Guidelines for waste management with special focus on areas with limited infrastructure

Report No. 413, rev1.1

September 2008 (updated March 2009)

International Association of Oil & Gas Producers

OGP

Publications

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Document revisions

1.1 Clarification as to withdrawn status of report 196 in Executive Summary

1.0 Initial release

Executive summary

Management of waste is an integral part of responsible oil and gas exploration and production activities throughout the world. Good waste management can be especially challenging in areas where supporting infrastructure or regulatory frameworks are not well developed or absent.

This document provides fundamental guidance on waste management in exploration and production (E&P) operations. It is based on an earlier (1993) OGP publication on waste management (OGP report number 196, now withdrawn) – a publication which is still relevant on many issues – this document particularly departs from it by focusing on managing waste in areas where there is little or no supporting infrastructure or where regulatory frameworks are developing. Operators in countries with limited infrastructure can be confronted with costly waste management options, especially if they are not taken into account until the later stages of field development or production.

This document emphasises and provides guidance on principles and practices of effective waste management, as well as information on waste streams and technologies typically applicable in E&P operations. At the same time, users of this document should recognise that site-specific conditions may limit the applicability of any guidance offered in this document. Practices discussed include:

- Taking a 'life cycle approach' to waste management in oil and gas projects and incorporating a systematic waste management planning framework. Using this approach, waste management considerations can be taken into account at the early stages of a project.

  Many companies now have management tools to communicate expectations and provide consistency in implementing common management practices. A brief overview of a project management tool developed by OGP called e-SHRIMP (Environmental, Social, Health and Risk Impact Management Process) is provided. e-SHRIMP describes for each phase of an E&P project a number of discrete steps that have the potential to lead to improved project delivery.
- ***Applying a hierarchy of pollution prevention elements to attempt to reduce waste production:*** Principles of the waste management hierarchy are provided and examples of reduction at source, reuse, recycling/recovery and residue treatment are discussed. Also included is a list of potentially higher risk wastes which operators should consider avoiding.
- ***Applying a risk-based approach to waste management:*** An example of a general framework for risk-based decision making is outlined which can be applied to a range of waste management activities.
- ***Evaluating existing waste management capacity early and use a risk-based approach:*** This includes evaluating available facilities and identifying gaps. A list of considerations is provided for assessing third party sites for potential use.
- ***Collecting, segregating, storing and transferring waste in a way that reduces risk of escape to the environment:*** Some practical guidance is included for this aspect of waste management. Appropriate methods for subsequent treatment and disposal are provided in Appendices 4 and 5, along with some key factors to consider when choosing a specific option.
- ***Taking into account critical site-specific environmental characteristics, regulatory environment, logistical challenges and community outreach:*** Due to the potential lack of infrastructure at oil and gas operations in developing areas, it may be necessary to make arrangements for waste management facilities to be constructed. Information on how to evaluate a location for a new waste site includes preliminary reconnaissance, detailed field studies and the development of a community outreach strategy. Community support is a key consideration in the development of a new waste management facility.
- ***Considering waste measurements and performance reporting as valuable tools to evaluate environmental performance and to help others understand our industry:*** Appropriate environmental performance indicators will take into consideration key drivers, coordination in planning and timeline for data collection, and good practices leading to a more proactive approach to use of information.

In addition, the guideline's appendices contain:

- A list of specialised OGP publications that supplement these guidelines.
- The e-SHRIMP toolbox.
- An example waste tracking form.
- An overview of the E&P process.
- Examples of waste treatment and disposal methods.
- A list of waste types common to E&P operations.
- A table of waste management options and waste definitions.
- Synopsis of conventions and treaties that may be applicable in managing waste.

This document is based on the lessons learned and experiences of OGP members. It came about after a number of these members, with extensive knowledge of the issue, formed the Waste Management Task Force in 2004 to tackle the challenge of managing upstream wastes, especially in countries with little or no infrastructure. This group drew their experiences together to create this document. It is hoped that the Guidelines will assist E&P Operators in further developing their waste management practices to improve the protection of the environment, the workforce and the local communities within which we work.

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1 Introduction

Waste management is an integral component of oil & gas exploration & production. The principal benefits of sound management include avoidance of impacts on human health and the environment. Proper waste management may bring additional benefits in terms of reducing operational and capital expenditures, reducing reputation risk, and reducing financial and legal liability.

Oil & gas activities are continually expanding to new areas. Frequently, these have a poorly developed waste management and regulatory infrastructure. As part of its mission to promote best practice sharing amongst its members and in the wider upstream industry, OGP has produced this waste management guidance publication with a particular focus on these areas. This publication builds on an earlier more general waste management document (OGP, 1993) by including current thinking and providing a context for these developments.

Waste is defined in a number of ways; by regulatory background and company approach. The term is frequently qualified with adjectives such as 'special', 'harmful', 'hazardous' or 'non-hazardous', but these qualifiers have no universal understanding such that they can be adopted in the context of this publication. For the purpose of this publication, waste is defined as 'any material that is surplus to requirement' and 'management' comprises E&P project definition, selection of technology, design of facilities, waste collection, storage, transport, treatment and disposal. In using the preceding waste definition, it is recognised that a waste material in these terms may in fact be a raw material or a material that is reusable in another context.

Waste can be of particular concern when it poses a threat to human health and the environment. Waste can also have aesthetic impacts by creating a visual disturbance and/or odours that may affect people who live or work near treatment and disposal sites. Finally, the production of waste can represent the unproductive consumption of a natural resource: it is unwanted by the producer.

Specific issues related to waste are not experienced uniformly. Rather, they tend to be governed by the type of activity or operation and the local/regional conditions. Issues depend, for example, on the sensitivities associated with the local physical environment and the nature of the environment itself. Similarly, waste becomes an issue where there are insufficient facilities to treat and dispose of it responsibly, or where resources, *eg* materials or sites for landfill, are scarce. This means that any solutions to waste issues are unlikely to be consistent in scope, but must be flexible in order to allow adaptation to the particular set of conditions faced.

There are sound business arguments in favour of managing waste effectively. The improper treatment and disposal of waste can place a significant cost burden on the company when remedial action is later found to be necessary. Poor management of waste may also potentially increases the risk of local complaints, public health risks, regulatory authority enforcement (including fines) and prosecutions or other administrative action. Bad publicity due to poor waste management practices (or perceived poor practices) can also cause longer-term damage to an organisation's reputation. This may manifest itself in opposition from local communities, scrutiny by regulators and governments' unwillingness to do business with the organisation. Failure to manage waste effectively, therefore, may not only be potentially detrimental to human health and the environment, but may also increase financial costs and the risk of reputation damage.

Properly managed E&P wastes are unlikely to pose significant threats to human health and the environment. However, it is recognised that E&P operations including waste management take place in a wide variety of settings. Responses to specific issues related to waste management may not be handled uniformly due to site-specific conditions.

Thorough assessment of waste issues in the early phases of a project life cycle can enable a wider range of more effective and less costly waste management alternatives compared with those that are available later in the life cycle. Good management of waste from point of generation through its ultimate disposition should decrease the potential risk of adverse impacts to people and the environment, company reputation and financial aspects.

This publication does not address in detail gaseous wastes, produced water, drilling fluids and cuttings, or materials that contain naturally occurring radioactive material (NORM). More detail on these classes of material is addressed in specific reports published by OGP (see Appendix 1).

2 Waste management across the oil & gas life cycle

There are many potential business drivers that direct approaches to waste management. The importance of these will depend on local context and operator policies and objectives. These include corporate responsibility, regulatory and legal compliance reputation, cost saving, risk reduction and being a good neighbour.

Oil and gas projects have a number of discrete phases, starting with a business case evaluation through project design, construction, commissioning, operations and final closure. Given that sound waste management is a prerequisite of responsible social and environmental performance, cost control and reputation management, it should be addressed at all stages of project development.

In 2007, OGP developed a project management tool called *e-SHRIMP* (Environmental, Social, Health and Risk Impact Management Process). This system describes a number of factors for each phase of an E&P project:

- Stakeholder participation.
- Risks, opportunities and assessment.
- HSE management plans.

Project delivery may be improved if such HSE Management Plans are developed in a timely manner.

The e-SHRIMP tool box (outlined in Figure 1) provides lists of questions that help to frame the different stages and accumulate a body of information that can be carried through the entire lifecycle of E&P operations. A key element of the e-SHRIMP framework is starting early.

The key oil and gas life-cycle phases identified in e-SHRIMP and the role of stakeholders in the process (those responsible for the project, those who influence or are influenced by the project) are given below. These stakeholders may include concept and project engineers, HSE staff, contractors, regulators, local community and on a case-by-case basis, international and local non-governmental organisations (NGOs).

Business Case Evaluation

At this stage, high level waste management issues are identified that may influence project viability in terms of capital and operational expenditure and community relations. These may relate to, for example, transport, local waste infrastructure or regulatory constraints. Such issues usually result from special characteristics of the effluent produced, *eg* sour gas or gas or condensates containing mercury which may lead to waste generation, together with limited local waste infrastructures or export routes. It is crucial to identify such issues as soon as possible, as they may influence the process selected and therefore the economics of the project.

Identify and appraise

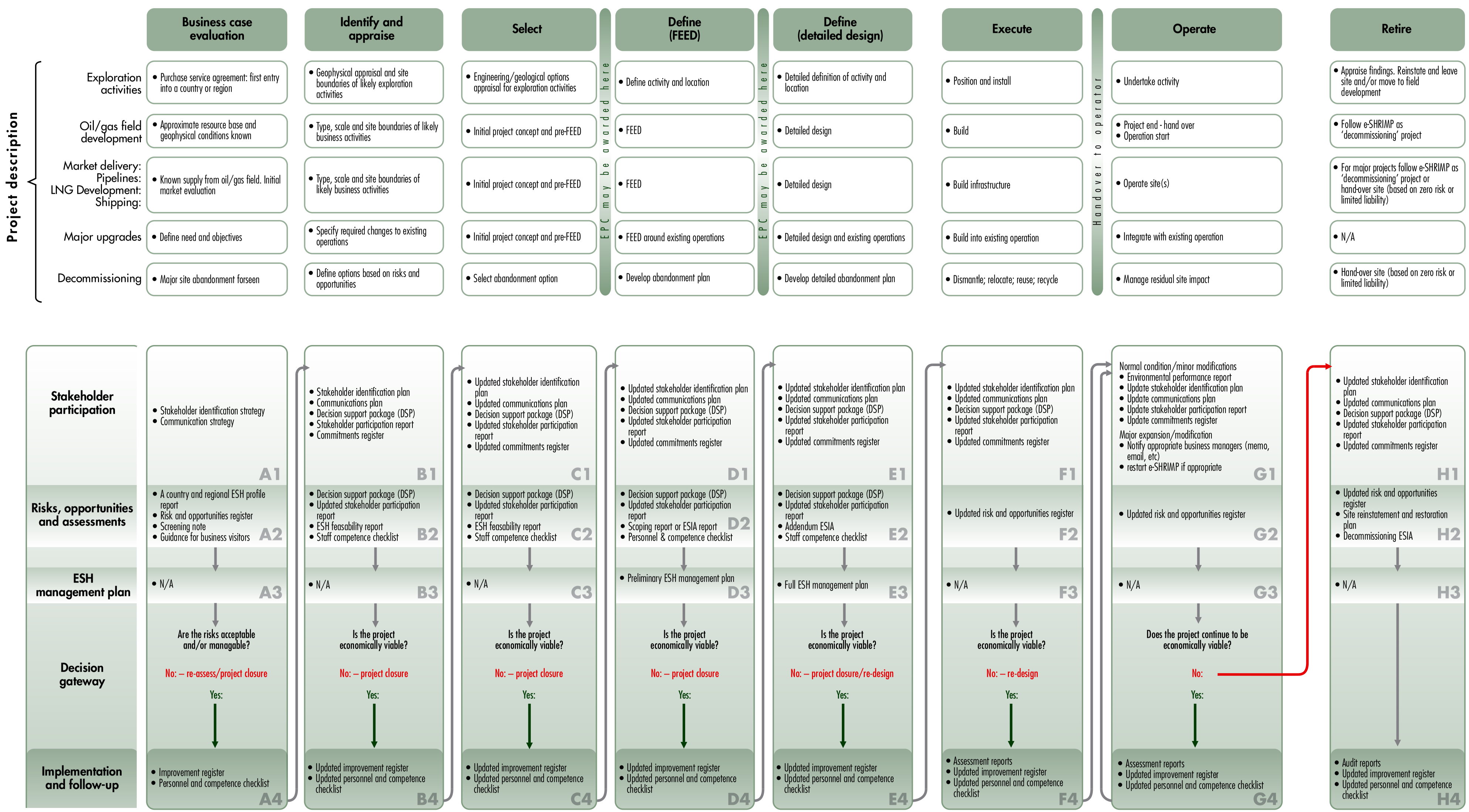
During this phase, work is required to generate sufficient information to compare project options so that waste management is a factor in the decision-making process. This refinement should account for company, international, national and regional development policies. At this stage local planning legislation may require a formal environmental impact assessment (EIA). Whether or not mandatory, an EIA, if deemed appropriate, can be used as a tool for project co-ordination.

An EIA may contain an outline for a Waste Management Plan that will record waste management principles and policies to be developed and implemented throughout the project development. In some countries, a waste management plan may be required as part of a Production Sharing Agreement (PSA) or other similar agreement authorizing E&P activities. Use of a Waste Management Plan is recognised as good practice. The key elements of a Waste Management Plan are shown in Table 1 at the end of this section.

Selection

During project selection, significant decisions are made such as preliminary process design and location. At this stage, any key waste management issues should be identified. These may relate to clarifying legal obligations, identifying whether there is a need to develop local waste management

Figure 1 – e-SHRIMP Toolbox Diagram



infrastructure, determining contracting and procurement practices, identifying current practices and suppliers of alternative waste technologies and community outreach.

Define

During Front End Engineering Design (FEED) and Detailed Design, waste management requirements are more clearly identified. The information can be used to develop and refine the various Waste Management Plans developed by the operator or their contractors (and sub-contractors).

Execute

This is the construction phase when design plans are realised and facilities are put in place. The construction phase often determines the range and size of waste management facilities required, since this is the period that generates the widest range of waste types and the largest volumes. Waste management involves implementing operational management plans and providing that development and construction wastes are managed in a manner consistent with the Waste Hierarchy (see Figure 2).

Operate

Waste management during operations can fall into two parts, (i) waste collection handling, storage, (sometimes waste may need to be stored for an extended period of time if infrastructure to dispose or treat it is not in place so managing waste storage is important to prevent container and label deterioration) treatment and disposal and (ii) periodic review of the waste management plan and implementation of opportunities for improvement.

Retire

This can be a project in itself depending on the size and wastes associated with a facility. In this instance, it may be necessary to go through the project development process outlined above. Decommissioning and divestment needs should be considered in the project development phases to avoid possible environmental impacts and to reduce potentially expensive remediation and divestment costs.

Table 1 – Elements of a Waste Management Plan

Stage	Action	Relevant section of these guidelines
Obtain management approval & commitment	• Review planning basis with management. • Resolve resource/scheduling issues. • Obtain management approval & commitment to develop plan.	Section 2
Define objectivE&Purpose	• Outline organisational & geographical boundaries covered by plan.	Section 2
Identify & categorise wastes	• Determine that all wastes generated within the area are covered by the plan. • Identify physical and chemical characteristics that may warrant special handling. • Determine volumes, frequencies and differing types and quantities of waste generation through life-cycle of project. • Determine types of waste that will be generated with contingencies i.e. plan for the unexpected. • Categorise waste as appropriate.	Section 3 Table 2 Appendix 6
Identify applicable regulations, restrictions & requirements	• Identify applicable host country and local laws and regulations. • Evaluate agreements (Intergovernmental agreements, lender commitments to internationally recognised standards e.g. World Bank requirements) and any potential trade restrictions. • Account for project partner(s) publicly stated company policies and operating standards.	Appendix 7
Identify infrastructure requirements	• Evaluate local waste management facilities and collection/storage/transportation/disposal or reuse systems. • Consider regulatory restrictions, engineering limitations, operating feasibility (locally available spare parts & trained personnel to operate specialised equipment), practicability and the availability of approved waste management sites.	Section 4 Table 3
List and evaluate waste management options	• List potential waste management practices. • Determine each option's HSE risk.	Section 4 Appendix 5
Perform Source Reduction Analysis following the waste hierarchy (Eliminate, Reduce, Reuse Recycle, dispose with energy recovery, Dispose)	• Evaluate opportunities for source reduction, followed by volume and toxicity reduction. • Re-use/recycle, if possible. • Evaluate contractual conditions for vendors to supply goods with reusable/returnable packaging or return unused product to vendor whenever practicable.	Section 3 Appendix 4
Select waste management methods	• Choose environmentally sound, practicable and legal method for the area of operation and location. • Select alternative management method if appropriate.	Section 4 Appendix 4
Develop & Implement Plan	• Procure/build/staff any additional plant or facilities. • Develop/ revise procedures for waste handling and facility operations. • Develop and execute deployment plan. • Provide communications and training/competence to affected parties. • Review & resolve any new resource commitments with management. • Test waste producer line of sight to the final treatment and/or disposal point of all wastes generated (Duty of Care). • Obtain management approval & commitment to implement plan.	Section 5 Section 3.3 Section 3.6
Review and Update Plan	• Verify and track environmental performance - Environmental Performance Indicators (EPIs). • Periodically review plan. • Evaluate new or modified waste management practices. • Revise plan as necessary.	Section 2 Section 5

3 Principles and practices of waste management

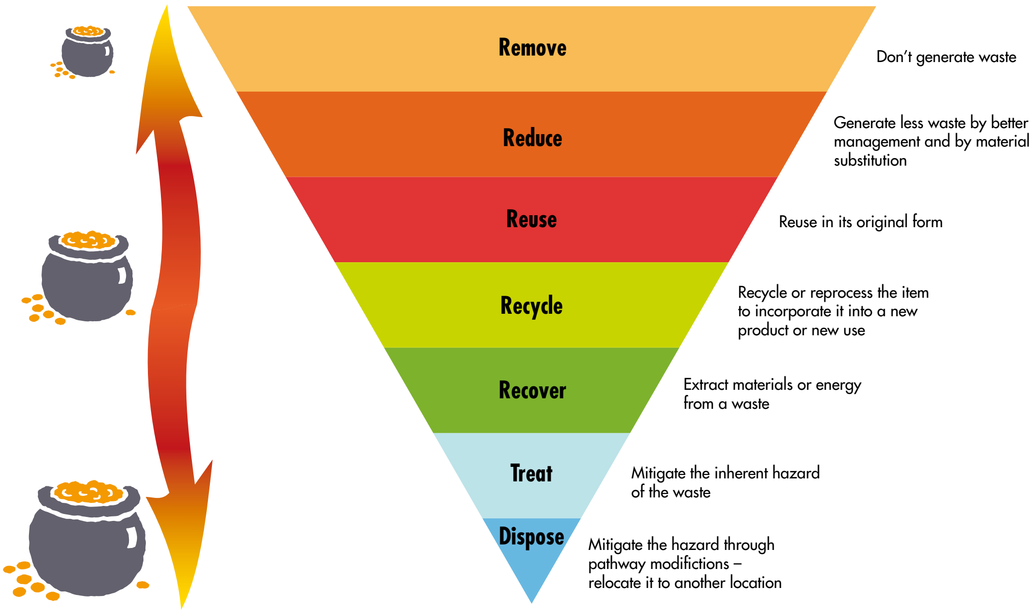
This section describes some key high-level principles that influence the approach taken to waste management. It begins with the traditional thinking about a waste management hierarchy and follows with risk-based management principles. It continues by identifying other factors that influence sequential application of the principle of a hierarchy.

3.1 Hierarchy

The principles of waste management include the incorporation of a hierarchy of management practices that is integral to the development of the strategy for dealing with wastes. This hierarchy is frequently expressed in terms of reduction, reuse, recycling and finally residue treatment and disposal. Waste management, however, begins with prevention. Prevention refers to the avoidance or removal of waste by modification of design and operating practices. This principle can be incorporated, to the extent practical, into all stages of the project life cycle.

The hierarchy is illustrated diagrammatically in Figure 2. This section provides some detail on steps that can be taken at each stage in the hierarchy. The examples given are illustrative and are not intended to be a comprehensive list.

Figure 2 – Waste Hierarchy



The elements of the hierarchy are described in more detail in the following sections:

3.1.1 Remove and Reduce

Collectively this is known as 'reduction at source'. Source reduction occurs prior to reuse, recycling, treatment, or disposal. Source reduction may be achieved through equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training or inventory control. Source reduction is often the most cost effective way to manage waste. Source reduction opportunities should initially be reviewed at the design phase of the project life cycle.

Volume reduction

- Process specification: use gravel packs and screens to significantly reduce the volume and formation of solids/sludges.
- Scheduling sequential hydro-testing to reduce the demand for test water and the volume of water for subsequent management and disposal.

- Inventory control and management to avoid surplus *eg* use of 'just in time' delivery of short shelf life consumables.
- Optimise purchasing supply contracts to favour bulk purchases therefore reducing the volume of packaging.
- Bulk supply of products in reusable containers *eg* chemicals supplied in reusable steel tanks rather than 25 litre plastic drums.
- Supply reductions: allow for return of unused products and recycled containers to vendors in contracts.
- Supplier take-back schemes e.g. computer equipment, empty containers *etc*.
- Improved housekeeping and spill prevention.

Toxicity reduction

Table 2 lists some chemicals/substances that should be avoided, because they have been regulated by various regulatory authorities, and identifies possible alternatives. Examples of reducing toxicity include:

- Use of non-chlorinated degreasing agents.
- Water-based paints in preference to solvent-based paints.
- Biodegradable 'plastics'.
- Asbestos-free gaskets and insulation.
- Mercury-free components (this includes lighting).
- Hydro-testing using low toxicity (or no) additives.

Table 2 – Chemicals and Substances to be Avoided

Substance to be Avoided	Alternatives
Polychlorinated Biphenyls (PCBs)	• Silicones, esters, cast resin.
Asbestos	• Non-asbestos containing materials.
Pentachlorophenol (PCP) and formaldehyde (biocides)	• Glutaraldehyde, Isothlazolin (or other low-toxicity biocides).
Chlorofluorocarbons (CFCs)	• Depends on use. CFC alternatives lists can be obtained through: – US EPA – CFR reference, 40 CFR 82 Subpart G Appendices. – UNEP DTIE – OzonAction Branch.
Leaded paints	• Unleaded paints. Also, water-based or low-volatility solvent formulations.
Chlorinated solvents e.g., carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene	• Non-chlorinated hydrocarbon-based solvents, steam cleaning.
Heavy metals (in reverse emulsion breakers, barite and grit blast)	• Polymer (non-latex)-based formulation, low metals concentration barite and grit blast.
Mercury (in pressure-measuring devices/ instrumentation)	• Differential pressure cells/transmitters, pneumatic or electric instrumentation.
Lead naphthenate (lubricant)	• Lead-free lubricants.
Leaded thread compound	• Lead-free thread compounds (for tubing and casing).
Chromate corrosion inhibitors	• Sulphite or organic phosphate corrosion inhibitors, especially those with reduced toxicity amine function.
Chrome lignosulphonate (as fluid loss controlling agent) – acceptable in small amounts for rheology control	• Carboxymethyl starches for fluid loss control. Improved mud control to reduce fluid loss. If used (for rheology), keep dose small and use formulations with trivalent form complexed in lignin structure.

N.B. Further information on chemicals can be can be obtained from US EPA.

3.1.2 *Reuse*

The re-use of materials in their original form such as:

- Chemical containers. Some containers can be reused only once to provide container integrity while others can be reused multiple times using an approved chemical vendor to refill chemical 'x' into the same used chemical 'x' container with the correct choice of container material and stock return procedures. Quality control checks should avoid cross contamination and integrity issues.
- Reuse of oily rags/pads that can be cleaned between uses. Need to consider the additional impact of solvents, detergents and oily residues related to cleaning – have the potential to create another waste stream.
- Refurbishment of equipment *eg* valves, meters.
- Supply of equipment in reusable containers. For example, the use of plastic boxes rather than cardboard can be considered. It is essential to identify a re-use option and to implement it; otherwise it may be better to use recyclable materials.

3.1.3 *Recycling/recovery*

This is the conversion of wastes into usable materials and/or extraction of energy or materials from waste. Examples include:

- Recycling scrap metal.
- Re-conditioning drilling muds and solvents.
- Using oily wastes for road construction and stabilisation (though consideration of chemical components and potential leaching to soil and groundwater should be undertaken before such use, for example, asphaltics may be appropriate for road use, but used oil may not).
- Using cleaned drill cuttings and crushed clean concrete for road construction material and hard standing.
- Discarding shredded tyres for landfill liner protective layers or as an alternate daily cover for landfills. For example, tires and high grip rubber mats/flooring might be suitable for use. The area of operation and availability of recycling facilities will dictate what can be done.
- Injecting used oil into the oil production plant.
- Use of (clean/decontaminated) split drums for reinforcing retaining walls.
- Recovering oil from tank bottoms.
- Using hydrocarbon and other calorific wastes (solvents, oils, wood) for energy recovery (consideration of chemical constituents should be given for air emissions).

3.1.4 *Residue Treatment*

The destruction, detoxification and/or neutralisation of residues through processes such as:

- Biological methods – composting (if appropriate, materials can be recycled), land farming.
- Thermal methods – incineration, thermal desorption.
- Chemical methods – neutralisation, stabilisation.
- Physical methods – filtration, centrifugation, compaction or shredding.

3.1.5 *Disposal*

- Injection.
- Discharge to water or land.
- Landfill.

3.2 Risk-based Waste Management

Risk assessment can provide an operator with a means to prioritise management and disposal issues and design options to manage potential human and environmental risks, especially in the absence of a full regulatory framework regarding waste disposal that addresses the protection of human health and the environment. The overall framework for risk-based decision-making may be applicable to all types of waste management sites including oil and gas E&P facilities as well as multi-party waste management facilities. The range of waste management alternatives that can be evaluated includes technologies or practices that reduce the volume of waste or the concentration of potentially hazardous components, as well as re-use, treatment and disposal alternatives.

In general, the risk assessment process involves three primary elements: hazard identification and toxicity characterisation, exposure assessment and risk characterisation. Specific to waste management, these elements focus on substances contained in/placed within waste management facilities and may include: simulating their release and movement in the environment of potentially hazardous components; estimating their uptake by both human and environmental receptors; and predicting the potential health risks associated with exposure. This information can then be combined with other factors, such as the probability that the modelled releases will occur and the viability or appropriateness of feasible management options in ultimately defining the preferred waste management approach.

3.2.1 Waste Management Hazard Identification and Characterisation

In the context of waste management, hazard identification and toxicity characterisation is accomplished by identifying the types, quantities and composition of wastes that are or may be generated by the technology and operating practices being considered. The characterisation should be sufficient to assess the potential to produce adverse health effects in human and environmental receptors. This will often involve the collection and analysis of waste samples, so that the substances of potential concern can be identified. In addition, changes in waste compositions resulting from interaction with the environment (such as weathering, evaporation, dilution, or reaction with other wastes or environmental media such as water or soil) should be considered.

Waste characterisation and toxicity assessment have inherent uncertainty. In particular, most of the existing toxicity data that is typically used for risk assessment purposes reflect specific combinations of test organisms, pure chemical doses/concentrations and exposure duration. The application of these data to wastes is complicated by the fact that most wastes are variable mixtures rather than fixed, pure substances. The effects that these mixtures may have on the toxicity of individual chemicals may not be known and, if so, add to the uncertainty of a risk evaluation.

3.2.2 Exposure Assessment

The exposure assessment introduces site-specific factors into the characterisation of site risk. The exposure assessment is typically a three-step process involving: (1) determination of the relative locations (proximity) of the hazards and potential receptors, including consideration of types and sensitivity of potential receptors; (2) identification of possible complete exposure pathways including consideration of the likelihood that the pathway may be complete; and (3) estimation of the magnitude and duration of the potential exposure. Exposure assessment for ecological receptors may involve additional consideration such as the size of the receptor population of concern, which should be considered on a site-specific basis.

3.2.3 Risk Characterisation

The final step is the assessment of risk. In this step, the results of the exposure assessment are combined with the toxicity information gathered in the previous step to quantify the potential risks to human health and the environment. Since safety factors are typically included at each step to account for uncertainty, the overall assessment of risk is typically conservative (*ie* often overstates the potential risks that the waste management option may present).

3.2.4 Risk-Based Decision Making

Once the risks associated with waste management options have been estimated, they can be evaluated and compared. In order to evaluate the risk estimates, individual companies should first identify applicable, comparable and appropriate action levels and approaches based on compatible risk-based regulatory schemes and other references or tools. The comparison of possible risks estimated for alternative waste management options then distinguishes those that pose acceptable risks and, for those that might exceed acceptable risk levels, the identification of possible mitigations to risk.

3.3 Waste Management Capacity Building

On entry to new countries and new regions, identify and appraise the local waste management infrastructure to assess the ability to handle the range of wastes expected to be generated. As part of risk based waste management, decisions on the selection of waste facilities should be made with input from a waste management practitioner/professional. Decisions should be made after appraising the local infrastructure, including third party facilities and identifying the gaps and shortcomings, as well as identifying future requirements and assessing the potential for building the capacities of the local infrastructure.

Appraisal of existing capacity might find absence of, or poorly-constructed or operated waste management facilities. Bearing in mind operator obligations under PSAs or similar agreements and company polices, an operator may attempt to fill these gaps by taking steps like providing its own infrastructure or facilities, helping to upgrade existing local facilities or encouraging local third-party capacity building. Since such upgrades will take significant time, it is advisable to undertake the infrastructure evaluation as early as possible to allow time to address any gaps.

Steps to address gaps in waste management infrastructure may include:

- Educating and training in waste management techniques and operations.
- Facilitating development of re-use and recycling operations for the local communities.
- Running pilot-scale projects.
- Building a facility that local populations can use or operate and that can be integrated into the local municipal infrastructure.
- Building a separate facility that is used only by oil and gas operations.
- Establishing independent sustainable projects.

3.4 Evaluation of Third Party Waste Management Facilities

An assessment of third-party, off-site recycling and waste treatment and disposal facilities helps to gain assurance that effective controls are in place to comply with appropriate regulations and to reduce any potential need for future human health and environmental activities associated with waste management activities. Third party waste management facilities should be evaluated with input from a waste management practitioner.

An assessment and inspection programme would typically include collection of data about the history and operation of the facility, a site visit to see the facility in person, a risk ranking, or evaluation of the information and periodic re-audits and site visits to confirm the facility stays in an acceptable condition. Table 3 outlines some key elements for consideration and review during a facility assessment.

Table 3 – Check List for Evaluation of Third Party Waste Management Facilities

Points to consider	Evidence Includes
What types of waste are accepted at the site for treatment and disposal, and what methods are used?	• Applicable site licence in place. • Site procedures.
Are the treatment and disposal methods appropriate for the types of wastes accepted?	• Local legislation. • Company policy. • Good practice.
Are all required regulatory permits in place?	• Copies of relevant permits/licences for site and equipment (if required).
Is the facility in compliance with regulations and permits?	• Reports submitted to regulator. • Regulator site inspection reports. • Records of breaches/fines.
Are the facilities located, designed and constructed to provide environmental protection?	• Was an Environmental Impact Assessment performed? • Appropriateness of design in relation to e.g. local geology, land use, topography, presence of usable groundwater, soil permeability. • Evidence of e.g. landfill lining, emission controls (for incinerators etc.), integrity testing for disposal wells.
Does the site have effective management and monitoring controls?	• Site procedures. • Environmental monitoring programme. • Evidence of monitoring and tracking emissions against maximum permissible limits. • Organised and effective waste manifest system. • Use of competent, accredited laboratories for analysis. • Vehicle maintenance and service records.
Have steps been taken to mitigate the risk of HSE incidents?* HSE management plan.	• Condition of containers holding waste materials. • Provision of secondary containment and/ or impervious barriers to prevent migration of materials and spills. • Level of housekeeping. • Any apparent spills and stains. • Training and awareness of staff.
Does the facility respond quickly and effectively to any incidents?	• Spill response plan. • Spill observation and reporting system. • Spill response training records. • Provision of spill kits on-site.
Does the facility have a good safety culture with adequately trained and resourced employees (including appropriate protective equipment)?	• Appropriate risk assessments. • Training plan and training records. • PPE availability on site. • Appropriate PPE, MSDS etc signs. • Performance track record.
Does the site have soil or groundwater impacts from previous or current operations?	• Site EIA/licence. • Records of previous use.
Are impacts from nearby sources potentially affecting the site, for instance from groundwater migration?	• Groundwater monitoring programme results.
How close is the facility to nearby residents, cultural properties, or sensitive environmental areas?	• EIA. • Site location plan.
Is security at the site adequate to prevent unauthorised access?	• Adequate fencing/patrolling. • History of security breaches. • Sightings of unauthorised personnel on site.
Are any sub-contracted services selected and managed responsibly?	• Evidence of effective sub-contractor audits.
What is the financial security of the facility, in terms of its longevity of operation and its ability to pay for potential incidents?	• Company funding/share owners, date of company founding, market share.
What are the relations with the surrounding community and regulators; is the facility a 'good neighbour'?	• Records of complaints, fines, local perceptions.
Does the facility have an end-of-life reinstatement plan and provision for its implementation, e.g. financial assurance?	• Decommissioning plan.

3.5 Waste Collection, Segregation and Temporary Storage

Waste that is collected should be handled, stored and transported in a manner that reduces the risk of escape to the environment (for example by particulates, infiltration, runoff or odours).

Waste sorting either at the source or after collection segregates wastes that require different treatment or disposal systems and avoid mixing non compatible products. For example, non-chlorinated solvents should not be mixed with chlorinated solvents. Dedicated containers (bins, skips *etc*) should be labelled clearly by type of waste (for example by colour-coding and illustrated by pictographs, and the potential need for multiple language labelling) and should be installed in the vicinity of work units and in living quarters. Containers should be made from durable materials compatible with the waste to be collected, be leak-proof, sturdy, stable and easily handled. They should be designed to prevent the ingress of animals (vectors), escaping odours and placed under cover if necessary for protection from the elements.

Medical waste should be separated from other wastes because they may contain infectious agents and potentially toxic substances; sharp objects should be packaged in puncture-proof containers. Containers used for medical waste should be marked prominently with universal warning signs and/or the word 'Biohazard'. Used needles and syringes represent a particular threat as failure to dispose of them safely may lead to recycling and repackaging which in turn lead to unsafe re-use. Where possible, management of clinical/medical wastes should be integrated into existing healthcare waste management systems.

Risk assessment may identify some wastes that should be handled using special holding arrangements at the site of generation at the waste management facility *eg* stored on an impervious surface and/or in a bunded area. It may be appropriate for some of these facilities to be connected to a drainage and collection system. The storage area may be equipped with suitable fire-fighting equipment and spillage recovery equipment such as shovels and absorbent materials. Access to the storage site should be limited to trained personnel. A restricted/controlled area may be required for some types of waste for example, radioactive waste and explosives. Waste storage areas and access ways should be kept clean and clear of trips/slips hazards.

3.6 Waste Transfer and Tracking

Once the treatment and disposal solution has been selected from available options, transfer and conveyance of wastes from the storage site to the site of treatment/disposal should be organised in accordance with applicable legal requirements.

Modes of transport and routes from the site of waste generation to the treatment/disposal site should be selected to reduce risks of release. Containers should be chosen to conform with legal requirements and method of transport (for example, European Community Code and International Maritime Organization stipulations and, for shipping, International Convention for the Safety of Life at Sea (SOLAS). Documentation on material properties and precautions to be taken in case of spillage (for example, the information on a Material Safety Data Sheet – (MSDS)) should be provided and should accompany the waste.

Tracking of waste types, quantities and methods and location of final disposal of those wastes should be considered as part of an overall waste management system to document the intended disposal of the waste.

Information to consider in tracking includes:

- Type of waste.
- Quantity or volume of waste.
- Final disposal location.
- Date of waste despatch, transfer or disposal.
- Waste contractor details.
- Archiving and retention of waste tracking records as required by statute.

For off-site waste shipments, more detailed tracking forms and signatures may often be used to document the chain of custody each time the waste changes possession from the site generating the waste, to the entity responsible for its transport to the disposal facility. A waste receipt from the receiving waste facility documents that the waste arrived at the appropriate waste facility. An example of a waste tracking sheet is given in Appendix 2.

3.7 Waste handling treatment and disposal methods

It is not possible within the context of this guideline to describe a comprehensive range of waste handling, treatment and disposal methods that would cover all circumstances. Appendix 5 describes waste handling treatment and disposal methods for a number of commonly occurring E&P waste materials.

4 New waste management facilities

Where it is not practicable to rely on existing waste management infrastructure, it may be necessary to design a new on-site or off-site facility. At an early stage in evaluating the location for a new site, it will be necessary to evaluate a range of environmental and social factors, possibly through a screening procedure and/or Environmental and Social Impact Assessment (see Figure 1, e-SHRIMP). In addition, this section can also be useful during evaluation of existing facilities (in conjunction with section 3.3, Waste Management Capacity Building). The following considerations are important when addressing specific waste management options:

- Environmental characteristics.
- The regulatory environment.
- Logistical challenges.
- Community and outreach.

4.1 Environmental characteristics:

In the siting of new waste management facilities, environmental characteristics may fall within two categories: (i) physical and (ii) community & social interaction. Table 4 provides the key physical studies and activities that are commonly used to determine site suitability.

Table 4 – Examples of environmental and physical field studies for siting of E&P waste management facilities

Study	Activities
Preliminary Reconnaissance: carried out during the appraisal stage of the project to obtain an overview of the environmental characteristics of the area of interest.	• Possible geohazards identification. • Gathering of existing environmental and historical data: – Aerial photographs and Cartographic maps. – Climatic records: seasonal regime, rainfall rate, wind intensity, temperature, etc. – Population of the area. – Main use of the land (industrial, agricultural, residential). – Similar projects carried out in the area. – Regional geology and geomorphology. • Visits to the area: – Identification of access routes. • Water bodies crossings, etc.
Detailed field studies: carried out from the e-SHRIMP 'Select' stage onwards to obtain the information required for the design and construction of a waste management facility	• Climatic conditions: wind intensity and direction, temperature range, rainfall rate. • Topographic survey: to identify potential hazards. To identify previously modified topography and assess the construction needs for cutting and filling required. The complexity of the survey will vary depending on the relief of the area. Topographic survey scales are generally 1:1000 for road design. • Geological, geomorphological and hydro-geological studies i.e. review hydrogeologic data to identify the location, size and direction of flow for existing surface water bodies and aquifers characterised as fresh or useable. • Geotechnical studies e.g. soil composition, granulometry, permeability, bearing capacity and water-table level; determine soil conditions prior to making decisions on loading for land-treatment, whether or not pits or landfills will require liners to protect shallow groundwater sources. For example, in high clay content and permafrost areas, liners may not be necessary. In other areas with sandy soils and shallow useable groundwater, liners or even tanks may be more appropriate. • Geohazard studies: landslides, seismic studies, ground conditions, etc. • Hydrology: characterise nearby water bodies, identify run off patterns, water flow, flooding risks, chemical and physical analysis of surface and ground water etc. • Fauna and vegetation characterisation: fauna and vegetation inventory, detection of endangered species, determination of breeding and/or mating grounds within affected areas, etc. • Environmental baseline and impact assessment. • Shallow gas presence assessment. In some places an archaeological assessment of the area may be required or appropriate.

External relationships, particularly with the local community, will be critical to the success of a new waste management facility. It is good practice to be proactive and seek to understand stakeholder issues and manage any concerns. Resolution of issues later when communities or individuals may be sensitised can be problematic. Therefore, the community should be consulted regarding siting, construction, and operation of a proposed facility. From a very early stage, disturbances to communities should be reduced through good consultation and design. These steps will help to foster good community relations and neighbourliness. Typical activities associated with waste management are, for example, truck traffic (wheeled loaders, cranes) associated with waste unloading and processing. Noise from waste compacters, grinders and other treatment conveyance systems may also have a potential to disturb communities. The following activities/elements (Table 5) may be considered in the preparation of a waste management site location.

Table 5 – Environmental aspects and communities

Activity	Aspect
ESIA	Community disturbance issues should be identified and risk assessed as part of the Environmental and Social Impact Assessment (ESIA).
Consultation	Early and continuing consultation with local stakeholders to discuss the potential for disturbances to the community should be undertaken throughout the project.
Performance (see Section 5)	Waste measurement (tracking, performance) and reporting against key performance indicators that can be used to track and evaluate a site's performance through a site environmental monitoring programme.
Grievance	Developing a mechanism by which local people and other stakeholders may raise grievances with the waste management site.
Abnormal & emergency	A community mitigation plan should be prepared involving the community for abnormal and emergency events.
Noise	For a new waste management facility, an assessment should be made of the possible impacts arising from increased noise and a mitigation plan implemented to deal with this aspect.
Vibration	Similarly waste management site equipment may have the potential for vibration and an assessment should be undertaken with a mitigation plan implemented where there is potential for disturbance particularly for local community structures.
Odour	An odour assessment should be undertaken with a mitigation plan implemented where a site has potential to release offensive odours to a nearby community.
Dust & particulates	Where a proposed waste management facility has potential activities that may result in an increase in local dust and particulates, a dust and particulates assessment should be undertaken as part of the environmental assessment.
Lighting	An understanding of project and operational lighting and its related environmental impacts should be undertaken in the waste management facility site design. Mitigation is usually through good positioning and design of lighting to avoid disturbance to a community.
Landscape	An understanding of a landscape and its visual impacts on local communities should be undertaken in the waste management facility site design to avoid detrimental effects on a community's cultural landscape.

4.2 The regulatory environment

Regulatory frameworks for control and organisation of capacity for waste management vary from country to country and even regionally within a country. Some locations have mature programmes that are fundamentally risk-based, taking into account factors such as waste characteristics, environmental setting and local infrastructure. In other areas, regulations may be substantially less mature. Compounding this, some locations may have construction and operating permit or licence mechanisms that impede obtaining timely, risk-based approval for new facilities. In other cases, legal frameworks may be absent, or they may be inadequate to meet an operator's needs.

In the early stages of an E&P project there may be a need to develop new waste management facilities. All legal requirements applicable (potentially including those under international treaties or other legal agreements) to the construction and operation of new facilities should be identified. These may include requirements for permits, notifications, authorisations, approvals or licences. In addition, it is also prudent at this early stage to evaluate availability of critical resources such as operating personnel (and their competence), maintenance support and laboratories required to operate any new waste management facility. All of these items can have significant impacts on a project's ultimate success, including impacts on resource and time requirements. Training is a key factor here and should be addressed at an early stage to enable trained staff to be available when the facility becomes operational.

4.3 Community and outreach

The surrounding community's perception and acceptance of a waste management facility can be as important as the reality of a particular facility's daily operations. Community approval is often key to the location of new facilities. For this and other reasons, facilities located in populated areas should consider the nature of their relations with the surrounding community. Community outreach is nothing more – and nothing less – than developing good two-way communication between the operator of the facility and the near-by community. It involves letting people know about the facility operations and sharing concerns the company might have; listening to others and understanding their concerns; working together on common goals and discussing differences in an open, respectful manner.

An effective community relations effort should begin early and consider the unique nature of both the proposed facility and its surrounding community. It may be valuable to evaluate the needs and concerns of the community. The needs and resources of the facility should also be considered. The greatest positive benefits are likely to be achieved through a programme that facilitates respect, cooperation and communication between the facility and the surrounding community. If a facility decides to implement a community relations programme, a key first step is to evaluate the facility and its operations, including an assessment of employee attitudes toward the facility. Once completed, facilities will be able to identify programmes, practices and initiatives that are effective and that can be shared with others. Outreach communication efforts may also alert the facility to aspects of operations that could be improved. After assessing its own operations, the facility can then assess the needs and concerns of the surrounding community. Effective outreach can be facilitated by: (1) determining what issues are important to the community; (2) understanding the current relationship of the facility to the community; and (3) developing contacts with key local figures and opinion formers.

5 Waste management (tracking, performance) and reporting

There are a variety of reasons to collect information regarding waste generation and disposal. These include:

- Monitoring and improving internal environmental performance.
- Fulfilling regulatory reporting requirements.
- Managing potential liability, past (inherited or legacy activities) and present with the ability to review and change current performance.
- Providing environmental information to external stakeholders such as communities and project funding entities.
- Cost control *eg* costs associated with cuttings disposal in remote areas where there are no existing facilities – integrated management of the drilling mud cleaning system and its associated residuals will help drive decisions on employing the most practicable waste reduction techniques.

5.1 Key drivers

Identify the key drivers for any measurement and reporting before developing a reporting plan. Key items to consider when developing a plan for measurement, tracking, performance and reporting include:

1. Identify the drivers and goals for reporting. How will the information be used?
2. Determine the audience for the reports. Will the reporting be internal only? Will some of it be shared externally?
3. Establish the scope of reporting. What will be included in the reporting? For example, will there be a focus on just certain types of waste (such as drilling waste), or broader categories (such as 'non-hazardous' wastes or 'restricted' wastes)?
4. Structure the reports to meet legal and corporate requirements. How will the categories of waste reported be defined; using the locally applicable regulatory definitions, or some uniform company or external set of definitions?
5. Establish separate reporting data categories for non-disposal options. Will some items be excluded from the definition of waste such as materials being reused/recycled or items covered under permitted discharges?
6. Agree on the frequency of data collection. How often will the data be collected and over what averaging period? For example monthly, quarterly and/or yearly.
7. Establish the accountability for reporting. Who, within the organisation, will be in charge of collecting and reporting data, and who will establish the 'tool' that will be used for collection/analysis of the data, for example, spreadsheets or databases?

5.2 Planning and timeline

The amount of effort that will be required to plan, coordinate and implement an enterprise-wide reporting system should not be underestimated. Participation and input from all affected areas of the company will improve success and smoothness of implementation.

5.3 Good practice

The foregoing describes passive monitoring. For more proactive monitoring operators can look to obtain information that informs management on compliance and avoiding future potential liability costs. For example, implementation of random internal audits and sampling to verify, for example, that the 'inert' waste disposal facility next to a community does indeed contain only inert material. Other examples may be an integrated approach to steer the employment of waste reduction techniques, such as:

- The use of waste generation information for trend analysis to determine whether one 'shift' produces more waste than another and thus requires more training or,
- A particular machine generates more waste-oil therefore needing maintenance or,
- The 'inert' waste generated from the site office is mainly plastic cups and, therefore, cost reductions may be gained through use of ceramic mugs.

Another area may look actively to the potential for diverting waste streams, for example, collecting information on the spent waste cement produced in drilling operations to see if it can be used locally by the block manufacturing company.

An example of a waste tracking sheet is given in Appendix 2.

6 Summary

These guidelines identify a series of management tools to develop and implement 'good oil and gas field waste management practices'. In presenting the waste hierarchy it recognizes that the best approach to waste management is not to generate waste in the first place. This means designing and operating facilities so that there are no materials surplus to requirements.

Useful tools and practices for waste reduction and elimination are identified. Finally, guidelines are provided on how to treat, manage and dispose of waste responsibly, where generation cannot be eliminated.

The management options discussed show how waste management considerations can be integrated with other project demands through the oil and gas project development life cycle (as shown by the OGP tool e-SHRIMP). In addition, these guidelines identify management techniques in a series of tables that can be used to drive effective waste management within operating companies and their associated contractors. These include (when appropriate): environmental impact assessment; risk assessment; community out-reach programs; and capacity building in the form of training, contractor development, and the building of new facilities. A key message is that good oil and gas field waste management practices often differ between locations. Specific waste management practices depend on the amount and characteristics of the wastes that must be handled, the sensitivity of the environment; technological constraints and recycling opportunities; mitigation measures needed to manage risk, and local regulations.

Appendix 1
Relevant OGP publications

Ref	Publication Title	Date
389	e-SHRIMP report	June 2007
364	Fate and effects of naturally occurring substances in produced water on the marine environment	Feb 2005
342	Environmental aspects of the use and disposal of non aqueous drilling fluids associated with offshore oil and gas operations	May 2003
332	Key questions in managing social issues in oil & gas projects	Oct 2002
324	Aromatics in produced water – occurrence, fate and effects, and treatments	Jan 2002
302	Guidelines for produced water injection	Jan 2000
285	Monitoring oil in produced water discharged into the sea: a review of current and emerging practices	Jan 1999
271	Aqueous discharges in the North Sea: an update from the E&P industry	Jan 1998
202	The physical and biological effects of processed oily drill cuttings	Apr 1996
187	Guidelines for the planning of downhole injection programmes for oil based mud wastes and associated cuttings from offshore wells	Oct 1993

Appendix 2
Example of a waste tracking sheet

Figure 3 – Waste Manifest Form

Part A – To be completed by GENERATOR

Source Site Location GPS coordinates and/or kilometre post mark or other location descriptor (use attachment(s) as necessary):	
Origin of waste:	

Waste description (use attachment(s) as necessary)	Waste type	Hazard	Container		Quantity shipped	Units, e.g. tonnes	Handling/disposition	Receiver use only (Part C)				
			No.	Type				No. containers received	Container type	Quantity received	Units	Handling/disposition

Generator additional information: e.g. condition of container, requirement to return empty containers	

Intended receiver: Company Waste Management Facility Third Party Facility
Include facility (company) name, full address, telephone number and name of contact individual

Certification	I declare that the information I have provided in Part A is correct and complete	
Name (print):	Signature:	Date (DD/MM/YY):
Telephone:	Fax:	24-hr Emergency

Generator's address: (this is the address to which the Receiver is to send the Waste Manifest Forms to)

Part B – To be completed by TRANSPORTER

Name of Transporter: (Include company name, full address, telephone number and name of contact individual)

Certification	I declare that I have received the wastes as described in Part A for delivery to the Intended Receiver and that the information in Part B is correct and complete.	
Name (print):	Signature:	Date (DD/MM/YY):
Telephone:	Fax:	24-hr Emergency

Part C – To be completed by RECEIVER

Date received (DD/MM/YY):	Intended receiver? (see Part A) Yes No

Receiving location: Company Waste Management Facility Third Party Facility
include facility (company) name, full address, telephone number and name of contact individual

Receiver additional information: e.g. condition of container, requirement to return empty containers

Certification	Except for the irregularities/discrepancies noted above, I declare that I have received the wastes as described in Part A and that the information in Part C is correct and complete.	
Name (print):	Signature:	Date (DD/MM/YY):
Telephone:	Fax:	24-hr Emergency

Part D – To be completed by GENERATOR

Name of Authorised Person (print):	Signature:	Date (DD/MM/YY):

Appendix 3
An overview of the oil & gas exploration and production process

***Extracted from OGP Report 196** – Exploration & Production waste management guidelines*

In order to appreciate the potential impacts of oil and gas development upon the environment, one should understand the activities involved. This Appendix briefly describes the oil and gas exploration and production process. The guidance in this document addresses only the waste management aspects of these activities. In order to fully understand the range of environmental impacts associated with these activities, reference should be made to other guidelines and documents listed in Appendix 1.

In the following discussions, common wastes are listed for each activity. A more detailed listing of waste definitions is provided in Appendix 6.

A3.1 Seismic Identification of potential hydrocarbon reserves

In the first stage of the search for hydrocarbon-bearing rock formations, geological maps are reviewed to identify major sedimentary basins. Aerial photography may be used to identify promising landscape formations such as faults or anticlines. More detailed information is then assembled using a field geological assessment, followed by one or more of three main survey methods: magnetic, gravimetric and seismic. Of these a seismic survey is the most common and is often the first field activity undertaken.

Description

Seismic surveys require the generation of acoustic waves at specified points along a relatively straight survey line. The acoustic waves are reflected by changes in the subsurface geological strata. The reflections are detected by many sensors arranged along several kilometres of the survey line (over several square kilometres in the case of a 3D survey) and recorded. Line preparation may involve cutting vegetation prior to surveying the data point and sensor locations. As recording progresses along the survey line onshore, the sensors are moved to new positions along the survey line by crews using vehicles or helicopters. The data are processed by computer to map the underlying strata and help define the size and shape of any geologic structure worthy of further investigation.

Several methods are available to generate the acoustic waves. These include the use of shot holes, Vibroseis techniques, or air or water guns. The shot hole method involves the detonation of small explosive charges placed in small diameter holes drilled to a depth generally ranging from one to thirty metres. In the Vibroseis method, a group of three to five heavy vehicles (vibrators) lower and then vibrate a heavy pad at specific points on the surface. Air or water guns create the acoustic waves used for the survey by releasing compressed air or water to create loud sonic vibrations.

Because land seismic activities are highly mobile, base camps are temporary in nature. In order to protect surface water bodies, sanitary pits and biodegradable garbage pits should be at least 100 metres from the water, if possible. Non-biodegradable, flammable wastes may be burned and the ashes buried with the non-flammable wastes. This burial should be at least one metre deep. If the area water table is high, burial criteria should be reconsidered.

Common wastes

The primary wastes from seismic operations include domestic waste, sewage, explosive wastes, lines, cables and vehicle (including ship) maintenance wastes.

A3.2 Exploratory Drilling

Once a promising geological structure has been identified, the only way to confirm the presence of hydrocarbons and the thickness and internal pressure of a reservoir is to drill exploratory boreholes ('wells').

The location of a drill site is dependent upon the characteristics of the underlying geological formations. Modern drilling techniques allow some flexibility in choice of location, allowing consideration of both environmental protection and logistical needs, while still reaching reservoir development objectives.

Description

A site is constructed to accommodate drilling operations and support services. Offshore, a drilling barge, semi-submersible drilling rig, or a drilling ship is used to provide all of the functions associated with drilling the well. On land, a typical one-hole exploration site occupies between 5000 and 20,000 square metres. The type of site construction is dependent on seasonal constraints and geography. Drilling rigs and support equipment are normally divided into modules to facilitate transportation. Depending on access roads, site location and module size and weight, drilling rigs may be moved by land, air or water transportation.

Once on site, the rig and a self-contained support camp are assembled. Typical modules include a derrick, drilling mud handling equipment, power generators and cementing equipment. The camp provides workforce accommodation, canteen facilities, communications, vehicle maintenance and parking areas, a helipad (for remote sites), fuel handling and storage areas, and provision for collection, treatment and disposal of wastes.

Once drilling commences, drilling fluid or mud is continuously circulated down the drill pipe and back to the surface equipment to balance underground hydrostatic pressure, cool and lubricate the bit and flush out rock cuttings. The risk of uncontrolled flow from the reservoir to the surface is further reduced by using blowout preventers, a series of hydraulically actuated steel rams that can close around the drill string or casing to quickly seal off a well. Steel casing is run into completed sections of the borehole and cemented into place. The casing and cement provide structural support to maintain the integrity of the borehole, isolate underground formations and protect useable underground sources of water. Where a hydrocarbon formation is found, initial well tests are conducted to establish flow rates, formation pressure and the physical and chemical characteristics of the oil and gas.

Common wastes

The primary wastes from exploratory drilling operations include drilling muds and cuttings, cementing wastes, well completion, workover and stimulation fluids and production testing wastes. Other wastes include excess drilling chemicals and containers, construction materials (pallets, wood, *etc*), process water, fuel storage containers, power unit/transport maintenance wastes, scrap metal and domestic and sewage wastes.

A3.3 Construction

Construction of some infrastructure and facilities will be required to support activities.

Description

Construction of facilities such as roads, camps, canals and pipelines may be required both before and during the development and production process. The construction process may use a wide variety of materials, equipment and methods. The facilities required for a specific activity will depend on the activity and its geographic location.

Common wastes

The primary wastes from construction activities include excess construction materials, used lubricating oils, paints, solvents, scrap metal, sewage and domestic wastes.

A3.4 Development and production

Development and production operations are conducted to extract oil and gas from underground reservoirs.

Description

A small reservoir may be developed using one or more of the exploratory wells. Further development of the reservoir may require additional wells. A production facility may be required to separate, store and transport produced fluids. The size and type of the installations needed for storing, separating and transporting oil, gas and water will depend on the nature and location of the reservoir, the volume and nature of produced fluids and the export option selected. These options include transport by road, waterway, pipeline or some combination of these.

Routine operations on a producing well include monitoring, safety and security inspections and periodic downhole servicing using a wire line unit or a workover rig. In some areas, a self-contained base camp may be established to support routine operations. The base camp provides workforce accommodation, communications, vehicle maintenance and parking, fuel handling and storage and provision for collection, treatment and disposal of wastes.

The operator will be able to extract only a portion of the oil present using natural pressure and simple pumping. A range of enhanced recovery methods, including waterflood, gas injection and methods employing chemicals, gases or heat may be used to increase the efficiency of oil production.

Common wastes

In addition to the wastes listed in sections 3.2, 3.3 and 3.5, the main wastes from development and production operations include produced water, flare and vent gas, production chemicals, workover wastes, *eg* brines, and tank or pit bottoms.

A3.5 Maintenance

Maintenance of vehicles, mechanical equipment and infrastructure may be required for operations of extended duration.

Description

Maintenance activities are common to all phases of the exploration and production process. During seismic and construction activities, maintenance is essentially limited to vehicle repair and inspection. Exploratory drilling maintenance activities include vehicle and drilling rig repair and inspection. Maintenance activities during development and production include repair and inspection of vehicles, generators, drilling rigs, workover rigs, fluid process equipment and infrastructure.

Common wastes

The primary wastes associated with maintenance activities include batteries, used lubricants, filters, hoses, tyres, paints, solvents, impacted soil, coolant and antifreeze chemicals, used parts and scrap metals.

A3.6 Decommissioning

Oil and gas installations are decommissioned at the end of their commercial life.

Description

Decommissioning generally involves permanently plugging and abandoning all wells, and may include removal of buildings and equipment, transfer of buildings and roads to local communities or host government entities, implementation of measures to encourage site re-vegetation and site monitoring.

Common wastes

The primary wastes from decommissioning and reclamation include construction materials, insulating materials, plant equipment, sludges and impacted soil.

Appendix 4
Waste handling, treatment and disposal methods

Some of the treatment and disposal methods that may be used for E&P wastes are described here. The range of treatments described is not intended as exhaustive; the omission of a particular management option from the list discussed here is not meant to imply that it cannot be effective. Certainly, as research on waste management progresses, additional options will be identified. The appendix does not address options for reduction, re-use or recycling that are discussed as part of the hierarchy section in the body of the guidelines.

A4.1 Biological treatment

Biological treatment methods are among the most practicable methods for managing E&P waste. Biodegradation is a natural process by which hydrocarbons and other organic materials are consumed by microorganisms (such as bacteria and fungi) that utilise these materials as a food source. Before beginning a biological treatment operation, one should consider several site-specific parameters to determine the feasibility of successfully bio-treating the wastes

Of the biological treatment methods described below, land-farming and land-treatment may be considered disposal options as well as treatment options.

Waste materials that can be land-farmed, land-treated and composted successfully include:

- Oily sludges – tank bottoms and pit sludges.
- Oil impacted soils.
- Drilling wastes – drill cuttings or muds – verify that the type of oil used is biodegradable.
- Waste biological solids.

Waste can be liquid, semi-solid, or solid, but must not contain materials that are toxic to microorganisms in the concentrations applied.

Wastes not suitable for biological treatment include:

- Motor oil, hydraulic oils and solvents.
- Wastes containing NORM.
- High salinity wastes.
- Spent acids/alkalis.

Factors to consider when choosing a biological treatment option

- Regulations – is the method chosen allowed by local regulators, do you need a permit, what are the treatment goals?
- Can cleanup target levels be met?
- Are the wastes biodegradable? Not all crude oils/wastes are amendable to biodegradation. The waste needs to be characterised to determine the types of components (hydrocarbons, metals, salts, *etc*) present. Other constituents should also be evaluated as they can affect the selection of the treatment – pH, salinity, NORM.
- Characterise the soil and site conditions.
  - Evaluate soil texture, water holding capacity and nutrient levels.
  - Determine the availability of water, ambient temperatures and wind conditions.
  - Determine distance to ground water, surface water and populated areas.
- Start-up considerations, operating procedures, equipment and monitoring needs, and final disposal options.

For composting, the availability and cost associated with bulking materials (manure, tree waste, wood chips *etc*) and nutrients will need to be considered.

There are several areas where risk-based decision-making can be applied in biological treatment methods. Where regulations do not dictate the design and operation of biological treatment processes, risk assessment can be used to:

- Establish treatment targets for oil content or specific constituent concentrations.
- Assess the need for engineered liner material in construction of biological processes.
- Determine if and where reuse of the treated residual materials is feasible.

A4.1.1 Land-farming

In land-farming facilities, waste is periodically re-applied to a receiving soil so that naturally occurring microorganisms present in the soil can biodegrade the hydrocarbon constituents. The land-farming area is periodically tilled to provide the necessary mixing and oxygen transfer. Active land-farming includes the addition of water, nutrients and other materials to enhance the biodegradation process in the waste/soil mixture, and to prevent the development of conditions that might promote leaching and mobilisation of inorganic contaminants. The conditions under which degradation takes place are typically aerobic. Volatilisation and dilution are two other important mechanisms for reduction of degradation products in land applications of waste. Land-farming should not be confused with land-filling or burial, in which the waste is deposited in man-made or natural excavations for an indefinite period of time.

The accumulation of non-biodegradable constituents such as metals, salts and high molecular weight hydrocarbons such a polyaromatic hydrocarbons (PAHs) is an important consideration. The effects of accumulated metals, salts and heavy hydrocarbons can be evaluated on a site-specific basis by performing a risk assessment.

Considerations for the application of land-farming should also include the site topography and hydrology, and the physical and chemical composition of the waste and resultant waste/soil mixture. Waste application rates should be controlled to reduce the possibility of run-off. When a facility is properly designed, operated and monitored, land-farming is usually a relatively practicable and simple technique. Land-farms may require government permits or approval and, depending on soil conditions, may require a liner and/or groundwater monitoring wells. Moisture control to reduce dust (particulates) may also be necessary during extended dry conditions.

A landfarm facility designed for long-term operation will produce a treated residue that may need to be removed once the target concentrations are reached. When feasible, beneficial reuse of the treated soil is desirable to eliminate the cost and consumption of landfill space. Reuse options for landfarm residual materials can include road base, fill material, and tank berms. Risks associated with reuse of the treated material can be assessed in addition to evaluating the mechanical properties (if appropriate for final application of material) of the final product.

A4.1.2 Land treatment

Land treatment methods include land-spreading, bio-treatment units and in-situ bio-treatment. These methods differ from land-farming in that they are a single treatment event rather than repeated applications of oily wastes. This practice reduces the potential for the accumulation of waste components in the soil, as might be the case in land-farming sites that receive multiple applications of wastes. In land-treatment as in land-farming, aerobic biodegradation of hydrocarbons may be enhanced by nutrient addition to the waste/soil mixture and by periodic tillage of the mixture to increase aeration. This method is most often used at sites that will not be producing wastes on a long-term basis, continuous basis such as drilling sites. Before land-spreading, free oil should be removed from the waste. For E&P wastes, salts and hydrocarbons are most frequently the components that limit the application rate of a waste on a site. Characterisation of a waste and 'treatability' studies can be used to determine whether land treatment may be implemented effectively.

Construction of a containment system (liners) or monitoring of leachates from the site is seldom required for land spreading sites. However, site topography and hydrology, and the physical and chemical composition of the waste and resultant waste/soil mixture should still be assessed and waste application rates controlled to reduce the possibility of run-off.

Land treatment can be considered in the following situations:

- Large land areas are available.
- Groundwater is very deep or an impermeable barrier can be constructed easily.
- Starting oil concentrations are typically <5% in soil.
- Long treatment times are not an issue – landfarming may be appropriate.
- One-time application of wastes – applies to land treatment only.

A4.1.3 Composting

Methods include: static/passive aeration piles (biopiles) (ht. ~9-10 ft), windrows (ht. ~3-4 ft) and forced aeration piles

Composting can be considered in the following situations:

- Land space is limited.
- Climate is cold (piles conserve heat) and the growing season is less than three to four months.
- Oil concentrations are high - starting oil concentrations can be up to 15% in soil. Bulking agents and nutrients are typically required.
- Control of volatiles is required.
- Fast biodegradation rates are required.
- Management of food wastes and residuals (land-farming and land-treatment operations typically do not produce the high temperatures needed to destroy pathogens).

Composting is a biological treatment technique similar to land treatment. Biodegradation rates are enhanced by improving porosity, aeration, moisture content and operating temperature. Treatment times can be as short as one month, or as long as one year depending upon the starting oil concentration and oil composition. As a general rule, the starting oil concentration should be less than 15%.

Characteristics of composting are:

- Waste is mixed with bulking agents *eg* wood chips, straw, rice hulls or husks, to provide increased porosity and aeration potential. Care should be taken to confirm that the bulking agent provides sufficient porosity to allow aeration even at high moisture levels.
- Manure or agricultural wastes may be added to increase the water holding capacity of the waste/media mixture and to provide nutrients.
- Nitrogen and phosphorus-based fertilisers may be added to enhance microbial activity.

Micro-organisms capable of degrading petroleum occur naturally in oily wastes, soil and bulking agents; therefore there is no reason to add inoculums or commercial 'bug' products to compost. Mixtures of the waste, soil and other additives are formed into small or large piles, the precise dimensions are dependent upon the aeration method used *eg* static piles/passive aeration, or mechanically mixed, and the availability of land.

The compost mixture moisture should be maintained at 80% of field capacity or approximately 25-50% weight percent to provide optimal moisture conditions for biodegradation. Compost systems are characterised by elevated temperatures (30-70°C) within the compost mixture. Temperature may be controlled by forced aeration, or by tilling the soil pile initially once a week or whenever the compost temperature reaches ~50-60°C.

As with landfarming, beneficial reuse of the composted material is desirable to eliminate the cost and consumption of landfill space. Risks associated with reuse of the composted material can be assessed.

A4.2 Thermal treatment

Thermal treatment is useful for primarily organic compounds but can also process other wastes. There are several types of thermal treatment technologies, but incineration and reuse as fuel (fuel blending) are the most applicable ones for the wastes considered in this guidance.

Risk-based decision-making can be applied to certain aspects of thermal treatment. Risk assessments can be used to evaluate:

- Siting and design of the facility to mitigate potential air quality, soil and groundwater impacts.
- Treatment targets for treated waste materials.
- Reuse or disposals options for the treated residual or ash generated by the thermal process.

A4.2.1 Incineration

Incineration is a high temperature combustion/oxidation process in which organic wastes are converted into gases and solid residue. Incineration objectives usually include reducing toxicity and volume prior to disposal of solid residues. Proper incineration can be very efficient but also very expensive. Air pollution control equipment is typically required, or should at least be considered based on a risk-management approach. Additional treatment may be necessary for metals and salts in treated solid residues, depending on the final fate of the waste.

In E&P operations, incineration in an engineered system may be an appropriate option for materials like medical waste, solid waste refuse and some types of waste from operational activities. Proper incineration of sludges and liquid wastes is much more complex than for solid waste.

There are a number of incinerator types and selection will depend on a number of factors. Units typically most appropriate to support E&P operations range from relatively simple static chamber units to more complex rotary kilns and associated air pollution control systems range from secondary gas combustion chambers to more complex air pollution control systems that also reduce particulate emissions and combustion gasses such as sulphur oxides. Incineration of liquids or sludges almost always requires systems that are significantly more complex than those for solid wastes.

The evaluation of Incinerator technology should be undertaken by suitably qualified and experienced specialists. The design must take into account that exhaust gas temperature, air supply, turbulence and residence times are sufficient to achieve the desired level of waste treatment performance. Particular consideration should be given to the following factors:

- Chemical and physical nature and quantity of waste to be treated.
- Regulatory requirements.
- Site selection.
- Risk and cost factors compared to alternatives.
- Design and operating requirements, including operating complexity and maintainability.
- Process and environmental monitoring requirements.
- Air pollution control measures necessary to prevent adverse impacts.
- Disposal requirements for treated residues.

Certain wastes should not normally be considered for incineration unless the necessary pollution control equipment is available. This includes wastes containing significant concentrations of arsenic, mercury, chlorine, fluorine, bromine, iodine and lead. Metals will not be destroyed by incineration and will either be present in the gas stream or remain in ashes and residues. The presence of concentrated metals in solid residues might also trigger requirements for their stabilisation prior to land disposal.

Certain other wastes can pose serious combustion problems, for example:

- Explosives.
- Waste in drums which cannot, for one reason or another, be opened, shredded and emptied.

- Extremely, or spontaneously, flammable materials. Where possible, these should be diluted or treated at source to reduce the risks of premature ignition.
- Extremely toxic materials that can pose severe restraints on the methods of handling and treatment of the materials prior to thermal treatment.

The volume of waste from a single operator may not be high enough to justify operation of an E&P site incinerator, but contract operation of a regional facility that manages waste from multiple area operators can sometimes be a practicable alternative, especially when used for liquid and sludge wastes.

Solid and liquid residues from the incineration process can contain constituents that may need to be treated with appropriate caution. These residues can include slag from the furnace, fly ash and liquids from the gas cleaning plant. Liquids may need to be treated to remove certain constituents of concern before discharge or re-use. Solids can either be recycled or disposed of. Recycling could include, for example, their incorporation into concrete. Care should be taken not to impair the quality of the concrete and to confirm that constituents of concern are properly bound into the matrix. Disposal should be carried out in an environmentally sound manner, having proper regard to the materials generated, and wherever feasible reducing unwanted constituents by pre-treatment.

A4.2.2 Fuel blending

Many hydrocarbon residuals, such as those separated and recovered from produced water streams, can be reused as fuel. This sometimes requires a blending step to remove impurities and adjust physical properties to achieve appropriate fuel specifications.

One of the simplest ways to reuse hydrocarbons as fuel involves recycling the oil recovered from separations of waste generated by E&P or 'downhole' operations by blending them into the produced oil stream. From there, they again become part of the produced oil stream and are subject to conversion by downstream refining processes into fuels.

A cement kiln, when available, is usually an attractive and less expensive alternative to incineration of E&P oily wastes that are not suitable for reintroduction into the produced oil stream. Oily or solvent based (paint) waste may go into a fuel blending programme to replace fuel otherwise needed to fire the kiln. The retention time and temperature (typically 1400 to 1500°C) within a cement kiln are adequate to achieve thermal destruction of organics. Cement kilns may also have pollution control devices to reduce air emissions from the process. The ash from wastes combusted in the kiln will become incorporated into the cement matrix. These ashes may provide a desirable source of aluminium, silica, clay and other minerals that are typically added in the cement raw material feed stream.

A4.2.3 Thermal desorption

A thermal desorption system is a non-oxidising process using heat to desorb oil from oily wastes. Most thermal systems burn fuel to provide heat to volatilise the oil, but there are some systems that use electric or electro-magnetic energy for heat. Thermal desorption systems are generally of two types: low temperature systems and high temperature systems. The working temperature of low-temperature systems is usually 250 to 350°C, while high temperature systems may employ temperatures up to 520°C. Low temperature systems may be sufficient to treat wastes with light oils. High temperature systems will be able to achieve lower final oil contents for wastes containing heavier oils.

Thermal desorption of waste streams will produce various secondary waste streams: solids, water condensate, oil condensate and possibly steam from the condenser. Each of these streams may require analysis to determine its characteristics so that the best recycle/disposal option can be chosen. This is important if the original waste had high salts or metals levels, or if there are no wastewater treatment facilities on site, since additional treatment may be required to reduce the potential for environmental impact from these streams. In the case of air emissions, analysis may suggest that air control measures be employed to capture certain constituents.

A4.2.4 Open burning

Sometimes, open burning is used to dispose of small amounts of material for which there are no re-use or recycling options and/or where the transportation of wastes is unsafe due to poor infrastructure. Open burning is lower on the waste management hierarchy than other treatment and disposal methods. It may therefore be considered a less preferable option. However, in the circumstances described above and where regulations permit, burning may be conducted in approved areas in daylight hours and should not cause a nuisance.

A4.3 Chemical treatment

Chemical treatment processes are those in which materials are altered by chemical reactions. The chemical reactions can improve or enhance a separation/filtration process or, in some cases, create a product that is in a more convenient form for further processing or disposal.

A4.3.1 Neutralisation

One of the simplest detoxification processes is neutralisation. Neutralisation consists of adding an acid or base to a waste in order to adjust its pH. Neutralisation is a chemical reaction in which an acid and a base or alkali (soluble base) react and produce a salt and water. As an example, this treatment method can be used to neutralise battery acids, certain types of drum rinses/wastes, acid and caustics.

Neutralisation can be applied to any waste stream or wastewater requiring pH control. It is commonly used prior to biological treatment since bacteria are sensitive to rapid pH changes and values outside a pH range of 6 to 9. Neutralisation, or pH adjustment, may also be required prior to discharge of treated wastewater to a receiving stream. Neutralisation is also used as a pre-treatment for several chemical treatment technologies, including carbon adsorbtion, ion exchange and chemical oxidation/reduction processes. It is also useful in breaking emulsions and precipitating certain organic materials.

Neutralisation of certain wastes has the potential of producing air emissions. Acidification of streams containing certain salts, such as sulphide, will produce toxic gases. Feed tanks should be totally enclosed to prevent escape of acid fumes. Adequate mixing should be provided to dissipate the heat of reaction if wastes being treated are concentrated. The process should be controlled from a remote location if possible.

A4.3.2 Solidification/Stabilisation

Chemical fixation (or solidification/stabilisation) technologies can be broken down into three classes of systems, solidification, chemical fixation and solidification and sorption. Solidification refers to those techniques that reduce the hazard potential of a waste by converting the contaminants into their least soluble, mobile, or toxic form. Solidification refers to techniques that encapsulate the wastes into a solid of high structural integrity.

Typically, a combination of Portland cement and other chemicals such as slag, fly ash, silicate and lime is added to the waste. In general, these processes produce dry solids, either monolith or dry granular solid similar to coarse soil.

These types of processes can reduce the mobility of unwanted substances and seeks to trap or immobilise contaminants within their host medium (*ie* the soil, sand and/or building material that contain them). Leachability testing is typically performed to measure the immobilisation of contaminants. Solidification/Stabilisation can be used alone or combined with other treatment and disposal methods to yield a product or material suitable for land disposal, or in other cases, that can be applied to beneficial use.

Factors to consider when choosing this waste management option include, but are not limited to the following:

- Regulatory requirements.
- Process type and processing requirements.
- Chemical and Physical characteristics of the waste:
  - Depending on the type of waste, cement based systems have limitations - they may not work with elevated organic levels; when there is less than 15% solids; and if there are excessive quantities of fine soil particles or too many large particles present.
  - Elevated oil and salt content can be a problem.
  - pH levels need to be closely controlled for some types of technologies to be effective. Elevated pH levels or high total alkalinity can pose a problem if the wastes are subsequently land-applied or used as a soil supplement.
- Treatment objectives.

A4.4 Physical treatment

Physical treatment processes are characterised by the ability to separate the various phases of a waste without performing any chemical reaction or changing the chemistry of the mixture. Phase separation, such as separating solids from liquids or oil from water, is useful in concentrating constituents or removing free liquids to render a waste suitable for land disposal. By concentrating the material, additional treatment can be done more economically or conveniently, or recycling/reuse options may be possible. Typical treatments utilised in this waste management process include evaporation, gravity separation and centrifugation.

A4.4.1 Evaporation

Evaporation reduces the volume of a liquid or a saturated material by transforming the liquid into a vapour. It can be used to concentrate liquors, as an effective final disposal or to dry solids/sludges. As a selected means of waste treatment, evaporation is usually restricted to the evaporation of water. It is seldom appropriate from an Health, Safety and Environmental (HSE) or legal perspective to use evaporation for disposal of volatile organic compounds (VOCs) unless absorptive material is present to trap the evaporate.

Lagoons – in its most simple form evaporation is undertaken in lagoons using the energy from the sun to drive the process of vaporisation. The principal problems with this low-technology approach are: very slow rates of evaporation; dependence on climate; large land area requirement; potential need for a significant construction effort; and expensive liners. Lagoons can create health, safety and environmental problems such as odour and risks to wildlife and people. Another key environmental factor is the consequence of any loss of containment which excludes some sites as possible lagoon locations.

An important design consideration for lagoon construction is the management of sediment deposits. Some of the questions to consider at the evaluation stage are the probability of liner damage if an excavator is used and what will the consequences be, and where will the sediment finally be disposed of. Conversely, if the lagoon is designed to leave sediment in place what is the risk that it is filled with wind-blown dust negating the planned objective?

Evaporators – 'Forced Air Evaporators' utilise blowers to force air in a counter current to a free falling spray of water within a column. It is practicable and highly efficient when the waste stream to be evaporated is preheated by another process and does not contain VOCs that will be emitted to the atmosphere. Factors to consider are the need to preheat wastewater, cost, the risk of creating air emissions if VOCs are present and poor suitability for wastewaters with a high solids content.

The factors to consider for evaporators are: pre-treatment needs, energy cost, risk of vaporising VOCs, component damage from salts and acids, the need to dispose of highly concentrated slurries and the risk of a system running dry resulting in meltdown.

Sludge drying beds – typically these might be seen as outdoor sand bed filters as sludge water is dewatered by two mechanisms (i) the open surface area to allow for evaporation and (ii) gravity as the filtrate settles through the sand bed and is collected in under drains. Facilities without filtration are commonly called 'sludge lagoons'.

As with evaporation lagoons sludge lagoons are most successful in dry climates with high evaporation rates, need a large land area and usually require isolation from existing soils and groundwater.

A4.4.2 Gravity separation

Gravity separation is primarily used to treat two-phase aqueous wastes such as oil in water emulsions/sludges. For efficient separation, the non-aqueous phase should have a significantly different specific gravity than water and should be present as a non-emulsified substance. Emulsion between water and oil is common, and achieving gravity separation may require pretreatment using heat, pH adjustment, or an emulsion-breaking chemical. It is usually desirable to keep separator design small and simple to reduce cost.

A variation of the simple oil/water separator is the coalescing plate and corrugated plate separator, both of which significantly increase the surface area for oil to coalesce.

Gravity separation offers a straightforward, effective means of phase separation, provided the oil and water phases separate adequately within the residence time of the tank. Operational requirements are minimal. If heat, pH adjustment, or emulsion-breaking chemicals must be added to promote separation, laboratory tests should be periodically conducted to provide adequate and/or optimal treatment levels.

Consideration must also be given to the disposal of the extracted waste materials collected. For gravity separation processes, this material includes any immiscible oil, in addition to the separated oil and wastewater streams.

A4.4.3 Centrifugation

Centrifugation is an extension of gravity settling, where centrifugal forces are introduced by changes in angular velocity when the waste is spun in a circular motion. From a treatment point of view, centrifugation is more efficient than gravity settling since acceleration produced by mechanical means can far exceed gravity. However, from an energy point of view, the energy input is prohibitive unless the waste is highly concentrated. Capital and operating cost can be high, particularly in remote locations or where there is little economy of scale. Centrifuges are most often used in E&P operations for dewatering/de-oiling tank-cleaning or gravity separator sludges.

Centrifugation is technically and economically competitive with other sludge dewatering processes, specifically vacuum filtration and filter presses. The advantage of centrifugation over these processes is that centrifugation is more capable of dewatering sticky, gelatinous sludge. Disadvantages include that it is non-selective in separating components from each other. Also, there is a relatively high maintenance cost when processing abrasive materials. Finally, as this is a physical separation process, centrifugation is not capable of destroying or chemically altering hazardous materials, though it can be an effective means to enable further treatment, recovery/recycle or secure disposal of oily waste streams.

A4.5 Waste-specific treatment

Several waste-specific treatment technologies that have particular relevance for E&P operations are highlighted below.

A4.5.1 Non-incineration treatment for medical waste

An appropriately designed and operated incinerator can render medical wastes safe for managed landfills. However, medical wastes can often be treated effectively by simpler and less costly methods than incineration.

Low heat-thermal processes – typically autoclave or microwave systems – and chemical processes are used to manage potentially infectious wastes associated with medical clinics supporting E&P operations in areas that are remote or have inadequate infrastructure.

In general, low-heat thermal technologies operate between 93 and 177°C. Wet heat treatment involves the use of steam to disinfect and sterilise waste, and is commonly done in an autoclave. Microwave treatment is essentially a steam disinfection process, since water is added to the waste and destruction of micro-organisms occurs through the action of moist heat and steam generated by microwave energy. In dry heat processes, no water or steam is added. Instead, the waste is heated by conduction, natural or forced convection and/or thermal radiation using infrared heaters.

Chemical processes employ disinfectants such as dissolved chlorine dioxide, bleach (sodium hypochlorite), peracetic acid, or dry inorganic chemicals. To enhance exposure of the waste to the chemical agent, chemical processes often involve shredding, grinding, or mixing. In liquid systems, the waste may go through a dewatering section to remove and recycle the disinfectant. Besides chemical disinfectants, there are also encapsulating compounds that can solidify sharps, blood, or other body fluids within a solid matrix prior to disposal.

Mechanical destruction can render the waste unrecognisable and is used to destroy needles and syringes to render them unusable. In the case of thermal- or chemical-based processes, mechanical devices such as shredders and mixers can also improve the rate of heat transfer or expose more surfaces to chemical disinfectants.

A mechanical process is supplementary and should not be considered a treatment process. Unless these devices are an integral part of a closed treatment system, they should not be used before the waste is decontaminated; otherwise, workers can be exposed to pathogens released to the environment by mechanical destruction.

A4.5.2 Wastewater treatment

Sanitary waste (sewage), domestic wastewater, industrial wastewater and some liquid waste can be treated in a wastewater treatment plant. Wastewater treatment is the process of treating or removing contaminants from the water and includes physical, chemical and biological processes to purify the water and concentrate contaminants for easier disposal. Its objective is to produce a waste stream (or treated effluent) which is of high enough quality to be reused or discharged back into the environment.

All wastewater treatment systems produce a solid waste or sludge. Sometimes these solids are suitable for reuse or discharge back into the environment. Prior to reuse or discharge, periodic testing should confirm constituents of concern are below harmful levels, otherwise, sludges should be disposed of at proper facilities.

Typically, wastewater treatment involves three stages, called primary, secondary and tertiary treatment. First, the solids are separated from the wastewater stream and sent to disposal. This removal may be by screening or clarification, with or without chemical enhancement. Then dissolved organic matter is progressively converted into a solid mass using indigenous, water-borne bacteria. Finally, the biological solids are neutralised then disposed of or re-used and the treated water may be disinfected chemically (usually with chlorine or ozone) or physically (for example by lagooning or extended aeration). The final effluent may be of high enough quality to be discharged into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, greenway or park. If it is sufficiently clean, it can also be used for groundwater recharge.

A4.6 Waste disposal options

Multiple approaches for waste management may be appropriate, depending on local needs and the availability of resources and technology. In any one region, site specific factors can be important in deciding which of the available disposal options is most appropriate and may provide the best environmental benefit in a risk-based and practicable manner.

A4.6.1 Underground injection

In some locations, particularly in sensitive environments where discharges are not permitted or where no local waste management infrastructure is available, operators may choose to inject E&P solids like drill cuttings and sludges to underground formations. This process is known by various names, including cuttings reinjection, slurry fracture injection, slurry injection, fracture slurry injection, drilled cuttings injection and grind and inject.

In slurry-fracture injection, solids are ground or processed into small particles and mixed with liquid (often seawater) to make a slurry. The slurry is injected into an underground formation at pressures high enough to fracture the rock. When the injection pressure is lowered, the liquids bleed off into the formation while the solids remained trapped in the cracks.

The two other common forms of underground injection are annular injection (of drilled cuttings) and injection of slurried waste or wastewater into a disposal well. Annular injection introduces the waste slurry through the space between two casing strings (known as the annulus). At the lower end of the outermost casing string, the slurry enters the formation. Many annular injection jobs are designed to receive wastes from just one well. On multi-well platforms or onshore well pads, the first well drilled may receive wastes from the second well. For each successive well, the drilling wastes are injected into previously drilled wells. In this mode, no single injection well is used for more than a few weeks or months.

The disposal well alternative involves injection to either a section of the drilled hole that is below all casing strings, or to a section of the casing that has been perforated with a series of holes at the depth of an injection formation. Injection programmes with a dedicated disposal well may inject into the same well for months or years.

In order for underground injection of cuttings or wastewater to be practical at a particular location, the geologic conditions beneath the site must be suitable to receive the injected material. Slurry-fracture injection relies on fracturing, and the permeability of the formation receiving the injected slurry is a key parameter in determining how readily the rock fractures, as well as the size and configuration of the fracture. When the slurry is no longer able to move through the pore spaces and the injection pressure continues to be applied, the rocks will crack or fracture. Most annular injection jobs inject into shale or other low-permeability formations, and most dedicated injection wells inject into high-permeability sand layers. Regardless of the type of rock selected for the injection formation, preferred sites will be overlain by formations having the opposite permeability characteristics (high vs. low). When available, locations with alternating sequences of sand and shale are good candidates to contain fracture growth. The geology of some areas may be unsuitable for injection due to the presence of extensive geological faults resulting in reservoirs small in areal extent, formations that seal poorly around a well, formations that tend to fracture to the surface, or formations with insufficient permeability or close proximity to aquifers.Problems have been observed in some cuttings reinjection jobs. The most common problems were operations-related *eg* plugging of the casing or piping because solids had settled out during or following injection; excessive erosion of casing, tubing and other system components caused by pumping solids-laden slurry at high pressure. Environmental problems associated with reinjection are rare but are of much greater concern. Unanticipated leakage to the environment not only creates potential environmental damage and liability to the operator, but also generally results in a short-term to permanent stoppage of injection at that site. Several large injection jobs have resulted in leakage to either the ground surface or the sea floor in the case of offshore wells. The most likely cause of these leakage events is that the fracture moved upward and laterally from the injection point and intersected a different well that had not been properly cemented or a natural geologic fault or fracture. Under the high downhole pressure, the injected fluids seek out the pathway of least resistance. If cracks in a well's cement or geological faults are present, the fluids may preferentially migrate upward and reach the land surface or the sea floor. In situations involving closely-spaced wells, the potential for communication of fluids between wells should be carefully evaluated.

A4.6.2 Landfill

A landfill is an engineered and constructed disposal unit for secure, permanent containment of large volumes of non-liquid wastes. Land-farming and land-treatment are not considered to be landfilling.

Landfills can be natural, topographic depressions and man-made excavations formed of earthen material. A key consideration in the operation of a landfill site is the need to provide long-term containment. Design considerations for a landfill site should consider an appropriate combination of the following controls:

- Single or double liner – Liners may be constructed of compacted clay, plastic sheeting or multi-layer linings with integrated drainage systems. A liner restricts the downward or lateral migration of waste constituents.
- Leachate collection and removal system – typical leachate collection system includes a drainage layer, collection pipes and a removal system.
- Leak detection system.
- Run-on, runoff – surface runoff water should flow away from the landfill or be diverted around it.
- Provisions for landfill closure and aftercare.

Landfills are not constructed to uniform standards. Wastes should only be placed in sites that are designed to receive and contain them. Additionally these sites should have appropriate monitoring and maintenance programmes. Landfill material should not be capable of reacting to generate excess heat or noxious gases. Special systems may need to be installed to monitor, capture and utilise landfill gases. Disposal sites should be operated either by the waste generator who will maintain responsibility for its own wastes or by a properly managed third party disposal facility.

A4.6.3 On-site burial

Burial is the placement of waste in man-made or natural excavations, such as pits, on a temporary or permanent basis.

On-site waste burial may be the preferred option, for example waste generated on exploratory drilling sites or seismic camps in remote onshore areas. Waste burial can be considered acceptable, once the associated risks have been assessed and provisions have been made for closure and aftercare (including records of location and content – see Section 5 above).

A4.6.4 Discharge to water or land

Surface discharge is one disposal option for treated aqueous waste streams where legally permissible (permit to discharge may be required). Factors to consider include the sensitivity and capacity of the potential receiving environment, the concentration of potentially harmful components in the waste and the volume of the discharge stream. For discharges to water bodies, the capacity to absorb pollutants naturally is a function of the dilution potential and volume of the receiving water body. In this regard, the discharge of a high volume, saline waste stream into a small creek may not be appropriate while discharge of the same waste stream into a large water body may be acceptable. For produced waters, the use of percolation or evaporation has been used in areas where fresh water is not present.

Appendix 5
Waste management options summary table

This table summarises some of the possible reduction/recycling, treatment and disposal methods that may be applicable to a variety of wastes typically found in E&P operations.

This list is not exhaustive. The preferred reduction/recycling, treatment and disposal methods may vary according to available facilities, local conditions and regulatory requirements. Indications in the table that reduction options may exist do not necessarily mean that a significant reduction in waste volume can be reasonably achieved. Similarly, indication that a treatment or disposal option may be applicable does not necessarily mean that it will be appropriate or effective for specific waste streams or all environments. Combinations of treatment and disposal methods may be required to meet management objectives.

When using the following guidance, please keep in mind that it is important to understand the chemical, physical and biological characteristics of the waste as well as the scale and frequency of generation.

Table 6 – Waste management options summary table

	Recycle				Treatment						Disposal		
	Reclaim/reuse	Use as fuel	Composting	Return	Incinerate	Neutralisation	Evaporation	Waste water systems	Land treatment	Solidification/stabilisation	Inject to sub-surface	Discharge to Surface†	Landfill‡
Acids/Alkalis	x			x	x	x	x	x			x	x	
Activated carbon	x	x		x	x				x				x
Asbestos/refractory materials													x
Ash (combustion residues)	x		x							x			x
Battery Electrolyte	x			x		x				x			x
Catalysts	x			x	x	x				x	x		x
Chemicals – Unused or Spent Chemicals and Residues	x	x		x	x	x	x	x		x			x
Construction and demolition material	x	x	x	x	x								x
Containers (empty) – drums/barrels	x			x	x	x							x
Domestic wastes/trash/food wastes	x	x	x		x				x				x
Drum Rinse	x	x			x	x	x	x			x		x
Electronic & computer wastes	x			x									x
Filters (air/water/other)	x	x		x	x					x			x
Gas Cylinders	x			x									x
Glass	x			x	x								x
Glycol and Antifreeze	x			x	x			x		x	x		x
Hydrotest fluids	x			x	x		x	x			x	x	
Insulating materials (non-asbestos)					x								x
Ion exchange resins/molecular sieves	x			x	x								x
Lubricants and hydraulic fluids	x	x		x	x					x			x
Medical waste					x					x	x		x
Mercury-containing wastes† (including fluorescent tubes)	x			x						x			x
Paper & packaging wastes	x	x	x	x	x				x				x
Paint & other coating wastes	x	x		x	x		x			x			x
PCBs & PCB-containing wastes					x								
Plastic & rubber wastes	x		x	x									x
Produced sand			x		x				x	x	x		x
Radioactive materials (not including NORM)	x			x						x	x		x
Refrigerants	x			x									
Scrap Metal	x												x
Sludge from domestic sewage treatment			x				x	x	x	x		x	x
Stranded chemicals/solvents – halogenated, non-halogenated, corrosive etc	x	x		x	x		x			x	x		x
Tyres	x	x		x	x								xΩ
Wastewater			x				x	x	x		x	x	

† After appropriate treatment as necessary.
‡ Liquid wastes should not be placed into landfills prior to solidification.
Ω Shredded.

Appendix 6
Waste definitions

Table 7 – Waste definitions

Waste	Definition
Acid/Alkalis including wet cell battery electrolytes	Waste acids/alkalis should be managed as corrosive wastes if their pH is less than 2.0 or greater than 12.5.
Activated Carbon	Discarded charcoal and activated carbon, including filters, used and unused. May be self-heating or pyrophoric if used in sour gas service.
Asbestos/Refractory Material	Both friable and non-friable asbestos waste containing more than 1% asbestos by weight.
Ash – (combustion residues)	Residual matter from combustion. May have a pH greater than 12.5.
Battery Electrolyte	Spent nickel-cadmium, lithium, mercury-cell, and lead-acid batteries. May be corrosive or water reactive.
Catalyst	A substance (solid, liquid, or gas) whose presence increases the rate of a chemical reaction and may be recovered at the end of the reaction.
Chemicals – Unused or Spent Chemicals and Residues	Chemicals and additives or their residues that may no longer be used for their intended purpose because of being spent or degraded, expired or obsolete (change in methodology).
Construction & Demolition Material	By-products of construction, maintenance, demolition activities. Most of these wastes tend to be inert.
Containers – (empty) drums, barrels	A container is empty if all material has been removed that can be removed using practices commonly employed to remove the material from that type of container e.g., pouring, pumping, aspirating. Containers that are not empty should be managed based on the characteristics of the contained material.
Domestic Waste/Trash/Food	Discarded items from the kitchen, bathroom, laundry, warehouse, offices, etc. Many of these items may be biodegradable; others will be inert.
Drum Rinse	Aqueous rinsate from steam cleaning, or rinsing containers.
Electronic and Computer Wastes	Toner cartridges, mobile phones, computers and other accessories.
Filters – (gas/air, water, other)	These filters may be sock, cartridge, or canister-type filters used to remove solids and impurities.
Gas Cylinders (empty)	A cylinder is empty if all material has been removed that can be removed using practices commonly employed.
Glycol and Antifreeze	Glycol solutions (& sludges) such as ethylene, diethylene, triethylene and tetraethylene glycol used in dehydration or cooling.
Hydrotest Fluids	Fluids used to test pipeline integrity.
Lubricants and Hydraulic Fluids	Petroleum-based lubricating greases, motor oils and transmission oil, hydraulic fluids as well as synthetic oils used for these same purposes. These oils may contain impurities, e.g. metals, as a result of their use.
Medical Waste	Wastes generated by general clinical procedures including sharps. Many of these may contain pathogens and be potentially biohazardous materials.
Mercury-Containing Wastes	Surplus mercury and devices containing mercury including fluorescent tubes.
Paper and Packaging	Paper, cardboard and wood.
Paint (and other coatings)	Liquid and semi-liquid coating and thinner wastes generated in construction and maintenance operations.
PCB & PCB Containing Equipment	PCB oil & filled equipment.
Plastic and Rubber	Materials comprised of plastics (PET, HDPE, PVC, LDPE, PS, etc) and rubber.
Produced Sand	Sands entrained in production fluids.
Radioactive Materials (not including NORM)	Radioactive source materials e.g. used in logging and detection of pipeline welds, smoke detectors and laboratory equipment.
Refrigerants	Cooling substances; any of the various halocarbon compounds consisting of carbon, hydrogen, chlorine and fluorine e.g. chlorofluorocarbons (CFCs).
Scrap Metal	Excess used and unused metal materials and equipment.
Sludge from Domestic Sewage treatment	Sludge consisting of the bio mass removed to remain equilibrium in a sewage treatment unit.
Sludge – Hydrocarbon	Hydrocarbon laden solids/sediments that accumulate in vessels, treatment, storage facilities (separators, fluid treatment vessels, impoundments) and in equipment which are typically recovered when performing maintenance/turnaround on these vessels.
Wastewater	Spent or used water with mixture of water and dissolved or suspended solids.

Appendix 7
International provisions related to waste management

Basel Convention on the control of transboundary movements of hazardous wastes and their disposal.

The Basel Convention aims to "protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes" (www.basel.int). This global convention, currently has 170 Party Countries and came into force in 1992. The Basel Convention focuses on international shipment (*ie*, the trans-boundary movement) of wastes. The Basel Convention requires that notification to affected Party Countries take place prior to exporting hazardous waste to a country, importing hazardous wastes from a country or even crossing through a Party Country with "hazardous and other wastes". A shipment of waste by a Party Country in violation of the Basel Convention is a treaty violation and illegal.

The Parties to the Convention adopted two significant amendments, although neither one is yet in effect as it has not been ratified by the required number of Member countries:

Basel Ban

This is a 1995 amendment, which would prohibit the export of hazardous wastes from highly industrialised countries (members of the Organisation for Economic Co-operation and Development or OECD countries[†]) to non OECD countries. This "Basel Ban" amendment has not yet been ratified by the required number of countries and is not yet in effect. However, European Union countries that are members of the OECD generally have agreed to follow the Basel Ban and restrict exports of wastes from their countries to non-OECD countries that are Basel Parties.

Liability Protocol

In 1999, a "Protocol on liability and compensation for damage resulting from trans-boundary movements of hazardous wastes and their disposal" was adopted. Again, it is not yet in effect[†].

It is worth noting that the Secretariat for the Basel Convention has put at top of its priorities for the next decade the creation of partnerships with industry and research institutions to create innovative approaches to Environmentally Sound Management (ESM) of wastes.

The Basel Convention defines the categories of wastes to be controlled (Convention Annex 1) and lists the hazardous characteristics that lead to an inherent definition of hazardous wastes for the purpose of the Convention (Article 1.1). Many wastes from E&P activities fall under these definitions: wastes containing heavy metals, asbestos, organic solvents, PCBs, *etc* According to Article 3 of the Convention, each party (State) to the convention should have a National definition of hazardous wastes, according to the criteria mentioned above.

Obligations under the Basel Convention are obligations between the States which are Parties to the Convention, not between an operator and a State. Nevertheless the States place on the individual operator/general the responsibility to provide all information required by the 'State of Export' to notify the State of Import (information to be provided is given in Annex VB to the Convention) about the nature of the waste and the intended shipment. A shipment of hazardous waste or other waste must be accompanied by a movement document from the point at which a trans-boundary movement begins to the point of disposal. Hazardous waste shipments made without such documents are illegal N.B. if shipments will occur on a regular basis, a single authorisation may be obtained to cover repeated shipments of the same waste between the same countries for a specific period of time. The competent authorities of the State of Export are not authorised to allow exportation of waste until the 'State of Import' has given clearance (Article 6). In addition a number of articles in the Convention oblige national governments which have acceded to the Convention to take

† *The current OECD Member Countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.*

appropriate measures to implement and enforce its provisions, including measures to prevent and punish conduct in contravention of the Convention (Article 9). In some cases, an affected Country may require that the operator/generator provide some form of financial assurance before a shipment of hazardous waste may proceed.

One of the guiding principles of the Convention is that hazardous wastes should be dealt with as close to where they are produced as possible. Under the Basel Convention, trans-boundary movements are to be allowed where the State of export does not have the capability of disposing of the hazardous waste in an environmentally sound manner.

Among the few UN countries which are not yet members of the Convention, it is worth noting Angola, Gabon and the United States of America (as at the time of writing these guidelines). Because these countries are not Basel members, Basel Convention Member Countries are forbidden from engaging in hazardous waste movements (imports, exports, in-transit movements) involving these countries. A significant exception to this prohibition is where a Basel Member Country has an independent bilateral, multilateral or regional agreement/treaty with a non-Basel Member that allows for the environmentally-sound management of hazardous waste, for example, the United States is an OECD Member and therefore may engage in hazardous waste management with other OECD countries pursuant to OECD agreements. Another example is the Bamako Convention, which aims at protecting Africa from import of hazardous wastes. If a country that is not a Basel Member is a member of the Bamako Treaty, the Basel Convention would allow the movement of waste between Bamako members, consistent with the terms of the Bamako Treaty.

Additional information can be found on the official website of the Basel Convention: www.basel.int

Annex V A *Information to be provided on notification*	**Annex V B** *Information to be provided on the movement document*
1. Reason for waste export 2. Exporter of the waste ① 3. Generator(s) of the waste and site of generation ① 4. Disposer of the waste and actual site of disposal ① 5. Intended carrier(s) of the waste or their agents, if known ① 6. Country of export of the waste Competent authority ② 7. Expected countries of transit Competent authority ② 8. Country of import of the waste Competent authority ② 9. General or single notification 10. Projected date(s) of shipment(s) and period of time over which waste is to be exported and proposed itinerary (including point of entry and exit) ③ 11. Means of transport envisaged (road, rail, sea, air, inland waters) 12. Information relating to insurance ④ 13. Designation and physical description of the waste including Y number and UN number and its composition ⑤ and information on any special handling requirements including emergency provisions in case of accidents 14. Type of packaging envisaged e.g. bulk, drummed, tanker 15. Estimated quantity in weight/volume ⑥ 16. Process by which the waste is generated ⑦ 17. For wastes listed in Annex I, classifications from Annex III: hazardous characteristic, H number and UN class 18. Method of disposal as per Annex IV 19. Declaration by the generator and exporter that the information is correct 20. Information transmitted (including technical description of the plant) to the exporter or generator from the disposer of the waste upon which the latter has based his assessment that there was no reason to believe that the wastes will not be managed in an environmentally sound manner in accordance with the laws and regulations of the country of import 21. Information concerning the contract between the exporter and disposer.	1. Exporter of the waste ① 2. Generator(s) of the waste and site of generation ① 3. Disposer of the waste and actual site of disposal ① 4. Carrier(s) of the waste ① or his agent(s) 5. Subject of general or single notification 6. The date the transboundary movement started and date(s) and signature on receipt by each person who takes charge of the waste 7. Means of transport (road, rail, inland waterway, sea, air) including countries of export, transit and import, also point of entry and exit where these have been designated 8. General description of the waste (physical state, proper UN shipping name and class, UN number, Y number and H number as applicable) 9. Information on special handling requirements including emergency provision in case of accidents 10. Type and number of packages 11. Quantity in weight/volume 12. Declaration by the generator or exporter that the information is correct 13. Declaration by the generator or exporter indicating no objection from the competent authorities of all States concerned which are Parties 14. Certification by disposer of receipt at designated disposal facility and indication of method of disposal and of the approximate date of disposal.
Notes ① Full name and address, telephone, telex or telefax number and the name, address, telephone, telex or telefax number of the person to be contacted. ② Full name and address, telephone, telex or telefax number. ③ In the case of a general notification covering several shipments, either the expected dates of each shipment or, if this is not known, the expected frequency of the shipments will be required. ④ Information to be provided on relevant insurance requirements and how they are met by exporter, carrier and disposer. ⑤ The nature and the concentration of the most hazardous components, in terms of toxicity and other dangers presented by the waste both in handling and in relation to the proposed disposal method. ⑥ In the case of a general notification covering several shipments, both the estimated total quantity and the estimated quantities for each individual shipment will be required. ⑦ Insofar as this is necessary to assess the hazard and determine the appropriateness of the proposed disposal operation.	**Notes** The information required on the movement document shall where possible be integrated in one document with that required under transport rules. Where this is not possible the information should complement rather than duplicate that required under the transport rules. The movement document shall carry instructions as to who is to provide information and fill-out any form. ① Full name and address, telephone, telex or telefax number and the name, address, telephone, telex or telefax number of the person to be contacted in case of emergency.

MARPOL, the Convention for the prevention of pollution by ships

MARPOL is another global convention (over 130 Parties) which addresses waste management. In particular, its Annex V for the "prevention of pollution by garbage from ships". The definition of ships includes fixed and floating platforms, *ie* offshore oil and gas production facilities. 'Garbage' is defined as "all kinds of victual, domestic and operational waste (...) generated during normal operation of the ship (...)". This excludes wastes generated by the E&P technical activities. Ships are required to provide a Garbage Record Book the form of which is specified. The disposal of garbage from a platform or a ship alongside or within 5000 metres of such installations is prohibited, except for food wastes for which disposal may be allowed under certain size restrictions and provided the platform is located more than 12 nautical miles from land.

Acronyms list

CFC	Chlorofluorocarbon
EIA	Environmental Impact Assessment
E&P	Exploration and Production
EPI	Environmental Performance Indicator
e-SHRIMP	Environmental, Social & Health Risk & Impact Management Process
ESIA	Environmental and Social Impact Assessment
ESM	Environmentally Sound Management
FEED	Front End Engineering Design
GPS	Global Positioning System
HDPE	High Density Polyethylene
HSE	Health, Safety and Environment
LDPE	Low Density Polyethylene
LSA	Low Specific Activity
MARPOL 73/78	International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978
MSDS	Material Safety Data Sheet
NGO	Non-Governmental Organisation
NORM	Naturally Occurring Radioactive Material
OECD	Organisation for Economic Co-operation and Development
OGP	International Association of Oil and Gas Producers
PAH	Polyaromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCP	Pentachlorophenol
PET	Polyethylene Terephthalate
PPE	Personal Protective Equipment
PS	Polystyrene
PSA	Production Sharing Agreement
PVC	Polyvinyl Chloride
SOLAS	International Convention for the Safety of Life at Sea (1974)
US EPA	United States Environmental Protection Agency
UNEP DTIE	United Nations Environment Programme; Department of Technology, Industry & Economics
VOC	Volatile Organic Carbon

What is OGP?

The International Association of Oil & Gas Producers encompasses the world's leading private and state-owned oil & gas companies, their national and regional associations, and major upstream contractors and suppliers.

Vision

- To work on behalf of the world's oil and gas producing companies to promote responsible and profitable operations

Mission

- To represent the interests of oil and gas producing companies to international regulators and legislative bodies
- To liaise with other industry associations globally and provide a forum for sharing experiences, debating emerging issues and establishing common ground to promote cooperation, consistency and effectiveness
- To facilitate continuous improvement in HSE, CSR, engineering and operations

Objectives

- To improve understanding of our industry by being visible, accessible and a reliable source of information
- To represent and advocate industry views by developing effective proposals
- To improve the collection, analysis and dissemination of data on HSE performance
- To develop and disseminate best practice in HSE, engineering and operations
- To promote CSR awareness and best practice

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