From: Peter.Eggleston@grd.com.au [mailto:Peter.Eggleston@grd.com.au]
Sent: 20 March 2006 7:00 PM
To: Baker, Rick
Cc: Hannes Partl
Subject: RE: Questions on Nolan-ITU report

Rick,

Please find attached the detailed response to your questions re the NolanITU report.
These were prepared by Hannes Partl, Principal Consultant
- Sustainability Services, Hyder Consulting Pty Ltd (formerly NolanITU).
Hannes' contact details are included below if you require any clarification.

Cheers,

Peter

Response to Questions raised by the Productivity Commission in relation to Global Renewables' submission

This paper has been prepared upon request of Global Renewables as a response to questions raised by the Productivity Commission's Waste Generation and Resource Efficiency Inquiry in their fax dated 27 February 2006.

1 Question 1 & 2 Avoided Landfill Benefits Valuation - Summary Response

What are the main reasons for the estimates of the negative externalities associated with 'best practice' landfills in the Nolan-ITU report being higher than the estimates cited above?

In the report, it is estimated that the net environmental benefit of the UR-3R process over landfilling in Sydney is $230 per tonne of waste input.

a *Of this, $87 per tonne is attributed to avoided landfill associated with the production of organic growth media. What proportions of this $87 can be attributed to the following categories?*
- *avoided landfill leachate;*
- *avoided landfill gas (non-greenhouse) emissions;*
- *avoided landfill greenhouse gas emissions; and*
- *avoided landfill – other (please specify).*

b *A further $103 per tonne benefit is attributed to stabilisation and energy recovery. What is the break-up between the following categories?*
- *stabilisation;*
- *energy recovery – avoided greenhouse emissions associated with methane capture;*
- *energy recovery – avoided greenhouse emissions associated with replacement of fossil fuel derived energy;*
- *energy recovery – avoided resource depletion & land rehabilitation associated with replacement of fossil fuel derived energy; and*
- *energy recovery – other (please specify).*

1.1 Comparison with the NSW EPA and BDA Valuation

The avoided landfill benefits valuation undertaken by Nolan-ITU for Global Renewables Limited is entirely consistent with the report of the NSW EPA (1996, p.60). The EPA estimate does not claim to be, and is not, a complete valuation of the environmental impacts of landfill. Dominant environmental impacts arising from avoided landfill are widely known and reported to be related to air emissions, leachate and visual impacts (EcoRecycle Victoria, 2003). With respect to the NSW EPA valuation, the Nolan-ITU method directly references and incorporates the EPA estimate for amenity and traffic corridor impacts within the "Solid Waste" impact category of the method.

The avoided greenhouse gas impact is calculated using the Australian Greenhouse Office calculation guidelines and Workbook - most current at the time of developing the method (AGO, 2001) which provides a more comprehensive approach than the earlier NSW EPA calculation. The estimates do not vary significantly. The BDA report (Zero Waste SA, 2004) merely reproduces the NSW EPA estimate, assuming improved landfill performance, and does not claim to be, and is not, a complete account of landfill impacts.

1.2 Comparison with the OECD Valuation

The OECD publication, *Addressing the Economics of Waste* (2004) is not, and does not claim to be, a complete environmental economic valuation of the impacts of landfill. The economic assessment conducted for the OECD report incorporates the environmental externality of greenhouse gas potential (at between $1.88 and $21.20 per tonne MSW) along side the landfill control costs of leachate management, clean up costs and monitoring costs.

If the OECD report had claimed this estimate to be a comprehensive environmental externality valuation of landfill, they would be reporting in direct contravention to the recommendations of the European Commission in its extensive research and reporting on environmental cost benefit assessment, including:

- *Cost Benefit Analysis and Policy Responses* (European Commission, 2000a). This report was developed by international collaboration between peak scientific institutions[1] and describes the environmental benefit assessment procedure to be applied to policy options. The report details monetary valuation techniques and relies heavily on 'benefits transfer' which involves taking existing monetary valuation studies and applying them outside the site and context where the study was originally conducted.
- The report for the European Commission, *A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste* (2000b) provides the most comprehensive review and critical evaluation of all waste management environmental economic assessment studies to 2000. The report makes a concluding recommendation against the use of control cost valuations and advocates valuation measures associated with

[1] Prepared by RIVM, EFTEC, NTUA and IIASA in association with TME and TNO under contract of Environment Directorate-General of the EC. Edited by D.W. Pearce, A. Howarth (EFTEC)

willingness-to-pay approaches. These approaches have also been recommended locally in Australia[2].

- The internationally acclaimed research endeavour in the field of externality valuation is the *ExternE' Project: Externalities of Fuel Cycles. Report Volumes 1 – 6* by the European Commission, DGXII, Science, Research and Development, (1995, 1999 Methodology Update). This research involved collaboration of a number of scientific institutions, supported by DGXII under the JOULE Programme over seven years.

Moreover, the OECD has made clear their interpretation of Full Cost Pricing (OECD, 1997) by stating that *"Full cost pricing thus reflects all resource costs of the final product, be they traded commodities or public resources, such as the environment. In other contexts, full cost pricing is also referred to as the "internalisation of external costs".*

The OECD website (March 2006) reports in its Glossary on Statistical Terms the objective of economic instruments to be the incorporation of environmental costs and benefits into pricing systems, with the objective "*to encourage environmentally sound and efficient production and consumption through full-cost pricing*".

1.3 Summary comparison with the three reports

In the valuation of landfill impacts, the reports quoted by the PC in their question to Global Renewables consider a very limited range of substances. They are not, and do not claim to be, a complete environmental economic valuation of the impacts of landfill The Nolan-ITU (now Hyder) estimate of the environmental benefit of avoided landfill (impact of landfill) accounts of a more complete set of substance emissions arising from landfill disposal, applying best available data and methods from a range of sources quoted on p 39 ff of the report.

1.4 The Nolan-ITU approach

The Environmental Economic Valuation approach used by Nolan-ITU was developed and internationally peer reviewed in 2001 to provide a national Cost Benefit Assessment (CBA) of kerbside recycling[3]. The original CBA quantified the environmental benefits of kerbside recycling, specifically providing an assessment of its impact on international indicators such as global warming, air and water pollution, resource depletion savings and

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[2] E.g. by RAC – Resource Assessment Committee, ESD – ESD Working Group (Fed Govt), OECD. Department of the Environment, Sport and Territories (est 1999): Forest Externalities, Estimating Values For Australia's Native Forests.

[3] Nolan-ITU. (2001). Independent Assessment of Kerbside Recycling in Australia. Report to the National Packaging Covenant Council.

landfill space. This approach was taken in order to incorporate costs that would otherwise have remained excluded – *the external (environmental) costs*. The method proved popular and beneficial and has since been used repeatedly in key reports and the development of decision support tools[4]. Its application has often been at the specific request of clients, despite cautions about the limitations of the method. The popularity of the approach reflects a trend in decision making towards more complete analysis and rigorous accountability of policy actions. This need is highlighted in the Productivity Commission, then Industry Commission, Report of 1996 on Packaging and Labelling which states:

"*The Commission recognises that full social cost pricing is not simple. However, any approach to be taken in developing policy responses to externalities needs to follow a coherent framework and the goal of full social cost pricing provides the basis for such a framework"* and *"Some notion of cost is necessary to enable comparison with the cost of internalisation".*

A more detailed overview of the method is presented in Appendix A.

1.5 The Nolan-ITU Valuation of Landfill

Landfills reduce the environmental impacts of discarded materials on the environment. Best practice landfills do so to a significant extent. However, when considering the impacts of landfills it is important to decide what these are being benchmarked against as there is no obvious 'baseline'. The Nolan-ITU estimates in the National Benefits Study (as in all other published studies) compares (Australian) best practice landfills (as described on p 41-43) against the GRL technology. Most of the benefits of using the GRL technology arise from avoided landfill impacts[5].

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[4] More recent public sector reports and decision support aids that have used the method in full, or part, include:

- Department of Environment and Conservation, Sustainability Division. (2004). *Getting More from our Recycling Systems* – Assessment of Domestic Waste and Recycling Systems.
- Environment Protection & Heritage Council. (2005). *Regulatory Impact Statement (RIS) on Revised National Packaging Covenant*
- Western Australian Local Government Association. (2004). Decision Support System for Integrated Resource Recovery.
- EcoRecycle Victoria. (2003). Life Cycle Assessment of Waste Management Options in Victoria by RMIT & Nolan-ITU
- NSW DEC. (2003). Alternative Waste Treatment Technologies Assessment Handbook and Software.

Recent private sector use includes: Orica, Nestle, Insurance Australia Group, ACOR, Visy Recycling.

[5] As would be the case for most Alternative Waste Treatment (AWT) technologies to a certain extent.

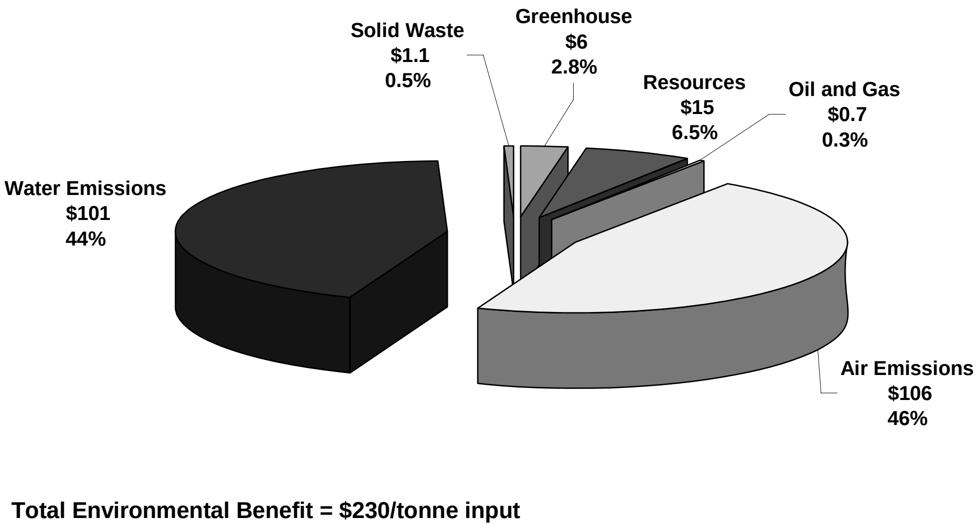

Figure 1: Avoided Landfill Benefits Assessment - Impact Categories % Composition

Based on the Nolan-ITU estimate, the greenhouse gas potential impact and the amenity/traffic impact ("Solid Waste") are a mere 2.8% and 0.5% of the net landfill impact respectively. The most significant landfill impacts arise from air and water pollution, with the human health and toxicity impacts from trace contaminants the most influential. The data and methods are summarized in Appendix B of the original report and repeated in Appendix B of this response, along with the range of pollutants included in the assessment.

The assessment approach adopted by Nolan-ITU has required a full input/output assessment of the landfill system into an inventory of resource and pollutant loads. These loads are assigned impact categories based on the best international scientific methods, as directed by the Society of Environmental Toxicology and Chemistry (SETAC) and International Standards Organisation (ISO). The impacts are allocated environmental economic values based on published government valuations or their derivatives using equivalence factors.

There is nothing unique about the assessment approach used by Nolan-ITU, it merely extends the valuation to a more complete range of impacts – particularly trace contaminants, than might be otherwise reported. This approach is consistent with international best practice in environmental cost benefit assessment of transport and energy systems (European Commission, 1999).

1.5.1 Further Development of the Method

Hyder Consulting (now incorporating Nolan-ITU) has submitted proposals to improve the environmental economic valuation method to DEH and NPCC. These are in response to continued client requests for application of the method in both government and private reports and in decision support tools. Despite the methods popularity, the Hyder team has identified a number of areas where the model could be improved, and has proposed a national collaborative effort to update the method and make it more broadly available.

The benefits of the method to decision making include:

- Translate complex technical and scientific information into a common and familiar performance indicator that is *more meaningful to more people;*
- Incorporate environmental impacts into CBA in a more complete, reproducible and transparent way;
- Ascertain options that *give the greatest environmental return for least cost to society* and make clear what the trade-offs are between options; and
- Define environmental externalities so that market imperfections may be identified and/or that economic and pricing instruments can be modelled or applied.

The proposals offer to refine and advance the original Eco-Dollar method and to release it publicly for more general application. In order to achieve this, Hyder Consulting believe that third party involvement is required both in terms of specialist advice and independent review.

The proposal also specifically offers to:

- Update externality valuations;
- Provide for sensitivity and data quality parameters and benchmark overseas data;
- Develop revised equivalence relationships to ensure consistency.

Apart form these technical aspects a wide range of stakeholders would be involved to contribute, review and thereby also increase the level of awareness and recognition of the method.

1.5.2 Further Development of landfill costings

Despite repeated efforts since 1998 to obtain the resources to conduct a full impact assessment of Landfill (first on behalf of the CRC for Waste Management and Pollution Control and subsequently as Nolan-ITU and Hyder Consulting), no such analysis has been undertaken in Australia. This work has been undertaken partially at the consultants expense in order to meet the standards required by client reports.

2 Question 3

What is the nature of the environmental benefit from stabilisation and how has it been costed?

The nature of the environmental benefit from stabilisation of waste is a significantly reduced leachate and landfill gas generation. This is described on p38 titled *Waste Reduction and Stabilisation of Residues*. It has been costed based on local and international life cycle data, facility operations data in combination with the EEV method as described in Sections 5.1.3 and 5.1.4 (all source material is also referenced therein, p39 & 40 “Main Data Sources”, and p42 “Derivation and source of data”, paras 1 & 2).

3 Question 4

How have the environmental benefits of avoided leachate been calculated? Are these based on the cost of treatment (equalisation, metals precipitation, organic load reduction etc), or on the environmental impacts of discharged leachate, or a combination of these? Of the latter, what proportion is made up by environmental impacts?

The valuation of environmental benefits of avoided leachate production has been undertaken in the same way as the environmental valuation of other environmental benefits and impacts i.e. these do NOT include any financial costs of treatment but aggregated impacts (monetised) of discharge, as described in Sections 5.1.1. and 5.1.4. Second part of question: 100% is environmental impact.

4 Question 5

How does the assumed treatment of leachate compare with current practice in Australia?

The assumptions reflect what is regarded best practice in Australia.

5 Question 6

How sensitive are the energy recovery benefits to assumptions about the effectiveness of landfill gas capture systems? For example, it is assumed that those landfills with such systems capture 55 per cent of gas for combustion – what difference would it make to the estimates if 75 per cent capture were assumed?

Sensitivities have been modelled in Section 5.4of the report: Landfills without energy recovery from captured gas (3% change to overall environmental result) and landfills without any gas capture (30% change) have been modelled. Assuming 75% gas capture for landfills has not been modelled however, based on the above sensitivity results this is expected to change the environmental performance by about 8%.

6 Question 7

It would appear that the cost of landfill that has been used includes landfill levies. Is this correct?

Yes (where levies are applicable).

7 Question 8

How has the revenue stream from Renewable Energy Certificates been treated in the cost benefit analysis?

It is incorporated in the gate fee.

8 Question 9

Has a discount rate been applied to future costs and benefits (for example, those associated with leachate)? If so, what rate has been used?

All costs and benefits have been calculated on an annual basis in 2004 dollar terms.

9 Question 10

The environmental valuation used for air and water emissions are based on pollutant type and quantity. Do they also vary according to population density, existing pollution loads or other characteristics of the environment into which they are released? What assumptions were made and how would differences in such assumptions change the estimates?

This is a frequently discussed issue. In general terms, the impacts have been valued as occurring in populated areas (NSW EPA) however, some impacts are of a global nature (e.g. greenhouse).

There are no agreed impact models differentiating between location of impacts in Life Cycle assessment however, the methods used to determine toxicity and potential impacts are strictly in accordance with the relevant ISO standards for LCA.

10 Question 11

What data sources were used for the life-cycle assessment of the UR-3R facilities (in particular for air and water emissions from the facilities)? Have these data been compared to actual performance at the Eastern Creek facility. If so, how do they compare?

This is described in report pp.39. For facility emissions, the EIS and the SEE were the main sources. Most facility emissions are regulated in the license conditions. Emissions tests have been carried out recently, and the facility complies with the conditions of the license.

11 Question 12

What proportion of composted material is assumed to be sold as organic growth media / compost and what proportion used as landfill cover? How do these proportions compare with current operations at Eastern Creek?

Section 5.1.2 b) *The UR-3R Process System* (p 36 second para) states "The modelling assumes that OGM produced amounts to approximately 20% of UR-3R Facility input".

The ADC and process residuals for this facility together amount to 28% of the input material (Section 3b) *Reduction of waste to landfill)*. ADC has been modelled as stabilised material in landfill (p36) as all other residues.

Current yields at the facility need to be confirmed by Global Renewables.

12 Question 13

The assumed gate fee for UR-3R facilities is $90 per tonne. How does this compare to the current gate fee at the Eastern Creek facility?

To be addressed by Global Renewables.

13 References

Australian Greenhouse Office, AGO. (2001). Greenhouse Challenge Workbook. Version 3 – November/December 2001.

EcoRecycle Victoria. (2003). Sustainability and the Waste Management Hierarchy. Appendix 1. Prepared by Lewis. H. and Gertsakis, J.

European Commission. (2000a). Technical Report on Methodology: Cost Benefit Analysis and Policy Responses. Prepared by D.W. Pearce and A. Howarth (EFTEC) in association with RIVM, EFTEC, NTUA and IIASA TME and TNO.

European Commission. (2000b). A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste. Prepared by COWI Consulting Engineers and Planners AS.

European Commission, DGXII, Science, Research and Development, JOULE. (1995; 1999). 'ExternE' Project: Externalities of Fuel Cycles. Report Volumes 1 – 6.

Industry Commission. (1996). Packaging and Labelling. Report #49.

Nolan-ITU. (2001). The Independent Assessment of Kerbside Recycling in Australia. Prepared for the National Packaging Covenant Council.

NSW EPA. (1996). Regulatory Impact Statement - Proposed Waste Minimisation and Management Regulation 1996. Appendix – External costs of waste disposal.

OECD. (1997). OECD/GD(97)71. Full Cost Pricing, Annex I Expert Group on the United Nations Framework Convention on Climate Change. Working Paper No. 3. Paris 68732

OECD. (2004). Addressing the Economics of Waste.

Zero Waste SA. (2004). Analysis of Levies and Financial Instruments in relation to Waste Management.

Appendix A
- Overview of the Environmental Assessment Method

The environmental assessment method used by Nolan-ITU is based on the well-established, international methods of Life Cycle Assessment (Inventory Analysis) and Environmental Economic Valuation. The assessment method quantifies material and energy inputs and outputs to the systems under study (ISO 14041), then categorises impacts according to established scientific methods (ISO 14 042) and then values these flows using established environmental economic values. The formal steps in the assessment approach are summarised below.

Step 1: System Characterisation

The analysis incorporates the entire life cycle system from cradle to grave. All significant inputs to, and outputs from, the system are recorded. All unit processes within the system are defined and examined from a mass balance perspective.

Step 2: Life Cycle Assessment (Inventory Analysis) ISO 14041

Life Cycle Inventory Data on the resource inputs and pollutant outputs to the system are developed or referenced from existing published studies. The range of resource inputs and pollutant outputs is extensive and data are publicly and commercially available for most commodity materials and many products. The data includes an extensive range of raw material inputs and more than 100 substances to air and water that spanned a wide range of pollutants including trace contaminants.

Step 3: Life Cycle Assessment (Impact Assessment) – Categorisation ISO 14 042

Inventory data are assigned impact categories based their individual potential to cause impacts.

Step 4: Environmental Economic Valuation

The Australian-based, environmental economic valuation method (Nolan-ITU, 2001; 2004) is applied in order to derive a monetary cost benefit assessment. The assessment is used to aggregate the complex information on substance (pollutant) flows derived from the LCA. It is designed to assist decision making by using a single indicator that is widely recognised and therefore more meaningful to more people. There are other methods that aggregate environmental performance into single indicators. Two prominent examples are the Ecoindicator Method widely used in Europe, and the Ecological Footprint method which is predominantly used to measure the impact of population and settlements, which is also used in Australia.

The method uses environmental economic values that have been either directly sourced, or derived from published government sources within Australia. Where the values are "derived", scientific equivalence factors have been used to relate a known base pollutant to the derived value in accordance with Life Cycle Impact Assessment characterisation approaches (Heijungs, 2001). This approach was used and internationally peer reviewed for valuation of pollutants for previous policy advice to the National Packaging Covenant Council (Nolan-ITU, 2001). More detail is provided in Table 0-1 below.

Environmental Economic Valuation - The 'Eco Dollar Method'

The Eco Dollar Method was developed for the national cost benefit assessment of recycling (Nolan-ITU and SKM Economics, 2001). The method was established in order to incorporate costs that would otherwise have remained excluded – the external environmental costs. The Eco Dollar Method applies all 4 steps listed above and uses published economic benefit valuation data to measure the significance of the environmental load for the impact categories of:

- Air Pollution;
- Water Pollution;
- Global Warming;
- Solid Waste; and
- Traffic and Noise.

Table 0-1. Description of Environmental Impact Categories

Impact Category	Short Description	Detailed Description
Water and Air Pollutant Valuation	Pollutant loads from the inventory are classified as Water Pollutant Loads or Air Pollutant Loads if they have the potential to effect: human health.	Environmental economic values from published Australian government sources are used where possible. If values are not available, equivalence factors are used to scale the economic values for unknown pollutants relative to known pollutant values. Equivalence factors are derived from local regulations and published international LCIA references. Base pollutant values (AUS$/kg) for air include: SO_2: $0.44, NO_x: $3.82, Fine Particulates (PM_{10}): $18.50, CO: $0.025. Base pollutant values (AUS$/kg) for water include: Lead $226
Greenhouse Gases - Global Warming Potential	Substances with global warming potential are common to all inventory data sets including the UR-3R facility, landfill and energy inventories. A limited range of greenhouse gases has been considered.	Global Warming Potentials are determined using CO_2 equivalence factors as determined by AGO (Australian Greenhouse Office, April 1999). The economic value used by the study is $20/t CO_{2eq}. Pollutants included ($/tonne): Carbon dioxide @ $20; Methane @ $410 and Nitrous oxide @ $610. Dichloromethane @ $300; Trichloromethane @ $500; Tetrachloromethane @ $ 26,000; 1'1'1 Trichloroethane @ $2,000
Resource Conservation – mineral resources	A small range of resource inputs have been considered The resources modelled are the most significant resources by weight in the inventories used: This limitation may devalue the resource value assigned in the valuation of systems as some of the trace materials such as copper have a relatively high environmental value.	Resource values have been referenced from published Australian valuation studies or estimated based on the application of international ranking to Australian data. The environmental economic valuation of mineral resource use has included categories of resource sustainability and land use impacts. The final resource value cost of coal is $47.50 per tonne. This results in subsequent values (AUS $/t) of: Bauxite: $111.55, Coal: $47.51 Crude oil: $34.84 iron (ore): $80.56 limestone and phosphate $91.52 and natural gas $34.84 and sand $10.37.

Impact Category	Short Description	Detailed Description
Resource Conservation –Forestry Resource Values	Inventory data distinguishes between three pulp sources: native and regrowth forest and plantation forests.	The environmental value (AUS $/t) of timber from native forests is 35.9, for regrowth eucalypt timber 12.6 and plantation timber 6.5. No published data on environmental values of timber could be sourced hence a conservative environmental valuation of forest resources was developed. The original reference data value of forest resources comes from the production of paper estimate by the Industry Commission (Industry Commission, (Feb 1991) *Report No.6 Recycling in Australia,- Appendix H, Forestry*) "hypothetical non-wood charges" for forest resources. The calculated harvested timber value assuming sustainable yield of 10.25% timber per year is 35.9 AUS$/t.
Solid Waste	This assessment includes the non-chemical environmental and social impacts of landfills. These are predominantly established by the EPA NSW for land value loss and loss of amenity.	Landfill externality costs as determined by cost benefit analysis (NSW EPA, 1997) are estimated to be between $ 13.10 - $33.20 per tonne of waste in metropolitan centres. After removing the cost components for chemical stressor impacts, the valuation used for landfill is based on amenity & intergenerational equity values of $9.35 per tonne for metropolitan centres.

Appendix B
– Landfill Valuation

Best Available Data

The data used for the study has been extensively gathered from local and international sources, and has been comprehensively modelled and benchmarked against other datasets for anomalies. It is considered to be the best available landfill data at the time of writing.

- COWI - Consulting Engineers and Planners for the European Commission, DG Government. (2000). A study on the economic valuation of environmental externalities from landfill disposal and incineration of waste.
- Eunomia Research and Consulting. (2002). Economic analysis of options for managing biodegradable municipal waste, Appendices to final report, 19-25.
- RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste Management Options in Victoria (including Energy from Waste).
- Grant *et al.* (2001). Life Cycle Assessment for Paper and Packaging Waste Management Scenarios in Victoria. Stage 1 & 2 Report. Melbourne. For Eco Recycle Victoria.

Nolan-ITU has been involved in a number of projects in the fields of landfill engineering and management science. A few examples are listed below.

- Nolan-ITU (2004/5). Assistance in Tender Submissions comparing environmental performance of AWT with emissions form Sydney landfills. For WSN Environmental Solutions.
- Nolan-ITU. (2002). Landfill Gas Tender. Prepared for Newcastle City Council.
- Nolan-ITU. (2002). Greenhouse Summary. Prepared for Bedminister.
- Nolan-ITU. (2002). Leachate Generation Modelling at Rosedale Sand Pit. Prepared for Maryvale Sand and Trading Supplies Pty Ltd.
- Nolan-ITU. (2001). Alternative Waste Disposal Technologies. Prepared for Global Renewables Ltd.
- Nolan-ITU. (2000). Expert Assessment. Prepared for Australian Greenhouse Office.
- Nolan-ITU. (1998). Highbury LFG. Prepared for Maunsell McIntyre.
- Nolan-ITU. (1997). Brunswick Gas. Prepared for Beveridge Williams & Co Pty Ltd.

Best Available Methods

The overall assessment approach is founded on the internationally standardized method of life cycle assessment.

Brief Description of the Landfill System

The landfill LCA data treats the landfill process as it does any waste treatment process, with the emissions to air and water recorded and assessed for their environmental impact, and credits assigned for electricity generation. LCA inventory data modelled for the landfilling of MSW attempts to quantify the total pollutant load to air and water over the life of landfill. In modelling the landfill system, average data from the landfill life is allocated to a unit of waste, in this case one tonne of Residual MSW landfilled. A 30 year time frame has been selected as this time period covers the "active" phase of the landfill, when most of the decomposition and chemophysical changes occur. A more detailed description of assumptions is provided in the original report for Global Renewables (pp.40)

Range of Pollutants Included

Pollutants to Water	Pollutants to Air
Benzene	1,2-Dichloroethane
Toluene	1,4 Dichlorobenzene
Xylene	1,1 Dichloroethane
Ethylbenzene	1,2 Dichloroethane
Trimethylbenzene	1,1,1 Trichloroethane
Naphthalene	Trans 1,2 Dichloroethylene
Diethylphthalate	Cis 1,2 Dichloroethylene
Di-n butylphthlate	2,4-D
Butyl-benzyl-phthalate	Acetone
Chlorobenzene	Butyl Benzyl Phthalate
1,2 - Dichlorobenzene	Benzene
1,4- Dichlorobenzene	Chloroform
1,1 - Dichloroethane	Carbon Tetrachloride
1,2 - Dichloroethane	Chlorobenzene
1,1,1- Trichloroethane	Creosol
Trans- 1,2 - Dichloroethylene	Diethylphthalate
Cis - 1,2 - Dichloroethylene	Di N Butyl Phthalate
Trichloroethylene	Ethylbenzene
Tetrachloroethylene	Ethyl Phenols
Methyl chloride	Methyl Chloride
Chloroform	Methyl Ethyl Ketone
Carbon tetrachloride	Naphthalene
Phenols	Phenol
Creosols	Toluene
Tri-n butylphosphate	Trichloroethylene
	Tetrachloroethylene
	Tri-N Butylphosphate
	Triethylphosphate
	Tetrahydrofuran
	Trimethylbenzene
	Xylene
	Dioxin/Furans