APPENDIX H:

Questionnaire to evaluate scoring guidelines

The following questionnaire has been used for purposes of evaluating the scoring guidelines:

Questionnaire: Evaluating Environmental Matrix Evaluation Tool
1. Did completing the scoring guideline questions prompt you to think of or consider aspects not previously taken into account? If so, what are these aspects?
2. Do you think the scoring guidelines address all relevant aspects? If not, what aspects should also be considered?
3. Comment on the following aspects of the scoring guideline questions: • Clarity • Level of difficulty • Availability of information to answer questions
4. Did you need to contact other project members to provide information? If so, what type of information?
5. How long did it take you to complete the scoring guideline questions per gate: • Gate 1: • Gate 2: • Gate 3:
6. Would you have done anything differently if the environmental matrix evaluation tool were available and used during the actual project?

7. General impression of the environmental matrix tool and its applicability for projects

APPENDIX I:
Economic Valuation Methods

I.1 Generally Applicable Techniques

The techniques, which are viewed as generally applicable to all projects, all rely on market prices to determine the economic values of environmental impacts.

I.1.1 Techniques in which market price are used

These are based on classical cost-benefit analysis methodologies. The reasoning is that impacts on environmental quality or quantity are reflected in changes in the productivity of the systems involved, and that these changes can be used to determine an economic value for the original impact (Dixon, Scura, Carpenter & Sherman, 1994). Examples of the use of the techniques can be found in Dixon, Scura, Carpenter & Sherman (1994).

a) Changes in Productivity

This technique value the physical changes in production caused by the environmental effect or project by using the market prices of input and output materials. It is based on neoclassical welfare economics. Dixon, Scura, Carpenter & Sherman (1994) identified three steps that must be taken in order to use the technique:

- Both on site and off site changes in productivity due to the environmental impact must be identified.
- The effects on productivity both of proceeding with the project (that causes the environmental impact) and of not going ahead should be discussed.
- Assumptions have to be made about:
    - Time over which changes in productivity must be measured.
    - The "correct" prices to use.
    - Future changes expected in relative prices.

A damage function can then be established, that can be used to determine monetary values.

b) Cost of Illness

This approach is often used for valuing the cost of pollution-related morbidity (sickness). The approach is also based on a damage function, which relates level of pollution to the degree of health effects. It therefore requires information on the damage function as well as information on how the project's environmental impacts will affect the levels of pollution. Typical costs associated with an increase in morbidity such as medical costs, e.g. hospital fees, and loss of earnings resulting from morbidity and any other related out-of-pocket expenses are used to determine an economic value for the environmental impact (The World Bank: Environment Department, 1998).

The cost-of-illness approach ignores an individual's preference for health versus sickness and the associated willingness-to-pay for health (Dixon, Scura, Carpenter & Sherman, 1994). Dixon, Scura, Carpenter & Sherman (1994) provide the following guidelines to identify projects with environmental impacts for which the cost-of-illness approach may be useful:

- A direct cause-and-effect relationship can be established and the etiology of the disease is clearly identifiable.
- The illness is not life threatening and has no chronic effects.
- An accurate estimate of economic value of earnings and medical care is available.

If this approach is extended to estimate the costs associated with pollution-related mortality, it is known as the human-capital approach (The World Bank: Environment Department, 1998).

c) Opportunity Cost

Opportunity cost refers to *"the value of these lost economic opportunities due to environmental protection"* (The World Bank: Environment Department, 1998). It therefore measures the cost of preservation and it does not measure the benefits gained from preserving.

It is a very powerful technique because although it follows a cost-side approach, it is actually used to evaluate the benefits of preservation, which cannot always be valued, by estimating the additional cost to use alternatives. The technique is often used to value unique natural resources and is relatively quick and straightforward (Dixon, Scura, Carpenter & Sherman, 1994). The approach also forms the basis of compensation payments by government (Garrod & Willis, 1999).

I.1.2 Techniques in which market prices of actual or potential expenditures are used

These techniques rely on market prices and are cost-side approaches i.e. the techniques do not attempt to assign monetary value to the benefits of environmental impact but look at the cost to mitigate, minimize or prevent it.

a) Cost-effectiveness Analysis

Cost-effectiveness analysis is a technique widely used by engineers and economists to evaluate the cost of mitigation. Dixon, Scura, Carpenter & Sherman (1994) set the following guidelines for applying this technique:

- Set a target for the effect of the environmental impact e.g. a certain ambient air quality or level of exposure. The target can be set after examining targets in both developed and developing countries as well as targets recommended by organisations such as the World Health Organisation.

- Evaluate the seriousness of the environmental impacts, which is to be controlled.
- Apply the cost-effectiveness analysis technique to all alternatives available to control the impact.
- Evaluate the effect of the most cost-effective method of control on the financial and economic return from the project.
- Determine whether compromises exist which will minimize environmental damage while still allowing the project to continue.

b) Preventive Expenditures

The technique relies on subjective valuations of the expenditures people will be willing to pay in an attempt to avert damage from pollution, to establish the minimum cost of these environmental problems. It thus views the expenditures on mitigation of environmental damage as a surrogate demand for environmental protection (Dixon, Scura, Carpenter & Sherman, 1994).

The technique gives a minimum estimate of the cost of environmental problems because actual willingness-to-pay is constrained by the ability to pay. The following assumptions are implicit in this kind of analysis:

- Accurate data on the costs of mitigating expenditures are available
- No secondary benefits are associated with the expenditures (Dixon, Scura, Carpenter & Sherman, 1994).

c) Replacement Costs

The technique is often used to estimate the cost of pollution. It does not rely on subjective valuations but uses true costs of damage that can occur (The World Bank: Environment Department, 1998). The technique gives an estimate of the upper limit of the costs of environmental damage but does not measure the benefits of environmental protection.

Dixon, Scura, Carpenter & Sherman (1994) identified the following assumptions implicit in this kind of analysis:

- The magnitude of damage is measurable.
- The replacement costs are calculable.
- No secondary benefits are associated with the expenditures.

d) Relocation Costs

The relocation costs approach is similar to the replacement costs approach, it only uses estimated costs of a forced relocation of a natural or physical asset due to environmental damage (The World Bank: Environment Department, 1998).

e) Shadow Projects

A shadow project is a special type of application of the replacement-cost technique. If an environmental impact diminishes environmental services, which are difficult to value, the costs thereof can be approximated by examining the costs of a hypothetical, supplementary project, which will provide substitutes.

Shadow-project costs are then included in the project economic valuation. The following assumptions are implicit in this kind of analysis:

- Endangered resource is scarce and highly valued.
- A human-built alternative will provide the same quantity and quality of goods and services as does the natural environment.
- Original level of goods and services is desirable and should therefore be maintained.
- Costs of shadow project do not exceed the value of the lost productive service of the natural environment (Dixon, Scura, Carpenter & Sherman, 1994).

I.2 Selectively Applicable Techniques

I.2.1 Techniques in which surrogate market prices are used

Market prices are not available for all aspects of the environment e.g. clean air and unobstructed views. Surrogate-market techniques use actual market prices to value an unmarketed quality of the environment with some limitations (Dixon, Scura, Carpenter & Sherman, 1994).

a) Travel Cost

Renowned resource economist Harold Hotteling observed that behaviour can be used to derive a demand curve as well as to estimate a value for an unpriced environmental good by treating increasing travel costs as a surrogate for variable admission prices. The technique thus assumes that changes in total travel cost are equivalent to changes in admission fees and that the total benefit visitors obtain can be calculated from this demand curve (The World Bank: Environment Department, 1998).

Travel cost is mostly used to value the cost of recreation and has been used numerous times to estimate individual's willingness to pay for national parks. The technique is however site-specific and has limited use in the project environment.

I.2.2 Contingent Valuation

It is not always possible to value the environmental effects and impacts of a project by using market-oriented techniques or surrogate-market techniques due to the fact that these markets do not exists or are not well-developed. In such cases a viable alternative is contingent valuation methods also known as hypothetical valuation.

These techniques involve the direct questioning of consumers to determine how they would react to certain situations. The concepts of "willingness to pay" and "willingness to accept" are utilized in these techniques. Contingent valuation techniques tend to rely on public surveys as a method to determine the consumers' reaction. Examples of contingent valuation methods include:

- Bidding Games
- Take-it-or-leave-it experiments
- Trade-off games
- Costless choice
- Delphi technique (Dixon, Scura, Carpenter & Sherman, 1994).

Contingent valuation techniques can in principle be used to value any environmental impact (The World Bank: Environment Department, 1998). These techniques are nevertheless limited by the fact that it only simulates conditions of the real world and does not analyse actual behaviour.

I.3 Potentially Applicable Techniques

I.3.1 Hedonic Value Techniques

Hedonic value techniques are based on an alternative to neoclassical consumer theory (Dixon, Scura, Carpenter & Sherman, 1994) and are used to *"examine the contribution of different attributes e.g. to prices for housing and to wage levels, including the contribution of environmental quality"* (The World Bank: Environment Department, 1998). The technique thus estimates the implicit contribution of various attributes, which together makes up the sale price or wage. Two types of hedonic value techniques are often used:

- Property and other land-value approaches that can be used to determine the value of environmental quality.
- Wage Differential that is based on the theory that workers have to be paid a premium to undertake jobs that are inherently risky.

I.3.2 Macro Economic Variables and Models

These types of techniques are used to assign a monetary value to the widespread environmental impacts resulting from macroeconomic policy decisions. Three techniques that are often used:

- Linear Programming
- Natural Resource Accounting
- Macroeconomic and economy-wide policies

APPENDIX J:
Multi Criteria Decision Analysis Techniques

J.1 Structured Approach to Decision-Making

Keeney (1992) stated that decision analysis provides decision makers with a structured approach to decision making. This systematic approach to decision making can be divided into two stages, namely problem structuring and problem analysis (Petrie, Basson, Stewart, Notten and Alexander, 2001).

The aim of the first stage, problem structuring, is to:

- Identify stakeholders
- Identify and obtain agreement about:
  - exactly what decision needs to be made
  - all possible objectives that must be satisfied by the decision outcome
  - available alternatives

The outcome of the first stage is often "*an objectives hierarchy, which shows criteria that can be used to evaluate alternatives*" (Petrie, Basson, Stewart, Notten and Alexander, 2001). The problem analysis stage is focused on evaluating the alternatives and determining to what extent each different alternative satisfy the agreed upon decision objectives.

J.2 Multi Criteria Decision Analysis

Decision-making involves trade-offs, usually within a context of uncertainty. Decision-makers usually have more than one objective against which they would like to compare the different alternatives. The introduction of multiple objectives resulted in the development of a new form of decision analysis, namely: Multi Criteria Decision Analysis.

The advantages of multi criteria decision analysis are that each decision criteria receives due consideration without necessarily converting it to a common scale such as a monetary value (Petrie, Basson, Stewart, Notten and Alexander, 2001). These techniques can assist in incorporating environmental criteria, which is often difficult to express in monetary values, into decision-making. A number of multi criteria decision analysis techniques are, e.g.:

- Goal Programming
- Preemptive Optimisation
- Weighted Sums
- Analytic Hierarchy Process

J.3 Analytic Hierarchy Process (AHP)

Thomas Saaty developed the Analytic Hierarchy Process. The procedure starts by breaking down the decision problem into a hierarchy of interrelated decision elements or objectives, e.g. sustainability that can be broken down into three decision elements, objectives or attributes, namely: economic, environmental and social. The number of levels in the hierarchy will depend on the complexity of the problem. Weights are determined for each one of these decision objectives, which must add up to 1. The alternatives are weighted against each other for each objective in order to determine a score for each alternative for each objective. There are many user friendly software products available that an be used for weighting and scoring purposes (Pöyhönen & Hämäläinen, 2001) and example is Web-HIPRE Multi Criteria Decision Analysis software, which is available online at http://www.hipre.hut.fi/WebHipre/.

J.3.1 Weighting Methods

Weights for the different objectives can be determined in numerous ways. Two techniques are discussed in more detail: Direct Weighting and Pair-wise Comparison.

a) Direct Weighting

The decision-makers must assign a direct weight to each attribute, usually the decision-maker is asked to divide 100 points between the various attributes. Decision-makers can also be asked to mention the level of uncertainty when assigning these weights. Advantages of this approach according to Heuberger & Brent (2002) are:

- Straight forwardness of approach.
- No computer or software package is needed.
- Trade-off between attributes become more visible.

b) Pair-Wise Comparison

Decision-makers are asked to compare two attributes at a time and to answer the question *"Which one of these two attributes is more important and how much more important?"*. The following numerical scale is used to express importance:

Numerical Value	Verbal Terms
1	Equally important
3	Moderately more important
5	Strongly more important
7	Very strongly/Demonstrably more important
9	Extremely/Absolutely more important
2,4,6,8	Intermediate Values

Table J.1: Values for Pair-wise Comparison

Source: Winston, 1994

Each attribute is weighted against all other attributes separately and decision-makers must indicate their level of uncertainty. Results are put into a matrix, from which the relative weight of each attribute is calculated (Heuberger & Brent, 2002). Software programs are often used for this purpose. Figure J.1 shows an example of a matrix that can be used to evaluate environmental attributes.

AHP	← Criterion A more important									Criterion B more important →								
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Level of uncertainty in decision
Criterion A	extremely more important		very strongly more important		strongly more important		slightly more important		equally important		slightly more important		strongly more important		very strongly more important		extremely more important	Criterion B
																		1= certain 3= strongly uncertain 5= extremely uncertain
Air Quality																		Water Quality
Air Quality																		Minersl / Energy Resources
Air Quality																		Land Resource
Water Quality																		Land Resource
Water Quality																		Minersl / Energy Resources
Land Resource																		Minersl / Energy Resources

Figure J.1: Example of pair-wise comparison matrix

Source: Heuberger & Brent, 2002.

J.3.2. Scores for alternatives

Scores for alternatives can be determined in numerous ways. Pair-wise comparison can also be used to determine scores for each alternative for each objective. Heuberger & Brent (2002) proposes a different scoring method that is discussed in Chapter 7. Scores can also be directly assigned or ranking can be used. Consistency should be checked.