Environmental regulation using a risk-based approach

A guide for EPA staff

October 2007

EPA South Australia

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ABBREVIATIONS

A&I	Aspect and impact
EIP	Environment improvement program
EMS	Environmental management system
EP Act	Environment Protection Act 1993
EPA	South Australian Environment Protection Authority
IIS	Integrated Information System
MSDS	Material safety data sheet
WWTP	Wastewater treatment plant

ENVIRONMENTAL REGULATION USING A RISK-BASED APPROACH —A GUIDELINE FOR EPA STAFF

This document guides South Australian Environment Protection Authority staff when making decisions about regulating the activities of people who are licensed under the *Environment Protection Act 1993*. It also helps the community and business understand how the EPA makes these decisions.

The EPA identifies and documents hazards using an 'aspects and impacts' approach. This can range from a desktop assessment to a comprehensive site assessment. The EPA may also use aspect and impact registers developed by businesses within an environmental management system.

Once hazards have been identified, risk analysis is carried out following the principles of the Australian Standard for risk management to identify 'priority risks'. Priority risks are those risks that are big enough to justify a regulatory response by the EPA. A key aspect of managing priority risks is to determine the most effective risk treatment approach as outlined by the EPA's environmental harm risk hierarchy:

1 Where reasonable and practicable AVOID the risk.

2 Manage the risk to ELIMINATE harm.

3 Manage the risk to CONTROL the degree of harm.

4 Retain the risk but MANAGE the consequence.

The EPA's risk treatment responses are typically imposed through a condition of licence, but may also involve inspections, orders, civil penalties or prosecution.

This document is not intended to be, nor is it, legally binding on the EPA or any other organisation involved in the administration and enforcement of the EP Act. It does not override the EP Act or limit the discretion of the EPA to take any action it sees fit under the EP Act.

1 INTRODUCTION

The South Australian Environment Protection Authority (EPA) is committed to best practice regulation of environmental risks. Best practice regulation is:

- effectively protecting the environment and human health
- risk based
- outcome focused
- cost efficient to business and government
- streamlined to minimise unnecessary administrative and regulatory burden.

This guideline outlines the system that the EPA uses to determine how risks associated with licensed activities are identified, documented and regulated.

1.1 A risk-based approach

In this system the principles of the *Environment Protection Act 1993* (EP Act) are applied within the framework outlined in the Australian Standard *AS/NZS 4360:2004 Risk management*. This delivers a risk-based system for determining how the environmental hazards associated with pollution and waste will be regulated.

The principles in this guideline promote regulatory actions that are consistent with the level of risk. This contrasts with the more traditional standards-based approach that can result in a 'one size fits all' solution. The risk-based approach also provides a framework that can be used by business and the EPA for working together to move beyond perceived risk to develop a better understanding of actual risks. The EPA then applies regulatory requirements when justified by the level of risk.

The aspect and impact (A&I) approach allows the EPA to document existing information on environmental hazards, identify knowledge gaps and then collect new information where required. Better retention and management of information improves the EPA's efficiency and effectiveness.

Environmental management systems (EMS) based on the international Standard *ISO14001* are a benchmark approach for environmental management. Aspect and impact registers are a fundamental part of these systems. Businesses may have existing A&I registers, or be interested in jointly developing an A&I register with the EPA. Businesses can use A&I registers and risk assessment to develop a management system and reduce risk through better controls—irrespective of the EPA's regulatory approach. This will reduce the chance of legal action, financial exposure and bad publicity over environmental incidents[1].

Finally, the EPA will clearly link regulatory requirements to environmental outcomes. An outcome-based approach gives business greater flexibility in applying innovative or site-specific methods to treat risk.

1.2 What is risk?

In everyday use the terms risk and hazard are often used interchangeably. However, these terms have specific meanings that are used consistently in this guideline and supporting. A sharp knife is an everyday example of a hazard as it has the potential to cause harm in certain circumstances. However, a knife does not always pose a risk, as shown by the following examples:

[1] The EPA encourages business to develop and implement environmental management systems. The implementation of systems, procedures and processes by business is essential to properly assess and manage their environmental risks—without a plan of action environmental performance is left to chance.

- while the knife is stored in a knife block it presents no risk as it cannot cause harm.
- when you use the knife to cut vegetables it presents a risk as you might cut yourself. The consequence falls somewhere between a minor cut and the loss of a finger. The likelihood of injury varies depending on your skill with a knife and the situation you are using it in.
- if you run with the knife it may present a greater risk. A fall may lead to a fatal injury, although the likelihood of death may be low.

The definitions below follow those in *AS/NZS 4360:2004 Risk management*, modified where required to fit the scope of the EPA's business.

Table 1 Definitions related to risk adapted from *AS/NZS 4360:2004*

HAZARD	A source of potential harm. An aspect is a type of hazard.
LIKELIHOOD	The chance of an event occurring.
CONSEQUENCE	For the EPA's purposes, the amount of environmental harm[2] that will occur if a hazard is realised (that is, if an incident happens). An environmental impact is a type of consequence.
OBJECTIVES	The EPA's objective here is to minimise environmental harm caused by pollution and waste and secure compliance with the EP Act and associated legislation.
RISK	The chance of something happening that will have an impact on the environment or breach environmental legislation. Risk is calculated as the product of the likelihood of an event and the consequences of the event if it did happen: **RISK = LIKELIHOOD x CONSEQUENCE**

1.3 Scope of this guideline

This guideline outlines the steps the EPA uses to determine how environmental risks will be regulated (see Figure 1). This risk-based approach is a key component of the EPA's project management of tier 1 and 2 licences which will have site-specific project plans that document the main risks posed by the facility and the EPA's regulatory approach <hub2.deh.sa.gov.au/epa/business/ebook/section12.asp>. A key requirement of each project plan is determining the priority risks using this A&I register/risk analysis approach. The risk-based approach presented within this guideline is also applied when developing industry sector regulatory approaches.

1.4 Scope of the Environment Protection Act

Generally when assessing hazards, EPA staff will only identify those impacts that are within the scope of the EP Act. However, a field or desktop audit may turn up issues that are not within the EPA's scope. This is particularly likely where a licensee provides their own A&I register, which will probably contain issues that are not relevant to the EPA. If a risk can cause environmental harm as defined in the EP Act then it is within the scope of this process. Section 5(1) of the EP Act defines environmental harm as follows:

> … environmental harm is any harm, or potential harm, to the environment (of whatever degree or duration), and includes an environmental nuisance.

[2] The scope of environmental harm the EPA has jurisdiction over is harm caused by pollution or waste.

Importantly, the scope of harm for the purposes of the EP Act is limited to harm caused by pollution:

> … whether the harm is a direct or indirect result of the pollution; and whether the harm results from the pollution alone or from the combined effects of the pollution and other factors.

Obviously environmental harm can be caused by factors other than pollution. Many environmental issues, like vegetation clearance, pest species and water extraction are outside the scope of the EP Act. Hazard identification may also turn up OHS&W or other non-environmental impacts[3]. If an impact is not within the scope of the EP Act then it does not require direct action by the EPA and is outside the scope of this process.

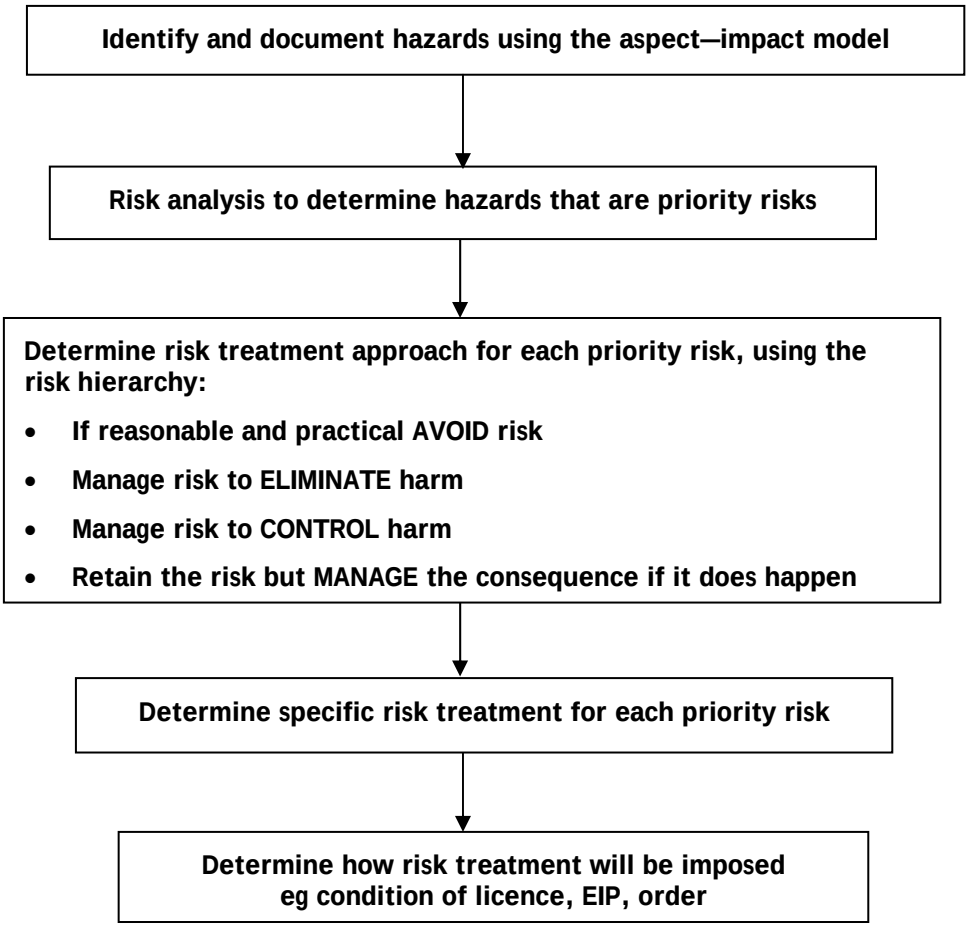

Figure 1 Steps in the EPA's risk-based process for regulating licences

[3] Ensure that the company, and where appropriate the relevant regulator, are informed of significant risks that we identify beyond the EPA's scope. This is a duty of care issue. However, EPA staff do not have the training or legal authority to pursue risks outside our legislation.

1.5 Causing harm on your own property as a defence

The environmental harm offences in Part 9 of the EP Act do not apply to harm someone causes on their own property:

84—Defence where alleged contravention of Part

(1) In any proceedings (criminal or civil) where it is alleged that a person contravened this Part, it will be a defence—

(c) if it is proved that the pollution resulted in actual or potential harm only to that person or that person's property, or to some other person or some other person's property with that other person's consent.

(1a) Subsection (1)(c) does not apply where the property harmed comprises water occurring naturally at ground level or water in an underground aquifer.

In practice, this means only hazards that have the potential to cause an off-site impact, including groundwaters and surface waters, should be recorded in an A&I register. When conducting a risk analysis to determine a priority risk, the level of consequence and likelihood is only determined for the off-site harm that a hazard may cause. Exclude on-site harm from the risk analysis.

Site contamination

Despite the issues discussed in Section 1.5, contaminating your own land does bring responsibilities. Where contamination has occurred, but is not managed, there may be a potential for risks to human health and the environment. Land that has been used for activities of environmental significance that require a licence may well have the potential for site contamination.

Licensees should identify potential site contamination by assessing current and historical land use for activities that have the potential to contaminate, to ensure land is suitable for current or proposed uses and provides a safe and healthy living and working environment.

Amendments proposed through the *Environment Protection (Site Contamination) Amendment Bill 2005* (the Bill) make specific provisions for site contamination in relation to the EP Act. This will have implications for licensees if they have caused or contributed to site contamination.

1.6 Responsibility for environmental hazards

Clearly, the responsibility for managing environmental hazards lies with the individuals and organisations responsible for creating them. This risk-based process does not diminish the responsibility of licensees to manage their activities in a manner that minimises environmental harm. What it does is identify issues the EPA needs to address to fulfill its responsibility as an environmental regulator. It then determines the appropriate regulatory response that the EPA should take, given the EPA's powers and responsibilities under the EP Act.

2 IDENTIFYING AND DOCUMENTING ENVIRONMENTAL HAZARDS USING THE ASPECT AND IMPACT APPROACH

The first step in managing priority risks is to identify the environmental hazards at a licensed premise. The EPA uses the A&I register approach to identify and document environmental hazards within the project planning framework for Tier 1 and 2 licensees. The EPA's method for developing A&I registers is based on the international Standard *ISO14001:2004 Environmental management systems: Requirements with guidance for use*. For the EPA's purposes an environmental aspect is:

> Any element of an organisation's activities that can interact with the environment

and an environmental impact is:

> Any adverse change to the environment, wholly or partially resulting from an organisation's environmental aspects.

2.1 Developing a simple aspect and impact register

Simple A&I registers start with an EPA officer documenting the aspects and impacts they know of in the A&I pro-forma. The register can be improved over time based on observations from inspections or audits of the site. Where A&I templates are available for a particular industry sector, they can be used as a starting point for a register. A workshop approach, utilising the skills of EPA staff with expertise relevant to the site, can be also be used to improve registers. This may be particularly important where the health or ecosystem impacts of emissions are complicated or not well understood.

The advantages of simple A&I registers include that:

- it is typically quick and easy to document the known and likely emissions from a facility and list the activities, aspects and impacts associated with these emissions.
- this method focuses on the main known environmental issues. The main activities and major environmental risks are not obscured by issues with low risk or impact.

The disadvantage of this type of register is that it is more open to bias and key environmental risks are more likely to be overlooked.

2.2 Developing a comprehensive aspect and impact register

The most comprehensive way to develop an A&I register is to undertake a systematic review of processes at a facility. Using a process flow chart, work from the beginning of the process to the end-product and wastes. Examine the processes to identify those that have potential for, or an actual, environmental impact.

The advantages of process-based A&I registers include that:

- this is a thorough and systematic approach working from cause to effect, and is an effective way of identifying things that might happen but haven't yet, or are happening and have not been considered.
- registers based on this approach are more likely to be accurate and unbiased, as reviewers' preconceived ideas are less likely to influence the process.
- the sources of the pollutants within the process are more likely to be determined, leading to a greater understanding of mechanisms available to reduce pollution and improve facility performance. This is a significant benefit when determining risk treatments.
- a better understanding of the processes will lead to greater information on the pollutants in each emission stream, which is more likely to lead to a greater understanding of the

potential impacts and more effective regulation. Monitoring, studies and/or EIP's can be more effectively targeted and hence more cost effective.

The disadvantage of this type of register is that it is more time consuming and resource intensive than the simple approach and an officer may end up identifying and documenting large numbers of below-threshold risks outside the EPA's interest. See Appendix 3 for further advice on developing comprehensive A&I registers.

2.3 Using the facility's aspect and impact register[4]

Where the licensee has an EMS and is willing to provide their A&I register to the EPA, this can be used as the basis for an EPA version. However, such a register will not be immediately suitable for EPA use. It will need to be edited and validated.

A register based on the Standard *ISO14001* will often contain many aspects and impacts that are outside the scope of the EPA's business (see Section 1.4) that must be removed. The EPA will then need to validate the register, which typically requires a site visit. When investigating processes at the site, work through the list in the register. If the facility's A&I register does not provide enough detail to satisfy the EPA's requirements then gather additional information as needed.

2.4 What type of A&I register: simple, comprehensive or facility?

Whichever method is used, there will often be considerable undocumented knowledge across the EPA that is relevant to an A&I register. This includes specific information about the facility in question, but also knowledge of the industry in general and likely environmental consequences of its activities. It is important to effectively capture and document relevant information. Therefore, a simple register should be the starting point for any other type of register. To help decide if the EPA needs to devote resources to develop a comprehensive register, consider which of the following two outcomes is least acceptable:

- the chance of missing priority risks that deserve a regulatory response
- the burden of spending large amounts of time potentially identifying 'below threshold' risks.

Facilities that are poorly understood, not well managed, have significant emissions, have a poor compliance record or are located in unsuitable or environmentally sensitive areas may merit a comprehensive assessment. This should be considered when developing the licence project plan. If a facility's register is available, then there are significant benefits in taking advantage of both the work they have done in preparing the register and the expertise they will have in their own business.

2.5 Completing the aspect and impact pro-forma

The A&I pro-forma in Appendix 2, is available in Microsoft (MS) Excel format here and can be used however the A&I register is developed. The pro-forma is formatted as a table for documenting aspects, impacts and related information.

Column 1 List activities

Each activity carried out by the facility is listed in the register under the activity column.

[4] There are two ways in which the EPA may be able to require an A&I register from the holder of a licence. An information discovery order (Section 96) could be used to gain a copy of an existing register. If the holder of a licence has breached the EP Act it may be possible to use Section 52 to require them to carry out an environmental audit program and provide the EPA with an A&I register. These options have not been subject to specific legal advice or been discussed by Executive.

Column 2 List aspects

An environmental aspect is any element of an organisation's activities that can interact with the environment. Each activity listed is considered for the likely aspects and these are listed against their activity. For example, in the aspect column the activity of 'Coal transport' has three aspects: (1) coal rail delivery, (2) coal unloading and (3) coal storage.

Column 1	Column 2
Activity	**Aspect**
Coal transport	Coal rail delivery
	Coal unloading
	Coal storage

Column 3 List aspect details

In the aspect details column list information about the aspect. The level of detail recorded will depend on what is known and the relevance of this to the risk assessment. Information may include factors such as the likely pathway of the emission (for example, furnace gasses emitted to atmosphere from stack A); pollutants contained within an emission; and concentration, load, intensity, duration and timing of emissions.

The aspect details column is an important record of the assumptions made in assessing the risks and determining what treatments to impose. Therefore, the A&I register becomes a central document to provide clear information to current and future EPA staff about the issues at a site.

Column 1	Column 2	Column 3
Activity	**Aspect**	**Aspect details** **Including:** • **pollutant** • **quantity** • **nature** • **fate etc**
Coal transport	Coal rail delivery	80 x 60 tonne carriages on site twice daily at 8 am and 4 pm
	Coal unloading	Coal unloading into bunkers by rotary dumper two carriages at a time and over a 120-minute period
	Coal storage	Coal stored in bunker with maximum capacity of 2000 tonnes

Column 4 List impacts

An environmental impact is any adverse change to the environment, wholly or partially resulting from an organisation's environmental aspects. The listed impacts should be general categories such as 'air quality', 'noise' or 'dust' for consistency and to allow easy sorting in MS Excel.

Consider each aspect for its potential and actual impacts and list these against their aspect in the impact column. For example, the aspect of 'Coal rail delivery' has the potential and actual impacts of (1) noise, (2) dust degrading air quality and (3) fumes degrading air quality.

Column 5 List impact details

In this column record details of the impact such as information about the receiving environment including receptors of concern, the mechanism of harm, or the capacity of the receptors to recover from the impact. Where appropriate, refer to other documents such as receiving environment studies. Thinking of the aspects and impacts using the hazard–pathway–receptor model gives a good indication of the type and level of information to be recorded in the A&I register (see Appendix 1).

Column 1	Column 2	Column 3	Column 4	Column 5
Activity	**Aspect**	**Aspect details** **Including:** **• pollutant** **• quantity** **• nature** **• fate, etc**	**Potential/actual impact**	**Potential/actual impact details**
Coal transport	Coal rail delivery	80 x 60 tonne carriages on site twice daily at 8 am and 4 pm	Amenity—noise	From rail movement due to stop-start process of positioner moving two carriages at a time into rotary dumper. Residential area 100 metres away
			Air quality degradation	Dust from uncovered wagons. Prevailing wind towards residential area 100 metres east
			Air quality degradation	Fumes from rail engine (SO_x, NO_x and hydrocarbons). Prevailing wind towards residential area 100 metres east

Column 6 Within the scope of the EP Act?

If an impact is not within the scope of the EP Act then it does not require direct action by the EPA. Generally when conducting hazard identification, EPA staff will only identify aspects and impacts that are within the scope of our legislation. However, a field or desktop audit may turn up risks, such as OHS&W, that are not within our scope. Also, where a licensee provides their own A&I register it will probably contain issues that are not relevant to the EPA. Therefore, this step provides a check to ensure we only deal with relevant issues. If a risk can cause environmental harm as defined in the EP Act then it is within the scope of this process (see Section 1.4)

Once we have determined whether the impacts are within the scope of the EP Act a 'yes' or 'no' is recorded against each impact in the 'Within scope of the EP Act?' column. Note the reason for exclusion if required.

Column 7 Has the risk been transferred?

We need to determine whether the risk posed by the impact has been transferred to another person off site. List 'yes' or 'no' against each impact in the 'Has risk been transferred?' column. For example, waste taken to landfill off site that is not part of the licence, or wastewater sold to a third party for off-site irrigation are transferred risks.

Column 8 Controls

Impacts are managed by the facility in some way, even if this is simply 'no controls'. List details of the management approach against each impact in the controls column. This enables risk analysis to be done on both the hazard with a control operating and on the possible failure of the control. See Section 3.1 for more information on this.

Column 9 Do any risks accumulate?

There are some impacts that will individually pose a minor risk. However, together they may have the effect of accumulative risk. For example, one noisy compressor in the middle of an industrial site poses a minor noise risk at the boundary. However, if there are several noisy items on site they may pose an accumulative risk, which is higher than the risk posed by each individual compressor. Identify accumulative risks by placing a 'yes' or 'no' against each impact in the 'Does the risk accumulate?' column. This is important so we can determine if the impact of the accumulative risk presents a priority risk.

Once details about all the aspects have been listed, sort the accumulative risks by the potential impacts (Column 4). This will allow examination of the likely issues due to accumulative risks. Create a new row in the A&I register for each accumulative risk category so that the accumulative risk can be analysed.

Column 10 Risk analysis

Record the risk analysis rating in this column. Calculate risk following the procedure in Section 3.

3 ENVIRONMENTAL RISK ANALYSIS

After the environmental hazards at a site have been identified and documented in an A&I register, assess them using risk analysis (see Section 1.2 for a definition of risk and other relevant terms). Risk analysis allows the EPA to rank hazards based on the level of risk, and determine which hazards present a big enough risk to consider treatment with a regulatory response.

The EPA has developed a risk matrix (see Figure 2) for the assessment of the risk of environmental harm. This risk matrix is based on the definitions of environmental harm from the EP Act, applied within the framework of the Australian Standard *AS/NZS 4360:2004 Risk management*. Combining approaches from the EP Act and the Australian Standard has a number of benefits. The standard provides us with a risk management framework and the EP Act defines the EPA's charter. This combination delivers a risk tool that is consistent with the legal principles of the EP Act and uses terminology that reflects EPA business and EPA staff are familiar with. While this risk matrix is suitable for use in any situation where the EPA wishes to assess the level of risk of environmental harm, it is used here to identify priority risks. The alpha-numeric codes are used to identify and record the location of a risk in the matrix.

CONSEQUENCE		Daily or more often	Once a week or more often	Once a month or more often	Once a year or more often	Once in ten years or more often	Once in 100 years or more often	Less often than once in 100 years
	Level 5 High-level serious environmental harm	A5	B5	C5	D5	E5	F5	G5
	Level 4 Serious environmental harm	A4	B4	C4	D4	E4	F4	G4
	Level 3 Material environmental harm	A3	B3	C3	D3	E3	F3	G3
	Level 2 Environmental nuisance and default non-compliance	A2	B2	C2	D2	E2	F2	G2
	Level 1 Minor consequence	A1	B1	C1	D1	E1	F1	G1
		LIKELIHOOD						

Figure 2 EPA environmental harm risk matrix

3.1 Assessment of environmental risk—an overview

Environmental risk analysis is often less certain than risk analysis in some other areas. There are a number of reasons for this:

- the complexity of environmental systems means they are often not well understood so the consequences of a pollutant can be difficult to determine
- environmental systems are often highly variable. Therefore, expert opinion is likely to consist of a range of possible outcomes. Even if measurements of consequence and likelihood are made, the statistical certainty of these will often be low
- there is often a lack of reliable data about consequences of a pollutant in the environment under consideration. While we can extrapolate from studies of similar systems no two receiving environments will be the same. This may lead to unexpected outcomes
- the long time scale that environmental impacts occur over can make prediction of future states very difficult. Some actions may not impact upon the environment until some time in the future.

However, these problems are not specific to risk analysis. They are common to all methods of environmental analysis, as they are due to the nature of environmental systems and data. Risk analysis provides a structured and systematic process that makes the best use of available information for making decisions about environmental issues.

The hazard–pathway–receptor model

This model provides a useful framework for describing and understanding the nature of a risk and how environmental harm may result from it. Understanding the nature of a risk is essential if risk analysis, as well as risk treatment (see Section 4), are going to be effective. See Appendix 1 for further explanation about this model.

3.2 Risk analysis and priority risks

The next step is to apply risk analysis to the hazards that have been documented in the A&I register, including the accumulative hazards. Analyse the hazards using the risk matrix to determine the level of risk and record the alpha-numeric code (for example, A1) in Column 10 of the A&I register.

Priority risks are those risks that are big enough to justify a regulatory response by the EPA. An accumulative risk will be a priority risk if it breaches the risk threshold. Only risks that are assessed as a 'priority' will be actively managed or regulated by the EPA. Priority risks are those that fall within the red (shaded) area of Figure 2.

Applying the precautionary approach to risk analysis

Section 10 of the EP Act requires the EPA to '*apply a precautionary approach to the assessment of risk of environmental harm*'. The precautionary principle[5] has implications for the risk analysis process. It says:

> Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

Therefore, when conducting risk analysis consider the quality of information and deal with it following these steps:

[5] As stated in the 1992 Intergovernmental agreement on the environment.

1 If an issue is well understood, carry out a risk analysis and record the level of risk.

2 If there is significant uncertainty or dispute over consequence or likelihood record the range of opinions. If the difference in risk analysis will make a difference to the regulation or management of that risk[6], seek further information to clarify the level of risk.

3 Depending on the circumstances, a desktop literature study may be adequate. However, sometimes further investigation will be required. Information may be gathered from EPA investigations or by requiring the licensee to undertake an investigation (for example, monitoring or irrigation sustainability study).

4 If the nature of the risk cannot be clarified as further information cannot be sourced, or it is impractical to pursue the data due to cost or some other factor, then take a precautionary approach to determining the likelihood and consequence of a hazard. This will deliver a *precautionary approach to the assessment of risk of environmental harm*.

Assessing risk—with controls or without controls?

Many organisations will have controls in place to deal with environmental risks. The EPA first analyses the level of risk present with controls in place. In the ISO14000 series this is termed the 'residual risk'. However, control measures can become less effective over time, or even fail completely.

For aspects with controls that may fail there may need to be two or more risk analyses for the one aspect. Such analyses may assess:

- risk when the control is working
- risk after acute problems such as complete failure of a control
- risk during chronic problems such as when a control is performing poorly due to lack of maintenance.

Obviously, these three options will not be relevant for all aspects. Sometimes there will be no control measures. Other times the controls will be fail-safe, such as adequate buffer zones owned by the licensee. However, many controls require significant management. Where required, this type of analysis will provide information that will assist the EPA to determine whether it needs to regulate the controls so they are kept in place, and are adequately reviewed and maintained.

3.3 Assessment of consequence

Assessing the level of harm; to either human health and well-being or the natural environment, can be a complex issue. Hazards can cause environmental harm in many different ways, at a range of temporal and spatial scales, to a broad range of receptors. There are a large number of combinations of these factors. These multiple factors mean there is no simple formula for quantifying the degree of harm that can be applied to all situations. However, the hazard—pathway—receptor model provides an excellent tool for understanding the likely consequences of a hazard (see Appendix 1). Always estimate consequence first, then the likelihood of that consequence.

The likely consequence level of an impact may be known from past experience when the event has occurred before, or from similar events. Often, it may be necessary to estimate the consequence from knowledge of the system. Research of similar cases may provide useful information. The consequence ratings in the risk matrix are based on the definitions of environmental harm from the EP Act.

[6] In this case, if the range of opinion falls across the priority risk line then that will make a difference to the regulation of that risk.

Level 1—Minor consequence

Harm that is below the threshold of environmental nuisance and does not breach the EP Act is categorised as minor.

Level 2—Environmental nuisance and default level for non-compliance

Environmental nuisance is:

(a) any adverse effect on an amenity value of an area that—

(i) is caused by pollution; and

(ii) unreasonably interferes with or is likely to interfere unreasonably with the enjoyment of the area by persons occupying a place within, or lawfully resorting to, the area; or

(b) any unsightly or offensive condition caused by pollution

By default, any 'environmental' contravention of the EP Act, or associated EPP's or regulations, is also categorised at this level. If a breach leads to a higher consequence it will be classified at a higher level but never at a lower level.

Note that this classification does not apply to 'administrative' breaches of the EP Act, such as late payment of fees. If an administrative breach does not lead directly to environmental harm it is outside the scope of this process.

Level 3—Material environmental harm

Environmental harm must be treated as material environmental harm if:

(i) it consists of an environmental nuisance of a high impact or on a wide scale; or

(ii) it involves actual or potential harm to the health or safety of human beings that is not trivial, or other actual or potential environmental harm (not being merely an environmental nuisance) that is not trivial; or

(iii) it results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $5 000

Level 4—Serious environmental harm

Environmental harm must be treated as serious environmental harm if:

(i) it involves actual or potential harm to the health or safety of human beings that is of a high impact or on a wide scale, or other actual or potential environmental harm (not being merely an environmental nuisance) that is of a high impact or on a wide scale; or

(ii) it results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $50 000.

Level 5—High-level serious environmental harm[7]

A high level of serious environmental harm occurs if:

- it involves actual or potential harm to the health or safety of human beings that is of a high impact **AND** a wide scale, or other actual or potential environmental harm (not being merely an environmental nuisance) that is of a high impact **AND** a wide scale

[7] High-level serious environmental harm is not defined in the EP Act. We have used a modification of *Level 4—Serious environmental harm* to categorise 'high-level serious environmental harm' to provide greater resolution in the risk matrix and support effective assessment, prioritisation and management of risks.

- it results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding **$500 000**.

Further guidance on factors to consider in determining the level of consequence, including the concepts of 'trivial', 'high impact' and 'wide scale', is provided in Appendix 4.

3.4 Assessment of likelihood

Likelihood is the chance of a consequence occurring, in this case an environmental impact. In the EPA risk matrix likelihood is expressed as the time period an event is predicted to occur in, such as once a month or once a year. Always estimate consequence first, then likelihood.

The level of risk is based on the likelihood of a consequence, not the likelihood of the aspect. This is because the probability of an aspect does not necessarily equal the probability of the environmental consequence (or impact) that can be caused by the aspect. For example:

- A nutrient emission may only cause an algal bloom under certain circumstances, such as when the temperature and hydrology are suitable. Therefore, while nutrient emission may occur every day, the chance of an algal bloom may only be once a year. There also may be no chance of a bloom in winter, as the appropriate environmental conditions may only be present in summer.
- The likelihood of a foundry emitting odour may be once a week. However, odour emissions may only impact on residents when the wind is blowing in one direction. Therefore, the likelihood of an impact is the probability of the odour emission multiplied by the probability of the wind blowing towards local residents.
- However, in some cases the chance of an aspect will equal the chance of an impact. A spill of winery wastewater into a permanent river will always deplete oxygen leading to fish kills and the death of other aquatic organisms.

The hazard—pathway—receptor model is a useful tool to help consider the likelihood of harm (see Appendix 1). Thinking about how the hazard impacts on the environment will help determine the relationship between these factors and the conditions under which an aspect will cause harm.

If the likelihood of an aspect is predictable and the relationship between the aspect and the impact is well understood, assessment of likelihood of consequence will be relatively simple. When aspects are not predictable, or the relationship between an aspect and an impact is not well understood, assessment of likelihood will be more difficult. In these cases, estimating the probability of a risk will require the professional judgment of an authorised officer[8]. However, when assessing likelihood, base assessment on factual evidence where possible[9].

[8] It may be possible to develop probability tables for common risks. The insurance industry provides a model for this and may be a potential source of information.

[9] Studies show that people, including 'experts', are not very good at assessing likelihood. The likelihood of common or familiar risks in particular tends to be underestimated. Estimating the probability of very rare events is also difficult.

4 DETERMINING AND IMPOSING A RISK TREATMENT APPROACH FOR A PRIORITY RISK

Once priority risks have been identified the EPA will determine an appropriate regulatory response, typically a condition of licence. To achieve effective control of environmental risks the EPA uses the following steps:

Step 1—Consider the risk treatment hierarchy (4.1)

Step 2—Review causes and controls of the risk (4.2) and determine the risk treatment

Step 2.1—Determine the risk treatment objective or outcome (4.3)

Step 2.2—What risk treatment options are there? (4.4)

Step 2.3—Decide the best risk treatment (4.5)

Step 3—Determine how the risk treatment will be imposed (4.6)

The underlying principle of the EPA's approach is that managing a risk is no substitute for avoiding a risk. When developing risk treatments, keep the risk treatment hierarchy in mind. Being mindful of this hierarchy will help deliver an optimal risk treatment solution.

Once a risk treatment approach is determined, decide whether monitoring data is required to support the specific risk treatment[10]. This process is discussed in Section 13 of the EPA's Authorised Officer E-Book, <hub2.deh.sa.gov.au/epa/business/ebook/section13.asp>.

4.1 The EPA risk treatment hierarchy

A systematic approach is important to optimise risk treatment. This hierarchy ensures that the risk treatment approach that leads to the best environmental outcome is considered first. The EPA will follow this hierarchy when determining which risk treatment option to impose as follows:

1 Where reasonable and practicable AVOID the risk.

2 Manage the risk to ELIMINATE harm.

3 Manage the risk to CONTROL the degree of harm.

4 Retain the risk but MANAGE the consequence.

Avoiding the risk of harm can provide a final solution to an environmental problem. The next best alternative to avoiding a risk is to control a risk so no harm is caused. This approach is less certain than avoiding a risk, as failure of the control measures will lead to harm occurring.

Under some circumstances the EPA may have to accept a certain level of environmental harm, typically due to balancing social and economic factors. In these cases, the harm must be controlled at an acceptable level.

For risks that have a low likelihood but a high consequence an emergency management plan will help minimise the consequences of an event if it does happen. Take this approach for events that are difficult to predict, prohibitively expensive to prevent or difficult to prevent.

For further discussion of the risk hierarchy and examples see Appendix 5.

[10] Monitoring has a specific role as a regulatory tool. Alone, monitoring is NOT a risk treatment. Monitoring can only provide information to support decision making about what risk treatment actions are required.

4.2 Review causes and controls

Effective risk treatment relies on an adequate understanding of the risk. In order to determine the best risk treatment, revisit the causes of the risk using the information in the A&I register including the existing controls.

If a simple approach was undertaken in developing the A&I register further investigation may be needed to gain adequate understanding of the facility's processes and receiving environment. Having done this, develop a hazard–pathway–receptor model (see Appendix 1) to assess potential risk treatments more effectively.

4.3 What is the risk treatment objective or outcome?

Always identify the objective or required outcome of the risk treatment. Without a clear aim, risk treatments are unlikely to deliver the desired outcome. It is also important that the EPA states the required outcome of risk treatment so the licensee understands what they are trying to achieve.

Where practical, the EPA will state the required outcome of risk treatment rather than a specific risk treatment. This places the responsibility of how best to achieve the outcome in the hands of the licensee, and provides opportunity for them to develop a site-specific, cost-effective and innovative treatment. This follows the principle that those who pose environmental risks, produce waste, or pollute the environment are responsible for their actions.

In addition to the outcome, the level of direction the EPA gives will depend on a number of factors. At one end of the spectrum, accredited licences are very outcome focused. A person holding an accredited licence has demonstrated that they are proactive in managing their environmental performance. Licensees that have not demonstrated a proactive approach to their environmental responsibilities, or have a history of non-compliance and poor performance, are more likely to be given specific direction.

4.4 What specific risk treatment options are there?

Theoretically, risk can be treated in two ways—by reducing likelihood or consequence. Operationally, risk treatment options can also be categorised into changes to infrastructure or processes. Risk treatment options are best developed by considering the hazard-pathway-receptor model and the mechanism of impact (see Appendix 1).

Eliminating the hazard (avoiding the aspect that creates the risk)

This may include:

- stopping an activity that presents a hazard
- finding an alternative approach, such as replacing a toxic substance for a non-toxic one
- modifying a process to eliminate a hazard, such as eliminating dust by replacing a dry mineral process with a wet one, or burning gas instead of coal
- infrastructure changes, such as roofing to prevent the production of contaminated stormwater.

Reducing the hazard

Examples of this include:

- tighter management procedures to reduce the likelihood of an incident leading to harm such as better maintenance or surveillance of processes, online monitoring, and so on
- treatment of wastewaters

- dilution of wastes using a suitable mixing zone or stack
- pollution control devices such as scrubbers or a bag house
- eliminating emissions by reuse of wastes that will serve as a resource.

Blocking the pathway

By doing this, the hazard is prevented from causing an impact. For example, the use of bunding to stop a leak reaching soil, or stormwater.

Modifying the receptor or receptor/hazard interaction

This may include:

- blocking the mechanism by which the hazard impacts the receptor
- moving the hazard so it cannot impact on a sensitive receptor
- moving the receptor.

4.5 Imposing risk treatments

Risk treatments can be imposed using various methods including conditions of licence and order. However, compliance with conditions can place a cost and administrative burden upon business, so it is important that conditions are only imposed where necessary. To achieve this, the EPA follows the principles below when imposing risk treatments:

1 The environmental risks must justify a regulatory response (for example, a priority risk as defined in Section 3.2).

2 The purpose and outcome of the risk treatment must be clearly defined and documented.

3 The EPA will pursue compliance with risk treatment requirements through the principles outlined in the *EPA guidelines for compliance and enforcement of the Environment Protection Act 1993*. Therefore, where risk treatments are imposed through licence conditions they must be legally enforceable.

4.6 Options for imposing risk treatments

The EPA can require risk treatments in a number of ways. Approaches will vary depending on the level of management required and whether the risk assessment and treatment (or outcome) is site specific or industry specific. For issues at the scale of industry or activity consider:

- codes of practice
- guidelines (for example, *EPA guideline for wineries and distilleries*)
- standard licence conditions.

In most cases, risk analysis will have been undertaken for a specific licensed site, and licence conditions will typically be the most appropriate form to impose priority risk treatment. Conditions of environment protection order, clean-up order and exemptions can also be used. The requirements may also be negotiated in environment performance agreements.

Conditions may relate to outcomes (including discharge limits, management plans or EIP's), infrastructure (such as stack heights and bunding) or prohibitions, process or procedural requirements (for example, not accepting toxic wastes).

The choice of risk treatment options relies on the expert judgment of licence coordinators, often aided by discussion with licensees. Some risk treatment options are categorised under

'non-activity-specific licence condition series numbers' as listed in Table 2. Activity-specific conditions are too numerous to list here—they can be found on IIS.

Monitoring may be required to better understand a situation or support risk treatment. *See* Section 13 Section 13 of the EPA's Authorised Officer E-Book, http://hub2.deh.sa.gov.au/epa/business/ebook/section13.asp.

Table 2 Condition series for non-activity-specific conditions

Condition number	Description
310	EIPs
315	management plans (environment, landfill, irrigation, etc), contingency plans, etc
330	maintenance, stormwater, housekeeping, etc
350	discharge limits

5 CONTINUOUS IMPROVEMENT

A&I registers should be updated and continuously improved when further information becomes available. Site inspections are excellent opportunities to validate and expand on the information in a register. Such information may be related to:

1 The facility and its emissions (for example, monitoring data on depth to groundwater, analytes within waste streams and so on)

2 The surrounding environment (for example, distance to nearest residential neighbour or a change in the values of the receiving environment)

3 The understanding of harm or mechanisms of harm (for example, new research on the impact of lead in children's blood).

In particular the A&I register, and resultant risk analysis and treatment method, should be reviewed when:

- there is a significant process change
- monitoring results provide evidence of harm (or reduction in risk)
- developing a licence project plan or before licence renewal.

GLOSSARY

Aspect	Any element of an organisation's activities that can interact with the environment.
Aspect and impact register	A document used to store a list of a site's aspects and impacts and related details.
Authorisation	A licence, exemption or works approval issued under Part 6 of the *Environment Protection Act 1993*.
Consequence	For EPA's purposes, the amount of environmental harm that will occur if a hazard is realised (that is, if an incident happens). The scope of environmental harm the EPA has jurisdiction over is harm caused by pollution or waste.
Control	Action taken to manage a risk.
Environmental harm	Any harm, or potential harm, to the environment including environmental nuisance. Importantly, the scope of harm is limited to harm caused by pollution or resulting from the combined effects of the pollution and other factors.
Hazard	A source of potential harm.
Impact	Any adverse change to the environment, wholly or partially resulting from an organisation's environmental aspects.
Likelihood	The chance of an event occurring.
Pathway	The route through which a pollutant reaches a receptor.
Precautionary principle	Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (as stated in the 1992 *Intergovernmental agreement on the environment*).
Prescribed activity	Relates to prescribed activities of environmental significance from Schedule 1 of the EP Act.
Priority risk	An environmental risk that is great enough to merit a regulatory response from the EPA.
Receptor	The part of the environment that is impacted by a pollutant, such as a habitat or ecosystem, human beings or any other living organism.
Risk	The chance of something happening that will have an impact

	on the environment or breach environmental legislation. Risk is calculated as the product of the likelihood of an event and the consequences of the event if it did happen. Risk = Likelihood x Consequence
Risk analysis	Systematic process to determine the level of risk.
Risk treatment	An action taken to reduce the level of risk posed by a hazard.
Site contamination	Condition of land or water where any chemical substance has been added above background level and represents, or potentially represents, an adverse health or environmental impact.

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APPENDIX 1 HAZARD–PATHWAY–RECEPTOR MODEL

This section describes the **hazard–pathway–receptor** model that provides a framework for describing the nature of a risk and how environmental harm may result. Understanding the nature of a risk is essential if risk analysis (see Section 3.1), as well as risk treatment (see Section 4), are going to be effective.

When trying to analyse the level of risk, first identify the **hazard**, which is the **aspect** from the A&I register. Then identify the possible receptors and the pathways through which the hazard can affect the receptors and document the mechanism of harm. Note that for one hazard there may be multiple pathways, receptors and mechanisms of harm. The **hazard–pathway–receptor** concept provides a model to base risk analysis upon and help determine the risk treatment options (see Table 3). An assessment like this can also be drawn as a flow chart, which is a useful way to represent multiple pathways, receptors and mechanisms.

Table 3 Examples of hazard, pathway, receptor and mechanism conceptual models

Hazard	Pathway	Receptor	Potential mechanism of harm
Fluoride in stack emissions from glass furnace	Release from stack into atmosphere	Grape vines and other sensitive vegetation	Fluoride is toxic to grape vines
Ethyl mercaptan for treatment of natural gas	Release of concentrated gas into atmosphere from storage	People living in the vicinity of storage area	Even very low concentrations cause discomfort, nausea and respiratory problems. In high doses it may cause liver and kidney damage
Ammonia-rich wastewater from soda ash production	Outlet drain into waters of Port River	Port River ecosystem	Bioavailable nitrogen supports nuisance or toxic algal blooms and seagrass epiphytes
		Waters of the Port river	Ammonia exceeds water quality EPP criteria
Microbes in treated effluent from WWTP	Effluent spray system used to irrigate golf course	People using golf course and living nearby	Infection of exposed people

APPENDIX 2 EXAMPLE OF AN ASPECTS AND IMPACTS REGISTER

The A&I register layout below can easily be expanded as the register is developed over time. See <link> for a MS Excel A&I register template. The example activity here is coal transport onto a site by rail for unloading. See Section 2.5 for information on how to complete the columns of the A&I register.

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Ref:	**Activity**	**Aspect**	**Aspect details** **Including:** • **pollutant** • **quantity** • **nature** • **fate etc**	**Potential impact**	**Potential impact details**	**Within Scope of the EP Act? Y/N**	**Has risk been transferred (and to whom)? Y/N**	**Controls**	**Does the risk accumulate? Y/N**	**Risk assessment +NA for no consequence (Risk rating from matrix)**
1.1	Coal transport	Coal rail delivery	80 x 60 tonne carriages onsite twice daily at 8 am and 4 pm	Amenity—noise	From rail movement due to stop-start process of positioner moving two carriages at a time into rotary dumper	Y	N	• community complaints register • procedure Inv1: excessive noise investigated after complaints • transport curfew 7am-7pm • maximum number of wagons = 80	Y	

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Ref:	**Activity**	**Aspect**	**Aspect details** **Including:** • **pollutant** • **quantity** • **nature** • fate etc	**Potential impact**	**Potential impact details**	**Within Scope of the EP Act? Y/N**	**Has risk been transferred (and to whom)? Y/N**	**Controls**	**Does the risk accumulate? Y/N**	**Risk assessment +NA for no consequence (Risk rating from matrix)**
1.2				Air quality degrade-ation	Dust from uncovered wagons	Y	N	• procedure CL1: water sprays on coal loading at coalfield • procedure CL2: wagon loading controls on potential overloading	Y	
1.3				Air quality degrade-ation	Fumes from rail engine (SO_x, NO_x and hydro-carbons)	Y	N	• engine maintenance procedure • lubricating system maintenance procedure	Y	
1.4				Amenity—visual	Aesthetic impact	N	N	• painted green to reduce visual impact	N	
1.5				Resource usage	Transport fuel	N	N		—	

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Ref:	**Activity**	**Aspect**	**Aspect details** **Including:** • **pollutant** • **quantity** • **nature** • fate etc	**Potential impact**	**Potential impact details**	**Within Scope of the EP Act? Y/N**	**Has risk been transferred (and to whom)? Y/N**	**Controls**	**Does the risk accumulate? Y/N**	**Risk assessment +NA for no consequence (Risk rating from matrix)**
1.6				Land contami-nation	Grease spillage from self-lubricating system	Y	N	• optimal self-lubricating system (minimum grease, maximum time between lubrication) • weekly line inspection	N	
1.7				Land contami-nation	Oil spillage from engine	Y	N	• engine maintenance procedure • regular inspection • regular dipping • oil pressure gauge routine log	N	

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Ref:	**Activity**	**Aspect**	**Aspect details** **Including:** • **pollutant** • **quantity** • **nature** • fate etc	**Potential impact**	**Potential impact details**	**Within Scope of the EP Act? Y/N**	**Has risk been transferred (and to whom)? Y/N**	**Controls**	**Does the risk accumulate? Y/N**	**Risk assessment +NA for no consequence (Risk rating from matrix)**
1.8				Land contami-nation	Fuel spillage from engine	Y	N	• engine maintenance procedure • regular inspection • regular dipping • fuel pressure gauge routine log	N	
2.1		Coal unloading	Coal unloading into bunkers by rotary dumper two carriages at a time and over a 120 minute period	Air quality degrade-ation	Dust	Y	N	• bottom dumping assessment project • rubber skirts in working order and routinely inspected • extraction fans for negative pressure & bag house, maintenance procedures	Y	

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
Ref:	**Activity**	**Aspect**	**Aspect details** **Including:** • **pollutant** • **quantity** • **nature** • fate etc	**Potential impact**	**Potential impact details**	**Within Scope of the EP Act? Y/N**	**Has risk been transferred (and to whom)? Y/N**	**Controls**	**Does the risk accumulate? Y/N**	**Risk assessment +NA for no consequence (Risk rating from matrix)**
2.2				Stormwa-ter contami-nation	Coal dust deposition onto ground	Y	N	• solids interceptor routine inspection procedure	N	
3.1		Coal storage	Coal stored in bunker with maximum capacity of 2000 tonnes	Air quality degrada-tion	Dust	Y	N	• bunkers maximum capacity not exceeded • structure engineered to minimise air blown coal fines	Y	
				Stormwa-ter degrada-tion	Coal dust deposition onto hard surfaces and transported by stormwater	Y	N	• stormwater solids traps kept clean to capture water-transported coal • coal deposited on hard surfaces control-washed during dry days	Y	

APPENDIX 3 DEVELOPING COMPREHENSIVE ASPECTS AND IMPACTS REGISTERS

This appendix describes the steps in carrying out a comprehensive site assessment to develop an A&I register as outlined in Section 2.2. A full site review by the EPA is ideally done with the cooperation of the licensee. When a licensee works with the EPA they can provide much of the information required to develop the A&I register.

1 Team desktop assessment prior to site visit—the project team reviews the processes of the facility based on the activities in the environmental licence. This meeting is essentially a brainstorming session where the aspects and impacts are broadly defined. The outcome of this stage will be a skeletal A&I register based on the aspects and impacts Pro Forma.

2 Entry meeting—the site visit is usually started with an on-site meeting with key site personnel to discuss the purpose of the visit and clearly define the objectives of the review.

3 On-site desktop assessment—a meeting with key site personnel who have a broad understanding of site processes. This begins with a review of each of the prescribed activities delivering a list of aspects related to each activity. Each aspect is then assessed for potential or actual impact. Useful tools include plans, drawings, flow charts, schematics and operation manuals of the facility.

4 Inspection—a site visit follows to see processes and provide a better understanding of the site. It is important that photographs are taken that can be linked to the A&I register to provide visual reminders. Steps 3 and 4 can be repeated if more information is needed.

5 Environmental risk assessment—once the aspects and impacts are documented in the A&I register, carry out a risk analysis using the EPA environmental harm risk analysis matrix (Section 3).

APPENDIX 4 DETERMINING THE LEVEL OF CONSEQUENCE

The level of harm is a major factor in risk analysis, as described in Section 3.3. The hazard—pathway—receptor concept (see Appendix 1) provides a model for understanding the mechanisms that may cause environmental harm. This section builds on that base and examines factors in determining the level of consequence.

Definitions of consequence

Based on the definitions of harm in the EP Act there are a number of tests that can be applied to determine the level of consequence, as follows:

1 size of an amenity impact for environmental nuisance

2 whether the consequence breaches the EP Act or associated legislation (non-compliance)

3 amount of financial loss if an environmental hazard is realised

4 nature and extent of environmental harm to human health or well-being

5 nature and extent of environmental harm to the natural environment.

The following table provides a quick reference for considering these five issues.

Table 4 Quick reference for considering definitions of consequence

Consequence level	Financial loss (C)	Actual or potential harm to human health	Other actual or potential harm to environment
1 Minor	—	—	—
2 Nuisance (A), Non- compliance (B)	—	Any adverse affect on amenity cause by pollution that unreasonably interferes with enjoyment of the area or an unsightly or offensive condition caused by pollution(A)	
3 Material environmental harm	>$5 000(C)	Not trivial(D)	Not trivial(D) Environmental nuisance that is high impact or wide scale(C, D)
4 Serious environmental harm	>$50 000(C)	High impact or wide scale(D)	High impact or wide scale (not nuisance)(D)
5 High level serious environmental harm	>$500 000(C)	High impact AND wide scale(D)	High impact AND wide scale (not nuisance)(D)

A Environmental nuisance

Environmental nuisance is an offence to amenity. To determine if an event will cause an offence of nuisance the nature of the event needs to be tested against the definition of nuisance and judgment made of the level of amenity impact. This decision relies on the observations and judgment of EPA officers. The EP Act empowers authorised officers to determine nuisance as follows:

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(4) In any proceedings for an offence against this Act where it is alleged that the defendant caused an environmental nuisance, evidence by an authorised officer that he or she formed the opinion based on his or her own senses—

(a) that pollutants discharged or emitted from a place occupied by the defendant travelled to a place occupied by another person; and

(b) that the level, nature or extent of the pollution within the place occupied by the other person was such as to constitute an unreasonable interference with the person's enjoyment of the place,

constitutes proof, in the absence of proof to the contrary, that the defendant caused an environmental nuisance.

B Non-compliance

To determine potential non-compliance, compare the consequence of an impact against the specific requirements and offences of the EP Act, EPP's, regulations or the mandatory requirements of an EPA code of practice[11]. A Level 2 consequence is only the default minimum for non-compliance and an event may be moved to a higher level if the other criteria here justify it.

C Financial loss

The EP Act defines financial loss as: 'the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent or mitigate the environmental harm and to make good resulting environmental damage'. Therefore, to determine financial loss combine the costs of the prevention of harm posed by an incident and the likely costs of clean-up and remediation. Financial criteria are:

- material harm: $5000 to $49,999
- serious harm: $50,000 to $499,000
- high-level serious harm: $500,000 and over.

D Impact—trivial, high impact and wide scale

The terms trivial, high impact and wide scale are fundamental to the definitions of environmental harm. Material environmental harm must be harm that is *not trivial*; serious environmental harm must be harm that is of a *high impact* or on a *wide scale.* However, the EP Act does not define these three terms. There is also little case law to provide guidance.

Trivial

If a specific impact upon the environment cannot be identified the consequence is probably trivial. If an impact is of a low intensity, occurs over a small area or for a short time it may also be trivial.

High impact

A high impact is an impact of high intensity. A toxic gas release that causes severe illness requiring lengthy hospitalisation is clearly a high impact. An oil spill that kills many birds and fish is also a high impact.

Impacts on high profile 'icon' species will be easy for most people to understand and appreciate. The death of marine mammals and waterbirds are examples of this. However,

[11] This is any specific requirement of a code of practice that is linked to an EPP.

high impacts may not be so obvious to the casual observer when they affect living organisms or ecosystem processes that people do not typically understand or value. For example, a build up of *Ulva sp* (sea lettuce) around the Port River due to elevated nutrients will not be recognised as an impact by many people. Elimination of invertebrates from aquatic or soil ecosystems by pollutants may even be considered a good thing by some people, despite the fact that these organisms are vital to a functioning ecosystem.

Wide scale

When considering the scale of consequence keep in mind that this applies to both spatial (area) and temporal (time) scales.

Spatial scale (area)

For impacts on the environment, spatial scale relates to the area likely to be affected by the risk or the number of living organisms impacted. For impacts to humans it relates to the number of people impacted.

Temporal (time) scale

If something occurs for a long time, but only in a small area, this is still a wide scale. For example, the overall level of harm caused by the following events is comparable:

- one person suffering a significant noise amenity impact over a ten year period
- ten people suffering the same impact over a one year period
- 120 people suffering the same impact over a one month period.

When considering whether the impact is 'not trivial' or 'high impact', factors that can be taken into consideration include:

- the nature and toxicity of the pollutant
- the nature and sensitivity of the receiving environment
- the nature of the likely impact.

These concepts are discussed in the next section.

Concepts to help determine the level of harm

Nature and toxicity of pollutant

There is a substantial amount of information available on the nature and toxicity of pollutants. Specific information can be found within MSDS's (material safety data sheets). There is also a large body of information in national and international standards and guidelines, including but not limited to:

- *National chemical reference guide—Standards in the Australian environment* (Environment Protection and Heritage Council), <hermes.erin.gov.au/pls/crg_public/!CRG_OWNER.CRGPPUBLIC.pStart>
- *Guidelines for fresh and marine water quality* (ANZECC & ARMCANZ 2000), <eied.deh.gov.au/water/quality/nwqms/brochure.html#water>
- National Pollutant Inventory—Contextual information (NPI 1999), <www.npi.gov.au/about/list_of_subst.html>

A list of guidelines, standards and reference materials can be found in Attachment B of 'Calculation Policy for the negotiation of civil penalties under the Environmental Protection Act' (EPA 2006) <www.epa.sa.gov.au/pdfs/calculations.pdf>.

How intense is the impact?

Rupture of a tank causing loss of a toxic chemical into a waterway will deliver high concentrations of the toxin into the waterway and will be more intense than the slow release of the same chemical from a leaking bund.

Rate of impact

The rate of an impact describes how quickly an impact causes harm to the environment. With slower impacts there may be more scope for intervention and harm minimisation that may reduce the consequence. Harm could occur over a number of time frames: immediately (for example, toxic gas release in an urban area), days, weeks, months, years, decades (coastal seagrass loss due to stormwater and wastewater) or centuries (climate change).

Duration of impact

The duration of an impact is determined by the duration of the emission, the longevity of the pollutant in the environment and the recovery and resilience of the receptor. If a system can recover quickly from an impact then the consequence will be less. If the impacts are irreversible then the consequences are permanent. That is why extinction of a species is such an important issue—it cannot be reversed. In contrast, the removal of noise can often lead to rapid, or even immediate, recovery. Recovery from persistent pollutants, such as DDT, can take far longer.

Sensitivity and value of receptor

The sensitivity and value of the receptor is important. A risk will have greater consequence when impacting on a more sensitive or valuable receptor.

For example, children are more sensitive to lead than adults. The consequence of lead emissions at an isolated mine site with only adult mine workers would be less than the consequences of lead emissions in a township with infants and children. An oil spill far from shore in the Southern Ocean results in less consequence than one that washes onto a beach on Kangaroo Island.

There can be a tendency to dismiss the importance of impacts upon degraded environments. However, healthy people, or pristine or high conservation areas are not the only things deserving protection. Degraded environments, and people previously impacted by a pollutant, can still be sensitive receptors. For example:

- A person whose respiratory system has been weakened by sulfur dioxide emissions may be more susceptible to other pollutants, such as dust. These people may require greater protection from air pollution.
- Some may say that an aquatic environment enriched by nutrients and with low biological diversity is less deserving of protection. However, such an environment may be far closer to complete collapse as it is less robust, and has less resilience. Often the greatest environmental impacts occur when an ecosystem is degraded so far that the natural ecosystem processes fail completely.

APPENDIX 5 EPA RISK TREATMENT HIERARCHY

This appendix expands on the explanation of the EPA risk treatment hierarchy in Section 4.1. The EPA will consider the following hierarchy when determining which risk treatment option to impose:

1 Where reasonable and practicable AVOID the risk.

2 Manage the risk to ELIMINATE harm.

3 Manage the risk to CONTROL the degree of harm.

4 Retain the risk but MANAGE the consequence.

Where reasonable and practicable AVOID the risk

Avoiding the risk of harm can provide a final solution to an environmental problem. If a priority risk does not exist it cannot cause harm. Avoiding the risk will often involve prohibiting the activity or changing locations, processes or materials so the hazard no longer exists. For example:

- use of wet processes in mineral operations prevents the production of dust and eliminates a source of dust emissions to air
- placing a roof over a loading or production area that produces contaminated stormwater prevents the production of the contaminated stormwater and eliminates polluted stormwater discharge from the area
- changing the process to eliminate toxic chemicals eliminates a pollution risk from those chemicals.

However, elimination of one risk may create another, such as the diversion of wastewater from marine discharge to irrigation. Any new hazards created must be assessed and managed through this process. Transforming the risk is an acceptable risk treatment approach, particularly when transferring from a higher consequence risk (for example, marine discharge) to a lower consequence or likelihood (for example, land irrigation).

Manage the risk to ELIMINATE the harm

The next best alternative to avoiding a risk is to control a risk so no harm is caused. Management of the risk often involves an infrastructure or process control that blocks the pathway between the hazard and the receptor. This approach is less certain than avoiding a risk, as failure of the control measures will lead to harm occurring.

Examples of harm elimination include:

- online monitoring of stormwater, combined with an automated diversion system, that can send contaminated stormwater to a treatment system
- leachate detection and collection system under a wastewater dam or lagoon.

Manage the risk to CONTROL the degree of harm

The EP Act requires consideration of social and economic factors. Under some circumstances these factors may require acceptance of a certain level of environmental harm. Examples of ways the actual or potential harm arising from a priority risk may be reduced to a level that is acceptable include:

- a stack can disperse air emissions in a manner that reduces ground-level concentrations and the degree of harm in the local area to an acceptable level
- treatment of contaminated stormwater in a wetland prior to discharge to a river will reduce the pollutants and hence minimise the likely harm from the wastewater

- process monitoring at a facility can provide early warning of performance problems. If monitoring indicates problems leading to unacceptable emission levels then management procedures can be implemented bringing the system back under control.

Where harm is managed at an acceptable level the receiving environment will continue to be impacted. The receiving environment may need to be assessed over time through monitoring to determine the level of harm and assess the adequacy of the control measures. This will help determine if further improvements or remediation are required.

Retain the risk but take action to MANAGE and minimise the consequence if it does occur

For risks that have a low likelihood but a high consequence an emergency management plan will help minimise the consequences of an event if it does happen. They can be especially useful for events that are difficult to predict, prohibitively expensive to prevent or difficult to prevent.

This is the last option on the risk hierarchy and should only be used when no other management options are practical.