

Information sheet

Environmental Protection Act 1994

Characterisation and management of drilling fluids and cuttings in the petroleum industry

1 Introduction

This information sheet describes the process for petroleum and gas operators to:

- assess and characterise waste drilling fluids and cuttings (which for this information sheet also includes rock materials, solids and fines); and
- develop ways to manage wastes produced from drilling activities that address environmental risks and are consistent with the requirements of Queensland's environmental legislation.

There are various drilling fluid systems used in the petroleum industry including freshwater, saltwater, oil, synthetic-based and pneumatic (e.g. air, foam) fluid systems (West et al., 2006). The term 'mud' is frequently used interchangeably with the term 'fluid'. The term 'mud' is used because of the thick consistency of the fluid system (Caenn, 2011). In general, drilling fluids in the petroleum industry are used to aid tools during the drilling of wells. The main functions of drilling fluids are:

- carrying cuttings from the hole
- cooling and cleaning the drill bit
- reducing friction
- maintaining the stability of the bore
- maintaining down-hole hydrostatic pressure
- to be non-damaging to the formation.

Drilling fluids contain a variety of specialty chemicals (called 'additives') each having a different purpose. For example:

- killing bacteria and adjusting pH (West et al., 2006)
- controlling viscosity, reducing fluid loss to the formation and inhibiting equipment corrosion (Ghazia, 2011).

The additives in drilling fluids are adjusted according to the physicochemical conditions of geological formations which invariably change with depth (Ghazia, 2011). In addition, drilling fluids are to be non-hazardous to the environment and personnel.

Drilling fluids are normally formulated in-situ by mixing the different additives in a dedicated storage tank, or less preferably, a sump that has been excavated within the drill site.

After drilling activities are complete, the waste fluid becomes contaminated with formation material and the final result is a large volume of liquid and solid waste that must be managed. The exact amount of waste drilling fluid produced is dependent upon numerous factors, including the depth of the well being drilled. For example, one company estimates that for a single coal seam gas well, there will be 45–55 cubic metres of cuttings and 200 cubic metres of fluids (Australia Pacific LNG Pty Limited & Worley Parsons, 2010).



Characterisation and management of drilling fluids and cuttings in the petroleum industry

2 Types of drilling fluids

Drilling fluids are a complex system of water-based, oil-based or synthetic-based fluids with several chemical and mineral additives (Ghazia, 2011).

Oil-based fluids are generally selected for their superior temperature stability, lubricity and hole stabilisation attributes (Caenn, 1996) but tend to have poor environmental performance in terms of their ecotoxicity and their tendency to persist in cuttings piles (Department of Industry and Resources, Western Australia, Drilling Fluids Management 2006).

Environmental concerns have been raised on oilbased fluid systems, in particular diesel-based fluids, as diesel is considered toxic to various organisms (Caenn, 1996).

Synthetic-based fluids are intended to replace either diesel or mineral oil, in oil-based fluids.

The Department of Environment, Science and Innovation (the department), as the environmental regulator of petroleum activities in Queensland, typically does not permit the use of oil and synthetic-based fluids via conditions on environmental authorities (EA) for petroleum activities issued under the *Environmental Protection Act 1994* (EP Act).

3 Regulatory framework

The department regulates the management and disposal of wastes in Queensland under the provisions of the EP Act, the *Waste Reduction and Recycling Act 2011* (WRR Act) and subordinate legislation.

The department must consider the object of both the EP and WRR Acts when regulating the management and disposal of drilling fluids. The object of the EP Act is to promote ecologically sustainable development. The object of the WRR Act is complementary to this in that it promotes waste management principles such as waste avoidance, reduction, and resource recovery and efficiency actions. Accordingly, drilling fluids should be used in such a way that enables drilling activities to be carried out efficiently and effectively but also in a way that minimises waste generation and protects the environment from adverse impacts.

4 Regulated waste

Regulated waste is defined in the Environmental Protection Regulation 2019 (EP Reg) as waste that:

- is commercial or industrial waste; and
- is of a type, or contains a constituent of a type, mentioned in Schedule 9, part 1, column 1 of the EP Reg.

However, waste is not regulated waste if:

- it is of a type mentioned in schedule 9, part 3, division 1 of the EP Reg; or
- if current test results for the waste for each relevant attribute and substance meet the requirements of the attribute and substance tables in schedule 9, part 3, division 2 of the EP Reg.

Schedule 9 of the EP Reg¹ identifies particular wastes as regulated wastes. Waste drilling fluids and/or cuttings can be considered as 'regulated waste' if they contain any of the items or even residues of any of those items listed in the above schedule.

¹ The full list of regulated wastes is listed in Schedule 9 of the EP Reg and can be viewed on the Queensland Government website at www.legislation.qld.gov.au.

Characterisation and management of drilling fluids and cuttings in the petroleum industry

4.1 Trackable waste

Schedule 11 of the EP Reg² provides a list of trackable wastes that are also 'regulated wastes'.

Trackable wastes have special record keeping requirements and material handling responsibilities that apply to generators, transporters and receivers of the waste. These requirements can be found in sections 78-81 of the EP Reg.

More information about the management of regulated and trackable wastes is available on the department's website at environment.des.qld.gov.au/waste/guidelines-information.html.

5 Assessing waste drill fluids and cuttings

To provide guidance to the petroleum industry on the appropriate management and disposal of waste drilling fluids and cuttings and any associated storage device, the department recommends the following systematic characterisation of the waste.

5.1 Assessment of waste drilling fluids

The assessment of waste drilling fluids should include:

1. characterising the waste in relation to the items in Schedules 9 and 11 of the EP Reg; and
2. considering the environmental risks of each of the additives present in the drilling fluids and the mixture.

This approach is recommended because:

- drilling fluids contain variable, and in certain instances, only trace amounts of the chemical listed as regulated waste; and
- contamination may be caused by naturally occurring substances present in the geological formations being drilled.

6 Characterisation of waste drilling fluids

In order to establish whether waste drilling fluid and/or cuttings are regulated and trackable waste, the material must be characterised by assessing whether it contains compounds, or result from processes, listed in Schedule 9 of the EP Reg.

The relevance of the items listed in Schedule 9 to waste drilling fluids and cuttings will depend on the additives used in the fluids and the characteristics of the geological formations being drilled.

Items listed in Schedule 9 that may be relevant to waste drilling fluids and cuttings include, but are not necessarily limited to:

- Item 1—acidic solutions and acids in solid form (e.g. if drilling in acid soils such as ASS/PASS)
- Item 7—basic (alkaline) solutions and bases (alkalis) in solid form (e.g. if potassium sulfide has been added)
- Item 20—ethers
- Item 30—inorganic sulfides (e.g. if potassium sulfide has been added)
- Item 38—mineral oils
- Item 40—non-toxic salts (e.g. if potassium chloride has been added)
- Item 41—oil and water mixtures or emulsions, or hydrocarbons and water mixtures or emulsions
- Item 43—organic solvents, other than halogenated solvents, including, for example, ethanol

² The full list of trackable wastes is listed in Schedule 11 of the EP Reg and can be viewed on the Queensland Government website at www.legislation.qld.gov.au.

Characterisation and management of drilling fluids and cuttings in the petroleum industry

- Item 50—phenols and phenol compounds, including chlorophenols
- Item 57—surface active agents (surfactants) containing principally organic constituents, whether or not also containing metals and other inorganic materials
- Item 65—vegetable oils.

There are also a number of items in Schedule 9 relating to metals which must also be considered in making a determination as to whether the waste is regulated.

Oil-based and synthetic-based fluids will most likely trigger the regulated and trackable waste classification because of either Item 41—oil and water mixtures or emulsions, or hydrocarbons and water mixtures or emulsions and, potentially, Item 65—vegetable oils.

If drilling is being carried out in any acid sulphate or potential acid sulphate soils, it is possible the waste drilling fluids and/or cuttings will be acidic and therefore trigger the regulated waste classification under Item 1—acidic solutions and acids in solid form. In this instance, the waste will also be trackable.

7 Environmental risk considerations of waste drilling fluids

In addition to the waste characterisation step described above, environmental risk information for each additive used in formulating the drilling fluids must be considered by petroleum and gas operators.

The information must be from a referenced source such as a Material Safety Data Sheet and/or scientific publications.

The environmental risk information must include:

- chemical composition
- chemical-physical properties (such as pH, solids content, emulsive properties, solubility in water)
- environmental fate and transport
- ecotoxicity (including chronic and acute)
- biodegradation (under anaerobic and aerobic conditions) and consideration of the risk of any metabolites
- potential for bioaccumulation
- potential pathway to sensitive receptors and the receiving environment.

7.1 Assessment of drill cuttings

Drill cuttings and fine solids are typically removed from the fluids by filtration and separation respectively and they can contain contaminants which come from the additives present in the drilling fluid and/or the geological formations being drilled.

Accordingly, petroleum and gas operators should carry out an assessment of drill cuttings against the criteria in the National Environment Protection (Assessment of Site Contamination) Measure 1999 (the ASC NEPM)³ to determine whether the material is suitable for any intended use/reuse, or be disposed to landfill.

7.2 Managing waste drill fluids and cuttings

Applications for petroleum and gas EAs where wells or bores are proposed to be drilled as part of the project must include the characterisation and assessment steps described above and a proposed management strategy. This will assist the department to assess the proposal and develop site specific conditions in the EA for managing environmental impacts associated with the handling, storage, treatment, transport and disposal of the

³ The ASC NEPM is available on the Australian Government's Federal Register of Legislation at www.legislation.gov.au.

Characterisation and management of drilling fluids and cuttings in the petroleum industry

drilling fluids and/or cuttings including the design and construction standards for pits, sumps or ponds that may be proposed. Having prescribed conditions on an EA to manage these issues will benefit applicants because they will have certainty about their legal obligations in relation to drilling fluid management.

Depending on the environmental risks (e.g. if the waste fluids have low toxicity, easily biodegrade and are demonstrated as having little effect on the environment), the waste drilling fluids and/or cuttings may be temporarily (i.e. less than 28 days in a calendar year) stored in pits/sumps and disposed of or land-farmed on site with site-specific authorisation conditions prescribed on the EA.

Waste drilling fluids and/or cuttings can also be used either by a petroleum company or another party.

The end of waste (EOW) framework under the WRR Act allows for the recovery of waste to be deemed a resource, through either an EOW code or approval, if the department considers that it meets specified quality criteria for its specific use.

EOW codes specify outcomes that need to be achieved in order for a waste to be deemed a resource. A waste producer may supply a waste as a resource under an EOW code provided they have registered with the department and can comply with the requirements of the code.

EOW approvals are considered on a trial basis for reusing waste as resources for which an EOW code has not been developed for the waste, and is issued to a single holder.

The EOW code for coal seam gas drilling mud (ENEW07543018)⁴ provides for the use of coal seam gas (CSG) drilling muds for manufacturing:

- compost, mulch or soil conditioners as either a feedstock in manufacturing the compost or an additive to the manufactured compost to create a final product; or
- a general purpose soil.

If you wish to use other drilling fluids and/or cuttings not covered under the EOW code above you may apply to the department for EOW approval to trial the waste as a resource. An application for an EOW approval will need to be accompanied by an assessment and characterisation of the proposed resource as described above.

More information about the EOW framework, the available EOW codes and applying for an EOW approval is available on the department's website at environment.des.qld.gov.au/waste/end-of-waste-framework.html.

The use of waste drilling fluids and/or cuttings can be authorised under an existing approval (e.g. a development approval for a composting and soil conditioning manufacturing facility) provided that the waste is not regulated. In these instances, the development approval/amendment application should include an assessment of the waste material as described above in addition to details of quantities, onsite storage methods and suitability. For composting and/or soil conditioning, the approval/amendment application must also demonstrate that the use of such inorganic wastes will not impact any biological degradation process (e.g. not be biocidal) and not result in environmental harm.

If the waste drilling fluids and/or cuttings are regulated waste, there are legal requirements for how they are to be transported and lawfully disposed of.

The transportation of trackable wastes—any amount of transported commercially or more than 250kg transported non-commercially—must be undertaken by a person or company who holds an EA for environmentally relevant activity (ERA) 57—Waste transport. Regulated waste must only be transported in

⁴ This EOW code is available on the department's website at environment.des.qld.gov.au/waste/end-of-waste-framework.html.

Characterisation and management of drilling fluids and cuttings in the petroleum industry

suitably designed vehicles, tanks, containers or secondary containers that are appropriate for containing the waste being transported.

In addition to having specified waste acceptance criteria, many landfills are not authorised to accept liquid wastes (i.e. greater than 30 per cent moisture content). If they do, it will be to a dedicated liquid waste disposal facility and not to the landfill cells. Where waste drilling fluids and/or cuttings are to be disposed of, waste acceptance criteria for each landfill must be observed. Only certain landfills have approval to receive and dispose of regulated wastes and these landfill operators will have specified requirements for which type of wastes can or cannot be received and disposed on-site.

References

Australia Pacific LNG Pty Limited & Worley Parsons. (2010). Volume 2: Gas Fields. Chapter 16: Waste.

Australia Pacific LNG Project Environmental Impact Statement., Volume 2 Chapter 16, (pp 1–31). Brisbane:

Australia Pacific LNG Pty Limited. Caenn, R., Darley, H., & Gray, G. (2011).

Composition and Properties of Drilling and Completion Fluids (6th Edition). (pp 535–616). Woburn, USA: Butterworth-Heinemann.

Caenn, R., Chillingar., G. (1996). Drilling fluids: State of the art. Original Research Article Journal of Petroleum Science and Engineering, Volume 14 (Issues 3–4), (pp 221–230).

González J., Arellanoa., J. Márquezb., R., Pernía, D., Quinteroa, J., & Sánchezc, C. (ARTICLE IN PRESS) Effects of interactions between solids and surfactants on the tribological properties of waterbased drilling fluids. doi:10.1016/j.colsurfa.2011.04.034.

Amarc, H., Duplaya, R., Ghazia, M., Khodjab, M., Kessaissiac, Z., Quarantaa, G. (ARTICLE IN PRESS) Life-Cycle Impact Assessment of oil drilling mud system in Algerian arid area. doi:10.1016/j.resconrec.2011.05.016.

Department of Industry and Resources. (2006) Drilling Fluids Management. Western Australia.

West, G., Hall, J., & Seaton S. (2006). Drilling Engineering In L Lake (Ed.), Petroleum Engineering Handbook. (pp II-89-II118). Richardson, USA: Society of Petroleum Engineers.

Approved:

10 OCT 2019

Enquiries:

Energy and Extractive Resources Business Centre
Department of Environment, Science and
Innovation
Ph. 13 QGOV (13 74 68)
Fax. (07) 3330 5634

Characterisation and management of drilling fluids and cuttings in the petroleum industry

Version history

Version	Effective date	Description of changes
1.00	27 March 2013	First published version of the information sheet.
1.01	01 August 2018	The document template, header and footer have been updated to reflect current Queensland Government corporate identity requirements.
2.00	10 October 2019	Updated to address the following: <ul style="list-style-type: none"> • Repeal of the Environmental Protection (Waste Management) Regulation 2000 (29 August 2014) • Replacement of the beneficial use approve framework by the EOW framework under the WRR Act (8 November 2016) • Changes to the regulated waste classification under the Environmental Protection Regulation 2008 (4 February 2019) • Remake of the EP Reg (1 September 2019).
2.01	16 February 2024	Updated to align with the MOG