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## CHAPTER III

### CURRENT AND ALTERNATIVE WASTE MANAGEMENT PRACTICES

#### INTRODUCTION

Managing wastes produced by the oil and gas industry is a large task. By the estimates gathered for this report, in 1985 over 361 million barrels of drilling muds and 20.9 billion barrels of produced water were disposed of in the 33 States that have significant exploration, development, and production activity. In that same year, there were 834,831 active oil and gas wells, of which about 70 percent (580,000 wells) were stripper operations.

The focus of this section is to review current waste management technologies employed for wastes at all phases of the exploration-development-production cycle of the onshore oil and gas industry. It is convenient to divide wastes into two broad categories. The first category includes drilling muds, wellbore cuttings, and chemical additives related to the drilling and well completion process. These wastes tend to be managed together and may be in the form of liquids, sludges, or solids. The second broad category includes all wastes associated with oil and gas production. Produced water is the major waste stream and is by far the highest volume waste associated with oil and gas production. Other production-related wastes include relatively small volumes of residual bactericides, fungicides, corrosion inhibitors, and other additives used to ensure efficient production; wastes from oil/gas/water separators and other onsite processing facilities; production tank bottoms; and scrubber bottoms.<sup>1</sup>

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<sup>1</sup> For the purpose of this chapter, all waste streams, whether exempt or nonexempt, are discussed.

In addition to looking at these two general waste categories, it is also important to view waste management in relation to the sequence of operations that occurs in the life cycle of a typical well. The chronology involves both drilling and production--the two phases mentioned above--but it also can include "post-closure" events, such as seepage of native brines into fresh ground water from improperly plugged or unplugged abandoned wells or leaching of wastes from closed reserve pits.

Section 8002(m) of RCRA requires EPA to consider both current and alternative technologies in carrying out the present study. Sharp distinctions between current and alternative technologies are difficult to make because of the wide variation in practices among States and among different types of operations. Furthermore, waste management technology in this field is fairly simple. At least for the major high-volume streams, there are no significant newly invented, field-proven technologies in the research or development stage that can be considered "innovative" or "emerging." Although practices that are routine in one location may be considered innovative or alternative elsewhere, virtually every waste management practice that exists can be considered "current" in one specific situation or another. This is because different climatological or geological settings may demand different management procedures, either for technical convenience in designing and running a facility or because environmental settings in a particular region may be unique. Depth to ground water, soil permeability, net evapotranspiration, and other site-specific factors can strongly influence the selection and design of waste management practices. Even where geographic and production variables are similar, States may impose quite different requirements on waste management, including different permitting conditions.

Long-term improvements in waste management need not rely, however, purely on increasing the use of better existing technology. The Agency does foresee the possibility of significant technical improvements in future technologies and practices. Examples include incineration and other thermal treatment processes for drilling fluids; conservation, recycling, reuse, and other waste minimization techniques; and wet air oxidation and other proven technologies that have not yet been applied to oil and gas operations.

### Sources of Information

The descriptions and interpretations presented here are based on State or Federal regulatory requirements, published technical information, observations gathered onsite during the waste sampling program, and interviews with State officials and private industry. Emphasis is placed on practices in 13 States that represent a cross-section of the petroleum extraction industry based on their current drilling activity, rank in production, and geographic distribution. (See Table III-1.)

### Limitations

Data on the prevalence, environmental effectiveness, and enforcement of waste management requirements currently in effect in the petroleum-producing States are difficult to obtain. Published data are scarce and often outdated. Some of the State regulatory agencies that were interviewed for this study have only very limited statistical information on the volumes of wastes generated and on the relative use of the various methods of waste disposal within their jurisdiction. Time was not available to gather statistics from other States that have significant oil and gas activity. This lack of concrete data makes it difficult for EPA to complete a definitive assessment of available disposal options. EPA is collecting additional data on these topics.

Table III-1 States with Major Oil Production Used as Primary  
References in This Study

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Alaska  
Arkansas  
California  
Colorado  
Kansas  
Louisiana  
Michigan  
New Mexico  
Ohio  
Oklahoma  
Texas  
West Virginia  
Wyoming

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## DRILLING-RELATED WASTES

### Description of Waste

Drilling wastes include a wide variety of materials, ranging in volume from the thousands of barrels of fluids ("muds") used to drill a well, to the hundreds of barrels of drill cuttings extracted from the borehole, to much smaller quantities of wastes associated with various additives and chemicals sometimes used to condition drilling fluids. A general description of each of these materials is presented in broad terms below.

#### Drilling Fluids (Muds)

The largest volume drilling-related wastes generated are the spent drilling fluids or muds. The composition of modern drilling fluids or muds can be quite complex and can vary widely, not only from one geographical area to another but also from one depth to another in a particular well as it is drilled.

Muds fall into two general categories: water-based muds, which can be made with fresh or saline water and are used for most types of drilling, and oil-based muds, which can be used when water-sensitive formations are drilled, when high temperatures are encountered, or when it is necessary to protect against severe drill string corrosion in hostile downhole environments. Drilling muds contain four essential parts: (1) liquids, either water or oil; (2) reactive solids, the viscosity- and density-building part of the system, often bentonite clays; (3) inert solids such as barite; and (4) additives to control the chemical, physical, and biological properties of the mud. These basic components perform various functions. For example, clays increase viscosity and

density, barium sulfate (barite) acts as a weighting agent to maintain pressure in the well, and lime and caustic soda increase pH and control viscosity. Additional conditioning materials include polymers, starches, lignitic material, and various other chemicals (Canter et al. 1984).

Table III-2 presents a partial list, by use category, of additives to drilling muds (Note: this table is based on data that may, in some cases, be outdated.)

### Cuttings

Well cuttings include all solid materials produced from the geologic formations encountered during the drilling process that must be managed as part of the content of the waste drilling mud. Drill cuttings consist of rock fragments and other heavy materials that settle out by gravity in the reserve pit. Other materials, such as sodium chloride, are soluble in fresh water and can pose problems in waste disposal. Naturally occurring arsenic may also be encountered in significant concentrations in certain wells and in certain parts of the country and must be disposed of appropriately. (Written communication with Mr. Don Basko, Wyoming Oil and Gas Conservation Commission.)

### Waste Chemicals

In the course of drilling operations, chemicals may be disposed of by placing them in the well's reserve pit. These can include any substances deliberately added to the drilling mud for the various purposes mentioned above (see Table III-2).



Table III-2 Characterization of Oil  
and Gas Drilling Fluids

Source: Information in this table was taken from American Petroleum Institute (API) Bulletin 13F (1978). Drilling practices have evolved significantly in some respects since its publication; the information presented below may therefore not be fully accurate or current.

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Bases

Bases used in formulating drilling fluid are predominantly fresh water, with minor use of saltwater or oils, including diesel and mineral oils. It is estimated that the industry used 30,000 tons of diesel oil per year in drilling fluid in 1978.<sup>a</sup>

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Weighting Agents

Common weighting agents found in drilling fluids are barite, calcium carbonate, and galena (PbS).<sup>b</sup> Approximately 1,900,000 tons of barite, 2,500 tons of calcium carbonate, and 50 tons of galena (the mineral form of lead) are used in drilling each year.

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Viscosifiers

Viscosifiers found in drilling fluid include:

• Bentonite clays	650,000 tons/year
• Attapulgite/sepiolite	85,000 tons/year
• Asphalt/gilsonite	10,000 tons/year
• Asbestos	10,000 tons/year
• Bio-polymers	500 tons/year

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<sup>a</sup> This figure included contributions from offshore operations. According to API, use of diesel oil in drilling fluid has been substantially reduced in the past 10 years principally as a result of its restricted use in offshore operations.

<sup>b</sup> API states that galena is no longer used in drilling mud.

Table III-2 (continued)

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 Dispersants

Dispersants used in drilling fluid include:

- |                                                               |                  |
|---------------------------------------------------------------|------------------|
| • Cadmium, chromium, iron,<br>and other metal lignosulfonates | 65,000 tons/year |
| • Natural, causticized chromium<br>and zinc lignite           | 50,000 tons/year |
| • Inorganic phosphates                                        | 1,500 tons/year  |
| • Modified tannins                                            | 1,200 tons/year  |
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## Fluid Loss Reducers

Fluid loss reducers used in drilling fluid include:

- |                                  |                  |
|----------------------------------|------------------|
| • Starch/organic polymers        | 15,000 tons/year |
| • Cellulosic polymers (CMC, HEC) | 12,500 tons/year |
| • Guar gum                       | 100 tons/year    |
| • Acrylic polymers               | 2,500 tons/year  |
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## Lost Circulation Materials

Lost circulation materials used comprise a variety of nontoxic substances including cellophane, cotton seed, rice hulls, ground formica, ground leather, ground paper, ground pecan and walnut shells, mica, and wood and cane fibers. A total of 20,000 tons of these materials is used per year.

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