Australian Journal of Environmental Management
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tjem19

Comparative Environmental Risk Assessment: A Practical and Applied Method

Su Wild River [a]

[a] Centre for Resource and Environmental Studies , Australian National University

Published online: 20 Mar 2013.

Comparative Environmental Risk Assessment: A Practical and Applied Method

*Su Wild River**

This article discusses the development and application of a Comparative Environmental Risk Assessment Method (CERAM) to determine the environmental and other outcomes of the Queensland Environment Protection Act, 1994. The Method's use of concepts such as inherent and residual risk, and its focus on the magnitude of environmental risks are detailed. The article also addresses key features of CERAM as an innovative, cost-effective method for quantitative, comparative environmental risk assessment.

Introduction

The past decade has seen new environmental protection legislation commence in most Australian States. The new acts tend to be flexible, with a focus on pollution prevention rather than regulation. They are also relatively holistic, with objects to achieve ecologically sustainable development within their jurisdictions. Despite these important similarities, much of the technical detail and implementation programs differ considerably between States. In Queensland, the *Environmental Protection Act 1994* (EPA) brought in sweeping changes. It increased the number of environmental licenses in the State from fewer than 500 to over 14,000. This shifted the focus of environmental protection regulation from strictly point-source pollution, to include thousands of other operations that pose environmental risks because they work with contaminants that might potentially enter into the environment through non-point sources.

This article begins by describing the links between contemporary Australian environmental protection legislation and environmental risk assessment and risk management. The development of a Comparative Environmental Risk Assessment Method (CERAM), through two consultancy projects aimed at benchmarking the environmental and other outcomes from the EPA is then described. In doing so, the method's use of concepts such as inherent and residual risk are set out as well as its focus on comparing the magnitude of environmental risks rather than detailing specific environmental impacts. The key features of CERAM in relation to the learning from other environmental risk assessment methods are also addressed. Finally, there is a brief report on the findings from a Queensland-wide study conducted using CERAM. Despite the Queensland focus, the relative consistency of contemporary statutory frameworks for environmental protection between States means that many of the concepts apply equally to environmental protection legislation now operating in other parts of Australia.

* *Su Wild River is with the Centre for Resource and Environmental Studies, the Australian National University.*

Fitting Environmental Risk Assessment to Queensland's Practical Environmental Protection Initiatives

The EPA commenced in March 1995 replacing several ineffective, outdated laws dealing with pollution control. The *Clean Air Act 1963* for example, had its first successful prosecution in 1995, after it had been replaced by the EPA. A handful of prosecutions succeeded under the *Clean Water Act 1971*, but these involved very low maximum fines for a limited range of offences. These were also highly difficult to prove in a court of law. Clearly, Queensland's pollution management Acts neither discouraged, nor punished polluters enough to address the State's growing environmental protection problems (Robson 1994).

The EPA was distinguished from its predecessor legislation in many other important ways. Environmental licensing under the Clean Air and Water Acts was limited to a fewer than 500 premises with pipes, stacks or other point sources of pollution into the environment. The new EPA required over 14,000 environmentally relevant activities (ERAs) to obtain environmental authorities (licences or approvals). This regulatory effort was shared between State and local government by way of a significant devolution of environmental management responsibilities. The administration and enforcement of environmental authorities for 28 ERAs was devolved to local governments by the first Regulation[1]. The administration and enforcement of several ERAs was also delegated to other more specialist State agencies

1. The magnitude of the licensing effort in Queensland distinguishes it from the other States. Other States did not devolve licensing to local governments, and hundreds rather than thousands of EP licenses are the norm elsewhere.

(Primary Industries for cattle feedlots and Minerals and Energy for mining). The devolution program covered most of the environmental licences, with 10,078 issued by local government in 1995-96, compared to 466 issued by the State Government in the first year (Department of Environment and Heritage 1994-5; 1995-6; 1996-7).

The environmental authorities provided a focus for negotiating environmental management practices between administering authorities and ERA operators. For the first time, they also provided budgets for inspecting, advising and if necessary, enforcing environmental requirements for thousands of potentially polluting operations across Queensland. These new opportunities also brought several major challenges during the early implementation. For instance, the Environmental Protection Policies that were to establish the detailed compliance requirements were not introduced until several years after the EPA commenced. And with 125 local governments, and three State Government departments all implementing the Act, this made consistency extremely difficult. Similarly, the promised provisions for on-the-spot fines to deal with minor pollution incidents did not commence with the introduction of the EPA (Wild River 1998: 59).

Although the EPA does not explicitly refer to environmental risk, there are strong links between the Act's regulatory framework and environmental risk in general. Risk assessment and management consider both the *probability* and potential *consequences* of occurrences with negative environmental impacts (see Standards Australia). The EPA reflects these concepts in both its environmental authority and enforcement provisions. It defines occurrences with negative environmental impact as causing environmental harm (s.119). In relation to environmental authorities, industry types are prescribed as ERAs by the *Environmental Protection Regulation 1995* on the basis that contaminants are likely to be released into the environment when the activities are carried out, and that environmental harm may result. Thus the licensing system considers both the likelihood and consequences of environmental harm (s.38). Similarly with enforcement, the EPA prescribes offences for placing contaminants where they may reasonably be expected to cause environmental harm. Offences are more serious when contaminants are released into the environment, thereby increasing the likelihood of environmental harm and the magnitude of the prescribed EPA penalties increase with the consequences of the contamination (Part 10).

Concepts of *inherent* and *residual* environmental risk are also implicit in the regulatory detail of the EPA's environmental authority system. Inherent risk focuses on the fundamental nature of an operation, based on the types, quantities and ways it uses contaminants. Inherent environmental risk is defined here *as the likelihood and consequences of environmental harm from an activity conducted considering only short to medium term production expediency.* Residual environmental risk relates to the environmental management systems in place to prevent pollution and is defined here as *the likelihood and consequences of environmental harm occurring, taking account of risk management measures.*

The ERAs whose administration and enforcement were devolved to local governments, were generally smaller and simpler than those licensed by the State. The devolved ERAs rarely involved regular, point source pollution, but rather covered the storage and use of small quantities of relatively benign contaminants. The State Government retains responsibility for larger, more complicated activities, those with point source pollution outlets, and those using comparatively more destructive contaminants. Because of these features, inherent environmental risk is generally lower for devolved than for the other ERAs. Differences in residual environmental risk are recognised by the incentive licence systems. These reward good operators by reducing the scheduled licence fee when environmental management infrastructure and practices reduce both the likelihood and consequences of environmental harm occurring as a result of the ERA.

Together, these features provide a sound basis for using an environmental risk framework to assess the environmental outcomes from the EPA. Indeed, Brisbane City Council (BCC) explicitly acknowledge the link between environmental risk analysis and the EPA by adopting key elements of the *Australian/New Zealand Risk Management Standard* (AS/NZS 4360-1999: *Risk management)* in their ground-breaking incentive licensing system. This and other influential initiatives led to CERAM's development, as discussed in the following section.

Developing CERAM

In 1997, managers at BCC contracted the author to benchmark the environmental and other outcomes resulting from Council's implementation of the EPA. The Council wanted to determine how effective it had been in preventing pollution, and what the local operators thought of BCC's EPA initiatives. BCC had a limited budget for the study, but wanted it to report on

Figure 1a. Chemical storage with poor environmental management. Inherent environmental risk is equal to residual environmental risk since the site is:
Outside, unlocked and uncovered,
Draining to stormwater,
Vulnerable to vehicle movement,
Unsorted, with all wastes combined.

Figure 1b. Equivalent chemical storage with best practice environment Likelihood and consequences of environmental harm are reduced by:
Inside, locked, dedicated storage area,
Bunding, with materials available to mop up any spills.

Figure 1. Approaches to Environmental Management

the basis of site inspections and interviews with a large enough sample of ERA's, so that the results would represent the population of devolved ERA operators throughout Brisbane (see Wild River 1997).

The methods used in the BCC benchmarking study were to focus on practical environmental issues, be developed with reference to the EPA and its objects, and to BCC's implementation program. The starting points for developing the method were the *Operators Environmental Guidelines* (OEGs) that BCC had produced to explain the EPA requirements to each type of ERA. The OEGs had been developed by committees made up of BCC staff, relevant industry peak bodies, and selected local operators. The OEGs describe *industry practices that pose a risk of environmental harm.* In this article, these are referred to as environmental hazards. The OEGs also describe simple environmental management systems for ensuring compliance and offer suggestions for best practice environmental management (see BCC 1995-98). Industry-specific environmental hazards might or might not be present at an individual ERA, and the effectiveness of associated environmental management systems may also vary between ERAs. The environmental licences issued by BCC had been closely linked to the OEGs, requiring operators to meet the management standards described there for each environmental hazard present on a site.

A generic example is provided by chemical storage. Most ERAs store, use and dispose of hazardous liquids as part of their operation. Common practice prior to the EPA commonly involved insecure chemical storage above stormwater drains. The OEGs established the standard that such chemicals be stored securely, preferably under cover, and within a bunded[2] area sufficient to hold 150 per cent of the volume of the largest single container of liquid stored there. Materials to clean up any spills safely were also required (BCC 1995-98). This pollution prevention practice would generally reduce both the likelihood of stormwater pollution occurring, and the consequences of any spills that occurred. Figure 1 shows common chemical storage practices before and after these requirements were imposed through the environmental licences. The inherent risk is similar in both photographs, but the residual risk is equal to the inherent risk in the Figure 1(a) chemical storage. In contrast, both the likelihood and consequences of environmental harm are lessened in the Figure 1(b) example of bunded, covered and separated wastes.

The first version of CERAM used an industry-specific checklist based on the OEGs to record the presence of specific environmental hazards on a site, and whether the pollution prevention systems recommended by the OEGs were in place for each. The code also indicated which pollution prevention systems had been installed as a result of the EPA. The cost of the improvement could also be recorded, along with responses to a survey of the importance and effectiveness of BCC's pollution prevention initiatives.

The study progressed by selecting a stratified random sample of over 200 ERAs based on their ERA type region within Brisbane, and whether they held a 'green' licence recognising environmental best practice under BCC's incentive licence system. After completing over 100 site inspections, the author reviewed the data that had been recorded to that point, and the various policy and statutory documents relating to the EPA, seeking to find a way to quantify the results. A solution was offered by BCC's incentive licence system and its adaptation of the risk management matrix from the *Australian/New Zealand Risk Management Standard.* The matrix was being used to assess the degree to which an activity's

2. A bund is a barrier or other structure designed to stop the movement of liquids.

Table 1: CERAM environmental risk matrix.

LIKELIHOOD	CONSEQUENCES				
	5	4	3	2	1
A (almost certain)	128 (E)	64 (VH)	32 (H)	16 (M)	8 (M)
B (likely)	64 (VH)	32 (H)	16 (M)	8 (M)	4 (L)
C (moderate)	32 (H)	16 (M)	8 (M)	4 (L)	2 (N)
D (Unlikely)	16 (M)	8 (M)	4 (L)	2 (L)	1 (N)
E (Rare)	8 (M)	4 (L)	2 (N)	1 (N)	0 (N)

N = Negligible L = Low M = Moderate H = High
VH = Very High E = Extreme

pollution prevention systems were reducing either the likelihood, consequences, or both, of environmental harm.

Table 1 is the CERAM environmental risk matrix. Table 2 gives the definitions of the levels of likelihood and consequences of environmental risks. It proved relatively simple to describe the risk of environmental harm occurring from ERA hazards using the definitions of likelihood and consequences of environmental harm that might result from them. This can readily be done both for the inherent risk (considering the features of the hazard itself and ignoring the pollution prevention systems), and for residual risk (taking account of those systems). Having described both dimensions of each hazard, both inherent and actual risk of an activity can be located within the risk matrix. However it is worth noting that individual hazards are often easier to place on a bottom-to-right diagonal, than in an individual cell, since an individual hazard will frequently be less likely to cause a major event, and more likely to cause a minor one.

The key innovation in CERAM's amendment of the risk matrix from its equivalent in the *Risk Management Standard* is that the qualitative risk ratings in the matrix

Table 2: Likelihood and consequence definitions and ratings.

Likelihood (How likely is the event to occur)			Consequence (Significance of associated environmental impact)		
Rating		Definition	Rating		Definition
A	Almost certain	The event is expected to occur in most circumstances	5	Catastrophic	Disaster with potential to lead to collapse
B	Likely	The event probably will occur in most circumstances (e.g. weekly to monthly).	4	Major	Critical event, which with proper management , will be endured
C	Moderate	The event should occurs at some time ie. once in a while.	3	Severe	Significant event, which can be managed under normal procedures
D	Unlikely	The event could occur at some time	2	Minor	Consequences can be readily absorbed but management effort is still required to minimize impacts
E	Rarely	The event may occur only in exceptional circumstances.	1	Negligible	Not worth worrying about

Source: Australian / New Zealand Risk Management Standard (AS/NZS 4360-1999: *Risk management*): As adapted by Su Wild River (1997) and BCC (1999).

have been augmented by the addition of a numeric risk score. The scale in the matrix ranges from 0 to 128, with risk scores being equal along the bottom-to-right diagonals. A step down in either likelihood or consequences involves halving of the risk score, so a step down in both results in a risk rating that is one quarter of the original score. This pattern was applied based on the assessment that the practices recommended in the OEGs could readily reduce residual environmental risk from a hazard to half, quarter or even less of its inherent risk. This assessment was made by the author, and checked with BCC's pollution prevention officers who had been conducting EPA site inspections and issuing licences. The relationship between environmental risk scores throughout the matrix was therefore adopted through experience and collaboration, rather than through direct measurement of environmental harm. Note that the zero in the scale does not imply the complete absence of an environmental hazard but instead that environmental risk of a zero-rated hazard is so small as to be negligible in comparison with other risks.

The BCC benchmarking study then assigned and calculated inherent and residual environmental risk scores for each hazard within each of 194 sampled ERAs[3], and used statistical techniques to determine the environmental outcomes from the EPA. The findings were later extended into a Queensland-wide study, discussed later in this article. At this point however it is worth stepping back from CERAM briefly to consider how CERAM addresses many of the problems that have plagued other risk assessment methods.

CERAM and the lessons from other methods

Environmental risk assessment must always address a suite of practical issues that can constrain both its accuracy and application. These include challenges in obtaining accurate scientific findings, high costs of detailed assessments, the resulting need to screen activities before conducting risk assessments, the translation of risk assessment into risk management and mismatches between public perception and findings to name just a few.

Rigorous environmental risk assessment usually seeks to predict accurately the environmental harm that might result from possible pollution events. Such assessments require extensive information about the contaminants that might be involved and ecological information about the surrounding environment and its capacity to absorb or recover from contamination. Not only are the costs of such intensive studies prohibitive, but the findings are also unlikely to be conclusive because of complexities in the receiving environment and the combinations of chemicals that might be involved (Sullivan and Hunt 1999).

CERAM bypasses this problem altogether by focusing on the types of processes and contaminants used in operations and the management practices applied to prevent pollution rather than the ecological and public health impacts that might result. Using the risk assessment matrix, the assessor's general knowledge of industrial pollution issues and the context of an individual site, CERAM estimates the magnitude, rather than the ecological detail of an environmental risk. The efforts already made to ensure that OEGs, environmental licences and other pollution prevention initiatives target key pollution issues, are a valuable background for CERAM risk assessments. The five points on the scales for both likelihood and consequences of contamination are sufficiently spaced to ensure robust and repeatable assessments are made[4]. The logarithmic rise in risk scores reflecting increasing likelihood and consequences also provide sufficient accuracy in distinguishing different risk levels so that appropriate management decisions can follow. In practice, this means that trained CERAM risk assessors will reliably assign the same risk scores to the same hazards, and that the low risk issues will be clearly and consistently distinguished from high risks using comparative analysis techniques.

The cost and complexity of environmental risk assessment usually makes it impractical to apply the methods at all possible pollution sites. Screening to ensure that risk assessments target those activities with the highest inherent risks is a common response to this problem (see Sullivan 1998). In contrast to other methods, CERAM is quick and simple even at large, complex sites, where CERAM's checklist can be completed in a matter of hours. Part of CERAM's contribution to environmental risk assessment is its ability to rigorously perform such screening to ensure that detailed risk assessments target activities with demonstrably high inherent environmental risks and on those whose residual risks are unacceptably high in proportion to their inherent risks. Both groups can be encouraged or required to implement sound pollution

3. Some of the original sample having been unavailable for inspection.

4. This was demonstrated by comparing the risk scores allocated by the four risk assessors involved in the Queensland statewide benchmarking study. Statistical analysis showed a consistent application by and between the assessors, based on a range of explanatory variables. Detailing that analysis is beyond the scope of this article.

prevention practices, as described in OEGs or equivalent industry environmental standards.

Mismatches between public perceptions and scientific assessments of environmental risk can also inhibit the effectiveness of risk management efforts (see Slovic 1991). CERAM does not solve this problem, but addresses it through simple procedures, coupled with a transparent assessment of different types of hazards. Hazards identified in a CERAM assessment are grouped according to the environmental values that they threaten. These were defined in a manner consistent with Queensland's (draft and final) Environmental Protection Policies. In calculating the total inherent and residual risk score for an activity, the scores can also be summed for those hazards that might cause air, water, noise, site contamination, or that will lead to resource wastage rather than recycling. Each hazard is weighted equally, but reporting can highlight risks by type of hazard, and therefore highlight the issues where public perceptions differ from a rigorous assessment.

Generic risk assessment and some findings from Queensland

On reviewing the findings from the BCC study that developed CERAM, the Queensland Department of Environment (DoE) initiated a project to continue that work across all of Queensland, and expand it to include both the devolved and non-devolved ERAs. The author tendered successfully for the project leading a team of nine others (Wild River 1998). Despite statewide administering authority adoption of standards similar to BCCs OEGs, it proved impractical to develop industry-specific checklists for the statewide study. The resulting generic version of CERAM is described briefly here, and some findings from the study, incorporating the earlier Brisbane data are also reported.

The key to developing CERAM into a generic environmental risk assessment method was provided by the distinction between different environmental values - or environmental risk areas - as defined in Environmental Protection Policies, rather than the different types of industry practices, as in the OEGs. The study team developed a new, generic risk checklist that grouped general examples of potentially polluting industrial practices into the environmental risk areas that they threatened.

Using the generic version of CERAM, risk assessors inspect a site and consider each environmental risk area in turn, observing practices and questioning the site manager about the likelihood of emission of various types of contaminants. Each hazard identified in this way is assessed in relation to its inherent and residual risk. The CERAM checklist includes indicative levels for inherent likelihood and consequences of contamination from typical hazards but the risk assessor decides on the appropriate level for each site. The assessor then considers the pollution prevention practices applied to each hazard and estimates whether and by how much each has reduced either the likelihood or consequences (or both) of contamination. This is again recorded for each hazard on each site. Recent or planned changes to pollution prevention practices can also be recorded. Having completed a site inspection, the risk assessor uses the matrix to determine the risk scores relating to each hazard, and sums them for each environmental risk area and for the site as a whole. This gives an opportunity to recheck the accuracy of the assessment, by comparing the scores for different risk areas on the site, and for different sites with similar practices. As with the BCC study, the data for all 408 sites were subjected to statistical analysis aimed at comparing environmental risk and risk reduction, and drawing conclusions about the environmental and other outcomes from the EPA.

The study identified features of ERAs that best explained observed differences in inherent environmental risk, risk reduction and residual risk. Environmental risk reductions were recorded for each ERA category, and the proportion of residual compared to inherent risk had dropped by an average of 41 per cent over the first three years of the EPA's operation[5]. The mean proportion of residual to inherent risk across the sample was at 19 per cent in 1998. Significant differences in inherent and residual risk, as well as risk reduction were found between regions, integrated and single licences, urban and rural areas and for different activities. Interestingly, there was no evidence of differences between devolved and non-devolved activities, sites that had environmental licences under previous legislation and those with new licences, or between publicly or privately owned activities. This suggests that EPA outcomes were fairly consistent in relation to those features.

There is not sufficient scope here to report in detail about the range of findings from the Queensland study. Figure 2 is a subset of these findings, showing environmental risk differences between activities operating at different stages in industrial processes. The graph shows the results of analysis conducted after the completion of the Queensland study, and is presented because it shows a

5. All differences quoted in this article are statistically significant. The data set is available from the author.

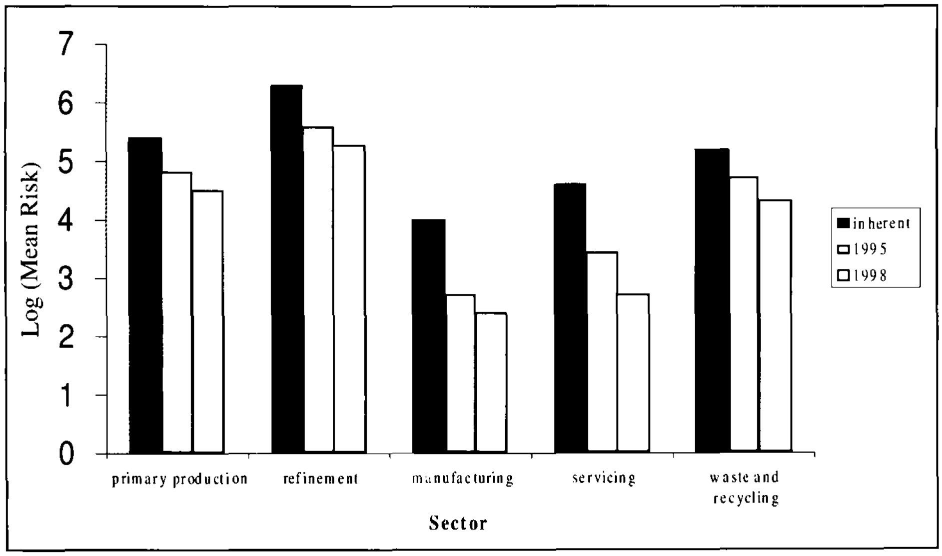

Figure 2. Inherent, 1995 and 1998 residual risk in Queensland, by sector, for a representative sample of environmentally relevant activities.

visual representation of CERAM results, and has implications beyond the Queensland setting[6]. On the left are primary production activities including mining and farming practices. On the right are waste management activities that return 'spent' resources to the environment. In between are activities that refine the primary resources and manufacture and service goods.

The graph shows the significant reductions in environmental risk achieved in each sector between 1995 and 1998. There is also great variation in the inherent and residual environmental risk between the sectors. Most of the lower-risk operations in the manufacturing and servicing sectors are devolved ERAs; the graph thus confirms that the devolution program has facilitated local government administration of the lower-risk activities.

The finding that inherent environmental risk was highest for the refinement sector was surprising. This was because of the important sustainability implications of removing natural resources from the earth, and therefore from the productive capacity of future generations, as is done by primary industries. The costs to future generations of committing either potentially hazardous or reusable materials to landfills and other waste sites also seemed to suggest a high inherent risk. On reflection the lower inherent risk ratings of these industries compared to refinement activities says more about the scope of contemporary environmental protection legislation than it does about those implicit intergenerational risks. The EPA and its equivalents in other States function to promote environmental management practices that minimise the environmental risk associated with activities, but they do not question the nature of the activities that are undertaken. Although their object is to achieve ecologically sustainable development, they will not, on their own, encourage practices that conserve irreplaceable natural resources.

Conclusions and future directions

This article has covered three main issues. First the connection between contemporary environmental protection legislation (especially the Queensland EPA) and environmental risk assessment, concluding that the latter is a reasonable approach to assessing EPA outcomes; secondly, an overview of a novel and cost effective environmental risk assessment method whose application yields reliable quantitative data allowing comparison of the inherent and residual environmental risks within and between operations; and finally, a brief report on the findings from CERAM's application in a Queensland statewide study, which showed that the EPA had delivered sound environmental outcomes over its first three years.

The future gives promise of a range of possibilities. Since the Queensland study, CERAM has been adopted as a tool to support corporate environmental risk management by both BCC and the Australian National University. Training courses, guidelines and other materials to support this and other initiatives, and to link CERAM to other environmental risk methods that address the ecological impacts of contamination will assist CERAM's development and consistent application. Continuation of EPA implementation, with a focus on ERAs with high inherent and residual risks is also called for, as are further efforts to integrate environmental protection legislation with other efforts at achieving ecologically sustainable development.

6. Error bars are not included on this summary graph, but there were significant differences in inherent and actual risk within each sector, and between all sectors except primary production and waste management.

Acknowledgments

This article owes much to the work of Ross Cunningham, Ian Christesen, Peta Jamieson, Pauline Jacob, Laura Hahn and Greg Miller, who were all involved in the Brisbane and/or Queensland studies when the author was with the former Queensland Department of Environment in Brisbane. The dedication and perseverance of those who developed the Queensland EPA also underpins this work. Although government authors of such documents generally remain anonymous, the work of Mark Ricketts, Murray Vincent, Ian Christesen and Doug Yuille is specifically acknowledged.

References

Brisbane City Council. 1995-98. *Operator's Environmental Guidelines*, for 'Spray Painting and Panel Beating', 'Motor Vehicle Workshops', 'Abrasive Blasting' and others. Brisbane City Council Pollution Prevention Unit.

Department of Environment and Heritage. 1995-98. *Report on the Administration of the Environmental Protection Act 1994, 1995-96, 1996-97, 1997-98*. Queensland Government, Brisbane.

Queensland Government. 1994. *Environmental Protection Act 1994*. Queensland Government, Brisbane.

Queensland Government. 1995. *Environmental Protection (Interim) Regulation 1995*. Queensland Government, Brisbane.

Robson, M. 1994. Second Reading Speech Environmental Protection Bill 1994, *Queensland Government Hansard, 9 September 1994*. Queensland Government, Brisbane.

Slovic, P. 1991. Beyond Numbers: A Broader Perspective on Risk Perception and Risk Communication. In Mayo, D. and Hollander, R. (eds.) *Acceptable Evidence: Science and Values in Risk Management*. Oxford University Press, New York: 48-65.

Standards Australia. 1999. *Australia/New Zealand Standard, (AS/NZS 4360-1999) Risk Management*.

Sullivan, R. and Hunt, A.R. 1999. Risk assessment: the myth of scientific objectivity. *Environmental and Planning Law Journal*. 16(6): 522-530.

Sullivan, R. 1998. Assessing the acceptability of environmental risk - a public policy perspective. *Australian Journal of Environmental Management*. 5(2): 72-80.

Wild River, S. 1997. Brisbane City Council Environmental Benchmarking Study: A Report into Environmental and Related Outcomes from Brisbane City Council's 1995-97 Implementation of the Environmental Protection Act 1994. Centre for Resource and Environmental Studies, Australian National University, Canberra.

Wild River, S. 1998. Statewide Benchmarking Study into Environmental and Other Impacts of the Queensland Environmental Protection Act 1994 for Environmentally Relevant Activities. Centre for Resource and Environmental Studies, Australian National University, Canberra.