An Evaluation of Site Selection Work Contained in ChevronTexaco's Environmental, Social, and Economic Review of the Gorgon Gas Development on Barrow Island

Report for the Environmental Protection Authority Service Unit

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INTRODUCTION

This review focuses on two documents; the Environmental, Social, and Economic Review of the Gorgon Gas Development on Barrow Island ('the ESE Review'), and a separate Appendix document that is accessible on ChevronTexaco's website, and on a Compact Disc enclosed with the ESE Review. This Appendix is titled: 'Technical Appendix C: Identification of Suitable Locations for a Land-Based Gas Processing Facility Linked to the Gorgon Gas Field' ('Appendix C').

The two documents are intimately linked, with Appendix C providing a good proportion of the material contained in Chapter 4 of the ESE Review ('Alternative Development Concepts'). When we refer to both of these documents in combination, we define them as 'the ESE project'.

Our review focuses on the following issues:

* the robustness of the overall strategy taken with regard to 'alternatives analysis';

* the linkage between the documents;

* the technical veracity of Appendix C; and

* alternative ways in which the proponent could have approached the location and site selection component of the ESE project.

Before beginning our review, we think that it is appropriate to note that the proponent has undertaken a serious process of alternatives analysis and has attempted to address sustainability issues. It is fair to say that many proponents have not dealt well with both of these aspects in the past.

ROBUSTNESS OF THE OVERALL STRATEGY

The proponent used a two-stage process to find a site for the Gas Processing Facility ("GPF"). We believe that the idea of using a constraint-based GIS system for sifting regional locations, followed by a more detailed matrix-based multi-criteria analysis process, is conceptually sound.

We are concerned, however, about the historical development of the approach to location and site selection. The proponent makes it clear that the 'alternatives analysis' work contained in chapter 4 of the ESE Review, and in Appendix C, was undertaken after an earlier decision was taken to propose Barrow Island as the best site for the GPF. This is made clear in the last paragraph of page 35 of the ESE Review, and in the first paragraph of section 13.1, in the same document.

This is a problematic foundation for rigorous alternatives analysis. Process legitimacy is all-important in this discipline. In our experience, and as discussed in the literature, a fundamental element of legitimate alternatives analysis is a commitment to begin with an 'open slate'. The ESE Review gives the strong impression that the process undertaken for analysing alternatives was designed 'after the fact'. It is not too big a stretch to conclude that the alternatives analysis work was 'retrofitted' to justify a decision that had already been made. Critical stakeholders could be further led to conclude that the process itself has been manipulated to result in a good ranking for Barrow Island.

LINKAGE BETWEEN THE DOCUMENTS

We are concerned about a number of aspects related to the uncertain linkage between Appendix C and the ESE Review.

Possibly our biggest concern relates to the exclusion (from the ESE Review) of some crucial detail contained in Appendix C.

Sections 6.3 to 6.5 in Appendix C contain the Stage 2 comparison of sites. Table 6.5 and Table 6.6 present the detailed scoring of alternative sites against a set of criteria developed by URS especially for the purpose.

Although this analysis is methodologically flawed (see the 'Technical Veracity of Appendix C' section of this report), it allows for a specific numerical comparison of site alternatives and points to the fact that all seven possible sites are quite closely grouped. Each has different ranking outcomes depending on whether the focus is on construction or operation. Three sites (Burrup, West Intercourse, and Maitland) are higher ranked than Barrow in relation to operation impacts, and two sites (Montebello and Thevenard) are ranked higher than Barrow when construction impacts are considered. The histograms presented in Figures 6.1 to 6.3 in Appendix C makes these conclusions clear.

Unfortunately, none of this material is presented in Chapter 4 of the ESE Review. Only the outcome Figure (Figure 6.4 in Appendix C, recast as Figure 4.3 in the ESE Review) is presented, and even this is confusing because it is headed 'Summary of Location Comparison' rather than the more correct 'Summary of Site Comparison'.

In addition, 'key cost driver components' presented in Table 4.3 of the ESE Review were not part of the Stage 2 multi-criteria analysis in Appendix C, and no other economic cost criteria were used in the site comparison analysis contained in Section 6.4 and Section 6.5 of Appendix C. In a sense, Appendix C does not contain a true 'triple bottom line' multi-criteria analysis process, because economic cost criteria have been left out. Somewhat strangely, Figure 6.4 in Appendix C includes a "Technical/Cost" row, although no "technical/cost" analysis was undertaken in Appendix C. Economic criteria have been 'added-in' late in the piece, in Section 4.2.5 of the ESE Review. It is our view that this results in artificially high weighting being given to economic criteria. They have been

effectively applied 'after the event', and therefore indicate to stakeholders that economic criteria are more important than all others.

TECHNICAL VERACITY OF APPENDIX C

This section of our report analyses the methodologies used to undertake the two-stage multi-criteria analysis process for location sifting and site comparison in Appendix C.

Defining multi-criteria analysis

Section 3.2 of Appendix C provides a conceptual background for the techniques used in the two-stage alternatives analysis process. Two comments can be made about this section. First, we are a little concerned that the average reader may get the impression that the first stage is more rigorous because it is defined as being 'scientific', whereas the second stage is more qualitative and value-based, and therefore less reliable. It is true that both stages use different multi-criteria analysis techniques. As practitioners and researchers, it is also clear to us that the Stage 1 'scientific-analytic GIS approach' involves just as much value judgement as the Stage 2 technique. GIS has a different way of presenting 'scores'—as overlay sheets rather than entries in a two-dimensional matrix—but it relies just as much on value judgement for determining scores and weightings as does the Delphic Judgemental Stage 2 process. In fact, Table 4.1 in Section 4.2.1 of Appendix C makes it clear that there is *more* value judgement built into Stage 1 than there is in Stage 2. This conclusion can be quite crucial.

For example, the scoring process used to fill in Table 4.1 gives a constraint factor of '5' for 'proximity to nature reserves', but excludes national parks (constraining factor of '999'). In our view, A Class nature reserves and national parks are hierarchically equal in law. If, instead, it had been decided to exclude A Class nature reserves, then Barrow Island would have been excluded as a possible location, or if A Class nature reserves were given a constraint factor of '10' (the same as mangroves), then Barrow Island's ranking may have changed.

The second comment we would like to make in relation to Section 3.2 of Appendix C is that the Stage 2 technique used by URS is more properly known in the literature, and in practice, as either 'additive weighting', or 'weighted summation'[1].

The role of stakeholders in multi-criteria analysis

Another serious concern that we have relates to the use of stakeholders in both stages of the alternatives analysis process. Earlier in this report we discussed the importance of

[1] Resource Assessment Commission 1992. Multi-criteria analysis as a Resource Assessment Tool. RAC Research Paper No. 6. Canberra: Commonwealth of Australia.
Annandale, D. and Lantzke, R. 2000, Making Good Decisions: A Guide to Using Decision-aiding Techniques in Waste Facility Siting. Perth: Murdoch University Institute for Environmental Science.

'process legitimacy' for the overall acceptance of the outcome of alternatives analysis. Another fundamental element of legitimate alternatives analysis is the involvement of stakeholders in the entire process of determining alternatives; listing comparison criteria; and providing weightings (values) for each of the criteria. It is stated in Section 1.3 that "seeking a location for a GPF involves careful consideration of stakeholder concerns, including local and state government, industry groups, public interest groups, and the wider community". However, there is no evidence whatsoever that the last two-mentioned stakeholder groups were involved in the process set out in the remainder of Appendix C.

Chapter 13 of the ESE Review makes it clear that the proponent has undertaken significant consultation on this proposal. In our view, however, this consultation was misfocused. A much more robust outcome would have been obtained from the two-stage multi-criteria analysis process if stakeholders had been involved in this aspect of the ESE project. Legitimate alternatives analysis requires all relevant stakeholders to accept that they have been fully involved in the three steps mentioned in the last paragraph. When full involvement is accepted, then the scores and weights used in multi-criteria analysis are also accepted by stakeholders … because it is they who determine them! As an example, it is in our view highly unlikely that external stakeholders would easily accept the proximity of A Class nature reserves being given a score of '5' in the stage 1 process. URS and its associated 'experts' have presumably derived this score. This score clearly has no basis in 'fact'. It is a value judgement. A stronger alternatives analysis process would have used a large stakeholder group to determine scores where these cannot be obtained by 'scientific' means.

Methodology in multi-criteria analysis

We have a number of serious concerns about the methodology used to undertake the two-stage multi-criteria analysis process.

First, Table 4.1 in section 4.2.1, provides details about constraint factors and buffer widths. The only attempt made in the text surrounding Table 4.1 to explain how 'constraint factors', 'buffer widths', 'buffer constraint factors' and 'weighting factors' were actually applied in calculations to determine GIS layers, is contained at the bottom of page 9, and in Figure 4.9.

In addition, we believe that Figure 4.9 could have been reworked to significantly improve the transparency of the overlay development process, for the following reasons:

- The numbers shown don't relate directly to the suggested examples of mangroves and watercourses. As set out in Table 4.1, there is no exclusion constraint factor of '999' associated with mangroves, nor is there a constraint factor of '3' for water courses.

- The algorithm for the economic/engineering criteria is more complex than the example provided in Figure 4.9, and so should have been separately explained.

- The adding of GIS layers, although illustrated diagrammatically in Figure 4.8, could also have been illustrated numerically using a typical range of values for each layer. The relative values between layers would have thereby been apparent.

Second, the development of 'weightings' for economic criteria presented in Table 4.3 is especially confusing.

For example, in Appendix A (of Appendix C) the table illustrates how the "Weighting Applied per Point" is calculated eg. the "Proximity to Gorgon gas field" criterion presents '70' as the "Weighting Applied per Point". However, in Table 4.3 the "Weighting factor" for the same criterion is 70%. Presumably - although this is not clear - the Constraint value is multiplied by this Weighting factor. Unfortunately, it is not clear whether the actual value of the Weighting factor is '70', or 70% (0.7). Whatever weighting factor is used would not make a relative difference within the Economic/Engineering overlay, and so Figure 4.6 would remain the same, but it would make a significant difference in developing the composite constraints overlay, where the values for each grid from the 3 overlays are added. For example, for the more distant locations a constraint value of '10' could be multiplied by 70 to give a value of 700. When compared to other overlays this value would dominate the summation, effectively making it an exclusion factor. On the other hand if it was 10 x 0.7 = 7 it would probably be too low, especially as the other criteria within the Economic/Engineering table are weighted much lower.

A final concern relates to the mathematics underlying the multi-criteria analysis work. The stage 2 additive weighting process described in Sections 6.3 to 6.5 uses a mathematically impermissible operation. The scores contained in the matrices in Table 6.5 and Table 6.6 are in effect 'ordinal'. This means that they are presented on a limited scale from –2 to +2 to distinguish the 'worst' from the 'best' by incremental changes. The mathematical rules for dealing with ordinally-scaled data are clear. All social science text books deal with this issue[2]. Ordinally-scaled data cannot be added, subtracted, divided, or multiplied. In other words, no mathematical operations can be applied to ordinally-scaled data. This is because we do not know the degree of difference between these scores. We only know that a score is better or worse than another, but not by how much. For example, in Table 6.5, air pollution/odour/noise is given a score for each alternative site from –2.0 (worst score) to –0.5 (best score). Let's assume for now that this is just measuring CO_2 emissions. Table 1, below, gives a hypothetical example of how this ordinally-scored criterion might look if it were possible to generate ratio-scaled scores for the same criterion.

[2] See, for example, Schutt, R. 1999, Investigating the Social World: The Process and Practice of Research. Thousand Oaks, California: Pine Forge Press.

Table 1: Hypothetical relationship between ordinal scores and ratio-scaled scores for CO2 emissions

Alternative	A	B	C	D
Ordinal score	-2	-1.5	-1	-0.5
Ratio-scaled score	100 tonnes/year	90 tonnes/year	80 tonnes/year	10 tonnes/year

It can be seen from this example that the ordinal scale differences are exactly the same (0.5). When the criterion is ratio-scaled, however, the differences between alternatives are pronounced. There is only 10 tonnes/year difference between alternative A and alternative B, but there is 70 tonnes/year difference between alternative C and alternative D. Applying mathematical operations to ordinally-scored data could therefore magnify these differences. This is why all mathematical operations applied to ordinally-scaled data are forbidden. It is important to note, therefore, that the 'Total' row at the bottom of Table 6.5 and Table 6.6 is not necessarily representative of reality.

In addition, we believe that Figure 6.4 is not well presented. There is no in-depth indication of how the values in Figure 6.4 were developed. It is not clear if they include both construction and operation constraints. The use of 'dots' is also potentially deceiving. The areas of the dots are not representative of the values presented in Table 6.5 and Table 6.6. As was mentioned earlier, the third row of data is titled "Technical/Cost". This information was not developed in Appendix C and we are at a loss as to where it originated from.

Finally, the site comparison work presented in Section 6.4 and Section 6.5 does not include any separate weighting of criteria (the ordinal values used are essentially weighted scores). Formal involvement of stakeholders, and consequent weighting of the site comparison criteria would have resulted in a more robust and reliable site ranking outcome.

Other errors and questions

The following errors also occur in Appendix C.

* The values used for the "Pipeline crossing" criterion in Table 1 of Appendix A are inconsistent with those used elsewhere in the document. On page 25 it refers to a constraint of '10' being used in combination with a weighting factor of 0.5%. This is equivalent to $0.5 million for each constraint point. This calculates out to a cost of $5 million for a pipeline crossing. This is consistent with the values used in Table 4.3. Appendix A, however, uses $2 million for the cost and a maximum constraint factor of 2 that results in a weighting applied per point of 1. This is confusing.

* Typographical error: page 4, third line. Replace "Section 6", with "Section 9".

* The middle sentence in the second-last paragraph on page 9 is confusing. It currently reads: "Values ranged between 1 (low constraint) and 10 (high constraint) for each factor". We believe that it should more correctly read: "Values ranged between zero (no constraint) and 10 (high constraint), although the maximum value may have been lower for any one factor".

* In Table 4.2 (page 20), under the "Tourism and Recreation Resources" heading, the Buffer Constraint Factor is given as "exclusion". On page 23, however, it is given a Buffer Constraint Factor of "5". The impact of this error cannot be tracked in the documentation provided. It would need to be viewed on the GIS database.

* In Table 6.6 (page 41), the third last row presents the "operations" values for the Normalised Score for Burrup Peninsula, West Intercourse Island, Barrow Island, and Maitland Industrial Estate. These values should be "positive", not "negative". These appear to be typographical errors, as positive values are used in the plots.

* On page 5 in the last paragraph, it is stated that docking facilities are required no more than 5 km from the 10 m isobath. However, Table 4.3 on page 21 indicates that distances greater than 5.5 km were included. In the same table it is stated that an index was developed around the distance to both 10 m and 5 m isobath. This issue is confusing.

* Figures 4.4 to 4.7 are developed on a "suitability scale", but the range associated with each level is not stated. It is not clear whether the suitability colour scales are uniform. Moreover, as the results were added to form the Composite ESE Constraints, it would have helped provide transparency to the process by indicating the range of values experienced in each constraints map.

* In Table 4.1, small islands (< 1000 ha) were excluded. An appendix indicating the size of these excluded islands would have helped assure the reader that a potential location wasn't automatically excluded by this limitation. In addition, Thevenard Island, which is approximately 500 hectares in area, was actually included in the analysis.

* The difference between constraint factors for Mangroves (10), National Parks/Marine Parks (exclusion) and A Class reserves (presumably "5", as A Class reserves are not listed separately) seems to be at odds. In our view it would have been better to include National Parks/Marine Parks with a high constraint factor (for example, "10") rather than make an arbitrary exclusion decision. In this fashion A Class reserves, which are hierarchically equivalent in law to national parks, could also have been given a high constraint value.

* On page 24 under the heading "Proximity to Gas Source", the proximity to the Gorgon gas field is considered to be a major factor. The ESE review, however, indicates that a domestic pipeline to the coast is required. In our view, the domestic pipeline should be 'offset' against the larger pipeline, reducing the constraint for the more distant mainland locations. Mainland locations are adjacent to existing domestic pipelines. There is no indication that this issue has been included in the Constraint Factor.

* On page 25, second last paragraph: for Figure 4.6 it is stated that it "shows … the parts of the coast excluded by various engineering requirements". This seems a superfluous addition to the sentence, as specific exclusion zones are not indicated. Moreover the same applies to the offshore islands. The absence of a colour for the exclusion grids on any of the Figures 4.4 to 4.7 also applies to all the constraint figures.

* On page 26, last sentence in the middle paragraph: There are several other locations that are 'green', including Onslow North and parts of the Montebello Islands. Certainly Barrow Island is the most extensive area with a smattering of green and yellowish locations, but with this broad-brush analysis we believe that it ought not be singled out.

* On page 27 under "Onslow North": The reason given for the exclusion of this site is not well developed. If there is a small 10 m deep basin, wouldn't this reduce the dredging costs?

* On page 31, last sentence in Section 6.2.3: How does the mitigating factor that it "is not connected to the mainland" differ from a similar limitation for island sites?

* It is not clear in Tables 6.5 and 6.6 whether the impacts of the over-land pipelines (for gas and CO2) on Barrow Island have been considered in the analysis.

* In Table 6.1 (page 36), other important social criteria could/should have been included, such as "Local Employment" and "Commercial Fisheries".

ALTERNATIVE APPROACHES

Our review has pointed to a range of methodological and strategic problems with the ESE project. From our experience with the design of alternatives analysis processes - and with the growing discipline of sustainability assessment - we suggest that a more rigorous and legitimate process would take the following structure.

Stage 1

We believe that a GIS-based stage 1 concept is a good way to begin the process of deciding on the best site for a GPF. We would, however, have made the process more transparent. First, we do believe that stakeholders should have been involved in commenting on the initial choices of locations, to the point where they could have added new alternatives or amended those presented by the proponent. In addition, we believe that the whole process should have started with a 'blank slate'. In other words, an attempt should have been made to determine the highest ranked site, and not to justify a decision already made to site the GPF on Barrow Island.

Second, we believe that using an 'exclusion' approach without adequate stakeholder input affects the legitimacy of the entire process. Questions can easily be raised about why national parks are excluded, but A Class nature reserves are not. In our view, a more legitimate process would not have automatically excluded any location. Exclusion would take place through the ranking process, where strong weights are applied to highly valued natural assets.

Finally, we believe that more effort should have been put into describing how the GIS layers were calculated and added. The outcome would have been a list of possible site locations, just as it was in the ESE project, but with no confusion over the methods used to calculate GIS layers.

Stage 2

We suggest that stage 2 could have followed the same overall structure, but with some substantial reforms.

Stage 2 could have started with the shortlist of locations determined in stage 1. It would then have used stakeholders - in a workshop setting - to determine a detailed list of comparison criteria, similar to those devised by the proponent and used in Table 6.5 and Table 6.6 in Appendix 2.

We are of the view that this process should have allowed the kind of economic criteria presented in Table 4.3 of the ESE Review to have developed from stakeholder consultation.

The next step would have been to assemble the alternatives and comparison criteria in an 'effects matrix', similar to the ones presented in Table 6.5 and Table 6.6 of Appendix 2. This is the point at which 'scoring' could take place. Where possible, criteria should be ratio-scaled. In general, this allows 'experts' to undertake scoring without requiring direct stakeholder input. Where criteria cannot be ratio-scaled—either because of their inherent 'unquantifiability', or because of resource constraints—these criteria should be scored by panels of 'experts' closely overseen by stakeholder representatives. This is the approach we have used recently on a number of road route selection projects.

After scoring has been undertaken, the stakeholders can be 'recalled' to undertake weighting of the criteria. Stakeholders would be given a list of the criteria and be asked to weight them from '1' to '10', where '1' is 'not important', and '10' is 'very important'. We would then average the weights of all the stakeholders present at the weighting workshop. We could also ask people to identify their interest group, and average the weights of these groups. This would allow for sensitivity analysis to be undertaken to ascertain the impact of using different weight sets on the ranking outcome.

The final step would be to place all of the above information into a multi-criteria analysis software programme. Our earlier comments indicated that the process used by URS – additive weighting – was not mathematically permissible, because all of the scores used were ordinally-scaled. We would therefore have applied one of the many techniques that have been developed to work with 'mixed', ordinally-scaled and ratio-scaled data. In our work we use concordance analysis or Evamix techniques[3].

The final outcome would have been a rigorous and transparent process for ranking possible GPF sites, using stakeholders at each relevant point, and so maintaining the legitimacy of the process all the way through.

CONCLUSIONS

In conclusion, we believe that we have addressed all of the 'terms of reference' presented to us by the EPA in Mr Tacey's letter of March 5th, 2003.

We accept that it is the proponent's right to present the site selection component as it sees fit. We also accept that a private proponent will often want to weight economic cost criteria highly, either in an explicit or implicit fashion. We have concerns, however, when alternatives analysis is presented as rigorous, triple-bottom-line multi-criteria analysis, when this is clearly not the case.

In our view, the strategic and methodological errors made by the proponent, and explained in some detail above, mean that it is impossible to state that Barrow Island is the highest ranked site for the proposed GPF, when looked at from the perspective of rigorous multi-criteria analysis.

The location and site comparison process outlined in detail in Appendix C does not unequivocally show that Barrow Island is the highest ranked option. The proponent obtains this outcome by ignoring some of the detail contained in Sections 6.4 and 6.5 of Appendix 2, and by adding-in new 'key cost driver components' in Section 4.2.5 of the ESE Review. The most that can be said, based on the Normalised Combined Totals at the bottom of Table 6.6, is that - based on the scores and weightings chosen by the proponent - there is no significant difference between most sites except for Exmouth

[3] Resource Assessment Commission 1992. Multi-criteria analysis as a Resource Assessment Tool. RAC Research Paper No. 6. Canberra: Commonwealth of Australia.

(South), which has a significantly higher constraint, and the Montebello Islands which have a moderately higher constraint.

While the use of alternatives analysis is to be encouraged, we believe that the process used by the proponent in the ESE project is fundamentally flawed. A strategically and methodologically sound alternatives analysis process would have followed a structure similar to the one that we have outlined above.