Sustainable Liquid Waste Management: Mining and Timing

Alicia Brown
GHD Pty Ltd, GradIEAust

Elis Smedley
GHD Pty Ltd

Christopher Gwynne
GHD Pty Ltd

ABSTRACT
Within the mining industry, liquid waste management facilities are often incorporated too late in the engineering design to enable best or sustainable practice. Unsustainable design of facilities can lead to environmental pollution, additional capital and operational costs for environmental retrofits and the instigation of operational problems. The solution to implementing sustainable liquid waste practice is a strategic and timely decision making process. Stepping through the pre-feasibility, feasibility and definition phases of mine establishment, this paper examines when and with what level of detail decisions need to be implemented to ensure integrated, cost effective and sustainable solutions to liquid waste management. Three common barriers to implementing sustainable liquid waste management in design have been identified:

1. A liquid waste design strategy is not defined and agreed early in design;
2. Design teams are (necessarily) focussed on core functional design, rather than sustainable design. Sustainability is everyone's and hence, no-one's responsibility;
3. Low risk, generic solutions are often implemented that are not tailored to the project environment.

The practical solutions offered include securing management agreement to a liquid waste management strategy early in the design, embedding environmental engineering teams into projects, conducting sustainable design reviews (in a similar way to safety or risk design reviews), providing rapid feedback on the sustainability impacts of design changes and designing to meet or exceed compliance in the long term. At a project specific level, examples of practical methods of liquid waste management such as bunding, drainage design, oily and wastewater treatment and spill management are identified in the context of project phases.

INTRODUCTION

Within the mining industry, waste does not drive the design process and is therefore normally incorporated as a downstream design element. This means that liquid waste management facilities are often considered and incorporated too late in the engineering design to enable best or sustainable practice. This results in long term liquid waste management issues that can result in increased operational costs, difficult to manage sites and presents significant environmental and safety hazards. Based on experience, these facilities are common candidates for retrofit projects which are highly constrained in their achievements and much more costly to implement than a well considered sustainable design.

Oily liquid wastes generated at mine sites typically comprise of contaminated surface water runoff, vehicle or fuel depot washdown water containing solvents, coolants or waste oil and waters that contain high sediment loads. For brevity this paper does not focus on domestic wastewater or process wastewater, however these are equally valid candidates for discussion. There are several practical reuse and disposal options available including landfarm irrigation, dust suppression, washbay reuse and environmental release. The solution to developing sustainable liquid waste management is a strategic and timely decision making process, it is simply not practical to consider waste only at the beginning or towards the end of a project. Stepping through the pre-feasibility, feasibility and definition phases of mine establishment, this paper examines when and with what level of detail decisions need to be implemented to ensure integrated, cost effective and environmentally viable solutions to liquid waste management in the mining industry.

COMMON PROBLEMS WITH LIQUID WASTE MANAGEMENT

Liquid waste management design is often a low priority early in a project and is usually assumed to be a standard approach (such as tankering offsite). As the project progresses, if the assumed standard approach is not appropriate, the options left are often less efficient, more expensive and unsustainable. Unfortunately, the opportunities for innovative design also pass.

Incorporating effective liquid waste management design into facilities is a multi-disciplinary task, however it is often allocated to individual discipline design managers for whom it is not a priority. It is not uncommon for liquid waste facilities to get built using generic drawings or processes, such that they are not appropriate for the quantity or quality of waste generated. This can lead to facilities that simply do not work, have higher operational expenditure, often cause environmental pollution and eventually affect the core functions of the site. For example, at a Western Australian power station the impact of an undersized oily waste bund led to oil entering the process water stream, causing significant operational impact.

Common liquid waste problems that have been encountered at mining and heavy industrial sites include:

- Poor sediment management, including:
  - Undersized or poorly designed sediment traps, resulting in sediment impacts on downstream drains and facilities;
  - Infrequent cleaning of sediment traps resulting in a loss of detention time and less efficient treatment;
  - Insufficient drainage grades resulting in sediment accumulation, blockages and flooding;
  - Soil and groundwater contamination associated with drying and disposing of oily or contaminated sediments.
- Poor oily water management, including:
  - Inability to isolate significant spills at the source;
  - Inappropriate oily water separators or insufficient maintenance (triple interceptors, blocking of plate separators, accumulation of hydrocarbons within sumps);
  - Oily water collection systems not appropriate for the sediment or oil loads being experienced.
- Inappropriate liquid waste storage and disposal facilities:
  - Inadequate facilities to either store or dispose of all the liquid wastes generated at the site;
  - Oil and oily water collection ponds typically leak or accumulate large amounts of bulk oil and represent significant environmental and health risks (including odour, bird kill, contamination, fire);
  - Challenges in designing an effluent disposal facility that is both compliant with licence conditions and appropriate for the local environment.
- Poor understanding of the long term liabilities and costs of clean-up (at mine closure or site divestment) associated with poor liquid waste management.

BARRIERS AND OPPORTUNITIES

From the previous examples it is clear that good liquid waste management has the potential to reduce financial liability and environmental pollution, but there are numerous other practical reasons that it should be implemented. Experience has shown that well designed facilities are easier to maintain, therefore they are more likely to be maintained and function for the whole of their design life. Engineering the design allows a firmer control over budgets, particularly with setting the capital expenditure (CAPEX) to operational expenditure (OPEX) ratio. It is always more sustainable to prevent pollution than to clean it up and appropriately designed facilities often obtain approvals faster and easier.

Mechanisms such as Environmental Impact Assessments (EIAs) and Environmental Management Plans (EMPs) have an important role to play in sustainable liquid waste management. Part V of the Environmental Protection Act (1986) states that 'a person who allows pollution to be caused commits an offence'. This legislation is integral in motivating mining companies to operate and sustain the facilities that treat and dispose of liquid waste and in defining acceptable discharge from the site. Good EIA should identify the key hazards likely to result from the operation and set the targets for engineering design. However, what has been observed is that the Approvals process is limited because it can only ever assesses the one option in front of it and any design, sustainable or otherwise, could pass at this level of assessment provided that it satisfies the legislative requirements. EMPs are another tool important in maintaining compliance and ensuring environmental protection. However, without a design which is manageable in the first place, including being suitable to the operational environment, the EMP process cannot be sustained in the long term, as observed in the power station case study. Ultimately, sustainable LWM is an engineering design problem and its three primary barriers are discussed below:

A. A liquid waste design strategy is not defined and agreed early in design.

This means that key project decisions are made that do not consider the implications for liquid waste. Early design may overlook large portions of waste management altogether, based on the thinking that standard solutions exist that are appropriate. However, liquid waste collection, treatment and disposal is highly constrained. It often requires large areas (e.g. storage and evaporation dams) and is necessarily very close to and must be integrated with other mining facilities. A strategy, while not providing exact design solutions, can assist by stating agreed preferences and aspects for each facility. A mine site liquid waste strategy would consider items such as bund stormwater management, washbay drainage and treatment, sediment trap location and sizing, gravity drainage over pumping or tankering and central versus distributed oily water treatment. The strategy would also identify environmental aspects such as location (disposal options can be spatially demanding) and sensitive receptors.

B. Design teams are (necessarily) focussed on core functional design, not sustainable design. Sustainability is everyone's and hence, no-one's responsibility.

It is not usually any one person's job to look after waste and sustainable design. Sustainable design has historically been divided into the design of individual components and not approached holistically. This has meant that many disciplines are involved, but rarely one person or team has control, leading to it often taking a backseat on design criteria or being overlooked. An allocated position is required to identify real issues from perceived ones and ensure that they are addressed within the appropriate project phase.

C. Low risk, generic solutions are implemented that are not tailored to the project environment.

Identifying the natural, operational, financial and work culture aspects of an environment is integral in ensuring a sustainable solution to liquid waste management for a site. To be optimised, solutions must consider the environment and the risk profile for the region, as opposed to relying on standardised solutions.

PRACTICAL SOLUTIONS

In response to these three barriers, practical solutions are required to implement a liquid waste management strategy throughout a project lifecycle. Firstly, there is a need to embed environmental engineering teams into projects. The role of the environmental engineer is to link design teams with the environmental approvals teams and to ensure that sustainability is considered during design. As professionals, environmental engineers gain specific experience over their careers, are up to date with the latest technologies and suppliers and create design tools that are highly specific to industry. Environmental engineers can ensure that designers and decision makers understand the financial, compliance, social and environmental implications of their decisions. By having an understanding of the overarching waste management issues, the important issues can be identified and debated so that whilst waste is not a driving process, it is given due consideration within the overall design.

The following practical solutions are also recommended:

- Conduct sustainability and environmental design reviews;
- Design for compliance. That is, develop a basis of design based upon the environmental and risk profile for the waste and the relevant license conditions;
- Consider both onsite and offsite impacts (odour, dust);
- Ensure that designs are practical to operate given the level of interaction likely for the site and equipment available; and
- Consider and manage issues associated with construction and operational activities.

By implementing practical solutions, the management of liquid waste will not only be compliant with environmental criteria, but will also be a tailored solution that is more effective, cheaper and potentially a flagship for future designs. Once the framework for implementing a waste management strategy has been formed, the details of more specific methodology can be investigated. There are several different aspects of liquid waste management and design which require implementing at different stages of the project. Key design aspects to be considered during the pre-feasibility, feasibility and definition phases of a project are discussed below.

TIMING OF IMPLEMENTATION

Pre-Feasibility Phase

The pre-feasibility phase of a mining project predominantly comprises the environmental management issues directly related to the ore body. Environmentally, this means mine dewatering which is effectively a black and white issue surrounding the ability to pump and dispose of the water. The mine will either be deemed feasible or not, such that it does not constitute the focus of liquid waste management. Key sensitive receptors may also be identified at this stage, as these may have ramifications for the feasibility of the mine proceeding.

Feasibility (Concept) Phase

The feasibility stage is where the quality and quantity of generated liquid waste are identified and conceptual flows, treatment pathways and disposal options are determined. This is the most important phase for the successful management of liquid waste. The feasibility stage requires consideration of the types of liquid waste, the method of its disposal (and treatment) and the environmental context such as drainage, rainfall and evaporation. The feasibility stage includes consideration of:

- Site layout, with regards to land allocation and both the on and offsite impacts from odour, dust and noise;
- Stormwater exclusion bunds;
- Liquid waste management philosophy (such as central versus local treatment, tankering versus piping versus pumping, water reuse options);
- Gravity drainage lines, sumps and onsite tanker receival facilities;
- Oily water treatment and wastewater treatment facilities;

- Integrated disposal options such as landfarm, washbays, evaporation facilities or controlled environmental release (cost dependant); and
- Discharge and licence conditions appropriate to the environment and risk profile.

Definition Phase

During the definition phase, the concepts become sized, located and designed for construction. The definition phase considers:

- Dual bay, sized and optimised sediment traps;
- Drying courts;
- Appropriate sump pumps (low shear for oily water);
- Specification of appropriate treatment equipment;
- Evaporation bunds (optimised approach for environment); and
- Spill management.

Table 1 provides a summary of the three project stages, the actions to be implemented during each of those stages and the outcomes that can be reasonably expected.

TABLE 1 Key Actions and Outcomes of Implementing Sustainable Liquid Waste Management

Project Stage	**Action**	**Outcomes**
Prefeasibility	Identify key sensitive receptors	Sets the environmental and risk profile (design criteria) of the LWM strategy
	Baseline environmental studies	Determines potentially significant activities required, such as mine dewatering, major water course diversion, etc.
Feasibility	LWM strategy	Identifies the most sustainable design (pumping versus tankered, central system versus distributed)
		Management buy-in to the design strategy
	Site layout and allocation	Sufficient facilities to store or dispose of liquid waste
		Location that considers legislative requirements, environmental risk, buffer zones, health and safety
		Gravity drainage used effectively
	Stormwater exclusion bunds	Reduce treatment volumes by preventing contamination, where possible
	Treatment and disposal facilities	Optimise the number and types of facilities across the site
		Integrated treatment and disposal facilities (landfarm/OWT/WWT/ evaporation facilities)
		Lowest cost reuse identified (dust suppression, landfarm, washbay)
	Licence conditions	Knowledge to negotiate conditions
		Discharge appropriate to the environmental risk profile of the site
Definition	Sizing of facilities	Solutions tailored to the site which consider flow rates, environmental sensitivity (e.g. frequency of overflows), meteorological conditions and machinery size
		Easier to obtain approvals and comply with them
	Specification of equipment	Appropriate materials and equipment are used that perform better with a longer life of service
	Spill management	Prevent pollution, health and fire hazards, and the impact on core functions

CONCLUSION

In conclusion, liquid waste management is often overlooked during the early stages of mine design because it is a downstream design element. Unsustainable management and poor design can lead to environmental pollution, additional capital and operational costs and the instigation of other operational problems. Currently, the three predominant barriers to effective liquid waste management are that; key project decisions are made without consideration of a liquid waste strategy, there is an ad hoc approach to waste management (because there is no one person or team that is allocated that responsibility) and the solutions are not tailored to the project environment. Practical solutions for establishing a liquid waste management strategy include embedding environmental engineering teams into projects, conducting sustainability design reviews and designing for compliance. At a project specific level, the practical designs for liquid waste management were identified in the context of project phases.

BIOGRAPHIES

Alicia Brown has three years experience working as an environmental engineer for GHD. Alicia played a key role in homogenising GHD's approach to odour assessment and has gained experience in a broad range of environmental disciplines, ranging from contaminated site assessments to environmental approvals. More recently, she has focussed on pollution management for mining and heavy industry, undertaking the engineering design of bunding systems, oily water treatment facilities and integrated liquid waste treatment and disposal processes.

Elis Smedley has 3 years experience within GHD working within the environment group. He has worked on a range of projects including projects related to water quality, water and oily water treatment, drainage design, sustainable design review, land capability assessment and waste management.

His previous experience in waste reuse includes site assessment of an effluent irrigated woodlot in Walpole, WA; assessment of potential water savings under various levels of re-use for a land development in Preston Beach, WA; developing a solid and liquid waste management strategy for BHP's RGP-6 expansion project; and designing oily water reuse facilities for several minesites within Western Australia. He has undertaken waste assessment projects for a range of clients, including Chevron, Rio Tinto Iron Ore, Iluka, Dampier Salt and BHP.

Christopher Gwynne has had a broad range of experience with air, soil and water contamination. He has specialist skills in the areas of investigation design, data collection and analysis, remediation design and facilities auditing. He has conducted and managed jobs in a wide variety of fields including OH&S monitoring and audits, ambient and industrial air quality assessment, construction/demolition environmental management, pollution investigation, industrial and wastewater odour assessment, environmental risk assessment and environmental auditing. Christopher has experience working in a wide range of industries including government, mining, mineral processing, agriculture, wastewater and railways.