Inland Aquaculture

Improving Economic And Environmental Efficiency

Business SA is the leading business organisation in South Australia. It works hard on behalf of business to influence government decisions, attract investments into South Australia, assist export development and be involved in initiatives which help its members to achieve prosperity.

Members are encouraged to have input into the formulation of policies and submissions to government on a variety of issues affecting their ability to do business in South Australia

Members also benefit directly from Business SA's influence and expertise through access to specialist industrial relations services; local, national and international networking and a range of other business and human resource support services.

Advice and assistance is available in the following key areas:

- International Trade
- Occupational Health and Safety
- Employee Relations
- Networking & Promotion
- Training & Education
- Workers' Compensation
- Environment Services
- Association Administration

The Environment Protection Authority (EPA) is South Australia's primary environmental regulator, responsible for the protection of air and water quality and the control of pollution, waste, noise and radiation.

In 2003, the EPA became an independent statutory authority. It is governed by the EPA Board which comprises of nine members with expertise in various areas such as environment protection, agriculture, industry, environmental science, regional issues, environmental law and local government.

The EPA administers the *Environment Protection Act 1993* which provides the regulatory framework to protect South Australia's environment.

IAASA

Inland Aquaculture Association of South Australia

Over the past decade aquaculture production in Australia has increased more than 200% to over 38,000 tonnes in 2000/2001, there has been a 400% increase in the value of production.

An Industry-Government Action Agenda has been formed to assist the industry reach a value of $2.5 billion by 2010.

South Australia's share of this target is $1 billion.

IAASA Inc (Inland Aquaculture Association of South Australia Inc) is an Association for everyone involved in inland aquaculture in South Australia. The aims are to enable:

- Information exchange and sharing
- Setting goals and benchmarks for the industry
- Setting and maintaining standards for aquaculture produce
- Setting and maintaining safe and healthy working conditions
- Career development and training
- Research and development for existing and new species
- Disease identification and control
- A united voice for negotiating with our elected government
- Monthly meetings, regular workshops and discussion groups.

Cover photos supplied from PIRSA Aquaculture and Tara Ingerson

Introduction

The inland aquaculture industry in South Australia farms a large variety of aquaculture species including barramundi, yabbies, marron, Murray cod, ornamentals, mulloway, black bream, rainbow trout, brine shrimp and even microalgae. Products for local, interstate and export markets can be live, fresh, chilled, pickled and smoked.

The industry is characterised by different types of farming practice of varying sizes. Operations range from small sideline operations to large commercial stand-alone farms. Systems used to culture fish include farm dams, purpose built ponds, tanks and Recirculating Aquaculture Systems (RAS). Systems can either be closed (no discharge) or open (discharge occurs).

Inland aquaculture is mainly conducted on private property. This simplifies the establishment of aquaculture farms and places the responsibility for environmental practices firmly into the hands of the farm owner.

The aquaculture industry is regulated under the *Aquaculture Act 2001* which is administered by PIRSA Aquaculture and promotes ecologically sustainable development of marine and inland aquaculture. The protection of the environment is managed under the *Environment Protection Act 1993* and associated environmental protection policies which are administered by the EPA. Environmental protection policies are under development and/or exist for noise, water, odour and waste.

The *Environment Protection Act 1993* determines liabilities with respect to environmental harm that may result from human activities. The Act, under Section 25 states that:

"A person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm."

The Act implies a general environmental duty. It also introduces the notion of due diligence which implies that a person is required to provide evidence that all reasonable and practicable measures have been undertaken to prevent environmental harm.

Due diligence may be demonstrated by the design and implementation of an Environment Management System (EMS). An EMS will assist industry with identifying potential environmental impacts associated with their farm and assist them with establishing mechanisms to minimise those impacts.

This document has been produced by the Environment Services Unit at Business SA in conjunction with South Australian EPA and the Inland Aquaculture Association of South Australia (IAASA) to assist existing and intending businesses involved in the inland aquaculture industry.

This document is split into two sections as described below.

Section 1 – Information and Guidelines

The guidelines included in this section aim to provide the grower with useful information to help minimise the potential for environmental impacts on their farm and reduce operating costs. Information will be provided on:

- Energy Contracting and Conservation
- Feed information
- Rules and Regulations
  - *The Aquaculture Act 2001*
  - *The Environment Protection Act 1993*
  - *The Environment Protection (Water Quality) Policy 2003 (Water Quality Policy)*
- Liquid Waste Reduction
- Solid Waste Reduction
- Odour Control
- Noise Control.

This section does not imply that growers are not already implementing good practises to run their businesses more efficiently. It provides additional information that can be used to help increase the profitability of the business and improve its environmental efficiency.

Section 2 – Environment Management System (EMS)

This section contains information on the main elements of an Environment Management System. It can be implemented by the business owner or operator and incorporates a fictitious case study to provide a demonstration on how an EMS can be applied.

An EMS can be a useful tool to assist the industry with identifying and managing potential environmental risks. It is used by a business/farm to determine the effects of the activity on the environment and what can be done to reduce those effects. A well-designed EMS will provide the following benefits:

- Legal Compliance
- Minimise the use of natural resources
- Minimise the use of energy
- Minimise the production of waste
- Provide potential cost savings
- Facilitate continual improvement towards industry best practice
- Ensure a clean green sustainable image for marketing purposes.

The EMS developed for the inland aquaculture industry can also incorporate the Environmental Monitoring Program (EMP), which is requirement of all PIRSA Aquaculture licence holders. **However it should be noted that while an EMS is voluntary, an EMP must be undertaken and submitted to PIRSA annually irrespective of whether an EMS is adopted or not.**

Information and Guidelines

For the inland aquaculture industry in South Australia

BUSINESS SA

IAASA
Inland Aquaculture Association of South Australia

Introduction

The following guidelines aim to provide industry participants with information on their environmental obligations. It will also provide strategies that will assist the industry in increasing the efficiency of their business in both an environmental and an economic aspect. Information will be provided on the following subjects:

- Savings on Electricity Use
- Diesel
- Feed Information
- Rules and Regulations
  - *The Aquaculture Act 2001*
  - *The Environment Protection Act 1993*
  - *The Environment Protection (Water Quality) Policy 2003*
- Liquid Waste Reduction
- Solid Waste Disposal
- Odour Control
- Noise Control.

Savings on Electricity Use

For many aquaculture operations particularly those using recirculating aquaculture systems to culture fish, electricity is the largest cost of production. Investigating options to reduce energy costs and use will not only improve the efficiency of the farm economically it will also reduce the production of harmful greenhouse gases that is formed when electricity is produced.

Electricity Contracting

The electricity bill is made up of a number of components, which include the cost of the energy, the cost of transmission and distribution and some charges that are applied by the National Electricity Market Management Company (NEMMCO).

South Australia is a member of the National Electricity Market and all customers are free to negotiate a commercial contract with any retailers that are active in South Australia. A cost-effective contract can be a good way to minimise the cost of electrical energy to the business. The following facts are important to know when negotiating a new contract:

- In practice, the only proportion of the contract that can be negotiated is the price of the energy itself. The relevant authorities set the transmission and distribution charges as well as the NEMMCO fees and the retailer acts as a collecting agent only
- The Transmission and Distribution charges make up around half of the total price
- The market is competitive, shop around before entering into a new contract. The retailers that are licensed to sell electricity in South Australia are listed on the Essential Services Commission of South Australia (ESCOSA) Website http://www.escosa.sa.gov.au/site/. ESCOSA can be contacted on 08 8463 4444 for more information regarding retailers
- Larger consumers are able to negotiate better contracts
- Contracts can be negotiated for one to five years. In general longer term contracts have more favourable rates. Shorter-term contracts are usually more expensive but offer the ability to renegotiate sooner if the electricity prices are falling.

Before starting the negotiation with the retailers, it is essential to collect and write down the following information:

- The location of the business
- Your National Metering Identifier (NMI) – this should be shown on the front page of your most recent electricity bill
- The total consumption in units (kWh) over the past two 12 month periods. This information can be obtained from the bills
- The split between peak and off-peak consumption in units (kWh) over the same periods. This can also be obtained from the bills
- Projected consumption over the next five years
- Willingness to pay by direct debit
- Any planned annual shut downs of the business
- Ability to run generators in case of a power failure
- What value added services they can offer you - eg advice on saving energy, incentives to reduce your energy consumption at peak times
- To discuss a contract with an electricity retailer, it will help you to understand kilowatt hours as confidently as you do litres, kilograms, metres and other common measurement terms. A kilowatt-hour (kWh) is the unit that measures your consumption, so when your bill indicates that you have used 500 units of electricity it means 500 kWh of electricity. Megawatts and kilowatts are common measures of the rate at which you use electricity. A single bar radiator is usually a kilowatt – if you leave it on for an hour you will use one kilowatt hour of electricity
- Have you been given sufficient written information to verify the offer being made to you?
- Make sure all price comparisons are based on the same electricity use
- What you can do if you have a complaint.

Useful Conversions
1000 watts = 1 kilowatt (kW)
1 kilowatt = 1 unit
1000 kilowatts (kW) = 1 megawatt (MW)
1 kilowatt hour (kWh) = use of 1 kilowatt of electricity for one hour
1 megawatt hour (MWh) = use of 1 megawatt of electricity for one hour

Electricity Conservation

The use of electrical energy can be a major cost to an aquaculture business particularly those using RAS to culture fish. Reducing electrical consumption will add to the economic bottom line. Electricity conservation makes good business sense. Optimising the electricity usage on a farm will also have environmental benefits.

The majority of electrical energy generated in Australia is derived from thermal power stations. These power stations burn gas or coal in boilers to produce steam. The steam is then fed into a turbine that turns a generator to produce electrical energy. For every kWh of electrical energy consumed, power stations generate approximately1 kg of Carbon Dioxide (CO2), a major contributor to the global accelerated greenhouse effect.

The majority of electricity consumption in the aquaculture industry occurs for pumping, temperature control of water and atmosphere, refrigeration and lighting.

The following guidelines aimed at assisting industry in identifying options to reduce their electricity consumption may or may not be applicable to different operations.

a) Pumping

In the Aquaculture Industry, pumps are used to move water to and from ponds, tanks etc. A pumping system comprises of an electrical motor that drives an impeller or a set of pistons in a housing where water enters the inlet side and is forced out the outlet side as the impeller or pistons move.

The efficiency of the pump system depends on the efficiency of the motor and the efficiency of the pump as well as the arrangement and size of pipes used. It is important to select the correct components for a system to deliver the required flow rate of water.

In many cases the designer of a pumping system aims to deliver a system at the lowest cost. This design philosophy often overlooks the operating cost of the system. It is important for the aquaculture farmer to compare initial system cost with operating cost. To demonstrate this, the following example is provided.

A farmer needs to replace a pumping system that has reached the end of its functional life. The system used an 11 kW motor and is usually running 24 hours a day throughout the year.

Replacing the system with the same components would cost $4800. However, the farmer included efficiency in the design parameter and the supplier has sourced an alternative system that has an overall improved efficiency of 15% but with an additional $1200 of initial capital cost. Below is a comparison of the two options for the replacement.

Table 1: Example of cost savings

Item	***Option 1 (replace with similar equipment)***	***Option 2 (replace with 15% more efficient equipment)***
Initial Cost	**$4800**	**$6000**
Extra Cost		$6000 - $4800 **= $1200**
Energy Consumption	365 days x 24 hours x 11 kW **= 96360 kWh/year**	365 days x 24 hours x 9.35 **= 81906 kWh/year**
Production of greenhouse gas	**96.36 tonnes CO2/year**	**81.9 tonnes CO2/year**
Savings in greenhouse gas		96.36t CO2 – 81.9t CO2 **= 14.46 t CO2 per year**
Cost of electricity	**$0.16/kWh**	**$0.16/kWh**
Operating cost / year	96360 kWh x $0.16 **= $ 15417.60**	81906 kWh x $0.16 **= $ 13105**
Savings in operating cost		$15417.6 - $13105 **= $ 2312.6/year**
Simple payback		**6.2 months**

Table 1 demonstrates the extra cost for the energy efficient option is paid back in little over six months. After this period, the system will save the owner around $2300 per year for the entire lifespan of the system. In many cases, the more efficient option is also a superior quality product since some of the efficiency gains are made by the use of superior bearings and other components. As an extra benefit, the increased efficiency also has the environmental benefit of reducing nearly 14.5 tonnes of CO_2 production per year.
Designing the correct pumping system for a particular application is a complex task that requires specialist engineering knowledge. But as the above example demonstrates, including running cost in the design calculations can deliver real long term benefits to the economic and environmental efficiency of the system. Optimising the pipeline system as well as the

pumping equipment may also lead to greater savings particularly if the number of fittings used in the system can be reduced.

b) Temperature Control of Water

In order to optimise the growth rate of the fish it is sometimes necessary to control the temperature of the water in which they are cultured. Various methods are adopted by the aquaculture industry to achieve temperature control.

The least favoured option is using electric heaters to raise the water temperature as they are designed for a wet environment, are expensive to buy and have relatively high maintenance costs. In most cases there are better options available to the farmer to optimise growing conditions while reducing heating costs. These include:

- Using solar convection heating
- Using waste heat generated from the pumps to heat the water
- Recovering heat from wastewater.

c) Temperature Control of Atmosphere

Sheds in which the fish are cultured are often heated to minimise the heat transfer between the water and the air and assist with maintaining the water temperature. To minimise the amount of extra energy required to maintain the room temperature, the farmer can:

- Use the waste heat from the pumps and blowers to heat the atmosphere
- Insulate the growing sheds to minimise the heat transfer between inside and outside
- Use control equipment to avoid unnecessary heating.

d) Refrigeration

Some aquaculture operations use refrigeration equipment to hold the stock between harvest and transport. To minimise cost it is important to consider the following issues:

- Ensure that the installed system has the correct capacity for the amount of refrigerated stock. The cost of cooling increases if the system is either over or under designed
- Ensure that the insulation of the refrigerator is in good condition and the door seals are intact
- Ensure that the system is turned off if there is no stock in it
- Avoid installing a refrigeration system near a heat source such as a pump or compressor;
- Ensure that the system is part of the electrical emergency distribution system to avoid spoilt stock during prolonged power failure
- Ensure that the thermostat is set at the required level
- Have the system maintained at regular intervals. Poorly maintained equipment does not only use more energy but is also more prone to failure.

e) Compressed Air

Compressed air may be used in the industry to oxygenate the water and within airlifts to pump water. Compressed air is costly and a number of measures can be taken to minimise the cost. These are:

- Check the system at regular intervals for leaks. Repair leaks immediately
- Implement a regular maintenance program for the compressor to check the oil level and to bleed the system of water

- Ensure that the compressor is set at the lowest pressure while still maintaining its efficiency. A given system uses less energy at lower pressure and is therefore more economical to run
- Investigate options to utilise heat generated from compressed air to heat the atmosphere or water
- Ensure that the compressor air inlet is not near a heat source. Cool air is denser and cheaper to compress.

f) Lighting

Do not forget to turn off the lights at the end of the day or when ambient lighting is sufficient. Timers are an excellent way to ensure that the lights are off during the night. One fluorescent tube left on over night costs around $25 per year. How many tubes are in your shed?

Diesel

Some aquaculture operations rely heavily on the provision of electricity to maintain the survival of their fish. Power outages for these operations can be devastating and can cause mass mortalities. The viability some operations therefore depends on the uninterrupted supply of electricity for pumping, aeration and heating. This is evident by the number of RAS operators who have installed an emergency generator in their internal electrical distribution system.

Diesel generators come in a variety of shapes and sizes. There are some important parameters to consider before purchasing a generator. These parameters include:

- The maximum demand of the essential operation of the business in kVA. To minimise initial infrastructure cost, the system should be designed to allow the operation to run in survival mode once the grid power fails
- The number of phases required. In most cases, the electrical consumers such as blowers and pumps are in a 3-phase configuration
- The expected maximum running time of the system. The system has to be designed to allow the generator to produce electricity for the longest possible power failure. This is of importance in determining the fuel capacity and the size and cooling equipment of the diesel generator. Using a diesel engine to generate electricity is more expensive than grid connected electricity
- The location of the generator should be chosen to minimise noise and air pollution issues while minimising the length of the electrical cable that connects the generator to the main switchboard of the farm. Often a compromise between distance and nuisance has to be achieved
- Are there any local regulations that prohibit or restrict the use of diesel generators? These restrictions are usually concerned with emission control and noise issues.

Feed Information

Besides electricity, feed can be a significant cost for many aquaculture farmers. Types of feed include pellets specifically manufactured for aquaculture species, straw and lucerne hay, vegetable scraps and grains such as lupins, wheat, barley and will vary depending on the species that is being farmed. Feed can be dispersed manually by hand or via an automatic feeder. It is in the farmer's interest to maximise the growth rate and the health of the animals while minimising the amount of feed required. This can be monitored by calculating the Food Conversion Rate (FCR) for the farmed species. The FCR is a measure of the amount of food being fed to the fish that is required to produce 1kg of fish product. For example if a farmer fed 3kg of feed to their fish to produce 1kg of fish, their FCR would be 3:1. Farms reporting

lower FCRs (ie less feed required to produce 1kg of fish), normally display good management practices with minimal overfeeding and low mortality rates.

Optimising feeding rates and hence FCRs is important as it can play an important role in determining the overall profitability of a farming operation. Too much feed results in poor water quality which can effect the health of the fish resulting in disease and mortalities. Wasted feed also equates to wasted money therefore reducing the wastage of feed by not overfeeding will result in less money being spent on feed. However underfeeding fish can also result in wasted profits by reducing growth rates and producing unhealthy fish. Feeding rates will also be optimised by providing good water quality.

Optimising the type and feeding method for individual species under various environmental conditions is the basis of much scientific work carried out mainly by the feed producers. Therefore if a pelleted feed is being used, information can be sourced from the feed manufacturing company on optimal feeding rates for a particular species of fish.

The amount and type of feed used in a fish farm has a major impact on water quality and the concentration of nutrients present in discharged water. Water quality of discharged water emanating from a farm, and its potential impacts on the environment, also depends on the method of water discharge and whether the water has been treated prior to discharge. These factors are used by PIRSA Aquaculture to determine the environmental risk of an aquaculture operation (Table 2), which in turn determines the level of environmental monitoring required by the licensee. A high risk operation requires a greater level of environmental monitoring than a low risk operation. Therefore improving food conversion ratios, and investigating opportunities to treat, reuse or recycle wastewater produced on the farm can reduce environmental monitoring requirements that must be undertaken by the licensee.

Table 2: Risk matrix

Discharge Type	**Description**
None	All water used in the aquaculture operation is retained on the licensee's property and does not interfere with any other water course or body (including groundwater) either through natural events (such as flooding) or any other means.
Controlled	Water used in the aquaculture operation is treated prior to discharge, in a manner which effectively reduces nutrient and suspended sediment loads to near ambient levels.
Uncontrolled	All water used in the aquaculture operation is discharged without treatment and enters a natural watercourse or body (including groundwater), either through natural events (such as flooding) or any other means.

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Feed Usage	Description
Natural	Less than 1500kg of natural feeds are used in the aquaculture operation per annum.
Minor Manufactured	Less than 1500kg of manufactured feed (eg: processed feed containing 30% of protein or equivalent) or more than 1500kg of natural feeds are used in the aquaculture operation per annum.
Major Manufactured	More than 1500kg of manufactured feed is used in the aquaculture operation per annum.

Environmental Risk		Discharge Type		
		None	Controlled	Uncontrolled
Feed Usage	Natural	Low Risk	Low Risk	Low Risk
	Minor Manufactured	Low Risk	Low Risk	Medium Risk
	Major Manufactured	Low Risk	Medium Risk	High Risk

Risk Assessment used by PIRSA Aquaculture to assess the environmental risk of an aquaculture operation. The higher the environmental risk, the greater level of monitoring is required to be undertaken by the licensee

NB: Licensees should contact PIRSA Aquaculture to discuss their environmental monitoring requirements for their operation.

Rules and Regulations

The Aquaculture Act 2001

The *Aquaculture Act 2001*, administered by PIRSA, is the principal piece of legislation that regulates aquaculture in South Australia. Every person conducting aquaculture activities requires an aquaculture licence and must comply with the conditions specified on their licence, the *Aquaculture Act 2001* and associated aquaculture policies.

An important condition of licence is the requirement for every licence holder to undertake an annual Environmental Monitoring Program (EMP). This EMP can form part of an EMS and therefore has been incorporated into this document. However it should be noted that although an EMS is voluntary, an EMP is a condition of a PIRSA Aquaculture licence and therefore must be undertaken and submitted to PIRSA.

The Environment Protection Act 1993

The *Environment Protection Act 1993* has been in operation in South Australia since 1995 and is administered by the Environment Protection Authority (EPA).

The centrepiece of the Act is the General Environmental Duty. Clause 25 states that**:**

"A person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm."

The clause requires that everybody, including directors, owners, operators and employees have a duty to take practical and reasonable steps to prevent or minimise environmental harm.

In case of an incident[2], the EPA will need to be satisfied that the above clause is met. Failure to meet this clause can lead to substantial fines or in some cases, imprisonment.

Furthermore according to Section 59 of the *Aquaculture Act 2001*, all new licence applications and amendments to existing licences must be forwarded to the EPA for consideration. It should be noted the EPA is also a mandatory referral agency under the *Development Act 1993* (ie all development applications are also forwarded to the EPA for consideration). The EPA must therefore assess all applications with regards to the objects of the *Environment Protection Act 1993* and associated Environment Protection Polices. In addition, all farms must ensure their activities meet the requirements of this legislation.

Given the above information it is clear to see the importance of documenting reasonable and practicable steps that a business is taking to prevent or minimise environmental harm that may arise due to inland aquaculture. A well-designed and maintained EMS is an informed and consistent way to capture the measures taken to prevent pollution and can be used as a defence in the event of an environmental incident.

Environment Protection (Water Quality) Policy 2003

The *Environment Protection (Water Quality) Policy 2003* (Water Quality Policy) has been introduced by the Environment Protection Authority (EPA) to provide a consistent approach to the protection of water quality across all South Australian waters. It encompasses marine, estuarine and inland waters (including underground and surface water), and replaces the *Environment Protection (Marine) Policy 1994* and certain other environment protection policies. The Water Quality Policy covers:

- Water quality objectives (environmental values plus water quality criteria)
- Management and control of point and diffuse sources of pollution
- Obligations relating to particular activities
- Water quality criteria, discharge limits and listed pollutants.

The object of the Water Quality Policy is to: **"achieve the sustainable management of the waters of the State by protecting and enhancing water quality while allowing economic and social development".**

[2] Examples of incidents that may cause environmental harm include chemical spill, overflow of nutrient rich wastewater from a sediment pond into a water course.

The policy seeks to promote best practice in environmental management and aims to encourage the management of waste via the 'waste management hierarchy' that identifies, in order of preference, the following waste management strategies:

- **Avoid** the production of waste
- **Reusing** waste
- **Minimising**, as far as reasonably practicable, the production of waste
- **Recycling** waste
- **Recovering** part of waste for re-use
- **Treating** waste to reduce potentially degrading impacts
- **Disposing** of waste in an environmentally sound manner.

Environmental harm is specified in the Water Quality Policy where 'a person**, by discharging or depositing a listed pollutant into any waters**, must not cause any of the following:

- Loss of seagrass or other native aquatic vegetation
- A reduction in numbers of any native species of aquatic animal or insect
- An increase in numbers of any non-native species of aquatic animal or insect
- A reduction in numbers of aquatic organisms necessary to a healthy aquatic ecosystem
- An increase in algal or aquatic plant growth
- The water to become toxic to vegetation on land
- The water to become harmful or offensive to humans, livestock or native animals
- An increase in turbidity or sediment levels.

Listed pollutants are specified in Schedule 4 and Schedule 5 of the Water Quality Policy. Some pollutants relevant to aquaculture include therapeutic compounds, animal (including fish) faeces, fertilisers, sediments, dead fish and nutrients.

The Water Quality Policy defines a set of 'protected environmental values' to promote a healthy ecosystem that will benefit both the environment and industry. Environmental values exist for marine and freshwater aquatic ecosystems; recreation and aesthetics, potable use, agriculture/aquaculture and industrial. These values are defined by water quality characteristics (chemical, physical, microbiological or biological measure) and criteria (values) and are adopted from nationally accepted criteria. Environmental values and corresponding water quality criteria specified in the Water Quality Policy that may be applicable to aquaculture are listed in Table 3 of this document. However, aquaculture operators should note there will be additional water quality characteristics and corresponding criteria listed within the specified environmental values that could be applicable in some circumstances. These are listed in Schedule 2 of the Water Quality Policy.

Table 3: Examples of the water quality criteria taken from Schedule 2 of the Water Quality Policy

	PROTECTED ENVIRONMENTAL VALUES (mg/L)	
Pollutant	***Fresh aquatic ecosystems***	***Marine aquatic ecosystems***
Inorganic pollutants		
Ammonia (total as nitrogen)	0.5	0.2
Ammonia (NH_3 as nitrogen)	0.01	0.05
BOD (5 day test)	10	10
Chlorine (total)	0.003	0.0075
Oxidised nitrogen (as nitrogen)	0.5	0.2
Phosphorus (total as phosphorus)	0.5	0.5
Phosphorus (soluble as phosphorus)	0.1	0.1
Salinity (% variation)	10%	
Sulfide	0.002	0.002
Suspended sediment	20	10
Total nitrogen (as nitrogen)	5	5
Total organic carbon	15	10
Turbidity (NTUs)	20	10
Colour (Hazen Units)	30	15
Other parameters		
Oxygen (dissolved)	>6	>6
pH (pH units)	6.5–9	

All aquaculture operators are obliged to comply with the Water Quality Policy. In effect, this will require aquaculture operators to:

- Avoid the discharge or deposit of any waste into any waters or onto land where waste is likely to enter waters
- Not contravene the water quality criteria specified in the Water Quality Policy
- Not cause environmental harm by discharging or depositing any pollutants (including nutrients and sediment) into waters or on land where waste is likely to enter waters
- Apply the ‘waste management hierarchy’ to their aquaculture operation.

Non-compliance with these and some other requirements set out in the Water Quality Policy is an offence which may attract an on-the-spot-fine and/or prosecution in court.

Copies of the legislation referred to in the document may be obtained on the Internet via the EPA website at www.environment.sa.gov.au/epa. Alternatively copies are available from the EPA, Telephone 8204 2000 or Freecall 1800 623 445.

Liquid Waste Reduction

The most common form of liquid waste emanating from a farming operation is in the form of wastewater. The amount of wastewater generated by the farm varies greatly and is a function of the type and the size of the operation and can be also be an indication of the overall efficiency of the operation. Wastewater can also contain a number of contaminants including:

- Veterinary drugs or chemicals
- Dead or dying stock
- Cleaning agents
- Bloodied water
- Animal faeces/uneaten feed
- Fertilisers
- Salt.

The composition of wastewater will also vary depending on the type of operation and the species being farmed.

Disposal of liquid waste must comply with the requirements of the Water Quality Policy. A number of actions can be undertaken by the business/farmer to minimise the generation of wastewater or to minimise the potential for wastewater to cause environmental harm. These include:

- Engaging suitable wastewater treatment processes (biological and mechanical filtration, wastewater storage lagoons, etc) to remove solids, organic carbon and dissolved nutrients from wastewater prior to discharge
- Ensure filtration systems that are used on the site are operating effectively
- Improving feeding practices to maximise food conversion ratios and minimise waste
- Incorporating a wastewater storage lagoon (settlement pond) on the site to collect and treat wastewater before discharge or to dispose of water via evaporation
- Recycling or reusing the wastewater produced by the farm
- Wastewater can be used for irrigation providing ponding or surface runoff is avoided, and the rate of application ensures that crops or other vegetation at the disposal site takes up all nutrients.

Should a wastewater storage lagoon be incorporated into an aquaculture operation, the Water Quality Policy specifies they must comply with the following:

- The lagoon must be constructed so that polluted water cannot intercept with any underlying seasonal water table
- The lagoon must be constructed of or lined with an impervious material
- Measures must be incorporated to control overflow, flooding and/or leakage
- Where required, a sufficient number of monitoring bores must be installed and properly placed to ascertain the presence of potential leakage
- The lagoon must not pose any risks to the health of any animals
- A distance of greater than 600mm must be maintain between the level of the wastewater and the level of the maximum carrying capacity of the lagoon.

Liquid waste can also consist of a number of other contaminants including oil, grease and other fuels, chemicals that may be used on site and water that is used to wash equipment. These contaminants should be stored in an enclosed and/or bunded area and disposed of appropriately when their use has been surpassed.

Solid Waste Disposal

Forms of organic solid wastes arising from farms includes dead product, uneaten feed, faeces, scales etc. However waste can also consist of litter, empty feed bags, pipes and hoses, unused equipment etc. Any solid waste generated on the farm must be disposed of in an appropriate manner that does not cause environmental harm.

To minimise potential environmental impacts that may be associated with the production of solid waste from a farm, a number of actions can be employed by the farmer/business such as:

- Solid waste (dead fish, litter, empty feed bags, organic sediment etc) should be stored or disposed of in an area where it does not come into contact or contaminate any water body that is present above or underground – this includes stormwater
- Investigate ways to convert mortalities to a useful product. This can be achieved by composting of sediment sludge as well as dead product. The compost generated will be high in nutrient and may have the potential to generate an additional income stream
- Organic sediment obtained from maintenance of dams and cleaning of tanks may be used as a top dressing over vegetated surrounds but shall only be applied at a rate which ensures full uptake of all nutrients by the vegetation
- Solid waste should be disposed of in a licensed waste depot.

Odour Control

Odour from an aquaculture activity can emanate from a variety of sources. The more common sources include:

- Inappropriate disposal of dead product
- Solid waste from filtration equipment
- Wastewater ponds
- A poorly run RAS
- Spoiled feed
- Poorly operating diesel machinery (including pumps, generators).

The notion of general environmental duty as discussed in the previous section, outlines principal criteria on odour. It is the general environmental duty of the business to ensure that all practicable and reasonable measures are taken to avoid environmental nuisance created by odour emanating from any activity related to aquaculture.

The overall assessment of the nuisance value is determined by a number of factors including:

- The number of people affected
- How often the offensive odour occurs
- The strength of the odour
- How long the smell lasts each time it occurs and
- How offensive the smell is.

Strategies that can be used to minimise the production of offensive odours include:

- Maintenance and cleaning of culture equipment
- Composting waste
- Minimise waste production
- Disposing waste in an appropriate manner using a licensed waste depot.

Noise Control

Noise levels in South Australia are currently regulated by the *Environment Protection Act 1993*, the *Environmental Protection (Machine Noise) Policy 1994* and *the Environmental Protection (Industrial Noise) Policy 1994*. However it should be noted that an *Environment*

Protection (Noise) Policy is currently in production at the printing of this document and will replace the both the Machine Noise Policy and the Industrial Noise Policy in the near future.

To satisfy the general environmental duty as stated in the *Environment Protection Act 1993*, the following guidelines[3] listed in Table 4 need to be met.

Table 4: Noise Guidelines

LOCATION	7 AM–10 PM	10 PM–7 AM
Rural or predominantly rural	47	45
Urban residential	52	40
Urban residential with some commerce, or with a school, hospital or the like	55	45
Urban residential with some manufacturing industry or with some place of public entertainment or place of public assembly or licensed premises	58	50
Predominantly commercial	65	60
Predominantly industrial	70	70

In most cases landbased aquaculture ventures emit very little noise. Noises from aquaculture ventures can be emitted from:

- Water pumps and filters
- Heavy machinery and vehicles
- High-pressure cleaning guns
- Water aerators
- Compressors
- Generators.

RAS are the most energy intensive and also create the most consistent level of ambient noise. Other systems may employ pumps and blowers but these are only operated in hatcheries or intermittently outdoors as and when required.

In general, noise becomes an issue where a business is operating in areas that also contain domestic premises. Most inland aquaculture operations are located away from built up areas and therefore noise is usually not an issue.

In case of a dispute the investigating officer will also take into account the level of reasonable and practicable measures that have been taken to reduce the level of noise. Environmental harm created from excessive ambient noise levels can be reduced by:

- Operating noisy machinery at appropriate times
- Locating housing pumps, compressors and other potentially noisy equipment in insulated housing or an enclosed shed where appropriate.

Noise is also regulated under the OH&S regulations and care has to be taken to protect people working on the farm from constant and excessive levels of noise. Exposure over time to consistent high level noise can cause industrial deafness. If noise is perceived to be a problem, the working area needs to be risk assessed and personal hearing protection may need to be worn.

[3] These guidelines will change when the new Environment Protection (Noise) Policy is implemented late in 2004 or in 2005. This document will be modified to reflect this change when the new policy comes into force.

Environment Management System

For the Inland Aquaculture Industry in South Australia

BUSINESS SA

IAASA
Inland Aquaculture
Association of
South Australia

Introduction to EMS

An EMS provides a systematic, consistent and informed approach to managing the effects of an inland aquaculture operation on the environment. A successful EMS ensures the following important business objectives:

- Legal compliance
- Minimise the use of natural resources
- Minimise the use of energy
- Minimise the production of waste
- Provide potential cost savings
- Facilitate continual improvement towards industry best practice
- Ensure a clean green sustainable image for marketing purposes.

The improved environmental performance can assist the inland aquaculture farmers in marketing their products as a "clean green product".

In addition, international markets increasingly demand compliance with environmental standards. The International Standards Organisation (ISO) has produced a comprehensive series of standards that govern environmental performance. Care has been taken to align this document to the strategies outlined in the ISO 14000 series of international standards. A farmer that complies with the EMS developed under this program will find it easier to take the next step to a fully accredited ISO 140001 EMS if the market demands it.

The following EMS strategies have been adapted from the ISO standards and will enable the farmer to develop a step by step procedure to satisfy legal obligation and to move their business towards best environmental practice.

There are seven steps involved in the production and maintenance of an EMS. These are pictured in Figure 1 and involve:

- Step 1 – The production of an environmental policy that states the farmer's commitment to environmental management.
- Step 2 – Identify the activities involved in an aquaculture operation that may result in an environmental impact.
- Step 3 – Develop a management program to address the potential environmental impacts.
- Step 4 – Establish and maintain emergency response procedures should a pollution event occur by developing an Emergency Preparedness and Response Plan(EPR).
- Step 5 – Monitor the environmental performance of the aquaculture operation.
- Step 6 – Identify appropriate actions should non-conformance occur.
- Step 7 – Review and report on the management of the operation and recommend changes if required.

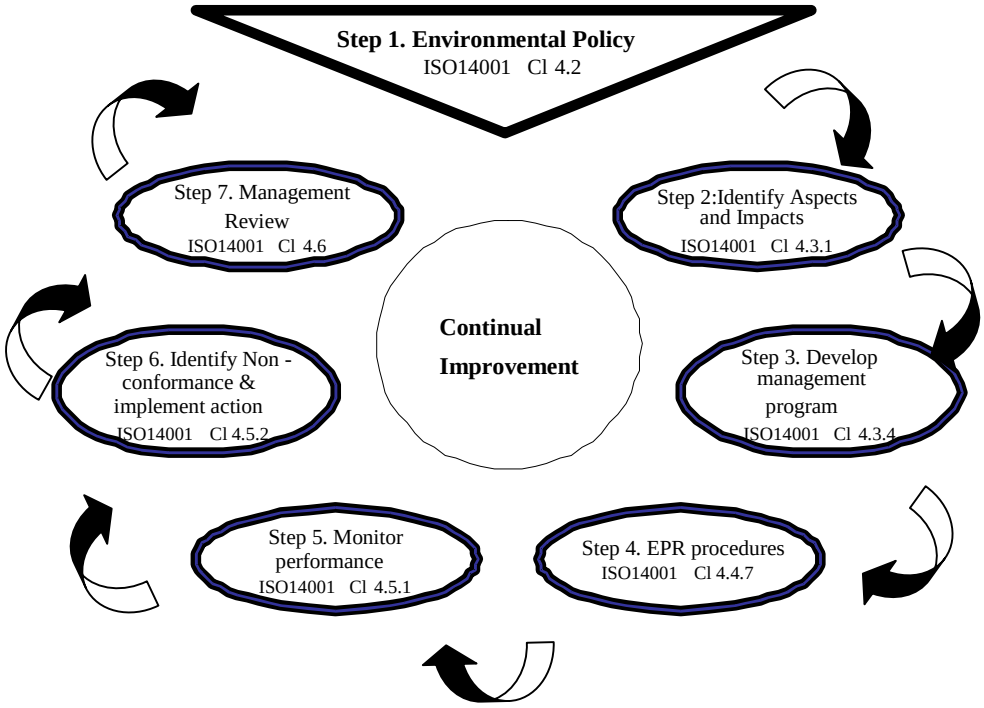


Figure 1: The main elements of the EMS. The circular notion of this diagram indicates continual improvement.

Step 1: Environmental Policy

The Environment Policy is a series of statements produced by the owner of the aquaculture business which outlines their commitment to improving the environmental performance of their operation. The statements are publicly available and continually reiterate the commitment to:

- Preventing pollution
- Continually improving eco-efficiency and environmental management
- Compliance with relevant environmental legislation.

The commitment by the owner or senior people of the business is of paramount importance to implementing a successful and effective EMS.

Step 2: Identify Aspects and Impacts

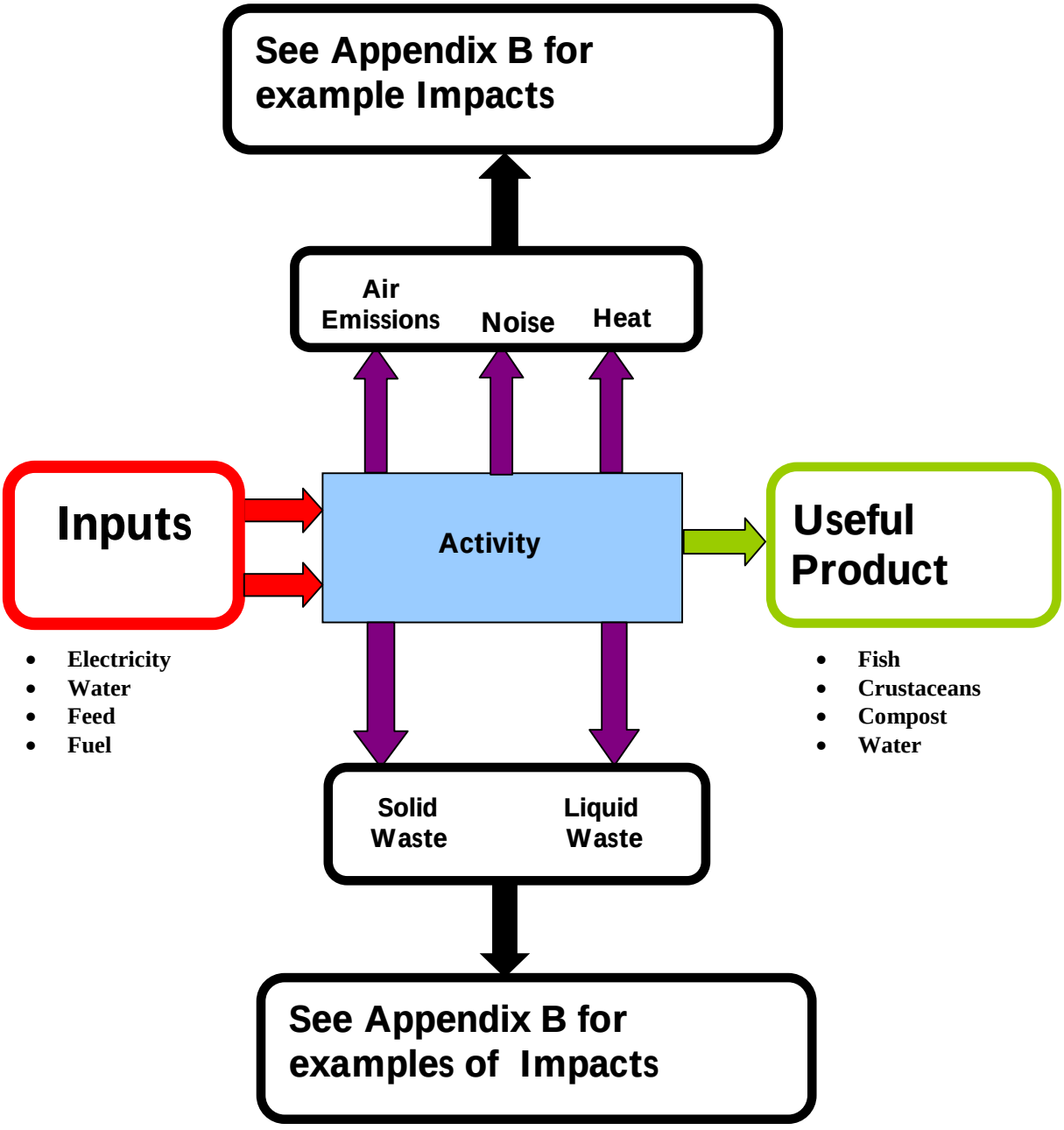


Figure 2: An Impact and Aspect Method

The Aspect and Impact[4] Register is the central piece of an EMS. The register will evaluate all the potential impacts on the environment that may occur during the operation of the business. Therefore it is important that enough time is devoted to the production of the register.

The size and complexity of the Aspect and Impact Register will vary according to the size and type of the operation. Owners and any employees should be involved in the process of developing the register to ensure it is relevant to their particular aquaculture operation. If more than one person works on a farm, a meeting to discuss the components that should be included in the Aspect and Impact Register will be useful. If this is not possible, employees can forward their ideas to the manager or owner of the farm for consideration.

Aspect and Impact Register Procedure

1. **ACTIVITY:** Place an activity in the centre of the blue box eg*:* filtration of water.
2. **INPUTS:** Near the red arrows note down every input into the activity eg: electricity, water.
3. **ASPECTS:** The purple arrows highlight the various aspects (hazards) associated with the activity eg: CO_2, heat, wastewater, sludge.
4. **IMPACTS:** See Appendix B for examples of common impacts for the aspects that you have evaluated.
5. **USEFUL PRODUCT:** The resultant product is noted near the green arrow eg: filtered water.

(Note that every activity has multiple aspects and aspects can have more than one impact).

Step 3: Develop Management Program

Once the impacts for the entire farm have been identified, the next step of the EMS can proceed. This involves undertaking a risk assessment of these impacts, developing mechanisms to manage these risks and identifying emergency procedures should a pollution event occur. This information can then be incorporated into an action plan that can be used by the farm management and staff to manage potential environmental risks that may occur.

During the development of an environmental action plan for the aquaculture operation, an environmental review also needs to be undertaken to identify:

- Legal and regulatory requirements
- Existing environmental management practices and procedures
- Current environmental performance
- Views of interested parties such as feedback from the community.

Undertaking a Risk Assessment of the Aquaculture Operation

A risk assessment assesses the potential impacts identified in the Aspect and Impact Register.

The following steps outline the process that is undertaken to assess the potential environmental risk of a particular activity associated with the aquaculture venture based on the consequence of the impact on the environment should it occur and the likelihood of that impact occurring.

[4] Environmental Aspect*: Element of an organisation's activities, products or services that can interact with the environment (eg: storage of chemicals, cleaning of tanks, wastewater discharge, filtration of water).*
Environmental Impact*: Any potential change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services (eg: heat, wastewater, fumes etc).*

1. For each impact identify the consequence of the risk occurring using Risk Assessment Table 5: Consequence Levels of an Impact.
2. For each impact identify the likelihood of the impact occurring using Risk Assessment Table 6: Likelihood Levels of an Impact.
3. Calculate the risk assessment rating by using Risk Assessment Table 7: Risk Ranking = Consequence x Likelihood.
4. Determine the appropriate category for the impact using Risk Assessment Table 8: Category of Risk Ranking based on the risk assessment rating calculated in the previous step.
5. Prioritise all aspects from extreme risks to negligible risks.

Once the risk assessment is complete, control measures for moderate, high and extreme risks should be reviewed and revised if necessary. This should be communicated to any employees or family members who work on the farm.

The management program should also include an Emergency Preparedness and Response plan (Step 4). This outlines the steps taken should a pollution event occur which will aim at minimising any impacts to the environment.

Risk Assessment Reference Tables

Table 5: Consequence levels of an impact

Consequence	Score	Definition
Negligible	0	Very insignificant impacts. Unlikely to be measurable.
Minor	1	Possibly detectable but minimal impact on structure/function or dynamics.
Moderate	2	Maximum appropriate/acceptable level of impact – recovery measured in months or years.
Severe	3	This level will result in wider and longer term impacts – recovery measured in years.
Major	4	Very serious impacts with relatively long time frame likely to be needed to restore to an acceptable level – recovery measured in years to decades.
Catastrophic	5	Widespread and permanent/irreversible damage or loss will occur – unlikely to ever be fixed.

Table 6: Likelihood Levels of an Impact

Likelihood	Score	Definition
Likely	6	It is expected to occur.
Occasional	5	May occur.
Possible	4	Some evidence to suggest this may possibly occur.
Unlikely	3	Uncommon, but has been known to occur.
Rare	2	May occur in exceptional circumstances.
Remote	1	Never heard of, but not impossible.

Table 7: Risk Ranking = Consequence x Likelihood

	Consequence					
Likelihood	**Negligible (0)**	**Minor (1)**	**Moderate (2)**	**Severe (3)**	**Major (4)**	**Catastrophic (5)**
Remote (1)	0	1	2	3	4	5
Rare (2)	0	2	4	6	8	10
Unlikely (3)	0	3	6	9	12	15
Possible (4)	0	4	8	12	16	20
Occasional (5)	0	5	10	15	20	25
Likely (6)	0	6	12	18	24	30

Table 8: Category of Risk Ranking

Score	Category
0	Negligible risk
1 - 6	Low risk
8 - 16	Moderate risk
15 - 18	High risk
20 - 30	Extreme risk

Step 4: EPR procedures

The emergency preparedness and response procedure is developed to assist the business in establishing measures to deal with accidents and emergencies in a manner to minimise or avoid environmental harm.

Examples of EPR Procedures are included in the sample EMS provided at the end of this document.

Step 5: Monitor performance

To continually improve the environmental performance of the aquaculture business it is essential to introduce a monitoring procedure. This procedure has to be designed to monitor and measure key characteristics of the business.

The monitoring procedure allows the business to continually track performance and measure positive and negative outcomes of the EMS. The data obtained will be an invaluable tool to fine tune the EMS and assure that all the desired outcomes are met.

Examples of monitoring programs are included in the sample EMS provided at the end of this document.

Step 6: Identify Non-conformance & Implement Action

A non-conformance report should be raised for any activity, which is identified as:

- A breach of procedures
- An unexpected incident
- A breach of licence condition.

These activities may be identified through employee observations, workplace inspections and regulatory authority inspections.

An employee who becomes aware of the non-conformance shall verbally notify the supervisor as soon as practical.

Corrective action

The supervisor/manager/owner should investigate the non-conformance to determine the root-cause of the non-conformance (i.e. lack of training, unsuitable maintenance program, inadequate inspections etc). Any corrective actions identified as part of the investigation should be implemented as required. This should be documented on the non-conformance report.

The supervisor/manager/owner will also determine if notification of appropriate regulatory bodies (eg: EPA; PIRSA Aquaculture) is required.

Preventive action

As part of the investigation, the Supervisor/Manager/Owner should identify any preventive actions that need to be implemented to ensure the non-conformance does not recur. Procedures need to be reviewed, amended and added as required. This should be documented on the Non-conformance report.

Details of the non-conformance, corrective and preventive actions and any changes to procedures need to be communicated to employees or family members assisting with the maintenance of the aquaculture operation.

Approval of non-conformance report

Once the non-conformance report is completed, the report should be signed off by the manager/owner of the aquaculture operation. In the event of the report being completed by an employee, the report needs to be forwarded to the manager/owner who will either:

- Accept the report if corrective and preventive actions are suitable or
- Reject the report and request further investigation/action.

The report can then be placed on a Non-conformance Register for future reference.

Review of corrective and preventive action

Corrective and preventive actions should be monitored to ensure they are effective in preventing the non-conformance recurring. This involves re-addressing the corrective and preventive actions that have been highlighted in the Non-conformance Register to make sure they are still relevant to that particular aquaculture operation.

Responsibilities

Depending on the size of the operation, there are a number of people who have a responsibility to ensure the EMS is maintained for the aquaculture operation and any non-conformance events are reported and actioned. These may include:

All employees or family members: Responsible for identifying non-conformances and advising the supervisor.

Supervisor: Responsible for completing the Non-conformance report, investigating non-conformance, taking action to mitigate any impacts caused and for initiating and completing corrective and preventive actions.

Manager/Owner: Responsible for reviewing the Non-conformance report, discussing with the environmental management representative and accepting the report.

Owner/Operator: Responsible for the entire management and operation of the EMS for the farm.

Step 7: Management Review

Management shall review the Environmental Management System on a regular basis (at least once a year). The purpose of the review is to ensure the continuing suitability, adequacy and effectiveness of the system. The agenda of the Management Review will include:

- Review Environmental Policy: review the policy to ensure it reflects the needs of the business and any changes to industry policy
- Review environmental performance:
  - Results from audits
  - Progress against objectives and targets (environmental management program)
  - Non-conformance reports
  - Community complaints
  - EPA/PIRSA correspondence
  - SA Water correspondence
- Review and revise Environmental Aspects and Impacts Register based on environmental performance
- Environmental management system implementation: review the structure and content of the system documentation to ensure it reflects the environmental aspects of the business.

Legal Compliance

An important component of an EMS is demonstrating compliance with relevant legislation that may be applicable to any aquaculture venture.

The main piece of legislation that regulates aquaculture in South Australia is the *Aquaculture Act 2001* which is administered by PIRSA. All aquaculture operations require an aquaculture licence pursuant to the *Aquaculture Act 2001*. According to Section 59 of the *Aquaculture Act 2001*, any licence application or licence amendment must be endorsed by the EPA prior to being issued. When assessing applications and amendments, the EPA must have regard to the objects of the *Environment Protection Act 1993* and associated Environment Protection Policies, in particular the *Environment Protection (Water Quality) Policy 2003 (Water Quality Policy).* All aquaculture operations must ensure that activities associated with their operations comply with the relevant legislation at all times.

To monitor the impacts that may be associated with aquaculture activities, every aquaculture licence holder must undertake an annual Environmental Monitoring Program (EMP) as a requirement of their PIRSA Aquaculture licence conditions.

Results from monitoring programs will also assist with determining if aquaculture operation is complying with the objects of the *Aquaculture Act 2001* and the *Environment Protection Act 1993* and relevant Environment Protection Policies.

The implementation of an EMS may assist aquaculture operations to comply with relevant legislation. The EMP required by PIRSA may also be incorporated into the EMS as a demonstration of compliance.

It is important to note that while an Environmental Management System (EMS) is voluntary, an Environmental Monitoring Program (EMP) is mandatory and is a requirement of every aquaculture licence. Results from an EMP must be submitted to PIRSA on an annual basis and failure to do so is a breech of licence condition.

It should be noted that some licensees may be required to undertake additional monitoring which will be specified on their PIRSA Aquaculture Licence. Licensees should check their licence to see if additional monitoring applies to their operation. Results from the additional monitoring will need to be submitted as part of the Licensee's environmental monitoring program.

Information on PIRSA environmental monitoring requirements can be found on the PIRSA website: www.pir.sa.gov.au/aquaculture or can be obtained by telephoning PIRSA Aquaculture on (08) 8226 0314.

References

AS/NZS ISO14001:1996 – Environmental management systems: Specification with guidance for use, Standards Australia

AS/NZS 4801:1999 – Risk Management, Standards Australia

HB 203:2000 Environmental risk management – Principles and process, Standards Australia

Examples of EMS for Inland Aquaculture Operations

The following section demonstrates how an EMS can be developed for inland aquaculture. Two examples are provided these being:

1) An EMS for a 50 tonne capacity recirculating aquaculture facility farming barramundi.

2) An EMS for a small operation farming yabbies in ponds.

It should be noted the EMS example provided is by no means complete and a fully operational EMS will require additional information.

Example 1: EMS for a 50 tonne capacity recirculating aquaculture facility farming Barramundi

Step 1: Environment Policy for ACME Fish Pty Ltd

ACME Fish Pty Ltd is a medium sized barramundi farm producing 50 tonnes of live fish per year using a Recirculating Aquaculture System (RAS).

The company is committed to managing its operations in an environmentally responsible manner at all times by implementing an Environmental Management System (EMS).

As such, ACME Fish Pty Ltd specifically commits to:

- Prevent and minimise pollution where possible and mitigate environmental impacts, property damage and process loss
- Set, monitor and review environmental objectives and targets through the implementation of an environmental action plan
- Use the waste management hierarchy to strive towards best practice industry standards
- Set reduction targets for energy consumption and waste production
- Operate a monitoring plan as part of the environmental management system (EMS)
- Review, upgrade and improve the environmental management system (EMS) to continually improve our environmental performance
- Commit to the requirements of the *Environment Protection Act 1993*, the *Environment Protection (Water Quality) Policy 2003* and other relevant Environment Protection Policies
- Comply with licence conditions as determined by the PIRSA Licence FT12345 including the undertaking of an environmental monitoring program (EMP)
- Comply with the requirements of the *Aquaculture Act 2001*.

Signed: Lates Calcarifer

Position: Manager/Owner

Date: 12/03/2004

Step 2: Aspect and Impact Register of ACME Fish Pty Ltd

Activity (see Figure 1 on page 25)	**Aspect (Output)– (see Figure 1 on page 25)**	**Impact – (see Appendix B)**
Pumping Water	Electrical Energy	CO2 to atmosphere – Global warming
	Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)
	Generation of heat	Heating up the environment
	Used Filters, flanges, old parts	Rain washes pollutants into environment
	Waste Lubricants	Soil Contamination
		Water Contamination
Storing Diesel	Fuel spillage	Soil Contamination
		Water Contamination
	Odour	Nuisance to workers, visitors and neighbours
Operating Diesel Generator	Air Emissions	Global Warming
		Human Health
	Fuel spillage	Damage to eco system
	Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)
	Heat	Heating up the environment
Disposal of dead fish	Odour	Nuisance to workers, visitors and neighbours
	Flies	Nuisance to workers, visitors and neighbours health risk
	Feral Animals	Negative impact on bio-diversity
Water filtration	Odour	Nuisance to workers, visitors and neighbours
	Generation of wastewater	Negative impact on nearby waters (both surface and groundwater)
Feeding	Nutrient buildup in waste and wastewater	Negative impact on nearby waters (both surface and groundwater)
**Note this table does not represent the complete register and is only shown for demonstration purposes.*		

Risk Assessment

Organisation: **ACME Fish Pty Ltd**

Date of risk assessment: **30 May 2004**

Risk assessment participants: **Fred Bloggs (Supervisor)**
Lates Calcarifer (Manager/Owner)

1: Activity, product, service See Figure 1 on page 25	2: Environmental aspect See Figure 1 on page 25	3: Environmental impact Appendix B	4: Consequence ranking	5: Likelihood ranking	6: Risk ranking (Step 4 x Step 5)	7: Priority
Pumping Water	Electrical Energy	CO_2 to atmosphere – Global warming	3	1	3 (Low Risk)	5
	Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)	1	4	4 (Low Risk)	4
	Generation of heat	Heating up the environment	3	1	3 (Low Risk)	5
	Used Filters, flanges, old parts	Rain washes pollutants into environment including stormwater	2	4	8 (Moderate Risk)	2
Storing Diesel	Fuel spillage	Soil Contamination	2	4	8 (Moderate Risk)	2
		Water Contamination	2	4	8 (Moderate Risk)	2
	Odour	Nuisance to workers, visitors and neighbours	1	4	4 (Low Risk)	4

Operating Diesel Generator	Air Emissions	Global Warming	3	1	3 (Low Risk)	5
	Fuel Spillage	Contamination of Water/Land	2	5	10 (Moderate Risk)	1
	Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)	2	5	10 (Moderate Risk)	1
	Heat	Heating up the environment	3	1	3 (Low Risk)	5
Disposal of dead fish	Odour	Nuisance to workers, visitors and neighbours	2	5	10 (Moderate Risk)	1
	Flies	Nuisance to workers, visitors and neighbours	2	5	10 (Moderate Risk)	1
	Feral Animals	Negative impact on bio-diversity	2	5	10 (Moderate Risk)	1
Water Filtration	Odour	Nuisance to workers, visitors and neighbours	1	5	5 (Low Risk)	3
	Generation of wastewater	Negative impact on nearby waters (both surface and groundwater)	2	5	10 (Moderate Risk)	1
Feeding	Nutrient buildup in waste and wastewater	Negative impact on nearby waters (both surface and groundwater)	2	5	10 (Moderate Risk)	1

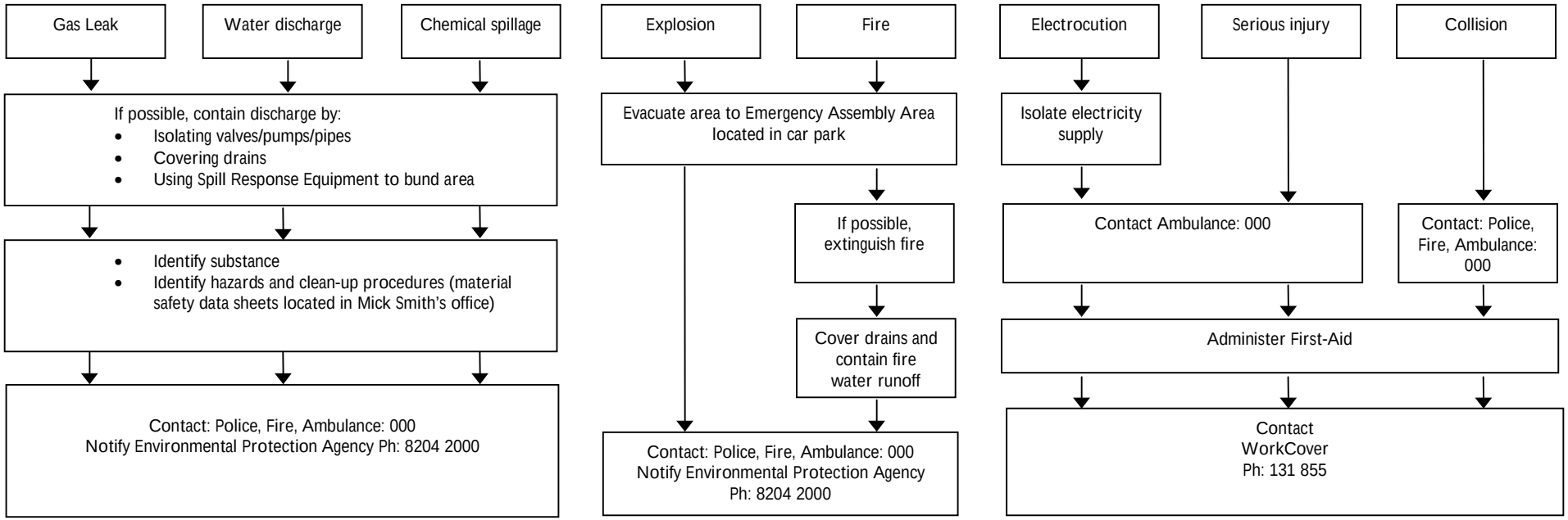
Reference: Business SA, *Small Business Environmental Solutions*, 2002

Step 3:Develop Management Plan (management plan with defined responsibilities).

Impact		Risk Ranking	Action	Responsibility	Timeline	Date Finalised	Action Details
Pumping Water							
Electrical Energy	CO2 to atmosphere – Global warming	3 Low Risk	Design and implement energy management system. A target of 10% energy reduction within 12 month has been set	Fred	August 2004		Fred will require some specialist assistance in this area
Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)	4 Low Risk	Investigate noise abatement methods	Fred	August 2005		Sound-proof the pump room.
Generation of heat	Heating up the environment	3 Low Risk	Utilise the waste heat of the pumps to increase the water temp of the fish tanks	Lates	March 2005		The viability of a heat exchanger
Used Filters, flanges, old parts	Rain washes pollutants into environment	8 Moderate Risk	Dispose of used parts using appropriate waste disposal	Lates	Ongoing		
Storing Diesel							
Fuel spillage	Soil Contamination	8 Moderate Risk	Install appropriate bund for fuel storage vessel	Lates	July 04		Obtain fact sheet on bunding structured from EPA website
	Water Contamination	8 Moderate Risk	Install appropriate bund for fuel storage vessel	Lates	July 04		Obtain fact sheet on bunding structured from EPA website
Odour	Nuisance to workers, visitors and neighbours	4 Low Risk	Ensure that storage vessel is correctly sealed to prevent vapour escape	Fred	July 04		

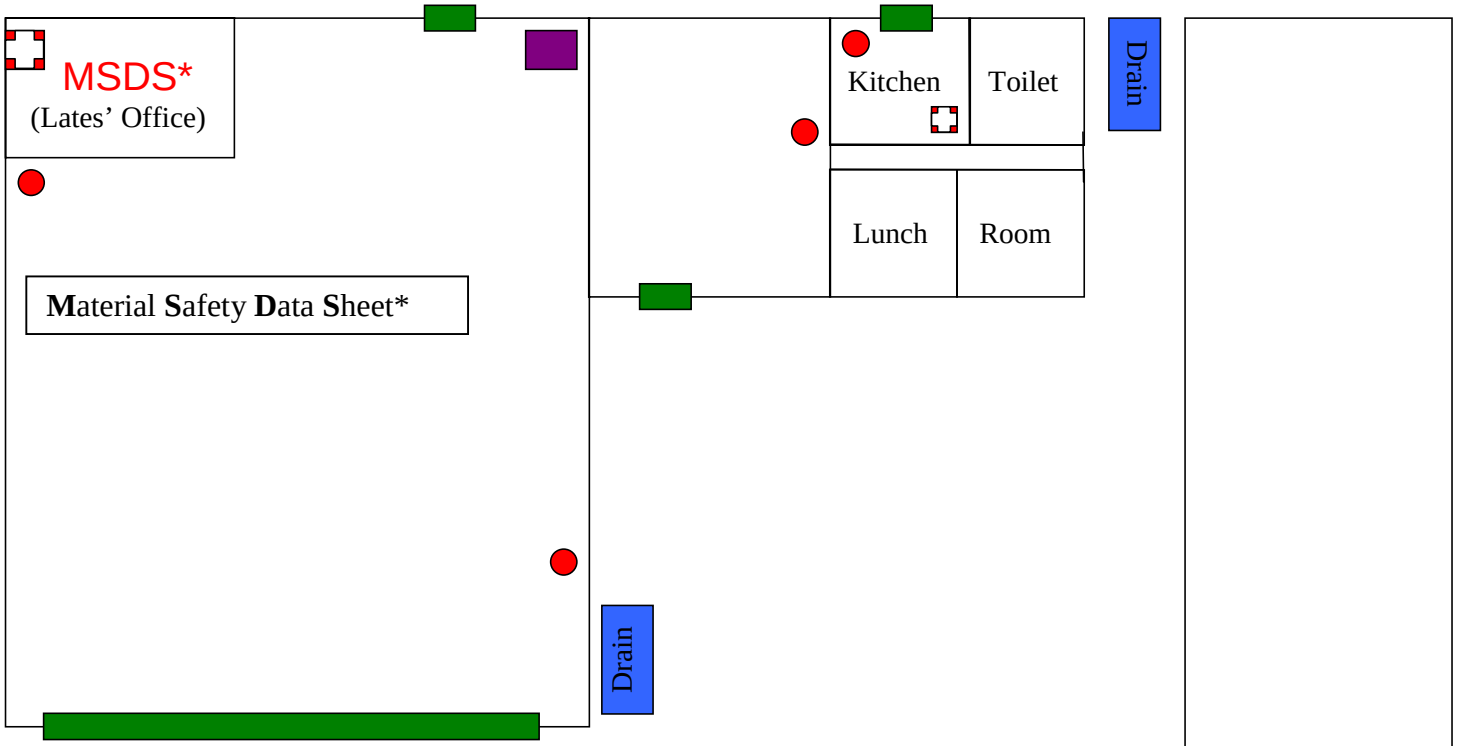
Operating Diesel Generator							
Air Emissions	Global Warming	3 Low Risk	Ensure that generator is regularly maintained to ensure efficient operation	Lates	July 04		Check with maintenance manual of generator
Fuel Spillage	Contamination of water and land	10 Moderate Risk	Ensure that fuel lines and other equipment is in good working condition	Fred	July 04		
Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)	10 Moderate Risk	Install noise abatement structures if required	Fred	July 04		If noise is an issue have the noise level measured using correct equipment
Heat	Heating up the environment	3 Low Risk	Minimise the use of the generator.				
Disposal of dead fish							
Odour	Nuisance to workers, visitors and neighbours	10 Moderate Risk	If mortality rate is consistently high, investigate commercial composting methods	Lates	August 05		Investigate use of commercial composting equipment
Flies	Nuisance to workers, visitors and neighbours	10 Moderate Risk	If mortality rate is consistently high, investigate commercial composting methods	Lates	August 05		Investigate use of commercial composting equipment
Feral animals	Negative impact on bio diversity	10 Moderate Risk					
Water Filtration							
Odour	Nuisance to workers, visitors and neighbours	5 Low Risk	Clean filters regularly and dispose of waste appropriately	Lates	Ongoing		
Generation of Wastewater	Negative impact on nearby waters (both surface and groundwater)	10 Moderate Risk	Dispose of waste appropriately and investigate methods for reusing/recycling wastewater	Lates	Ongoing		
Feeding	Nutrient buildup in waste and wastewater	10 Moderate Risk	Optimise feeding regime	Lates	July 04		Liaise with feed manufacturer

Step 4: Inland Aquaculture Emergency Procedure



- All employees will be notified of the emergency procedure/in the induction.
- Alarm systems shall be used to notify employees of an emergency and will be activated by the supervisor once an emergency that requires evacuation has been reported.
- The alarm system will be tested in February, April, June, August, October and December to test alarm and allow staff to recognise the alarm.
- All staff will be trained in the use of fire extinguishers on an annual basis.
- Emergency response drills will be undertaken randomly, as determined by the supervisor.

Site plan



A site plan is used to display the physical locations of items important in an emergency. The site plan should be displayed in prominent locations such as the office, lunchroom and near the chemical storage area.

Step 5: Monitoring plan to measure the grower's environmental performance

ACTION	FREQUENCY	METHOD	LIMIT	JAN	FEB	MAR	APR	MAY	JUN	JUL
PLANNING										
Identify and review aspects and impacts	Annually (change is scope or change in leg)	Risk assessment procedure	N/A							
Develop action plan	Annually	In consultation with other employees	N/A							
Review action plan	Monthly	Lates and Fred	N/A							
IMPLEMENTATION AND OPERATION										
Review and revise procedures	1 per month	Fred	N/A							
Test alarm	Monthly	Emergency response procedure	N/A							
Emergency response drill	6 monthly	Emergency response procedure	N/A							
MONITORING										
Volume of freshwater	Continuous	Automatic system	6 – 9							
Volume of waste water	Continuous	Automatic system	15l/sec							
Noise	Yearly	Noise monitor from 5:00am to 7:00pm	75 dBA							
CHECKING AND CORRECTIVE ACTION										
Review outstanding non-conformances and follow-up	Monthly	Non-conformance procedure	N/A							
MANAGEMENT REVIEW										
Undertake management review	Annually	Management review procedure	N/A							

Note: This table contains only 6 months of data.

Step 6:Non- Conformance Reporting

Details of non-conformance	Number:	0012

Date: 12 March 04 Time: 3:30 pm

Location: On Farm

Details of non-conformance: A small amount of Diesel fuel has leaked out of the storage tank and seeped into the ground

What happened: The tank has been ruptured by a forklift while unloading fish pellets

What contributed to non-conformance: The tank has no mechanical protection and there is no bunding to collect any spillage

Have any third parties been notified? No

Qty (if release into enviroment): Approximately 5 litres

Potential Impacts: If the spill would have been major, the fuel could have entered the nearby creek and contaminated the waterway

Corrective action

Actions undertaken to manage non-conformance: All the contaminated soil has been removed and stored in a drum for safe disposal by an appropriate waste contractor. The tank has been replaced.

Date: 12 March 04

By whom: Lates Calcarifer

Signature:

Preventive action

Actions undertaken to prevent non-conformance recurring: All delivery drivers are informed of the location of the tank. A sign has been placed to alert drivers regrading the position of the tank. A bollard has been erected to protect the tank. A bund is on order to contain any future spills.

Date: 23 April 04

By Whom: Lates Calcarifer

Signature:

Review by: Monica Calcarifer Accepted: Yes / ~~No~~

Signature: Date: 23/4/04

Comments: All reasonable measures have been taken to protect the tank

Step7: Management Review

Organisation: ***ACME Fish Pty Ltd*** **Date of management review:** **June 04**
Participants: ***Lates Calcarifer*** **Position : Owner**

Agenda	Comments	Action	Responsibility	Timeline
Review Environmental policy Is it relevant to the business? Are changes required?	The policy is new and needs to be reviewed regularly	Review the policy in six months time	Lates	January 05
Review environmental performance Results from audits Progress against objectives and targets (Environmental management program) Non-conformance reports Community complaints EPA/PIRSA correspondence SA Water correspondence	The business has been operating more efficiently since the EMS has been introduced. One non-conformance has been logged and will be investigated. There has been no correspondence from the government	Investigate non-conformance and implement corrective action	Lates	September 04
Review Environmental Aspects and Impacts Register Does the register capture the issues identified as part of the review of the company's environmental performance?	The Aspect and Impact Register has just been completed	Update the register in six months time	Lates	December 04
Environmental Management System implementation. Are the procedures relevant to the business? Are changes required?	So far the implementation of the EMS has had a positive impact on the business	Maintain the efforts to improve the EMS in the coming years	All	N/A

Example 2: EMS for a small Yabbie farm

Step 1: Environment Policy for YABBIE Pty Ltd

YABBIE Pty Ltd is a family run small sized yabbie farm producing under one tonne of live yabbies per year using ponds.

The operation is committed to managing its operations in an environmentally responsible manner at all times by implementing an environmental management system.

As such, YABBIE Pty Ltd specifically commits to:

- Prevent and minimise pollution where possible and mitigate environmental impacts, property damage and process loss
- Set, monitor and review environmental objectives and targets through the implementation of an environmental action plan
- Use the waste management hierarchy to strive towards best practice industry standards
- Minimise the use of energy, and the production of solid and liquid waste by a percentage set in the action plan
- Operate a monitoring plan as part of the environmental management system (EMS)
- Review, upgrade and improve the environmental management system (EMS) in order to continually improve our environmental performance
- Comply with all applicable environmental laws, regulations and standards pertaining to the inland aquaculture activities
- Commit to the requirements of the *Environment Protection Act 1993*, the *Environment Protection (Water Quality) Policy 2003* and other relevant Environment Protection Policies
- Comply with licence conditions as determined by the PIRSA Licence FT12345 including the undertaking of an environmental monitoring program (EMP)
- Comply with the requirements of the *Aquaculture Act 2001*.

Signed: Cherax

Position: Owner/Operator

Date: 12/03/2004

Step 2: Aspect and Impact Register of YABBIE Pty Ltd

Activity – Blue Box	Aspect – Purple	Impact – Appendix X
Pumping Water	Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)
	Generation of heat	Heating up the environment
	Used Filters, flanges, old parts	Rain washes pollutants into environment
Storing Fuel for pumps	Fuel spillage	Soil Contamination
		Water Contamination
	Odour	Nuisance to workers, visitors and neighbours
Disposal of dead yabbies	Odour	Nuisance to workers, visitors and neighbours
	Flies	Nuisance to workers, visitors and neighbours health risk
Feeding	Increased nutrient load in water	Potential water contamination
Disposal of Wastewater	Nutrient load in water	Potential water contamination
**Note this table does not represent the complete register and is only shown for demonstration purposes.*		

Risk Assessment

Organisation: Yabbie Pty Ltd

Date of risk assessment: 12 May 2004

Risk assessment participants: Cherax Destructor

1: Activity, product, service Blue Box	2: Environmental aspect Purple Arrows	3: Environmental impact Appendix B	4: Consequence	5: Likelihood ranking	6: Risk ranking (Step 4 x Step 5)	7: Priority
Pumping Water	Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)	1	4	4 (Low Risk)	4
	Generation of heat	Heating up the environment	3	1	3 (Low Risk)	3
	Used Filters, flanges, old parts	Rain washes pollutants into environment including stormwater	2	4	8 (Moderate Risk)	2
Storing Fuel for Pumps	Fuel spillage	Soil Contamination	2	4	8 (Moderate Risk)	2
		Water Contamination	2	4	8 (Moderate Risk)	2
	Odour	Nuisance to workers, visitors and neighbours	2	4	8 (Moderate Risk)	2
Disposal of dead yabbies	Odour	Nuisance to workers, visitors and neighbours	1	2	2 (Low Risk)	5
	Flies	Nuisance to workers, visitors and neighbours	1	2	2 (Low Risk)	5
Feeding	Nutrient buildup in waste and wastewater	Negative impact on nearby waters (both surface and groundwater)	2	5	10 (Moderate risk)	1
Disposal of Wastewater	Nutrient load in water	Potential water contamination	2	5	10 (Moderate risk)	1

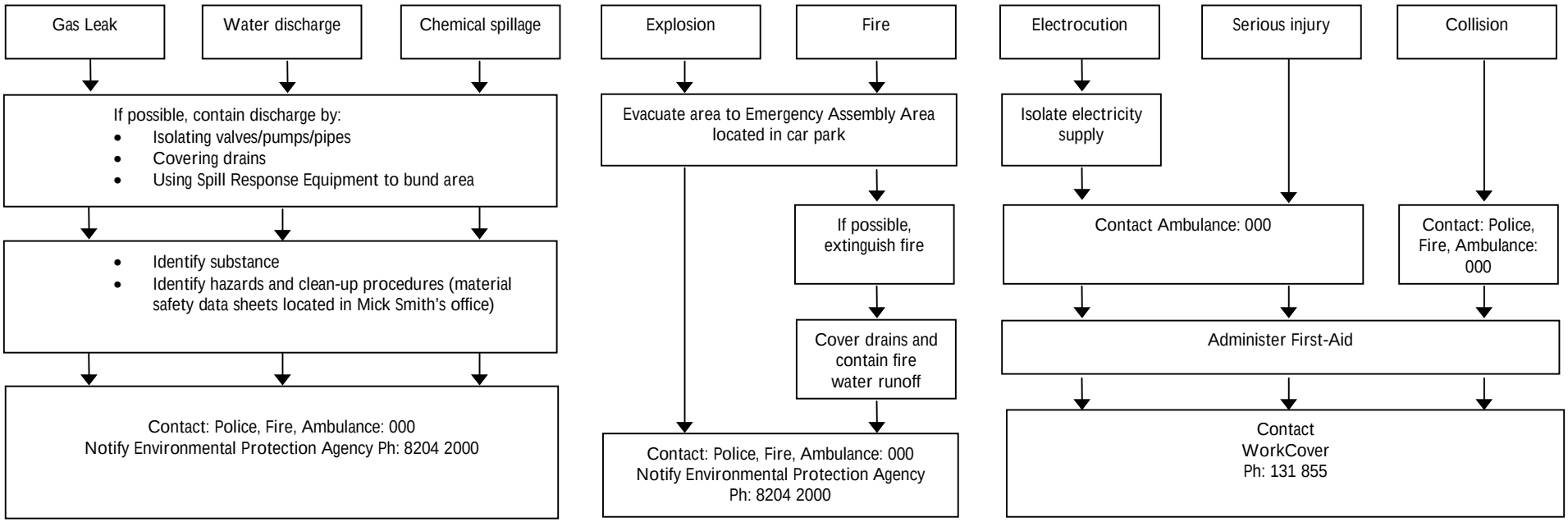
Reference: Business SA, *Small Business Environmental Solutions*, 2002

Step 3:Develop Management Plan (management plan with defined responsibilities).

Impact		*Risk Ranking*	*Action*	*Responsibility*	*Timeline*	*Date Finalised*	**Action Details**
Pumping Water							
Noise	Nuisance to workers, visitors and neighbours (may exceed legal limits)	4 Low Risk	Investigate noise abatement methods.	Cherax	August 2005		Operate pumps at appropriate times
Generation of heat	Heating up the environment	3 Low Risk	Minimal heat generated from the pump	Cherax			
Used Filters, flanges, old parts	Rain washes pollutants into environment	8 Moderate Risk	Dispose of used parts using appropriate waste disposal	Cherax	ongoing		
Storing Fuel for Pumps							
Fuel spillage	Soil Contamination	8 Moderate Risk	Install appropriate bund for fuel storage vessel	Cherax	July 04		Obtain fact sheet on bunding structure from EPA
	Water Contamination	8 Moderate Risk	Install appropriate bund for fuel storage vessel	Cherax	July 04		Obtain fact sheet on bunding structure from EPA
Odour	Nuisance to workers, visitors and neighbours	8 Moderate Risk	Ensure that storage vessel is correctly sealed to prevent vapour escape	Cherax	July 04		
Disposal of dead Yabbies							
Odour	Nuisance to workers, visitors and neighbours	2 Low Risk	Leave morts in ponds for other yabbies to consume	Cherax	August 05		Investigate use of commercial composting equipment

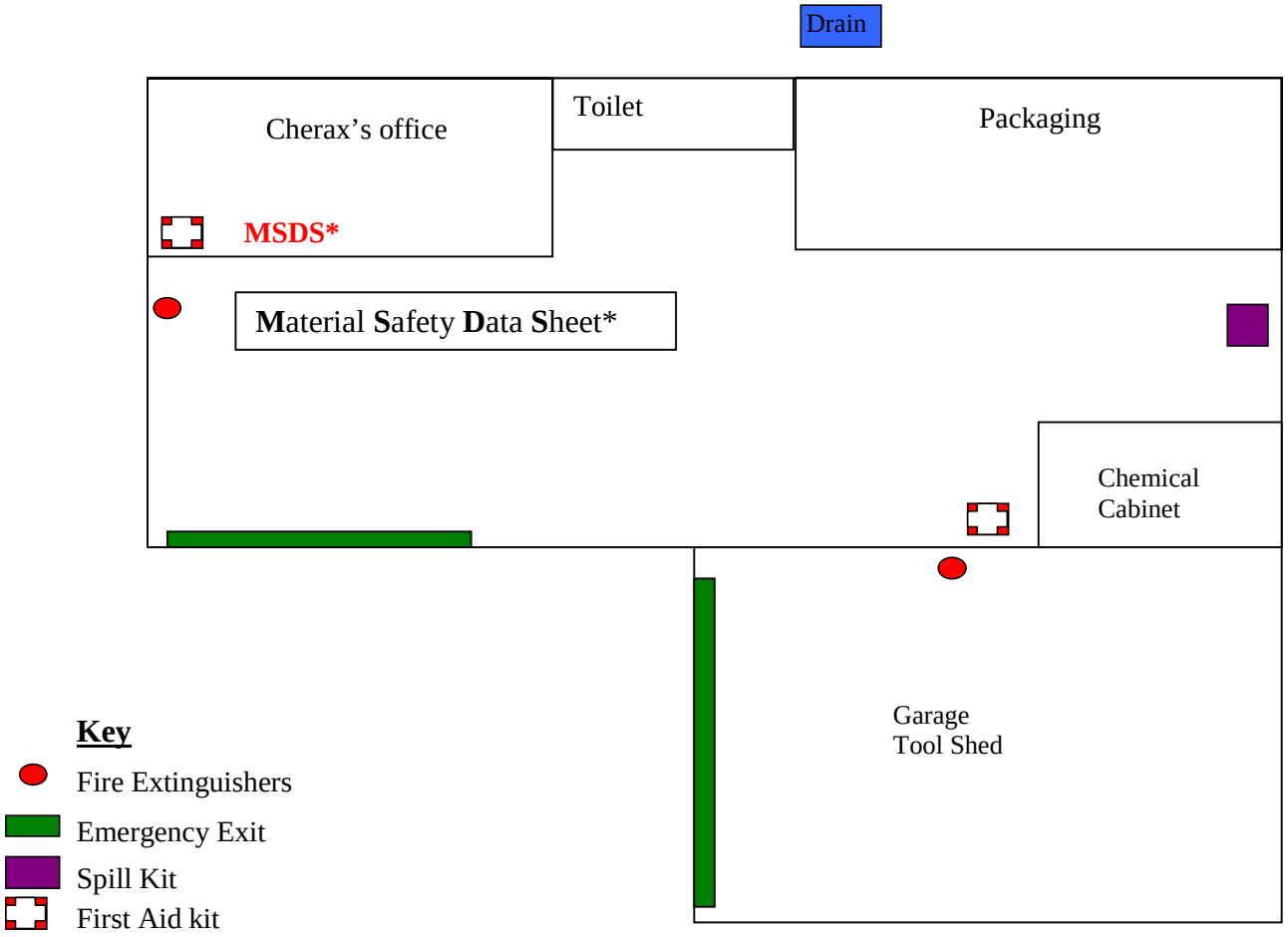
Flies	Nuisance to workers, visitors and neighbours Risk to human health	2 Low Risk	Leave morts in ponds for other yabbies to consume	Cherax	August 05		Investigate use of commercial composting equipment
Feeding							
Nutrient Buildup in waste and wastewater	Negative impact on nearby waters (both surface and groundwater)	10 Moderate Risk	Optimise feeding regime	Cherax	July 04		Liaise with feed manufacturer if required
Disposal of Wastewater							
Sediment of non consumed food	Nutrient load in solid waste	10 Moderate Risk	Investigate opportunities for recycling/reusing water (eg: on crops)	Cherax	July 04		

Step 4:Inland Aquaculture Emergency Procedure



- All employees will be notified of the emergency procedure/in the induction.
- Alarm systems shall be used to notify employees of an emergency and will be activated by the supervisor once an emergency that requires evacuation has been reported.
- The alarm system will be tested in February, April, June, August, October and December to test alarm and allow staff to recognise the alarm.
- All staff will be trained in the use of fire extinguishers on an annual basis.
- Emergency response drills will be undertaken randomly, as determined by the supervisor.

Site Plan



A site plan is used to display the physical locations of items important in an emergency. The site plan should be displayed in prominent locations such as the office, lunchroom and near the chemical storage area.

Step 5:Monitoring plan to measure the farmer's environmental performance

ACTION	FREQUENCY	METHOD	LIMIT	JAN	FEB	MAR	APR	MAY	JUN	JUL
PLANNING										
Identify and review aspects and impacts	Annually (change is scope or change in leg)	Risk assessment procedure	N/A							
Develop action plan	Annually	Cherax	N/A							
Review action plan	Biannually	Cherax	N/A							
IMPLEMENTATION AND OPERATION										
Review and revise procedures	Biannually	Cherax	N/A							
MONITORING										
Volume of waste water	Continuous	Automatic system	nil							
Noise	Yearly	Noise monitor from 5:00am to 7:00pm	75 dBA							
CHECKING AND CORRECTIVE ACTION										
Review outstanding non-conformances and follow-up	Biannually	Non-conformance procedure	N/A							
MANAGEMENT REVIEW										
Undertake management review	Annually	Management review procedure	N/A							

Step 6:Non-Conformance Report

Details of non-conformance	Number:	002

Date: 11 July 04 Time: 11 am

Location: On Farm

Details of non-conformance: Nutrient rich feed has entered a nearby creek

What happened: A heavy rainfall has washed feed into a nearby Waterway

What contributed to non-conformance: The feed has not been stored in a safe manner and rain water was able to dissolve the feed and transport it into the creek.

Have any third parties been notified? No

Qty (if release into env): 15 kg

Potential Impacts: If more feed would have been stored in this manner, the creek environment could have been damaged by high nutrient load.

Corrective action

Actions undertaken to manage non-conformance: The feed has been washed away and recovery was not possible. Due to the small amount, no further action has been taken.

Date: 11 July 04

By whom: Cherax

Signature:

Preventive action

Actions undertaken to prevent non-conformance recurring: The feed is now stored in a safe and dry place away from the influence of the weather.

Date: 18 July 04

By Whom: Cherax Destructor

Signature:

Review by: Anna Destructor Accepted: Yes / ~~No~~

Signature: Date: 18/07/04

Comments: The new storage method also keeps the feed in better condition.

Step 7:Management Review

Organisation: **Yabbie Pty Ltd** **Date of management review:** **June 04**
Participants: ***Cherax*** ***Position Owner***

Agenda	**Comments**	**Action**	**Responsibility**	**Timeline**
Review *Environmental policy* Is it relevant to the business? Are changes required?	The policy is adequate for the operation	Review once every year	Cherax	December 04
Review environmental performance Results from audits Progress against objectives and targets (Environmental management program) Non-conformance reports Community complaints EPA /PIRSA correspondence SA Water correspondence	Some of the results from the audit have been surprising. One non-conformance has occurred and the corrective action has been put in place.	Continue to keep all aspects of the EMS up to date and increase the environmental performance of Yabbie Pty Ltd	Cherax	N/A
Review *Environmental aspects and impacts register* Does the register capture the issues identified as part of the review of the company's environmental performance?	The register will require further fine tuning in the coming years to optimise the benefits from the EMS	Review the aspect and impact register every six month over the next two years	Cherax	December 04
Environmental management system implementation Are the procedures relevant to the business? Are changes required?	We are happy with the outcomes of the EMS at this stage.	Maintain the effort in continually improving the environmental performance of Yabbie Pty Ltd	Cherax	N/A

Appendix A

Blank Templates

Please Print or Photocopy these blank templates to design an EMS in your own operation.

Risk Assessment Template

1: Activity, product, service	2: Environmental aspect	3: Environmental impact	4: Impact ranking	5: Likelihood ranking	6: Risk ranking (Step 4 x Step 5)	7: Priority

Environmental Action Plan Template

Impact	Risk ranking	Action	Responsibility	Timeline	Date finalised	Action details

Non-Conformance Template

Details of non-conformance	Number:	

Date: ..... Time: .....

Location: .....

Details of non-conformance: .....

What happened: .....

What contributed to non-conformance: .....

Have any third parties been notified? .....

Qty (if release into env): .....

Potential Impacts: .....

Corrective action

Actions undertaken to manage non-conformance: .....

Date: .....

By whom: .....

Signature: .....

Preventive action

Actions undertaken to prevent non-conformance recurring: .....

Date: .....

By Whom: .....

Signature: .....

Review by: ..... Accepted: Yes / No

Signature: ..... Date: .....

Comments: .....

Non conformance Register Template

Non-conformance number	Non-conformance details	Procedures revised / developed	Date raised	Date signed off

Management Review

Organisation: ..... **Date of management review:** _____
Participants: ***Name*** ***Position***

Agenda	**Comments**	**Action**	**Responsibility**	**Timeline**
Review *Environmental policy* Is it relevant to the business? Are changes required?				
Review environmental performance Results from audits Progress against objectives and targets (Environmental management program) Non-conformance reports Community complaints EPA/PIRSA correspondence SA Water correspondence				
Agenda	**Comments**	**Action**	**Responsibility**	**Timeline**
Review *Environmental aspects and impacts register* Does the register capture the issues identified as part of the review of the company's environmental performance?				
Environmental management system implementation Are the procedures relevant to the business? Are changes required?				

Appendix B

Sample Impacts And Solutions

Electricity Use (Aspect)

Impacts

- **To generate 1 Unit (kWh) of electrical energy, an average of 1 kg of carbon dioxide (CO2) is produced at coal and gas fired power stations**
- **CO2 is a principal greenhouse gas assisting in global climate change**
- **Fossil fuels such as gas and coal are non-renewable resources.**

Solutions

- **Involve everybody in the business in energy efficiency**
- **Set energy reduction targets**
- **Make energy efficiency a part of your decision making parameters**
- **Ask suppliers about more efficient energy solutions**
- **If warranted employ energy efficiency expert for analysis.**

Fuel leak (Aspect)

Impacts

- **Clean up cost**
- **Fines (if storage is non compliant)**
- **Contamination of ground water**
- **Bad relationship to neighbours**
- **Negative impact on brand name**
- **Negative impact on industry sector**
- **Soil contamination**
- **Fuel is poisonous to the environment.**

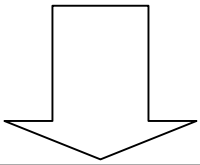
Solutions

- **Install a good quality storage vessel**
- **Check vessel on regular basis (include in monitoring program)**
- **Install a physical bund**
- **Install the storage vessel under cover.**

Solid Waste (Aspect)

Impacts

- **Waste creates odour that upsets neighbours**
- **Is unsightly and will turn customers off products**
- **Waste is paid for twice. Once when purchasing the waste then on disposal**
- **Less waste means more efficient process**
- **Problems with disposal**
- **Waste contains nutrient and other pollutants that can enter the surrounding environment.**



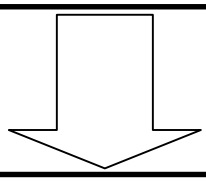
Solutions

- **Set waste reduction targets**
- **Follow the waste management hierarchy of:**
  - **avoid the production of waste**
  - **reusing waste**
  - **minimising, as far as reasonably practicable, the production of waste**
  - **recycling waste**
  - **recovering part of waste for re-use**
  - **treating waste to reduce potentially degrading impacts**
  - **disposing of waste in an environmentally responsible manner.**

Liquid Waste (Aspect)

Impacts

- **Fines if not conforming to legislation**
- **Liquid waste in the environment can infiltrate into ground water and make the aquifer unusable**
- **Neighbours are discontent**
- **Bad publicity for industry sector**
- **Ground water contamination**
- **Surface water contamination**
- **Algal blooms**
- **Death of aquatic organisms**
- **Long term negative environmental impact**
- **Waste is a measure of efficiency, less waste more efficient**
- **Clean up costs can be significant.**



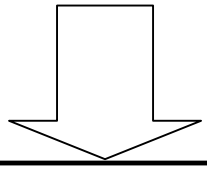
Solutions

- **Implement sound waste water management plan**
- **Optimise feeding to avoid high nutrient load of waste water**
- **Employ waste management hierarchy of:**
  - **avoid the production of waste water**
  - **reusing waste water**
  - **minimising, as far as reasonably practicable, the production of waste water**
  - **recycling waste water**
  - **recovering part of waste water for re-use**
  - **treating waste water to reduce potentially degrading impacts**
  - **disposing of wastewater in an environmentally responsible manner.**

Noise Pollution (Aspect)

Impacts

- **Noise has very high annoyance potential. This can lead to bad neighbour relationships and a negative image of the entire industry**
- **Fines if noise is outside allowable level**
- **Abatement cost**
- **Noise is a pollutant. Negative impact on human and animal well being.**



Solutions

- **Conduct a noise audit if noise levels are perceived to be to high**
- **Relocate source of noise if possible**
- **Restrict noisy activity to day time only**
- **Install noise abatement measures.**