude the site from scoring the lowest of all sites indicating the environmental value of the site itself.

The northern sites are less sensitive to removal of the pipeline corridor when compared with the sites in the southern region. Though all three northern sites benefit from the removal of the statistics associated with the pipeline, Kawana is the least sensitive confirming the value of the Kawana site at 400 ML/d. When comparing Marcoola with Bribie Island, removal of the pipeline reveals a slight increased preference to Marcoola which can be attributed to the longer length of pipeline necessary for Marcoola. However Marcoola needs a pipeline almost double the length for Bribie implying that Marcoola should be more sensitive to the removal of the pipeline corridor. Given that this is not evident in the results it would indicate that further optimisation of the pipeline corridor for Marcoola is unlikely to provide added environmental or social benefit.



**Figure 3 Sensitivity analysis comparing non-cost scores calculated with and without pipeline**

Another variable in this study is the weighting which has been applied to the criteria. The weights attached to the criteria are one of the key influencing factors in the outcome of this MCA study and therefore the overall ranking of the sites. The weights have been determined also using a pairwise comparison method. These weights in general are subjective and are more likely to be in dispute amongst stakeholders than other parameters. A need to assess the robustness of the ranks to change in weights is necessary and this assessment is undertaken below.

Different weighting was applied to examine the sensitivity of the ranks relative to changes in evaluation criteria weights. This approach allows simultaneous changes of the weights and generates results/ranks that provide insights into the multi-criteria ranking and therefore study recommendations. Four cases are considered in this sensitivity testing: original pairwise comparison weights, alternate weights put forward by QWC, inverse weights to the original pairwise comparison weights and equal weights. These weights are shown in Table 16. The weights have thus been modified within reasonable bounds changing the emphasis between environmental and social criteria.

These alternate weights have been applied to the 100 ML/d scenario for testing of sensitivity and the outcome displayed in Figure 4.

**Table 16 Sensitivity testing to weights**

Category	Criteria	Agreed weights used in this study	Emphasis	Alternate weights (QWC)	Overall Emphasis	Inverse weights	Emphasis	Un-weighted	Emphasis
Environmental	Protected area	0.271	0.69	0.228	0.76	0.032	0.41	0.111	0.56
	Remnant vegetation clearance	0.035		0.071		0.154		0.111	
	Essential Habitat	0.148		0.173		0.067		0.111	
	Ramsar wetland	0.154		0.255		0.035		0.111	
	Fish habitat	0.079		0.031		0.124		0.111	
Social	Existing sensitive land uses	0.067	0.31	0.059	0.24	0.148	0.59	0.111	0.44
	Minimise land related issues	0.032		0.048		0.271		0.111	
	Native title	0.091		0.109		0.091		0.111	
	Visual Impact	0.124		0.026		0.079		0.111	

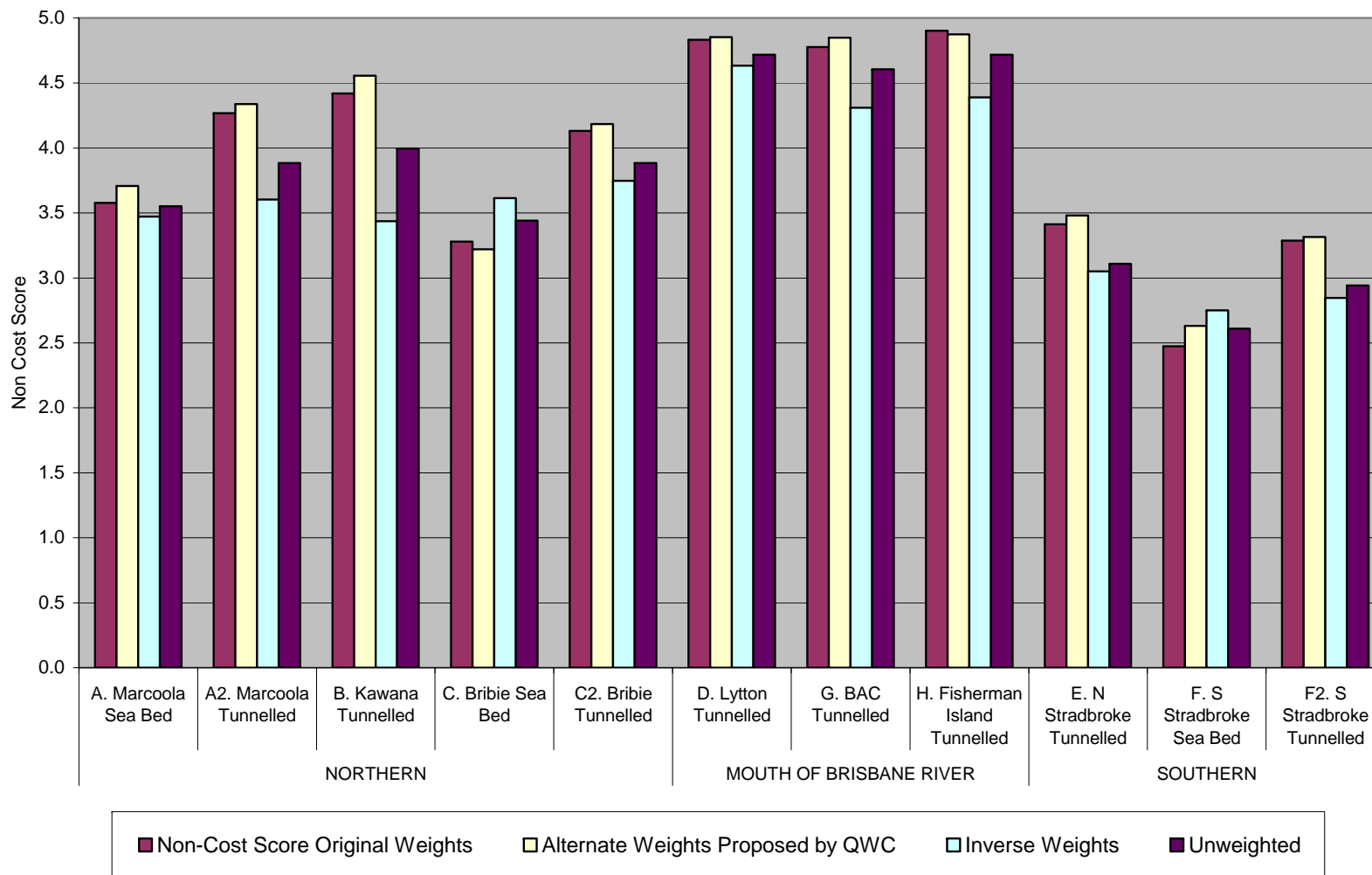


Figure 4 Sensitivity analysis to change in weights on non-cost scoring (100ML/d)

The inverse weights scenario refers to swapping of weights between highest and lowest weighted criteria and similarly between second highest and second lowest. The inverse weights scenario results in a levelling effect on the scores within each region. The effect of inverse weights is to reduce the emphasis on the environmental component while increasing emphasis on social criteria. The low emphasis on the environmental criteria counters the high environmental scores of the environmentally valuable sites. Sites whose score originally has a greater social focus become less preferred under the inverse weights scenario. Overall the results show that under this scenario the southern sites score the lowest (i.e. greatest environmental impact) while the mouth of the Brisbane River sites score the most (i.e. least environmental impact).

The analysis incorporating the proposed changes in weights generally reveals that the overall outcome of the study is insensitive to weights used here. The weighted score for each criterion is a product of the score (based on measures) and the weights. A general insensitivity to weights indicates that the overall score for each criteria is influenced largely by the 'measures' based score and less by the weights. What is observed is that the general pattern of scoring amongst the northern, mouth of Brisbane River sites and southern sites remains the same and therefore outcome of non cost scoring is unaffected by modifying the weights within reasonable limits.

#### F1.7 Summary

---

The outcome of the non cost assessment includes:

- Site E – North Stradbroke Island and Site F – South Stradbroke Island both attain low scores in comparison to other sites being investigated;
- Site F – South Stradbroke Island is considered the least preferable of all sites considered for the siting of a desalination plant at both a 100 ML/d and 400 ML/d capacity;
- Sea bed laid construction method for the intake and outfall reduces the relative preference of the sites where this option was investigated;
- The non cost score for Site B – Kawana is sensitive to plant production capacity and becomes the least preferred of the northern sites for the 400 ML/d production capacity
- The assessment indicates a preference to Marcoola of the three northern sites; and
- The three mouth of the Brisbane River sites score consistently better than all other sites due to their industrial setting.

#### F1.8 Next Step

---

The integration of non-cost scores with the costs is the next step to understanding the preference order of the sites and this is investigated in the Phase 2 Siting Study Report. An analysis of expansion of the Tugun desalination plant and the non cost score derived for this option will also be investigated in the Phase 2 Siting Study Report.