# POLLUTION PREVENTION
# BEST MANAGEMENT PRACTICES
## for the New Mexico Oil and Gas Industry

Prepared for
New Mexico Energy, Minerals, and Natural Resources Department
Santa Fe, New Mexico

2000

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Volume 1


2000

ACKNOWLEDGEMENTS

Appreciation is extended to the Railroad Commission of Texas, the Interstate Oil and Gas Compact Commission, and Texaco Exploration and Production for researching and developing information used as a reference for this manual. Appreciation is also extended to Robert B. Pojasek, Ph.D. for developing the systems approach to pollution prevention that is described in this manual. Representatives of the New Mexico oil and gas industry participated in formatting and reviewing this manual and provided valuable suggestions and comments regarding its final content.



This manual was produced with funds from the U.S. Department of Energy and the New Mexico Energy, Minerals and Natural Resources Department.

May 1999

# Contents

# Tables

## Figures



## Process Maps

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# ACRONYMS

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# ACRONYMS

| | |
|---|---|
| BBL | Barrel |
| BPD | Barrels per day |
| BTU | British Thermal Unit |
| CFR | *Code of Federal Regulations* |
| $CO_2$ | carbon dioxide |
| $CS_2$ | carbon disulfide |
| d | day |
| DEA | diethanolamine |
| DOT | Department of Transportation |
| e.g. | for example |
| E&P | Exploration and Production |
| EPA | U.S. Environmental Protection Agency |
| $H_2S$ | hydrogen sulfide |
| hp | horsepower |
| K | thousand |
| Kwhr | kilowatt hour |
| lb | pound |
| LQGs | Large Quantity Generators |
| MCF | 1000 cubic feet |
| MEA | monoethanolamine |
| MSDS | material safety data sheet |
| NaOH | sodium hydroxide |
| NMED | New Mexico Environment Department |
| NORM | Naturally Occurring Radioactive Materials |
| OCC | Oil Conservation Commission |
| OCD | Oil Conservation Division |
| O&M | operate and maintain |
| RCRA | Resource Conservation and Recovery Act |

## ACRONYMS (continued)

| | |
|---|---|
| sf | square foot |
| SQGs | Small Quantity Generators |
| SW | salt water (brine) |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TPD | tons per day |
| UIC | Underground Injection Control |
| WQCC | Water Quality Control Commission |

# Section 1.0

## Introduction, Purpose and Scope

Over time the oil and gas industry has developed practices that have reduced the generation of waste, improved the economics of drilling and production operations, and led to safer operations. The pollution prevention practices referenced here have been shown to reflect process improvements that can work. Local conditions may require modifications of these practices but they can serve as a general guide for the entire industry. As industry develops new and innovative ideas and as other down-to-earth methods come to light this manual will grow to encompass that knowledge and information.

This manual for the New Mexico oil and gas industry provides the tools and information needed to develop a comprehensive pollution prevention-based environmental management system. The benefits of developing and implementing a pollution prevention-based environmental management system include the following:

***A pollution prevention-based environmental management system is a framework to help a business identify pollution prevention opportunities, analyze their cost-effectiveness, identify areas for improvement, and develop action plans for implementation.***

- A more informed work force
- Better communication between labor and management
- Improved productivity
- Better environmental stewardship
- Reduced cost of waste treatment and disposal
- Reduced raw materials requirements
- Improved control of regulatory compliance costs and reduced regulatory burden
- Improved understanding of the true costs and causes of waste
- A framework to continuously improve operations and reduce waste.

A pollution prevention-based environmental management system provides a flexible framework for identifying and implementing pollution prevention alternatives and other process improvements. By developing a system specific to a company's culture and needs, creative problem-solving will be encouraged on a continuous basis. This is in contrast to a traditional pollution prevention plan, which

usually provides a discrete checklist of pollution prevention opportunities to implement. A pollution prevention-based environmental management system is integrated into core business practices.

This manual is presented in two Volumes. Volume 1, Pollution Prevention Best Management Practices Manual, presents the tools for developing an effective pollution prevention plan. The tools are designed to assist in the implementation of a continuous improvement framework for pollution prevention-based environmental management. The development of such a framework, which can be integrated into all business operations, will stimulate increased efficiency, improve environmental performance, increase health and safety, and encourage process innovation.

Volume 1 also provides examples of pollution prevention **alternatives** for four oil and gas industry sector categories, as follows:

- Oil and Gas Exploration and Production
- Transportation
- Gas Processing
- Oil Field Services

Volume 1, Section 4.0 provides case studies from the oil and gas industry.

Volume 2 of this manual provides non-process-specific information for typical wastes generated by the four industry sectors that can be used for quick lookup and reference. Volume 2 **focuses** on treatment, disposal, and end-of-pipe recycling opportunities (these do not depend on the process that generated the wastes). Volume 2 also provides a summary of regulations pertaining to the oil and gas industry waste management.

Accompanying this manual is a pocket guide containing information that can be used in the field quickly. The pollution prevention categories presented in the pocket guide include material substitution (e.g., replacement of hazardous chemicals with nonhazardous alternatives), good housekeeping practices, and equipment maintenance. It is strongly recommended that the pocket guide be used in the field whenever possible to implement environmental best management practices so on-site workers have easy-to-understand guidance in the field.

The pocket guide can be updated to reflect innovations generated through implementation of the pollution prevention-based environmental management system. Repeated use of the tools will help refresh workers and keep them aware of what they can do to reduce waste on the job every day.

The tools and information described in this manual are compatible with the New Mexico Green Zia Environmental Excellence Program (Green Zia), a partnership of state agencies, federal laboratories, universities, and private industry. Green Zia promotes pollution prevention, energy efficiency, and resource conservation through the same decision-support tools presented in this manual, thereby allowing companies and organizations to develop a strategy for pollution prevention and to focus on continuous quality improvement, teamwork, and demonstration of success. Businesses that work through the tools to develop a pollution prevention-based environmental management system can apply for recognition through the Green Zia Program. For further information on the New Mexico Green Zia Environmental Excellence Program, call 505-827-0677, or on the internet at http://164.64.146.5/.

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## Section 2.0

# Introduction to Pollution Prevention, Energy Efficiency, and Other Best Management Practices

Pollution prevention and energy efficiency, two of the most prominent and cost-effective best management practices, stress economic benefit while protecting the environment and conserving natural resources. Over the last 10 years, a significant shift in focus from pollution control (and waste management) to pollution prevention (and waste minimization) has occurred. The predominant factor causing this shift was the realization that pollution and waste cost money and do not result in any positive revenue stream for the industries that generate them.

Today, pollution prevention, energy efficiency, and other environmental best management practices are considered to be quality programs as much as environmental programs. As quality programs, they:

- Focus on process (means) as well as product (end)
- Require top management commitment
- Are instituted company-wide
- Are best utilized through continuous quality improvement principles

***Implementing pollution prevention and energy efficiency programs results in true economic savings.***

As a proactive approach to environmental protection, these best management practices usually require a level of planning at both the strategic and tactical levels. The major question to answer for pollution prevention and energy efficiency at the strategic level is "Why?" and at the tactical level is "How?" The requirement of top management commitment is critical to promote and champion the development of the strategy. At this level, issues such as investment in "clean" technologies, return on investment, and appropriate level of risk are typically addressed. Tactical issues typically include training on how to use new technologies and processes, implementation schedule, and monitoring and documenting success. Whether your organization is 3 people or 300, this approach can work with management commitment.

This manual describes tools that are designed to help provide answers to both the why's and how's through development of a comprehensive, but flexible, cost-effective system for identifying and implementing waste reduction alternatives.

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# Section 3.0

# Systems Approach to Pollution Prevention and Energy Efficiency

## *Developing a Pollution Prevention-Based Environmental Management System*

The systems approach described in this section is an analytical framework that includes process analysis, problem solving and decision-making and results in a series of action plans for implementation. These action plans will have a high likelihood of success both in terms of environmental and economic benefits. A well designed pollution prevention-based environmental management system is action-oriented and provides for continuous improvement. The individual tools within the systems approach are summarized below and described in greater detail in this section.

- *Build a pollution prevention team*. Whether it's 2 people or 10, bring people together who have process knowledge and a vested interest in a successful pollution prevention program. This will result in the best team to develop and implement a pollution prevention plan.
- *Create process maps.* Draw diagrams and maps that indicate the processes that generate waste, use energy, and consume resources to identify areas for improved efficiency and productivity.
- *Perform activity-based costing and Pareto analysis*. Identify total costs for generating and managing wastes to aid in prioritizing areas that require improved efficiency and productivity.
- *Perform root cause analysis*. Identify the root cause for wastes or losses to determine the most effective avenues for improvement.
- *Identify alternatives*. Generate a complete list of alternatives using tools to ensure that all possible solutions are considered.
- *Prioritize alternatives*. Rank alternatives based on relevant factors (e.g., cost, technical feasibility, timetable to implement) to allow for consensus on preferred approaches.
- *Develop an action plan*. Incorporate the results of the previous steps into a cohesive plan to realize cost-effective pollution prevention, energy efficiency, and resource conservation.

***An Action Plan identifies financial information and human resources needed to implement a pollution prevention alternative.***

## Build a Pollution Prevention Team

***Pollution prevention requires a diverse team to develop a comprehensive approach.***

Pollution prevention is a cross-cutting activity within a company. Like a company's quality program, pollution prevention almost always requires a diverse team of knowledgeable personnel to develop a comprehensive approach. The team usually includes personnel who are knowledgeable in areas such as engineering, budget, regulatory compliance, facility management, and waste management. As few as 2 or 3 people may comprise this team. In some cases, it is helpful to include vendors, customers, or other stakeholders on the team, especially if their requirements would impose limitations on the alternatives considered. The team also must implement alternatives identified in a pollution prevention action plan once it has been developed.

## Process Mapping

Process mapping is used to graphically illustrate the various steps that comprise an overall process that is being analyzed, as well as the functional dependency between those steps. In most instances, these maps must be developed by a team who has particular process knowledge or a vested interest in the process. In fact, this team should be involved in the entire pollution prevention decision-making process to ensure consistency and completeness. Typically, a process map contains boxes that represent individual process steps (drilling, monitoring, transportation, etc.); arrows between the boxes represent material flow or time sequence (see Figure 3-1). The map also contains information regarding material flow into individual process steps (usually from above or from the left of the box), as well as wastes and other by-products of the individual steps (usually below or to the right of the box). In many cases, individual process steps may be too complicated to be easily addressed in a single process map. In this instance, a hierarchical set of process maps is used; each map has a different level of detail to facilitate reading and interpretation.

Process maps also include ancillary and intermittent operations, which often have as much environmental impact as the primary process. Ancillary operations are those that *support* primary operations, but are not considered part of primary operations. Ancillary operations may include machining parts to be used in primary operations or water purification to generate a water supply to be used by the primary operation. Intermittent operations occur occasionally and are not directly connected to primary operations (e.g., maintenance and inspection).

Process maps have several critical uses. One is to ensure that all materials have been accounted for in the operation. Materials accounting is helpful in indicating that maps have been developed completely and that processes are displayed in a sufficient level of detail to make optimum process improvements. Process maps also clearly illustrate to management the locations of potentially wasteful areas and inefficiencies of operations. Process maps are also extremely helpful in illustrating the interdependency between the various operations steps, which is critical since many improvements to a single step will have consequences at other stages. Also, as processes change, process maps can easily be updated for use in the decision-making process to provide continuous improvement.

***Process mapping graphically illustrates the steps that comprise an overall process, and the functional dependency between those steps.***

Figures 3-1 and 3-2, respectively, illustrate a process map with an ancillary function (rig maintenance) and a hierarchical, more detailed process map (under rig operation).

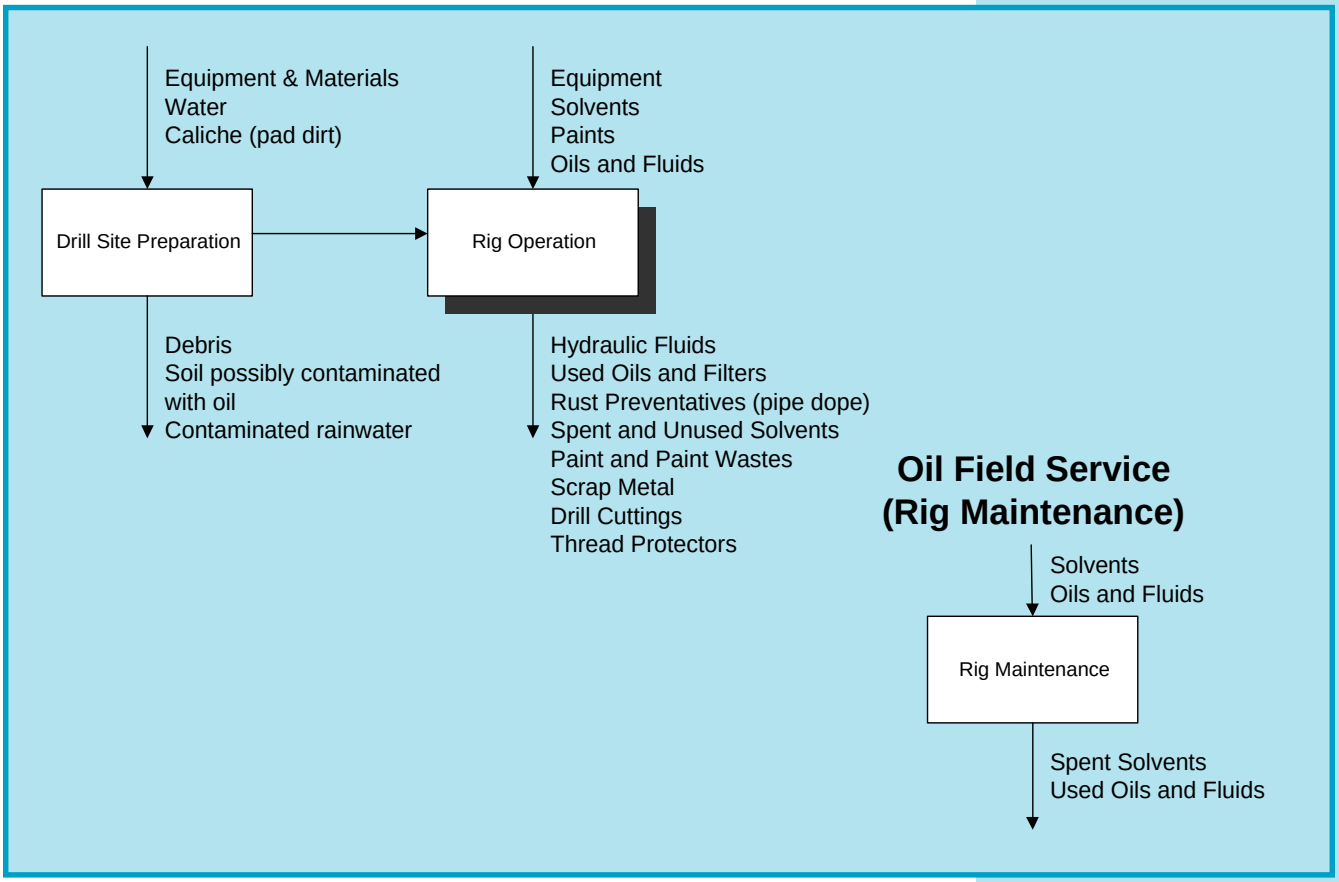



**Figure 3-1. First Level Process Map of Drilling Process**

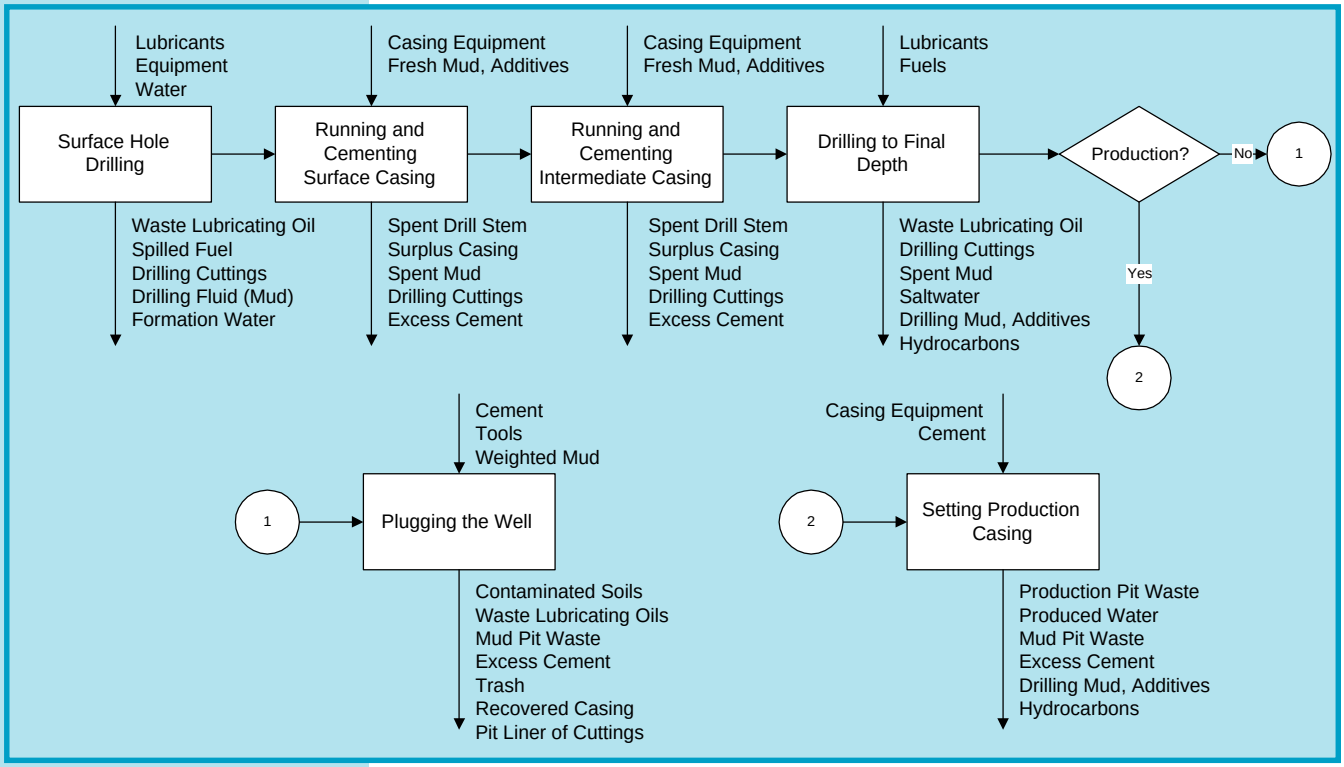



**Figure 3-2. Second Level Process Map of Rig Operations**

## Activity-Based Costing

Once the team generates the process map(s), it is critical to identify the true costs associated with the various activities within the process so inefficiencies can be easily assessed and evaluated based on economic impact. Activity-based costing is a proven method of identifying and prioritizing costs attributed to inefficiency, waste, or other types of losses.

Activities are the individual steps within a process (e.g., production, maintenance, documentation, and waste management). If a particular process or operation has a particular budget associated with it, activity-based costing will itemize the costs as a function of each activity. If this can be carried out completely, the costs associated with the losses (i.e., "negative" activities — energy, waste, etc.) will be determined. The critical feature of activity-based costing is identifying the "true" costs for generating waste, wasting energy, or other inefficiencies within a given process.

In activity-based costing, it is extremely helpful to be able to differentiate between direct costs and overhead costs because

reducing the overhead costs will, by definition, improve process efficiency and, therefore, reduce waste. For example, most of the waste management and regulatory compliance costs are overhead costs. Direct costs primarily comprise the labor and materials required to achieve a particular result or product. For each waste (or loss), a chart that contains the various costs (both direct and overhead) itemized by the individual factors that make up that cost can be generated. This technique of identifying individual costs generates a more accurate depiction of the true cost for the particular waste or loss.

***Most waste management and regulatory compliance costs are overhead costs.***

Figure 3-3 is a sample spreadsheet for the types of costs associated with produced water from oil production.

Table 3-1 illustrates a simpler example of activity-based costing, specifically the cost savings in the replacement of a mapping plotter that does not use hazardous materials or generate hazardous waste. Use of the new plotter would eliminate Hazardous Waste Satellite Storage Areas, eliminate the solvent waste stream and provide energy and maintenance savings.

Once costs have been identified for the various wastes (or losses), the Pareto diagram is a helpful tool for prioritizing each loss (see example in Figure 3-4). The Pareto diagram is based on the Pareto principle, which states that 80 percent of the cost is derived from 20 percent of the process. The Pareto diagram is a technique to illustrate this aspect by charting all losses with their associated costs. This diagram depicts a bar chart with each waste (or loss) on the horizontal axis and associated costs on the vertical axis. Often, a bar chart is generated, descending from left to right, with larger economic losses on the left side of the chart. Again, by utilizing the principles of continuous improvement, if the wastes and losses on the left side of the Pareto diagram can be reduced or eliminated through process improvement, losses to the right side of the diagram are still available for process improvement.

***Pareto principle: 80 percent of the cost is derived from 20 percent of the process.***

## Benefits

- Hazardous Waste Reduction: 51.13 kg of solvent (RCRA) waste per year
- Solid Waste Reduction: 10,600 kg/ yr. of paper waste. Existing plotter uses paper that can not be recycled. Paper from new plotter can be recycled through the on site paper recycling program.

| Assumptions - general | |
|---|---|
| Field size (Acres) | 20 |
| # wells in field | 20 |
| Total fluids production (BPD) | 500 |
| Brine production (BPD) | 150 |
| Oil production (BPD) | 350 |
| wells are free-flowing | |
| Field Life (years) | 20 |
| Oil specific gravity | 0.8 |
| Brine specific gravity | 1.08 |
| Brine salinity | 10% |
| Brine is managed in an evaporation pond | |

| Treating System Assumptions | |
|---|---|
| Treater temp rise (deg F) | 100 |
| Gas cost ($/MCF) | $1.50 |
| Pump hp | 10 |
| elec cost ($/kwhr) | $0.075 |

| Chemical Use Assumptions | |
|---|---|
| Biocide rate | 0.005% |
| cost/lb | $3.00 |
| | |
| Corrosion Inhibitor rate | 0.005% |
| cost/lb | $1.00 |
| | |
| Pond Treating rate | 0.001% |
| cost/lb | $2.00 |

| Field Facilities Assumptions | |
|---|---|
| Initial Cap Investment | $2,500,000 |
| Replacement rate/year | 5.00% |

| Brine Treatment Assumptions | |
|---|---|
| Pond liner life (years) | 7 |
| Liner replace cost ($/sf) | $1.50 |
| Pond Cap Cost ($/Acre) | $75,000 |
| | |
| Brine Sluge disposal cost ($/ton) | $25 |
| Brine Remed | $250,000 |

| Labor Cost Assumptions | |
|---|---|
| Operator Salary | $40,000 |
| Overhead Multiplier | 3.0 |
| Annual Supplies/equipment | $20,000 |
| Annual hours Worked | 2080 |
| % brine managment hours | 35% |

| | Vol (BPD) | Vol (cu ft/d) | Mass (TPD) |
|---|---|---|---|
| System Production rate | 10000 | 56097 | 1547 |
| System Oil rate (BPD) | 7000 | 39268 | 980 |
| System Brine Rate (BPD) | 3000 | 16829 | 567 |

| Maintenance/Repair/Remediation Analysis | |
|---|---|
| Facility Maintenance/Repair | $125,000 |
| Annualized Remediation cost | $12,500 |

| Evaporation Pond Calculations | | |
|---|---|---|
| Evap Pond Volume (30 d HRT) | 90000 (bbl) | 504875 (cuFt) |
| Surface Area (Acre) @ 3 ft depth | 3.86 | |
| Brine sludge generation rate (ton/year) | 20665 | |
| Initial Capital cost | $289,758 | |
| Annual liner repair cost | $36,063 | |
| Annual pond oil managment cost | $12,000 | |
| Annual brine sludge disposal | $516,627 | |
| **Total Annual Pond cost** | **$579,178** | |

***Note:*** *The data represented in this table are shown as examples only. Actual costs determined through an activity-based cost analysis may be different from the cost estimates reflected in this example.*

**Figure 3-3. Activity-Based Costing Analysis of Produced Water Management (continued on next page)**

| Energy Analysis | |
|---|---|
| Energy for treater (BTU/d) | 113,233,391 |
| heat transfer efficiency | 0.85 |
| energy needed (BTU/d) | 133,215,754 |
| Natural gas supply (MCF/d) | 133.2 |
| Natural gas cost ($/year) | $72,936 |
| | |
| Electric energy to pump (kW hr/d) | 179 |
| **Electric energy cost ($/year)** | **$4,901** |

| Chemical Analysis | |
|---|---|
| Biocide use | 56.62 |
| Biocide cost | $61,995 |
| Corrosion Inh. use | 56.62 |
| Corrosion Inh. cost | $20,665 |
| Pond Chem use | 11.32 |
| Pond Chem cost | $8,266 |
| **Total chemical cost** | **$90,926** |

| Operating Labor Analysis | |
|---|---|
| Operator hours/year | 728 |
| Direct labor and overhead cost | $42,000 |
| Supplies/equipment cost | $20,000 |
| **Total Annual Operator cost** | **$62,000** |

| Labor Allocation | % | Labor | Supplies/Equipment |
|---|---|---|---|
| Maint/Repair | 5% | $6,000 | $2,857 |
| Chemical Treating | 5% | $6,000 | $2,857 |
| Brine Separation | 10% | $12,000 | $5,714 |
| Remediation | 0% | $0 | $0 |
| O&M Evaporation Pond | 5% | $6,000 | $2,857 |
| Inspections/Reporting | 10% | $12,000 | $5,714 |
| **Total** | **35%** | **$42,000** | **$20,000** |

| Cost Summary | Cost | Cost/BBL SW |
|---|---|---|
| Total Annual Pond cost | $579,178 | $0.529 |
| Facility Maintenance/Repair | $125,000 | $0.114 |
| Annualized Remediation cost | $12,500 | $0.011 |
| Natural gas cost ($/year) | $72,936 | $0.067 |
| Electric energy cost ($/year) | $4,901 | $0.004 |
| Total chemical cost | $90,926 | $0.083 |
| Total Annual Operator cost | $62,000 | $0.057 |
| | | |
| **Total Brine managment cost** | **$947,441** | **$0.87** |
| | | |
| Annual Brine production (BBL) | 1,095,000 | |
| Annual Oil Production (BBL) | 2,555,000 | |

**Notes - Abbreviations**
BPD = Barrels Per Day
TPD = Tons Per Day
MCF = 1000 cubic feet
hp = horsepower
BTU = British Thermal Unit
Kwhr = kilowatt hour
SW = Saltwater (brine)
sf = square foot
d = day
O&M = Operate & Maintain
BBL = Barrel
lb = pound
cuFt = cubic feet

**SUMMARY TABLE**

**Cost Factors for Management of Produced Water from Model Well Field**

| Activity/ Cost Factor | Labor | Supplies/ Equipment | Materials | Utilities | Services | Total |
|---|---|---|---|---|---|---|
| Maintain/Repair Brine Piping/Mechanical Systems | $0.005 | $0.003 | $0.023 | | $0.091 | **$0.122** |
| Brine Chemical Treating | $0.005 | $0.003 | $0.083 | | | **$0.091** |
| Brine Separation and Handling | $0.011 | $0.005 | | $0.071 | | **$0.087** |
| Remediation of Brine-impacted Media | $0.000 | $0.000 | | | $0.011 | **$0.011** |
| Operation & Maintenance of Evaporation Pond | $0.005 | $0.003 | | | $0.529 | **$0.537** |
| Inspection/Reporting | $0.011 | $0.005 | | | | **$0.016** |
| **Totals** | **$0.038** | **$0.018** | **$0.106** | **$0.071** | **$0.632** | **$0.865** |

***Note:*** *The data represented in this table are shown as examples only. Actual costs determined through an activity-based cost analysis may be different from the cost estimates reflected in this example.*

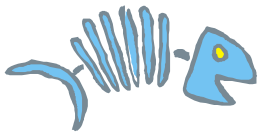
**Figure 3-3. Activity-Based Costing Analysis of Produced Water Management (concluded)**

- Cost savings by eliminating the required weekly internal inspections and the routine Facility and State inspections.
- Energy and cost savings by eliminating the temperature/humidity controlled environment required for the current plotter.
- Significant reduction in plotter maintenance contract costs.
- Cost savings through the elimination of the personal protective equipment required when handling the hazardous waste (i.e. chemical gloves, chemical apron, goggles, etc.).
- Costs saving through reduced plotter supply costs.
- Improved safety by eliminating a potential fire hazard (stored hazardous waste) and eliminating employee exposure to hazardous waste and materials.

**Table 3-1. Simplified Activity-Based Costing Example**

| Expense Item | Cost $ | |
|---|---|---|
| 1. Equipment Investment (One time Costs)<br>• Purchase<br>• Installation<br>• Ancillary Equipment | $14,500 | |
| 2. Project Expenses (related to purchase and installation)<br>• New procedures and Training<br>• Miscellaneous supplies<br>• Startup/testing<br>• Readiness reviews/management assessment | $ 0 | |
| 3. Annual Operating and Maintenance Costs<br>(Before costs are for current plotter; After costs are estimated for new plotter) | **Before $/year** | **After $/year** |
| 3.1 Raw materials and supplies | $2500 | $1000 |
| 3.2 Process operation costs<br>• Energy and utility costs<br>• Routine Maintenance<br>(Note: Current plotter requires an Air Condition/controlled environment in addition to the power to operate.) . | $1500 | $300 |
| 3.3 PPE & related health/safety costs | $100 | $0 |
| 3.4 Waste Management costs<br>• Hazardous waste disposal costs (includes packaging, labeling, storage, transportation, disposal, Facility-wide compliance)<br>• Solid waste disposal costs<br>• Internal/local waste area inspection/compliance costs<br>(Estimated for internal efforts only; Facility and State compliance costs are included in the treatment/storage/disposal costs ) | $0<br>$652<br>$1,378<br>$2,400 | $0<br>$0<br>$0<br>$0 |
| 3.5 Administrative/other costs<br>• Maintenance service contract for plotter | $10,000 | $1,000 |

## Root-Cause Analysis



Once the particular wastes (or losses) that should be addressed first have been identified through the Pareto analysis, the team should then perform a root-cause analysis to identify what factor(s), out of the dozens possible, would positively reduce the waste (or loss) of a particular operation to the greatest practical degree. The diagram that is used to perform the root-cause analysis is sometimes called the "fishbone" diagram. In the diagram, the various causes for the particular waste (or loss) are classified by groups. Methods, machines, materials, and people comprise one typical classification of four possible causes for waste (or loss) to occur. For each category, the team identifies subcategories, which can contain the root cause. For example, the "methods" category may include a subcategory addressing outdated procedures, which are used to properly maintain the equipment. Each subcategory is then subdivided until the team has reached practical decision endpoints.

***The root-cause analysis identifies what factors would positively reduce the waste (or loss) of a particular operation to the greatest practical degree.***

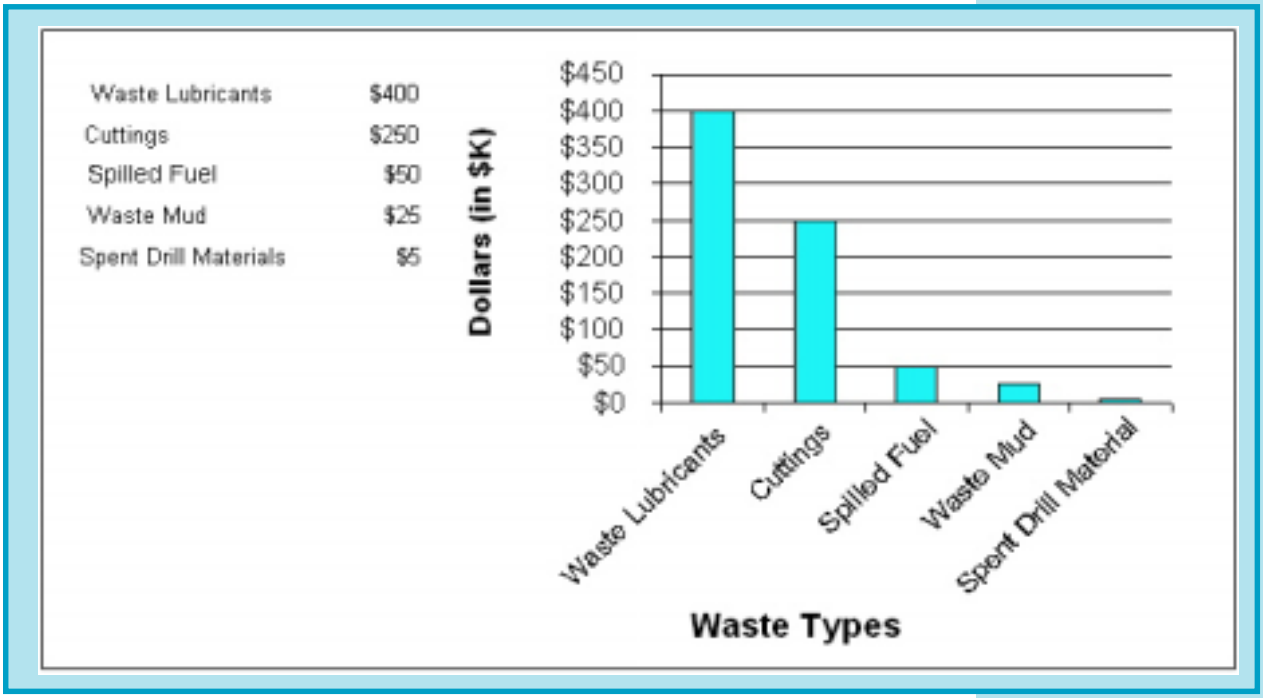



**Figure 3-4. Pareto Analysis for Rig Operations**

One of the best methods to develop the root-cause diagram is to ask and answer a series of "why?" questions. For example:

- Why is this step so wasteful? (Because we are using inefficient equipment.)
- Why are we using inefficient equipment? (Because it meets customer specifications.)

Once an entire fishbone diagram is assembled, team members then decide which decision endpoint would have the greatest positive impact on the waste (or loss) if updated, replaced, or otherwise changed. Because people who represent different interests within the process comprise the team, each member may have his or her own impression of what the root cause may actually be. Through discussion and analysis, the team must agree to one root cause to practically solve a problem.

Figure 3-5 shows an example of a root-cause fishbone diagram for generating spent muds. A discussion with team members would conclude that one of the **causes** illustrated on the diagram is most likely the root cause. Since diesel fuel is often used as the lubricating medium in the mud, one possible root cause for spent muds is the need to use diesel as the lubricant in the drilling process. Replacing the diesel with a less hazardous lubricating medium or modifying the methods so that lubricating fluids were not necessary would alleviate much of the cost of treating spent muds.

## Identifying Alternatives

Once the root cause for the particular waste (or loss) is identified, the team derives a list of alternatives that address the problem. It is critical that this process be performed to the satisfaction of the entire team and that all possible alternatives are considered. Typically, at least 20 alternatives are generated during this phase. It is important not to eliminate any ideas that are developed. During the prioritization phase, those ideas the team feels are ineffective fall to the bottom of the alternatives order. In deriving alternatives, several factors must be considered, including cost, timetable to implement, and technical feasibility. It is also important to recognize that many alternatives potentially do not require innovative technologies. All potential solutions, ranging from complete process changes through innovative technologies to simple administrative solutions, must be considered.

***In deriving alternatives, several factors, including cost, timetable to implement, and technical feasibility, must be considered.***

It is important that the technique used to derive the alternatives does not reward bias and allows for dissenting views. Brainwriting is one technique that meets these criteria. Brainwriting allows each team

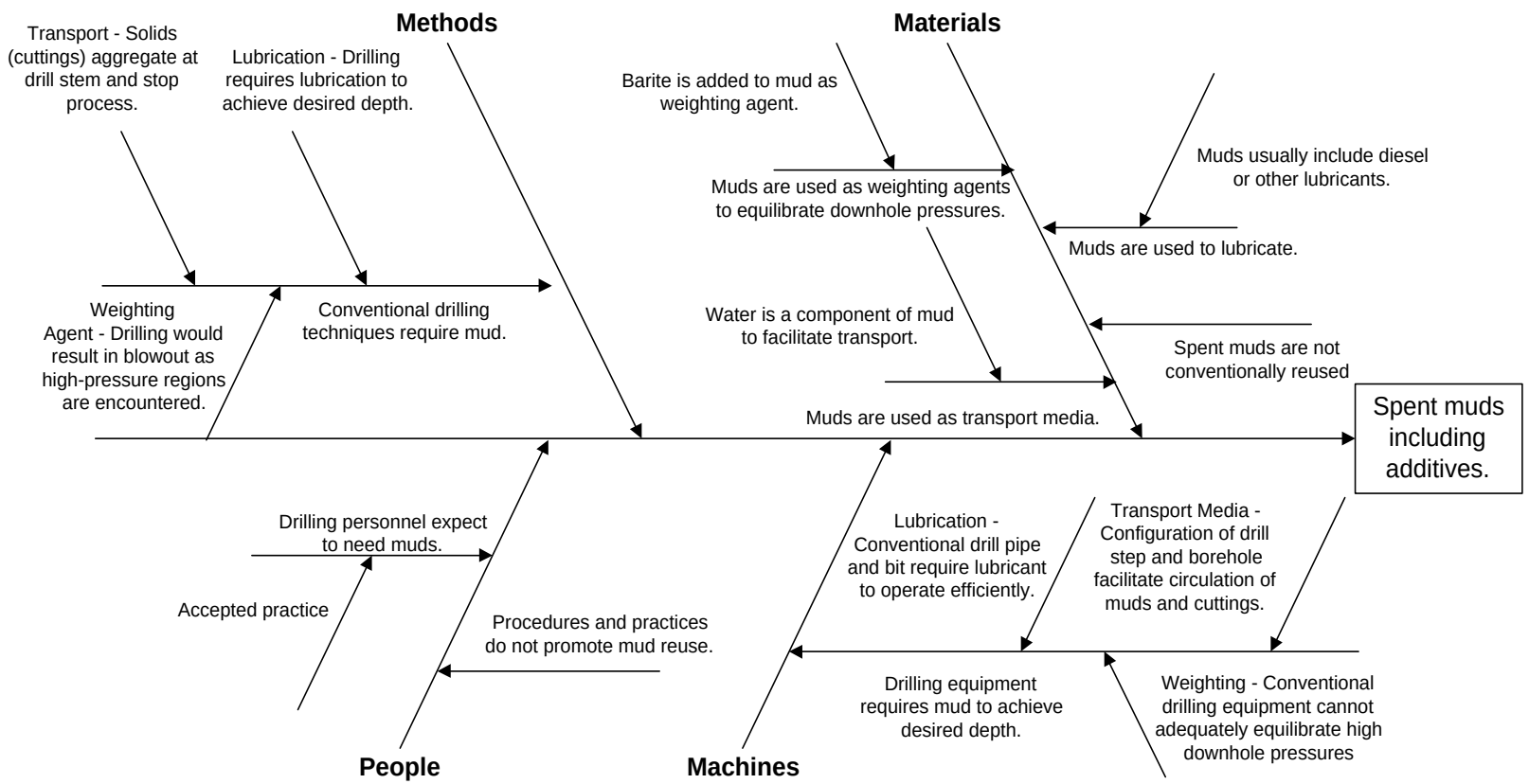



**Figure 3-5. Root-Cause Analysis (Fishbone Diagram) of Spent Mud Waste Generation**

member to introduce alternatives in writing that may solve the problem, as well as to comment on or improve upon other team members' ideas. Since the process is done in writing, and therefore anonymously, bias is not introduced. Once all ideas are written down and are subject to criticism or improvement, a list of alternatives that are acceptable to the team is compiled and duplicate ideas are eliminated.

## Prioritizing Alternatives

Once all possible alternatives are assembled, the team prioritizes the alternatives. Again, there are many techniques to perform this prioritization. The bubble sort algorithm allows for pair-wise comparison between two alternatives in sequence until the entire array of alternatives have been evaluated and placed. Figure 3-5 illustrates how the buble sort algorithm works. When making the pair-wise comparisons, it is even more important to address the factors discussed previously (cost, timetable to implement, and technical feasibility) to determine the preferred alternative. In many instances, these different factors must be weighted against one another to arrive at a final, prioritized list (e.g., low cost/low risk/low return on investment versus high cost/high risk/high return on investment). It is not unusual to find the short-term/low-cost alternatives at the top of the list and the longer-term/higher-cost/moderate risk alternatives in the middle of the list. Individual teams decide how to weigh these various factors when prioritizing the alternatives list.

The bubble-sort example performs pair-wise comparison to generate a prioritized list of four alternatives.

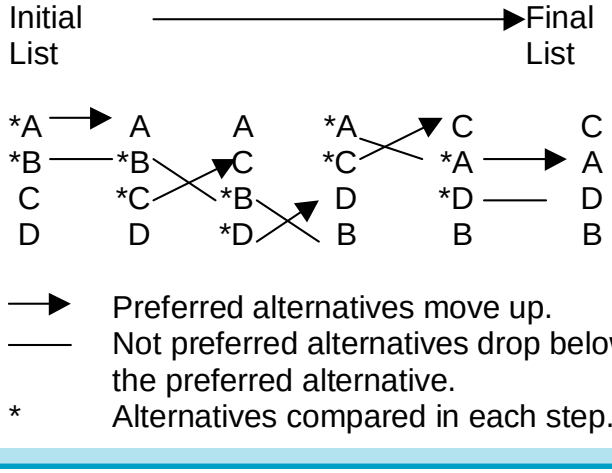



**Figure 3-6. Bubble-Sort Algorithm Example**

## Developing an Action Plan

The culmination of all of these tools is a set of specific actions that need to be implemented in a practical, cost-effective manner. The alternative with the highest rank after prioritizing the alternatives list becomes the "goal" in the action plan. If the alternative with the highest rank cannot practically be achieved, other alternatives in the prioritized list are incrementally addressed until a practical plan can be developed. Development of action plans with specific assignments, goals, and deliverables is critical for the success of the pollution prevention program in this endeavor. Because pollution prevention, energy efficiency, and other environmental best management practices are continuous improvement activities, these action plans need to be flexible to the changing environment.

***Development of action plans with specific assignments, goals, and deliverables is critical for a successful pollution prevention program.***

Action plans need to be marketable to those who would provide the funding to implement the pollution prevention plan. Therefore, the team should be prepared to address questions such as the following:

- Why is implementing this pollution prevention alternative important for our company?
- Why is it important for our customers?
- What are the risks involved if we implement this alternative?
- What are the risks if we do not implement this alternative?
- What changes do we have to make to get the alternative implemented?
- Who should do what by when?
- How do we get from here to there?
- What is the most efficient budget and schedule?
- How will we know if we are headed in the right direction?
- How will we follow up to ensure completion?

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# Section 4.0

## Case Studies and the Effective Use of the Systems Approach for the Oil and Gas Industry

Section 3.0 described the systems approach tools that, in general, are the most effective in the order in which they are presented. Circumstances do exist, however, when these tools are most effective when used in a different order. For example, if processes do not change frequently, but new, cost-effective alternatives are continually being developed and demonstrated, it may not be necessary to make use of the process mapping, activity-based costing, or root-cause analysis tools in order to address new alternatives.

For many oil and gas operations, routine processes are very similar from company to company. For this reason, tools, such as process mapping, might not be necessary to implement proven alternatives (often related as “case studies”) that often have been helpful aids to the oil and gas industry in formulating a successful pollution prevention program.

This section provides some case studies with references to additional case study information for this purpose. The systems approach tools outlined in this manual capitalize on the individual needs of each organization to promote continuous improvement and optimum benefit.

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# CASE HISTORY 1

# DRILLING OPERATIONS



## USE OF "CLOSED DRILLING PIT SYSTEM" TO REDUCE DRILLING WASTE

(submitted by Langham Petroleum Exploration Corp.)
cited in the Railroad Commission of Texas, 1994

**CHALLENGE —** Challenges associated with conventional reserve pits include volume of drilling wastes; drill site installation and restoration costs; pollution of land and/or surface water due to failure of pits and/or containment system and associated cleanup costs; and potential for subsurface pollution due to downward migration from pits and/or surface soil permeability.

**SOLUTION —** Use closed-drilling pit system to reduce volume of drilling waste, as follows:

Conventional reserve pit (235' x 77' x 5'), cuttings pit (20' x 10' x 5'), and water pit (40' x 10' x 5'):

| | |
|---|---|
| TOTAL DRILLING MUD AND WASTES IN PITS | 16,625 BBL |

With closed-loop drilling fluid system (eliminated reserve pit), cuttings pit, and water pit:

| | |
|---|---|
| TOTAL DRILLING MUD & WASTES IN PITS | 1,100 BBL |
| TOTAL REDUCTION IN DRILLING MUD AND WASTES IN PITS | 15,625 BBL |

CASE HISTORY 1

The drilling contractor maintained "safe pit levels" and recycled drilling fluid to minimize pit volumes and disposal requirements. Waste management costs due to procedures other than those specified were also the responsibility of the drilling contractor. Cost savings provided the incentive to implement and maintain proper procedures to minimize waste generation in the closed-loop system.

(*Note: Optimum use is for on-shore, normal pressure, relatively shallow drilling operations.*)

**BENEFITS —** The following benefits were realized:

- TOTAL ESTIMATED COST SAVINGS (considering reduced costs for drill site installation, fluid hauling and disposal, dirt work, and surface damage payment): $11,000.00
- Reduced potential for environmental impact to surface and groundwater

# CASE HISTORY 2

# RESERVE PIT MANAGEMENT SYSTEMS



Summarized from the following papers as cited in Railroad Commission of Texas, 1994:

Hall *et al.*, "The Use of a Managed Reserve Pit System to Minimize Environmental Costs in the Pearsall Field," Society of Petroleum Engineers (SPE) Paper 22882, (October 6, 1991)

Pontiff *et al.*, "Theory, Design and Operation of an Environmentally Managed Pit System," Proceedings of the First International Symposium on Oil and Gas Exploration and Production Wastes, New Orleans, LA (Sept. 10–13, 1990), 977–986

Spell *et al.*, "Evaluation of the Use of a Pit Management System", Proceedings of the First International Symposium on Oil and Gas Exploration and Production Wastes, New Orleans, LA (Sept. 10–13, 1990), 491–501

**CHALLENGE —** Using conventional reserve pits, high volumes of drilling wastes that require relatively high management costs are mixed with wastes that have relatively low management costs

**SOLUTION —** The reserve pit management system was selected to replace the conventional reserve pit. The reserve pit management system uses a set of at least four separate pits constructed in an area that would otherwise be occupied by a conventional reserve pit. A separate pit is constructed for at least each of the following discharges: 1) shaker solids, 2) settling, 3) storage, and 4) emergency. Space for a dragline is allowed to facilitate the movement of solids from one pit to another.

CASE HISTORY 2

**BENEFITS —** The reserve pit management system offers advantages such as the following:

- Wastes (such as salt cuttings, unexpected saltwater flows, and muds with high barium concentrations) are kept separate from the normal, uncontaminated drilling waste, thus minimizing the volume of contaminated waste to be handled.
- Solids (such as contaminated drill cuttings) may be removed from the pits for appropriate management during drilling operations.
- Rainwater can be collected and discharged with minimal treatment when kept separate from contaminants.
- Water from the segregated pits is available for use as makeup water in the mud system, resulting in cost savings.
- Site remediation costs and the potential for long-term liability are minimized.

Twelve case histories are compared in this attachment. Two drilling operations using reserve pit management systems had waste handling costs of $0.40 and $1.84 per barrel. In comparison, the typical waste handling costs for a closed mud system were reported to range from $2.67 to $7.00 per barrel.

# CASE HISTORY 3

# SOURCE REDUCTION OF ENGINE LUBRICATING OIL



Summarized from the following paper as cited in Railroad Commission of Texas, 1994:

Fullerton, R.D., *"Monitoring Engine Oil,"* Society of Petroleum Engineers Paper 18663, Society of Petroleum Engineers, February 28, 1989

**CHALLENGE —** Large volumes of lubricating oil and filters were used in diesel engine power plants on drill rigs. The company was concerned with increasing costs of lubricating oil and filters, and the management of large volumes of resulting waste. Although the subject of this case history is a drill rig power plant, this source reduction opportunity is applicable to nearly all operations.

**SOLUTION —** The volume of waste lubricating oil can be reduced at the source by extending the time interval between oil changes. R. D. Fullerton has presented the results of such a program at Helmerich & Payne International Drilling Company. Diesel engines that were the primary source of power were the subject of this project, which was described as an effort to reduce daily operating costs. However, as an added benefit, the volume of generated waste lubricating oil was also reduced.

Oil changes had previously been scheduled every 500 hours. A program of regular sampling and laboratory analysis of the engine lubricating oil was implemented as a method for determining the maximum time interval for oil changes. Each sample of lubricating oil was analyzed to measure three areas of interest: 1) wear rate of engine components; 2) presence of contaminants; and 3) oil additives. Elements commonly detected include copper from bearings and water;

CASE HISTORY 3

iron from liners, gears and shafts; silicon from dirt and cooling additives; aluminum from pistons, bearings and paint; and lead from bearings and clutches. Several oil sample tests were performed at 250-hour intervals while maintaining the 500-hour oil change interval to establish a wear pattern for each element. Once this baseline was established, oil changes were made based upon the continued analysis of oil samples at each 250-hour interval. Oil changes were made: 1) if sample analyses showed an increase in elements signifying engine wear or contaminants; or 2) at 1,250 hours of service after the previous oil change.

**BENEFITS —** The program to extend lubricating oil service time resulted in a decrease in oil costs from $63.73 per day when the oil sampling program was implemented, to $41.15 per day two years later. The author also reported that there was no harm to the engines and no increase in engine maintenance costs associated with the extended lubricating oil service life. The author does not address the cost savings realized from the reduced volume of waste lubricating oil requiring handling.

CASE HISTORY 4

# OIL FIELD PRODUCTION OPERATIONS

## CASE HISTORY 4
## PARAFFIN DEPOSITION

(submitted by RWA Corporation)
as cited in Railroad Commission of Texas, 1994

**CHALLENGE —** This company had problems with paraffin deposition in pumps, tubing, surface equipment, and tank bottoms. The paraffin deposition caused the well to "lock up" (stuck rods), which sometimes caused the rods to part. Excessive paraffin in tank bottoms resulted in occasional "turn downs" by the crude oil purchaser. The well was treated with chemical paraffin solvent and hot-oiled every 10 days.

**SOLUTION —** A magnetic fluid conditioner was installed in the well. The magnetic fluid conditioner is designed to direct the produced fluids through a strong permanent magnetic field to alter the growth patterns of paraffin and scale crystals. The magnetic fluid conditioner also increases the solubility of the crude oil and affects the cloud point, pour point, viscosity, and deposition temperatures.

**BENEFITS —** The well was pulled 49 days after installation of the magnetic fluid conditioner. No new paraffin deposition was found in the well. Also, flow lines, which previously were clogged with paraffin, were checked every few days and found to be free of paraffin deposition. The magnetic fluid conditioner had apparently worked well in preventing paraffin deposition.

Benefits of this equipment modification (source reduction) include the following:

CASE HISTORY 4

- The tool cost of $5,000.00 is expected to pay out in five to six months.
- Paraffin waste was minimized, and production was maximized at less cost.
- Releases of crude oil from paraffin clogged flow lines was eliminated (pressure would increase in flow line to point of rupture). Cleanups of crude oil-contaminated soil were minimized.
- Chemical treatment and hot oiling for paraffin removal is no longer necessary, saving workover expense and increasing production efficiency.
- Tank bottoms were minimized, and “turn downs” by purchasers were avoided.

# CASE HISTORY 5

## VOLATILE ORGANIC VAPOR EMISSIONS

Summarized from the following article as cited in Railroad Commission of Texas, 1994:

Webb, W.G., *"Vapor Recovery Uses Produced Water,"* The American Oil & Gas Reporter, June 1993

**CHALLENGE —** Conoco recognized that excessive vapor emissions from tank batteries were being flared or vented. Under certain circumstances, this situation may soon require air emission permitting under the Clean Air Act amendments of 1990. Also, emission monitoring and control equipment may be required.

**SOLUTION —** A vapor recovery system designed by Conoco engineers is being installed on tanks in order to eliminate vapor emissions. The vapor recovery system (called the "Vapor Jet") directs produced water through a venturi, which draws tank vapors into the water stream. The Vapor Jet system equipment includes the venturi, a centrifugal pump and drive motor, and piping. Produced water with the entrained vapors is piped to the low-pressure separation system. The separated vapors are sold with other lease gas or are injected in a water flood or water disposal system.

**BENEFITS —** Installation of this vapor recovery system at 20 Conoco facilities has provided the following benefits:

CASE HISTORY 5

- Air emissions were significantly reduced.
- Vapor recovery system maintenance costs were as little as $250.00 per year per unit. Considering added revenue from the recovered vapors, this source reduction is cost-effective.
- According to Conoco, the installation of the vapor recovery systems may result in avoidance of permitting and emission control requirements under the Clean Air Act amendments of 1990.

# CASE HISTORY 6

# GAS PLANT OPERATIONS



## GAS PROCESSING PLANT WASTE WATER

(Submitted by a company that wishes to remain anonymous)
as cited in Railroad Commission of Texas, 1994

**CHALLENGE —** In gas processing plants, wastewater is one of the largest quantities of generated waste. Among this category, the cooling tower is one of the most significant sources of wastewater generation. Whenever the amount of solids in the water becomes too high, a dump valve opens to remove a portion of the water, while fresh makeup water replenishes the basin level.

Chemicals are added to the cooling tower water to inhibit the formation of scale. These chemicals essentially disperse solids, thus preventing the formation of scale. In the past, the particular brand of inhibitor used was pH sensitive (i.e., the water had to be treated with sulfuric acid to achieve a low pH so the inhibitor chemical would properly perform its function). Chlorine was also injected into the water to act as a biocide.

**SOLUTION —** Another chemical manufacturer was contacted to see whether it could provide a substitute product with better dispersion qualities. Further investigation and testing determined that a different brand of scale inhibitor was available which allowed the water to be "cycled" more times through the cooling tower before it had to be blown-down and subsequently disposed. In addition, this new chemical was not pH sensitive, so the use of sulfuric acid was eliminated from the process. It was also discovered that chlorine, which does not perform well at high pH levels, could be replaced by bromine tablets, which are safer to use. In addition to these product changes, a chemical injection

CASE HISTORY 6

system was installed to provide small, continuous doses to the water, which proved to be more efficient than adding large amounts on a periodic basis.

**BENEFITS —** The net benefits to the gas plant operator were as follows:

- Reduced makeup water volumes
- Reduced water disposal volumes
- Eliminated the use of sulfuric acid
- Increased safety by substituting bromine for chlorine
- Increased efficiency of chemical usage

The most significant cost savings (thousands of dollars per year per cooling tower) originated from the reduction in wastewater disposal since the operator was paying trucking and disposal fees to a Class II well.

# CASE HISTORY 7

# GAS PLANT OPERATIONS

## HEAT MEDIUM OIL FILTERS

(Submitted by Warren Petroleum)
as cited in Railroad Commission of Texas, 1994

**CHALLENGE —** Heat medium oil is used to supply the heat needed to regenerate the rich monoethanolamine (MEA) in the sill reboiler. Over the years, the solid content in the oil increased to a point where it caused plugging problems in the sill reboilers and the heat medium heaters. Because of this, more filters were added to the system. A side stream of oil taken out of the system was cooled, filtered, and returned to the system.

This filter system worked; however, the filters were being changed frequently and at considerable cost. Three sets of filters were used. Filter set one consisted of 36 filters, which were changed once per week at an approximate cost of $15,650/year (includes filters, lost oil, labor, and maintenance equipment). Filter set two consisted of three filters, which were changed biweekly at an approximate cost of $2,840/year. Filter set three consisted of 54 filters, which were changed bimonthly at an approximate cost of $13,800/year.

Also, a new type of oil was added to the system when the level in the surge allowed a load to be brought in. The new oil was more stable and did not break down at the high heater temperature (445°F). Also, this new oil acted as a solvent and cut away the coke buildup. This, in turn, increased the importance of filtration.

CASE HISTORY 7

**SOLUTION —** Spinner-type filters (centrifuges) were installed to replace the conventional filters. In the new spinner filtration system, the oil is circulated through a water cooler until the temperature is below 170°F. A valve is open to the spinners, and the bypass is closed to circulate the oil through the two spinners and the water cooler. The oil is pumped back into the system after 24 hours of circulation, and the process begins again. Use of the spinners resulted in lowering solids (including soil) in the heat medium oil from three to approximately one percent. Size of the contaminants was reduced to below 3 microns. The spinners are taken out of service and cleaned three times per week.

The installation and use of the spinner system resulted in the complete elimination of conventional filter sets one and two, thus eliminating weekly and biweekly changes. The feasibility of eliminating filter set three (bimonthly changes) was under investigation at the time of case history submittal.

**BENEFITS —** Two sets of conventional filters were eliminated, saving approximately $18,500/year in filter, lost oil, labor, and maintenance equipment costs. If the elimination of filter set three is found to be operationally feasible, the cost savings would escalate to approximately $32,300/year.

The management of 1,950 waste filters per year was eliminated. Liability concerns, as well as costs associated with system maintenance requirements and waste filter disposal, were eliminated.

# CASE HISTORY 8

# GENERAL OPERATIONS

## INVENTORY CONTROL

**CHALLENGE —** The staff of an area of operation (which included drilling, gas production and compression) of a major oil and gas company determined that its inventory of chemicals was excessive and that much of the generation of chemical waste was unnecessary. The company was also concerned about the generation of hazardous wastes resulting from its chemical inventory management.

**SOLUTION —** The company addressed the problem by designing and implementing an inventory control system. The inventory control system is based on a complete inventory of all chemicals in the area of operation. To minimize chemical waste, the company identified suitable (e.g., less toxic) substitute chemicals, eliminated the use of all halogenated and nonhalogenated organic solvents, determined instances where a specific chemical could be used for multiple purposes, and eliminated the use of 55-gallon drums, where possible. An important part of the system is a chemical evaluation prior to its purchase using material safety data sheets (MSDSs) and other manufacturer's information. The purchase of a new chemical is approved only after it is determined that the chemical complies with the inventory control system. Finally, all purchased chemicals are closely tracked to ensure efficient usage.

**BENEFITS —** The company eliminated about 32 unnecessary chemicals and products within six months of the program's initiation, which resulted in reduced regulatory compliance concerns (e.g., hazardous waste regulations) and savings in operating costs. Waste management concerns and costs were reduced due to the reduction in the number of 55-gallon drums on inventory. Also, the company's chemical suppliers were aware of the inventory control system and worked to supply chemicals which would be approved by the company's system.

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## Additional Case Study References:

"Waste Minimization In The Oil Field," Railroad Commission of Texas, Oil and Gas Division-Environmental Services, 1994, Chapter 6

"Guidelines for Waste Minimization in Oil and Gas Exploration and Production," Interstate Oil and Gas Compact Commission Waste Minimization Subcommittee, 1994, Chapter 6

American Petroleum Institute website – www.api.org (see, for example, "An Examination of Incentives for and Obstacles to Pollution Prevention in the Petroleum Industry," www.api.org/pasp/rs087.pdf)

Gas Research Institute – www.gri.org (see, for example, "Waste Minimization in the Natural Gas Industry: Regulations, Methodology, and Assessment of Alternatives)

## Effective Utilization of Systems Approach Tools with Case Studies

Once a case study has been presented and subsequently validated, the first step that should be taken to integrate the study into the pollution prevention planning and implementation process is an activity-based costing **validation** step. (This assumes that activity-based costing has already been performed to identify the most costly wastes.) This step should be used to determine whether the improvement illustrated through the case study addresses a significant (cost savings or cost avoidance potential) waste or loss within the organization. If one hundred case studies are presented, it is unlikely that most companies will have the funding or the need to immediately implement all one hundred case studies. This activity-based costing validation step should pare down the number of applicable case studies to a select few that address a costly waste or loss and should be implemented quickly. It is important, as with the other continuous improvement techniques, to maintain information regarding all of the case studies whether they should be implemented immediately or not because they may be applicable or more easily implemented in the future.

Once the case studies have been pared down to the most applicable ones, it is then important to determine whether the case studies provide the greatest benefit to the organization. It is often likely that the alternatives provided through the case studies would demonstrate significant benefits. However, the development and

prioritization of pollution prevention alternatives should still be carried out with the case studies as part of an overall alternatives list. This will insure that all alternatives are still considered and that the case studies do not introduce bias to the decision-making process. At this point, the process is analogous to the systems approach tools described in Section 3.0. After the alternatives have been evaluated and prioritized, an action plan is developed and implemented.

Case studies can be extremely helpful in the formulation of a successful pollution prevention program. However, it is critical that they are evaluated (and potentially implemented) in a practical manner and as part of an overall decision-making process. Organizations will not attain the greatest benefits if they are always reacting to case studies (successes) from other organizations (including competitors). Each organization has its own issues, its own timetable, its own agenda. The systems approach tools outlined in this manual capitalize on the individual needs of each organization to promote continuous improvement and optimum benefit.

# Section 5.0

## Pollution Prevention Program Development

Traditionally, pollution prevention has been promoted through a hierarchy that addresses (in order from most to least cost-effective) the following:

- Source Reduction
- Recycling
- Treatment
- Disposal

Through the use of the tools outlined in this manual, this hierarchy often will be followed when alternatives are derived. However, the tools do not mandate that this order be followed and, in some instances, the most cost-effective alternatives at any point in time may be treatment and disposal alternatives.

## Source Reduction

Source reduction involves the use of processes, practices, or products to reduce or eliminate the generation of pollutants and wastes. Source reduction includes, but is not limited to, material substitution, process substitution, and process elimination. Examples of some source reduction opportunities are described below.

### Material Substitution

Materials that will result in less toxic wastes can be substituted for materials that are currently being used. Examples include the following:

- The substitution of less toxic drilling fluid additives will result in less toxic drilling wastes.
- Shifting from solvent-based paints to water-based paints reduces the toxicity of paint wastes.

### Process Substitution or Elimination

Processes that result in less waste and increased efficiency can be substituted for processes that are currently being used. Also, entire

processes can be eliminated if pollution prevention is implemented. Examples are use of the following:

- Well designs and drilling methods that reduce the volume of cuttings generated
- Improved transportation methods that reduce the risk of spills and leaks
- Improved separation techniques at the well that eliminate the need for several gas processing steps

## Good Housekeeping and Equipment Maintenance

Good housekeeping and equipment maintenance are two best management practices that are often low-cost/high-benefit approaches to pollution prevention. A common example of good housekeeping practices involves the use of drip pans to catch leaks or drips from equipment. Equipment maintenance is important for two distinctly different reasons: 1) routine maintenance will reduce the occurrence of leaks and drips, and 2) routine maintenance will extend the lifetime of the equipment. When thinking about pollution prevention, it is important to consider that when equipment comes to the end of its life it also becomes a waste!

***When equipment comes to the end of its life, it also becomes a waste!***

## Water Conservation

Water conservation is another best management practice which, if successful, will greatly reduce the waste volume from oil and gas operations. Examples include the following:

- Low solids, nondispersed drilling fluid systems may replace dispersed systems that typically require large volumes of water
- Careful use of water during equipment cleanup and efficient operations of cooling towers may result in reduced water volumes
- Increased use of “smart” pigs or ultrasonic devices to test wall thickness or detect weak spots can enable better targeting of pipeline sections requiring pressure testing or replacement. More efficient pigging and precleaning of pipelines prior to hydrostatic pressure testing will result in greatly reduced volume and toxicity of waste hydrostatic test water.

## Pollution Prevention in Design and Planning

Designing or planning for a new process or operation is the best time to address pollution prevention considerations. With an existing process, implementing pollution prevention can require some possible down time due to either equipment reengineering or technician training. This will greatly add to the cost and, therefore, reduce the economic benefit of the particular pollution prevention approach. In the design and planning phase, there is no status quo and, therefore, no down time and associated costs.

## Training and Awareness

Training and awareness programs are critical to ensuring that pollution prevention is realized to its fullest potential. The best ideas will come from persons who work with machines, use materials, and generate waste. These persons must be aware that often there are alternatives and that they constantly need to be thinking about ways to improve operations, efficiency, etc. It is always more effective to provide pollution prevention training to persons with process knowledge (often, the implementers and stakeholders) than to provide "pollution prevention experts" with process knowledge to develop a pollution prevention plan.

## Life-Cycle Analysis

Pollution prevention often utilizes a principle known as "life-cycle analysis" to address all associated costs and possible solutions associated with a particular process or waste. Life-cycle analysis, sometimes referred to as "cradle-to-grave" analysis, is often used to track a particular material from its inception to its ultimate demise. This tracking usually requires documentation from other companies (both vendors and customers) in the material chain. In material substitution, for example, a possible material alternative that would drastically reduce a particular waste stream may require a process change by the vendor first. Also, a positive pollution prevention approach implemented by a particular company could have negative impacts to its customers or contractors. For these reasons, it is helpful to include vendors, customers, and contractors as part of the pollution prevention team!

***It is helpful to include vendors, customers, and contractors as part of the pollution prevention team!***

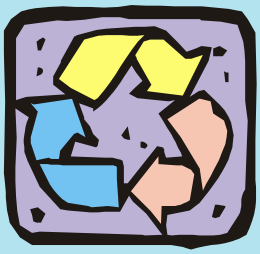
## Inventory Control

Inventory control addresses the effective use of data and information to track the procurement, use, and management of materials throughout the operation. Inventory control practices include the following:

- *"Just-in-Time" procurement.* Only purchase what is needed in the amounts needed. This is extremely important for chemicals or materials that have relatively short shelf-lives and have to be disposed if not used in a timely manner.
- *Affirmative Procurement.* Only purchase materials that have been or can be recycled. Purchase nonhazardous chemicals and materials whenever possible.
- *Barcoding.* Use barcodes to track material usage throughout the facility. This is extremely helpful in limiting the amount of material purchased if it is known how much of that material may be already stored at the facility. Through a chemical or material exchange program, chemicals and materials can be obtained from operations within the facility instead of having to purchase the materials.

## Recycling

For the purposes of this manual, recycling is addressed in two different fashions whenever possible: 1) in-process recycling, and 2) end-of-pipe recycling.



*In-process recycling* implies that a material is recycled before it becomes a waste. If the material is not being treated as a waste, then waste management regulatory requirements are not applicable to these processes (no treatment permit required, for example). Because the recycling is in-process, the development of the alternatives require knowledge of the process itself. The tools described in this manual are conducive to addressing in-process recycling.

*End-of-pipe* recycling implies that the material being recycled has already become a waste. In many cases, waste management regulatory requirements are applicable to these recycling processes. Because the recycling is end-of-pipe, knowledge of the process that generated the waste is normally not necessary. End-of-pipe recycling as a pollution prevention alternative does not, therefore, depend on the processes that generated the waste. For this reason, most end-of-pipe pollution prevention alternatives are not included in Volume 1 of this

manual. End-of-pipe recycling alternatives, as well as treatment and disposal alternatives, are discussed further in Volume 2 of this manual.

The New Mexico Oil Conservation Division (OCD) regulates end-of-pipe recycling and reclamation practices under the Oil and Gas Act and Water Quality Act. For further information see Volume 2.

## Treatment (including waste segregation)

Waste treatment is usually the third option after source reduction and recycling opportunities have been exhausted. Treatment includes techniques such as precipitation, neutralization, stabilization, and incineration. For the purposes of this manual, waste segregation is also considered as a treatment alternative. In many cases, waste treatment is performed off-site by a contracting organization. The waste generating organization must maintain very careful records regarding the contents of the waste so the proper waste management procedures can be carried out. In many cases, information regarding the process that generated the waste is maintained with the waste information. This information is helpful in demonstrating an understanding of how (and why) the waste was generated, and it lessens the risk to the contracting organization that may be treating wastes it may otherwise not be permitted to treat.

Waste segregation is an environmental best management practice designed to reduce costs through storing incompatible wastes separately, including separating hazardous from nonhazardous wastes, or regulated from nonregulated wastes. In many circumstances, mixing regulated with nonregulated wastes renders the entire waste contents regulated and unnecessarily increases waste management costs.

## Disposal

If there are no other practical options, disposal needs to be carried out in an environmentally responsible manner. In the majority of cases, waste disposal will be provided by a contractor. It is critically important that proper documentation and records are maintained regarding waste disposal both by the parent company and the contractor. In many regulatory environments, for example, liability for the disposal of waste is not totally eliminated after the waste is removed from the site.

All wastes must be disposed of at an OCD approved site (see OCD web page at www.emnrd.state.nm.us/ODC/ for further information).

***In addition to pollution prevention practices, energy efficiency can provide significant cost reduction opportunities.***

In addition to the pollution prevention practices discussed, energy efficiency can also provide significant cost reduction opportunities. Some examples are described below and should be considered.

## Energy Efficiency

In most instances, energy efficiency opportunities are most prevalent in heating, ventilation, and air conditioning systems (e.g., insulation) and in lighting. Many of the energy efficiency best management practices address good housekeeping principles, such as the following:

- Use small lamps to direct light onto areas where you are working.
- Use dimmer switches to keep lighting down to the level necessary.
- Use outdoor lighting only when necessary. If you do use lighting, use fluorescent globes for lights left on for extended periods.
- Keep equipment well oiled to reduce wear and maintain energy efficiency.
- Use timers or motion detectors.
- User timers on thermostats.
- User energy management systems in buildings.

***For more information on the EPA's Natural Gas STAR Program***

*Energy Star® Website*
*http://www.epa.gov/unix0008/p2/energy/estar.html*

*Hotline: 1-888-STAR-YES*

The U.S. Environmental Protection Agency's (EPA's) *A Guide to Implementing the Natural Gas STAR Program* reports a number of energy-efficient best management practices for reducing methane emissions. The STAR Program reports that companies involved in the program have reduced methane emissions by over 26 billion $ft^3$. The best management practices described in the EPA guide are listed under two categories: 1) transmission and distribution companies, and 2) production companies.

## Transmission and Distribution Companies

- Directed inspection and maintenance at gate stations and surface facilities
- Identify and rehabilitate leaky distribution pipe
- Directed inspection and maintenance at compressor stations
- Use of turbines at compressor stations for new installations or when retiring reciprocating engines
- Replacement of high-bleed pneumatic devices
- Reducing emissions when taking compressors off-line
- Reducing emissions from compressor rod packing systems
- Replacing wet seals with dry seals in centrifugal compressors

## Production Companies

- Identify and replace high-bleed pneumatic devices
- Install flash tank separators on glycol dehydrators
- Reducing the glycol circulation rate in dehydrators
- Installing vapor recovery units on crude oil storage tanks

Many of these examples stress preventative maintenance and inspection to identify leaks and other potential losses before they become significant. The EPA guide contains many other examples of best management practices for reducing methane emissions, as well as several detailed lessons-learned studies, which describe the best management practice and the economic benefits realized through implementation.

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## Section 6.0

## Traditional and Discrete Recommended Best Management Practices

The OCD has put together a list of traditional best management practices that are normally imposed on a facility. The list is not conclusive and sometimes may vary with site specific conditions. These best management practices were taken from the OCD's guidelines for permitting certain types of facilities in the oil and gas sector. They can be applied to other facilities as needed. The emphasis here is to supply industry with best management practices that have normally satisfied most regulatory concerns for the protection of public health and the environment.

Any good pollution prevention plan should detail the methods or techniques the operator proposes to use which ensure the operator's activities will not cause state regulations or groundwater standards to be violated and provides protection to public health and the environment as mandated by New Mexico Statutes.

These best management practices should be used as guidance in considering alternatives in the company's comprehensive pollution prevention environmental management system. The list is as follows:

1. Waste Disposal: All wastes must be disposed of at an OCD approved facility. Only oilfield exempt wastes may be disposed of down Class II injection wells. Non-exempt oilfield wastes that are non-hazardous may be disposed of at an OCD approved facility upon proper waste determination per 40 CFR Part 261.
2. Drum and Saddle Tank Storage: All drums and saddle tanks containing materials other than fresh water or fluids that are gasses at atmospheric temperature and pressure must be stored on an impermeable pad with curbing. Chemicals in other containers such as sacks or buckets must be stored on an impermeable pad and curb type containment.
3. Facility General Areas: Any facility area which shows evidence that leaks and spills are reaching the ground surface must be either paved and curbed or have some type of spill collection.
4. Above Ground Tanks: All above ground tanks which contain fluids other than fresh water must be contained in an impermeable bermed enclosure to contain a volume of one-

third more than the total volume of the largest tank or of all interconnected tanks.

5. Below Grade Tanks/Sumps: All below grade tanks, sumps, and pits must have secondary containment and leak detection.
6. Housekeeping: Proposed methods for preventing contaminants from reaching the ground surface must be stated in the BMP. Records of inspections must be made and retained.
7. Spill Reporting: All spills/releases will be reported and remediated pursuant to OCD Rule 116 and WQCC 1203.
8. Surface Water Protection: Any water contaminants must be contained within the facility boundaries. A description of the methods used to achieve this goal must be included in the BMP.

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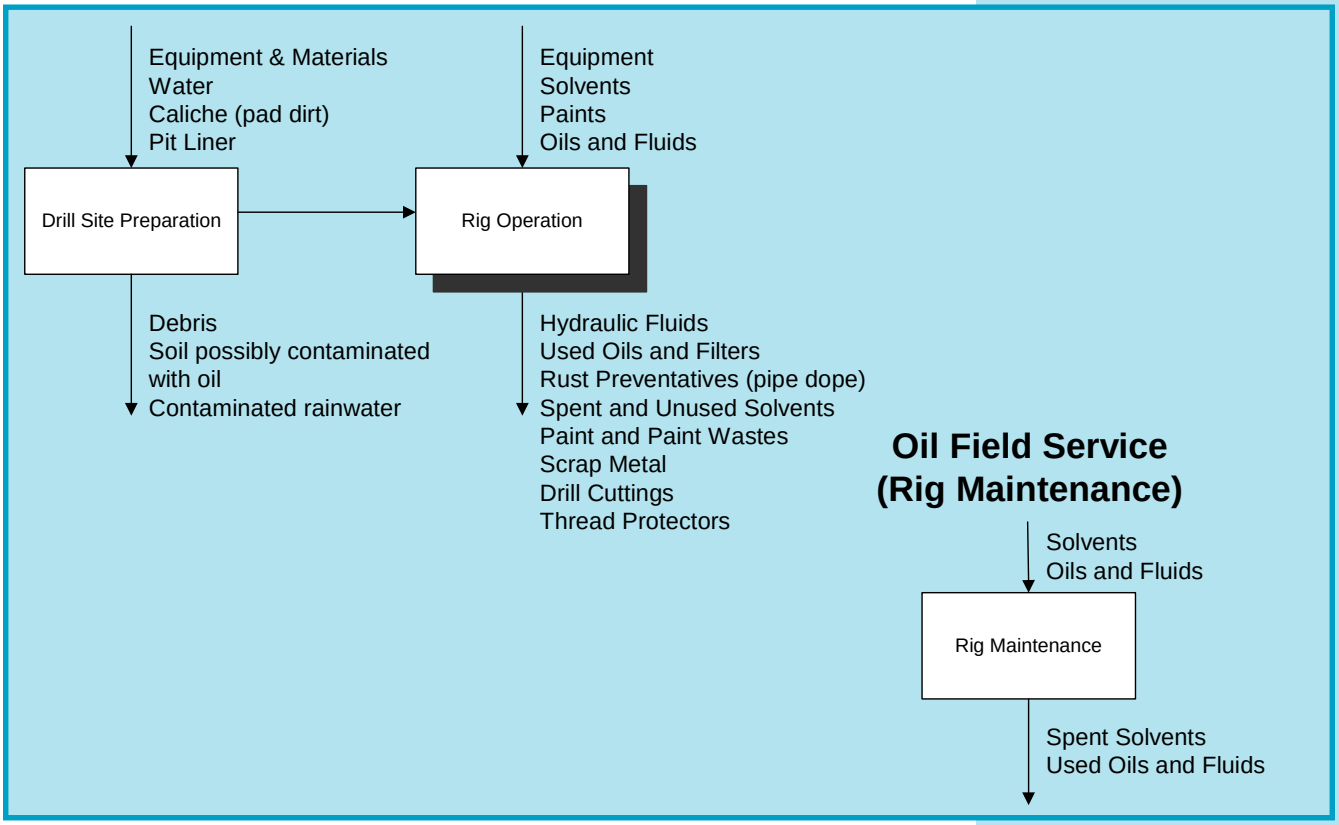
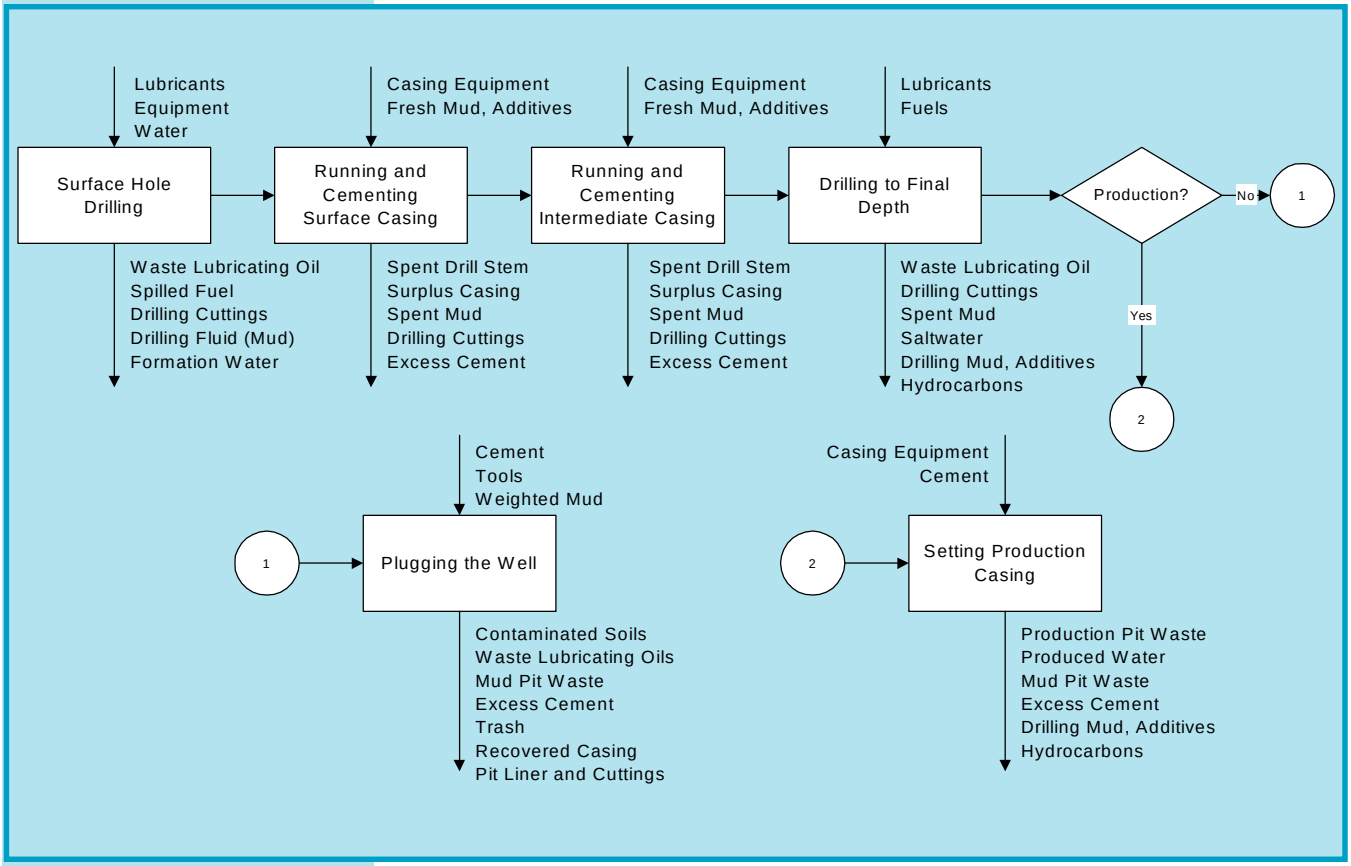
# Section 7.0

## Oil and Gas Exploration and Production

Oil and gas exploration and production activities include drill site preparation and drilling rig and oil field production operations. Examples of oil and gas exploration production process maps are presented below. Following each process map is a description of typical waste streams and pollution prevention alternatives that would likely result from implementing the systems approach tools. The pollution prevention alternatives described on Tables 7-1 through 7-6 focus on source reduction and in-process recycling which are often process dependent. End-of-pipe recycling, treatment, and disposal alternatives (not process dependent) are discussed in Volume 2. Process Map 7-2 is a second level map that corresponds to the rig operation box in Process Map 7-1. The process map for exploration includes an intermittent rig maintenance operation which is discussed in Section 10.0, Oil Field Services. It is included in this map to demonstrate that it would be useful to include rig maintenance issues in the exploration pollution prevention alternatives.




**Process Map 7-1. Exploration (First Level)**




**Process Map 7-2. Drilling Rig Operation (Second Level)**

## Drill Site Preparation

Drill site construction and rigging up are conducted in preparation for drilling activities. Drill site construction includes clearing and leveling land; building access roads; digging and lining the drilling mud reserve pit (see Section 4.0, Case Histories 1 and 2); installing underdrains; and digging and preparing the cellar, rathole, and mousehole.

Rigging up includes erecting the rig, guardrails, walkways, and stairways; installing auxiliary equipment to supply electricity, compressed air, and water; and setting up storage facilities. Rotary rigs are the most common in the oil patch today. Most are portable, moved in and assembled to drill the hole, and then disassembled and moved to another drilling site.

**Table 7-1. Drill Site Preparation Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Debris | • Develop procedures to keep areas clear of debris and practice good housekeeping to prevent contamination with lubricating oil.<br>• Store in labeled containers/dumpsters.<br>• Do not mix with contaminated or potentially hazardous material.<br>• Recycle paper, metal, cardboard, and aluminum cans. |
| Lubricating oil-contaminated soil from heavy equipment (e.g., bulldozers) | • Develop procedures to prevent contamination of soils; include preventative maintenance on lubricating oil system and containment.<br>• Contain lubricating-oil spill; pick up and store in labeled container or recycle (if free liquid). |
| Contaminated rainwater (storm water) | • Improve work processes, and maintain equipment and facilities to prevent leaks and spills.<br>• Cover facilities to prevent contamination of rainwater. |

## Drilling Rig Operation

***Mud accounts for the largest volume of waste and a major portion of the costs associated with drilling a deep well.***

Drilling activities include the operation of the drill rig and string to drill a surface hole and a drilling mud system. Drill rig operation uses numerous systems and various types of machinery.

A drill rig is used to handle the drill pipe and bit that drill the surface hole. At some depth when the hole has permeated beyond the near-surface strata, drilling stops and the drill stem is withdrawn from the hole to change bits or run samples (called "tripping out"). Once the pipe is out, the casing crew runs the surface casing. An oil well cementing service company usually cements the casing in place. After the cement hardens and tests indicate that the job is satisfactory, the rig crew attaches and tests the blowout preventer stack, and drilling is resumed.

To resume drilling, the drill stem and a new, smaller bit that fits inside the casing must be tripped back into the hole (called "tripping in"). At a specific depth, drilling stops again to run another string of casing that is smaller in diameter than the initial run. The final part of the hole is drilled using a smaller bit. The bit and drill stem are tripped in and the intermediate casing shoe is drilled out. Drilling (to the final depth) resumes, and the cuttings are examined and/or well logging is conducted to determine whether the formation contains sufficient hydrocarbons to produce enough oil or gas to cover the costs associated with casing and completing the well. If the well is determined to be a dry hole, it is plugged.

*Drilling fluid* ("mud") is used to maintain hydrostatic pressure for well control (to prevent a blowout), carry drill cuttings to the

surface, and cool and lubricate the drill bit. Mud is usually fresh water, salt water, or oil combined with a mixture of clays and chemicals, depending upon the conditions encountered.

Water used to make up the mud (called "makeup water") may require treatment to remove dissolved calcium and/or magnesium. Soda ash is added to form a precipitate of calcium carbonate. Caustic soda (NaOH) is added to form magnesium hydroxide.

Chemicals and additives used to treat mud include the following:

- Acids and caustics
- Bactericides
- Defoamers
- Emulsifiers
- Filtrate reducers
- Shale control inhibitors
- Thinners and dispersants
- Weighting materials
- Lost circulation materials

Solid additives are usually introduced into the mud system in a mixing (jet or "shotgun") hopper. Other chemical additives used to control mud viscosity and gel strength are mixed in tanks connected to the mud stream. Several devices used to remove solids from the mud as it circulates include shale shakers, centrifuges, and cone-type desanders/desilters.

Lined reserve pits or tanks constructed during drilling preparation receive spent mud, drill cuttings and solids, rig wash, and surface runoff from the drilling location. If the location is an ecologically sensitive area, trucks are used to transport waste material to a proper disposal site. [*Note: Resource Conservation and Recovery Act (RCRA)-regulated hazardous waste should not be allowed to enter the reserve pit.*]

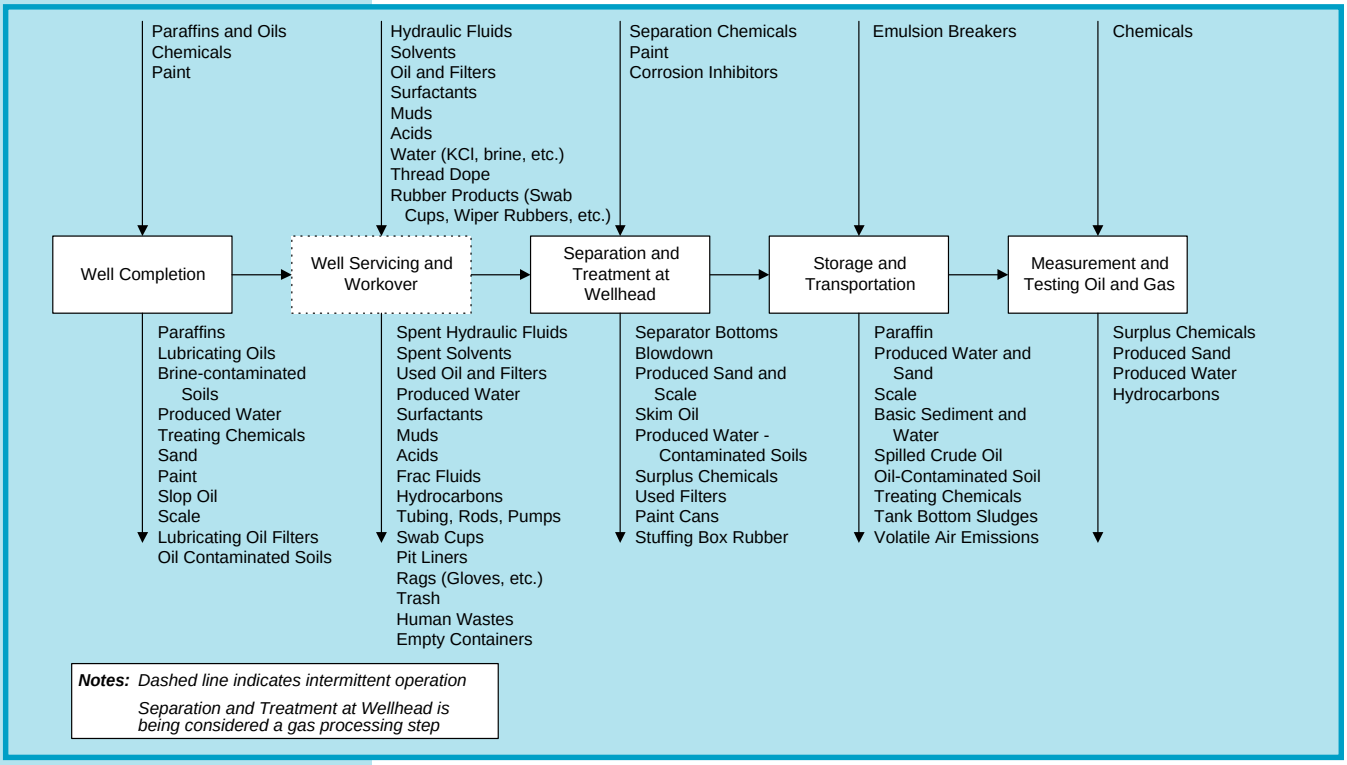
If the operating company decides to set casing, a contract casing crew with special equipment for running and making up the casing is called in to haul pipe to the test site, test the pipe, and make all other necessary preparations to run the pipe into the well.

Drilling operations generate an abundance of paper and plastic waste from packaging and wrappers on parts and equipment. Metal and wood debris are also generated. Roll away trash trailers can be placed conveniently and emptied as needed to encourage their use.

## Table 7-2. Drilling Rig Operations Alternatives

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Lubricating oil | • Test oil and extend its use based on wear versus accumulated operating hours. [*Note: Some oil suppliers offer free testing.*]<br>• Recycle in-process whenever possible. |
| Spilled fuel | • Contain spill as soon as possible.<br>• Incorporate good housekeeping to prevent spills. |
| Drilling cuttings | • Minimize drilling hole size when possible.<br>• Design and monitor drilling mud activities to minimize caving.<br>• Substitute organic additives, polymers, or biodegradable additives for oil-based mud to reduce costs associated with cleanup of oil-based drill cuttings. |
| Mud and additives | • Use a closed-loop mud system. (See Section 4.0, Case History 1).<br>• Use the reserve pit management system. (See Section 4.0, Case History 2.)<br>• Optimize solids control.<br>• Use low solids, nondispersed muds.<br>• Use an inside diameter wiping tool for drill pipe.<br>• Control inventory (accurately estimate amounts required and purchase only as needed), and plan ahead to avoid unused materials.<br>• Use unused additives at other sites. |
| Pipe dope | • Choose biodegradable, lead-free pipe dope.<br>• Purchase only what is needed. |
| Spent drill stem | • Purchase highly durable drill bits. |
| Surplus casing | • Purchase and use only what is needed.<br>• Use surplus at other sites. |
| Cement/grout | • Purchase and use only what is needed.<br>• Use surplus cement for erosion prevention.<br>• Return unused dry cement to vendor. |
| Produced water (See Figure 3-3) | • Use a closed-loop drilling fluid system. (See Section 4.0, Case History 1)<br>• Drill horizontal wells to minimize water production.<br>• Optimize production rate to minimize the influx of water.<br>• Treat the producing formation with polymers that decrease the permeability of water, while maintaining the permeability of hydrocarbons.<br>• Hydrotest pipelines, equipment, and tanks with produced water. |
| Drums and containers | • Reuse drums and containers, clean (triple rinse) first only if necessary. |
| Spent and unused solvents | • Substitute nonhazardous biodegradable surfactants (soap) for hazardous solvents (mineral spirits) to clean equipment.<br>• Use drip pans to collect solvent for reuse (use dirty solvent for initial cleaning and clean solvent for final cleaning, if necessary).<br>• Use spent solvent for paraffin removal or as paint thinner.<br>• Control inventory (accurately estimate amounts required and purchase only as needed) to minimize the storage of unnecessary solvent. |
| Oily rags | • Maintain equipment and facilities so that cleanup with rags is minimized.<br>• Segregate from other waste, and wash for reuse. |
| Surplus chemicals | • Control inventory by accurately estimating amounts required, or purchasing smaller quantities only as needed.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Use nonhazardous products.<br>• Store and maintain chemicals properly to prevent spills or leaks. |
| Rigwash | • Use dry cleaning when feasible.<br>• Use low-volume, high-pressure hose nozzles with automatic cutoffs.<br>• Remove paint solids from water and reuse. |
| Paint and paint wastes | • Paint only when necessary.<br>• Purchase only the required amount and use it all before it becomes unusable.<br>• Size the paint batch according to the specific job.<br>• Purchase highly durable paints.<br>• Control and reduce overspray. |
| Sandblast media | • Use paints that do not require sandblasting.<br>• Use as aggregate in road mix, if allowable. |
| Litter and debris | • Rent rollaway trash trailer at drill site. Dispose of trash as needed. |

***Using an inside diameter wiping tool can save approximately 0.4 barrel of drilling fluid per 1,000 ft of drill pipe***




**Process Map 7-3. Production**

## Oil Field Production Operations

Production is defined as the operations involved in bringing well fluids to the surface and preparing the fluids for transport to a refinery via pipelines or trucks (see Process Map 7-3 and Table 7-3). The first step in production is to start the well fluids flowing to the surface (called "well completion"). Well servicing and workover consists of performing routine maintenance operations (such as replacing worn or malfunctioning equipment) and performing more extensive repairs, respectively. Well servicing and workover are an intermittent step and necessary to maintain the flow of oil and gas, and are discussed in greater detail in Section 10.0, Oil Field Services, (see Process Map 10-1). Next, the fluid must be separated into its components of oil, gas, and water; stored; and treated (for purification), measured, and tested before being transported to the refinery.

### Well Completion

To put the well into production, a well servicing contractor performs the necessary well completion operations. The characteristics of the reservoir and its economic potential determine the type of completion method used (open hole, liner, and perforated casing).

When a well is completed, it produces oil and/or gas by natural flow and/or artificial lift.

Flowing wells consist of a wellhead assembly and associated equipment used for well treatment. When pressures in the oil reservoir are not sufficient to produce naturally, some method of artificial lift must be used. Artificial lift is accomplished by use of beam, gas lift, or submersible pumps. Flare pits collect unburned materials from the flare.

**Table 7-3. Well Completion Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Paraffin | • Install magnetic fluid conditioner to prevent paraffin formation. (See Section 4.0, Case History 4.)<br>• Use paraffin inhibitor chemicals.<br>• Use hot-oil treatment to dissolve paraffin in well and flow lines. |
| Lubricating oil | • Test oil and extend its use based on wear versus accumulated operating hours. [*Note: Many lubricating oil suppliers offer testing service at no charge.*] (See Section 4.0, Case History 3.)<br>• Recycle in-process whenever possible. |
| Produced water (see Produced Water Activity-Based Cost Analysis, Section 3, Figure 3-3) | • Use a closed-loop drilling fluid system. (See Section 4.0, Case History 1.)<br>• Drill horizontal wells to minimize water production.<br>• Optimize production rate to minimize the influx of water.<br>• Treat the producing formation with polymers that decrease the permeability of water, while maintaining the permeability of hydrocarbons.<br>• Hydrotest pipelines, equipment, and tanks with produced water. |
| Treating chemicals | • Control inventory by accurately estimating amounts required, or purchasing smaller quantities only as required.<br>• Offer to give to or exchange unused chemicals with other facilities in lieu of recycling, treatment, or disposal.<br>• Use nonhazardous products.<br>• Store and maintain chemicals properly to prevent spills or leaks. |
| Sand | • Optimize production rate to minimize sand production.<br>• Use uncontaminated sand as fill material. |
| Paint | • Paint only when necessary.<br>• Purchase only the required amount and use it all before it becomes unusable.<br>• Size the paint batch according to the specific job.<br>• Purchase highly durable paints.<br>• Control and reduce overspray. |
| Slop oil | • Recycle back into production stream.<br>• Replace impeller-type pumps used for fluid transfer service with “canned” submersible pumps to eliminate leaks from impeller pump seals and gear boxes.<br>• Send slop oil that cannot be recycled into production to a state-permitted tank bottoms reclamation facility. |
| Scale | • Use scale inhibitors.<br>• Avoid mixing incompatible produced waters, which results in scale formation. |
| Lubricating oil filters | • Change filters only when necessary. (See Section 4.0, Case History 3.)<br>• Use reusable filters.<br>• When handling filters, take precautions to prevent oil spillage.<br>• Isolate all drained fluids in a resealable container for in-process recycling. |
| Pit Liner | • Remove waste and liner for proper disposal.<br>• Remove oil and salt-laden mud, fold in and close with liner in place. |

## Separation and Treatment of Well Fluids

Well fluids often consist of a mixture of oil, gas, and water, which must be separated into components, measured, and treated. A few major considerations during this phase of production include vapor

recovery, evaporation control, and fire hazard communication and control.

Therefore, separation and treatment are often conducted at points along the gathering system. Any number of stage separators may be used in stage separation as long as each stage operates at a successively lower pressure.

***To obtain more complete recovery of liquids, more than one stage of separation is desirable.***

Two-phase separation of produced liquids from gases, three-phase separation of produced water from liquid hydrocarbons, and/or gas floatation treatment may be installed. Before oil can be delivered to the pipeline, the water must be removed. Free-water knockouts are used to separate oil and water at appropriate locations in the gathering system. This separation occurs before the emulsion is transported through the flow lines to the treatment plant.

Heater treaters separate emulsified oil and water. Depending on the service for which it is designed, a heater treater unit may contain several systems, including oil and gas separator, free-water knockout, heater, water, wash, filter section, stabilizing section, heat exchanger, and electrostatic field. Filtering improves the quality of liquids and produced water. Centrifugal desanders remove excessive volumes of produced sand and other solids.

**Table 7-4. Separation and Treatment of Well Fluids Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Blowdown | • Recycle back into production stream.<br>• Operate cooling towers efficiently to minimize the generation of blowdown.<br>• Cascade water use. |
| Produced sand and scale | • Optimize production rate to minimize sand production.<br>• Use uncontaminated sand as fill material.<br>• Use scale inhibitors.<br>• Avoid mixing incompatible produced waters, which results in scale. |
| Produced water-contaminated soils | • Follow procedures, including maintenance, to prevent soil contamination.<br>• Use impervious primary and secondary containment.<br>• Use cathodic protection or coated pipe to reduce leaks due to corrosion. |
| Surplus chemicals | • Accurately estimate amounts required, or purchase smaller quantities only as required.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Use nonhazardous products.<br>• Store and maintain chemicals properly to prevent spills or leaks. |
| Filters | • Change filters only when necessary.<br>• Use reusable filters.<br>• Use differential pressure as an indicator of needed change.<br>• When handling filters, take precautions to prevent oil spillage.<br>• Isolate all drained fluids in a resealable container for in-process recycling. |

Well treatment and gas treatment are often conducted at the wellhead either by batch treatments or continuous injection. Corrosion inhibitors are chemicals used to counter the reaction between the acid in the gas and the iron of the tubing or other equipment.

The water vapor in natural gas must be removed from the gas stream to prevent hydrates from forming.

***Hydrates are a problem because they may pack solidly in gas gathering systems, which results in blocked flow lines.***

Hydrate inhibition at the wellhead is accomplished by injection of glycol, ammonia, methanol, or brine. Also, hydrate inhibition may be accomplished by the use of indirect heaters that use bath solutions containing calcium chloride or glycol. Impurities (such as sand and excessive amounts of water) are sometimes separated at the wellhead.

Produced water is managed in preparation for recycling or proper disposal. Produced water may be stored in pits for remaining solids and oil separation. Underground injection, using electric or gas engine-powered pumps to pressurize water, is a common method for managing produced water.

## Storage and Transportation

Flow lines (gathering systems) are used to move produced oil to treatment and storage facilities (commonly referred to as "tank batteries"). Tank batteries consist of separation and treatment equipment and stock tanks. The number and size of stock tanks vary depending on the daily production of the well(s) and frequency of pipeline runs. Stock tanks are used to store treated crude oil and produced water. Most stock tanks are constructed of steel and equipped with a bottom drain outlet for draining basic sediment and water. The tanks require periodic cleaning to remove basic sediment and water.

Crude oil custody transfer is typically accomplished by moving the oil onto tank trucks via a loading line or into a pipeline.

## Measurement and Testing

The lease operator measures the volumes of oil, gas, and salt water produced by each lease to ensure that the oil and gas volumes are within the limits set by state regulations. The oil producer samples and tests the oil according to procedures prescribed by the pipeline company that purchases the oil. Oil samples can be obtained from storage tanks using the thief or bottle sampling methods. Although an average sample consists of proportionate parts from all tank sections,

different sampling methods may be conducted. All concerned parties should agree on which sample method(s) is used. Gas sampling is conducted in accordance with field procedures.

Because crude oil is bought and sold on a volume basis, several measuring and gauging tests must be performed, including temperature, gravity, and basic sediment and water content, in the presence of witnesses representing the lease and the pipeline, or by a lease automatic custody transfer unit. Field and laboratory tests on gas include charcoal and compression testing and fractional analysis. Test results may be used to determine a seller's price. Table 7-6 provides pollution prevention alternatives for measurement testing.

***See Case Histories about paraffin deposition, recycling drilling fluids, and volatile organic vapor emissions***

**Table 7-5. Storage and Transportation Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Paraffin | • Install magnetic fluid conditioner(s) to prevent paraffin formation. (See Section 4.0, Case History 4).<br>• Use paraffin inhibitor chemicals.<br>• Use hot-oil treatment to dissolve paraffin in well and flow lines. |
| Produced water (See Produced Water Activity-Based Costing Analysis, Section 3, Figure 3-3) | • Use a closed-loop drilling fluid system (See Section 4.0, Case History 1).<br>• Drill horizontal wells to minimize water production.<br>• Optimize production rate to minimize the influx of water.<br>• Treat the producing formation with polymers that decrease the permeability of water, while maintaining the permeability of hydrocarbons.<br>• Hydrotest pipelines, equipment, and tanks with produced water. |
| Produced sand | • Optimize production rate to minimize sand production. |
| Scale | • Use scale inhibitors.<br>• Avoid mixing incompatible produced waters which will result in scale.<br>• May contain naturally occurring radioactive materials (NORM). |
| BS&W\tank bottoms | • Identify and reduce the source of solids.<br>• Recycle back through treatment system.<br>• Use cone-bottomed stock tanks and frequently run bottoms through heater-treater. |
| Oil-contaminated soil | • Develop procedures to prevent contamination of soils; include preventative maintenance on flow lines and primary and secondary containment under tank battery load-line connections.<br>• Use summary or secondary containment under tanks.<br>• Contain crude-oil spill; pick up and store in labeled container or recycle (if free liquid). |
| Treating chemicals | • Control inventory by accurately estimating amounts required or purchasing smaller quantities only as required.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Use nonhazardous products. |
| Volatile air emissions | • Install a vapor recovery system. (See Section 4.0, Case History 5). |

**Table 7-6. Measurement and Testing Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Surplus chemicals | • Control inventory by accurately estimating amounts required, or purchasing smaller quantities only as required.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Use nonhazardous products.<br>• Store and maintain chemicals properly to prevent spills or leaks. |
| Produced sand | • Optimize production rate to minimize sand production. |
| Produced water (See Produced Water Activity-Based Costing Analysis for Section 3, Figure 3-3) | • Use a closed-loop drilling fluid system. (See Section 4.0, Case History 1).<br>• Drill horizontal wells to minimize water production.<br>• Optimize production rate to minimize water influx.<br>• Treat the producing formation with polymers that decrease the permeability of water, while maintaining the permeability of hydrocarbons.<br>• Hydrotest pipelines, equipment, and tanks with produced water. |
| Volatile air emissions | • Install a vapor recovery system. (See Section 4.0, Case History 5). |

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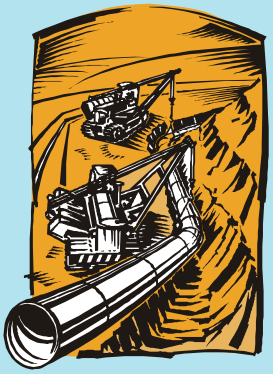
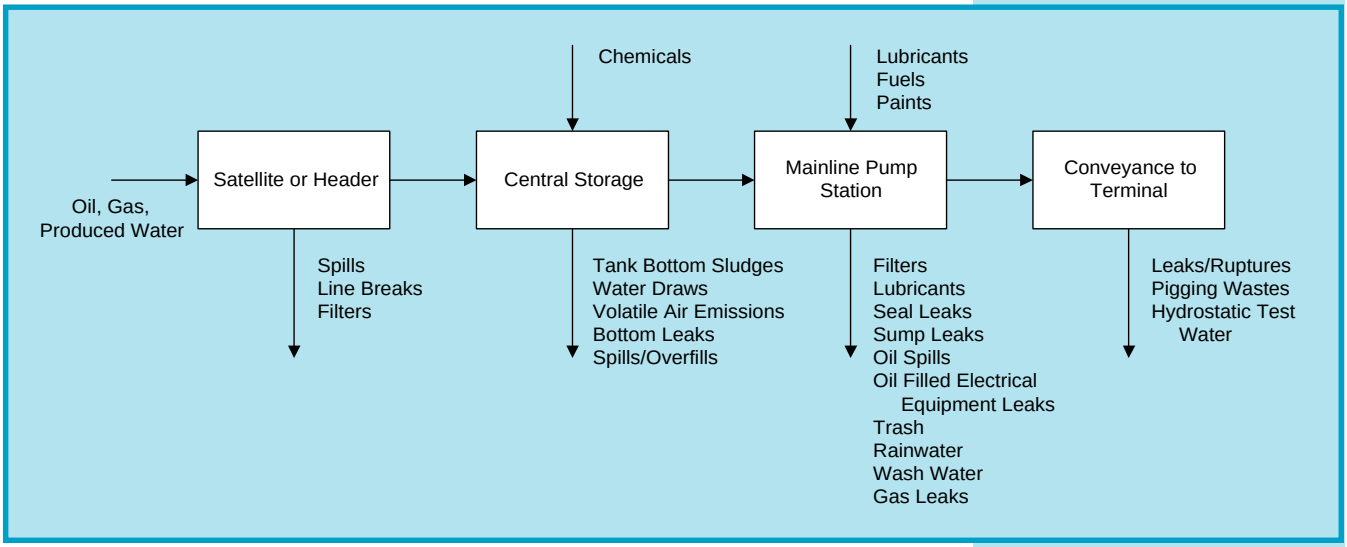
# Section 8.0

## Pipeline Transportation



Transportation of oil and gas includes the equipment and facilities used to move products through pipelines. Moving products by truck is addressed in Section 10.0, Oil Field Services. Process Map 8-1 illustrates an example of a transportation process map. Following the process map is a description of typical waste streams and pollution prevention alternatives that would likely result from implementing the systems approach tools. The pollution prevention alternatives described in this section focus on source reduction and in-process recycling which are often process dependent. End-of-pipe recycling, treatment, and disposal alternatives (not process dependent) are discussed in Volume 2.




**Process Map 8-1. Transportation**

Gas and oil pipelines are essentially similar, with the greatest operational difference resulting from the varying needs of transporting gas versus liquid. Oil pipelines require pumps to propel their liquid contents, while gas lines rely on compression to force the resource through the pipe. In both pump and compressor stations, corrosion of piping and vessels must be monitored constantly to prevent failure. Pipelines can be cleaned and surveyed with cleaning pigs used to prevent unwanted materials from contaminating the pumps or compressors. Pigs with high technology instrumentation are used to monitor pipeline conditions and detect potential problems.

*Oil Pipelines.* Oil pumped from the ground travels through pipes to lease tanks, where it is treated, measured, and tested. Typically, a separator is used to separate oil, gas, and water. A fired heater is used to break water/oil emulsions to promote removal of water from the oil. Tanks store oil until it is shipped as crude oil by truck or, more commonly, by a gathering line connected to storage tanks. From these tanks, the oil is moved through large-diameter, long-distance trunk lines to refineries or other storage terminals.

Trunk lines rely on pumps to initiate and maintain pipeline pressure at the level required to overcome friction, changes in elevation, or other pressure-decreasing factors. Pumps are required at the beginning of the line and are spaced along the pipeline to adequately propel the oil along the line.

*Gas Pipelines.* Gas pipelines operate at high pressures and use compressors (instead of pumps) to force the gas along the line. Unlike oil, gas does not undergo refining, and transmission lines connect directly to utility companies that distribute the gas to consumers via small, metered pipelines. Gas is often treated in scrubbers or filters to ensure that it is "dry" prior to distribution. Gas-well flow lines connect individual gas wells to field gas-treating and processing facilities or to branches of a larger gathering system. The gas is processed at the treating facility to remove water, sulfur, acid gases, hydrogen sulfide, or carbon dioxide. Most field gas processing plants also remove hydrocarbon liquids from the produced gas stream. From field processing facilities, the dried, cleaned natural gas enters the gas transmission pipeline system (analogous to the oil trunk line system). Downstream from compressor stations, lubricating oil from the compressors is removed from the gas lines.

Table 8-1 lists potential pollution prevention alternatives for pipeline operations.

**Table 8-1. Pipeline Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Waste from leaks | Reduce amount of waste generated by the following methods:<br>• Use leak detection technology (e.g., chemical sensing cables).<br>• Inspect for leaks in natural gas pipelines with surface-sampling instruments by the flame-ionization principle.<br>• Inspect areas for pools of product or dead vegetation on the pipeline right of way (Leaks in liquid natural gas pipelines are not as easily detected, and the soil around the line must be tested for constituents like propane and butane.)<br>• Detect leaks through investigating loss of working line pressure.<br>• Train dispatchers and employees to recognize situations that are likely to result in leaks and to intervene appropriately.<br>• Inspect for worn gaskets and valve stem packings, fractures and corrosion in the pipeline and perform preventative maintenance. Inspection may be done manually or using smart pigs.<br>Prevent corrosion in pipelines that may cause leaks or structural problems by the following methods:<br>• Coat pipe and joints to insulate metal from soil.<br>• Construct anodes or “ground beds” at strategic points along the pipeline. These ground beds provide cathodic protection by inducing a very small electrical charge into the soil, impeding the flow of electrons to the pipe.<br>• Add corrosion protection to tank bottoms.<br>• Monitor groundwater.<br>• Inspect seals, valves, and pumps and perform preventative maintenance to avoid leaks.<br>• Ensure that liquids have impermeable primary and secondary containment.<br>• Aboveground tanks should have secondary containment underneath tank bases and piping (or move piping above ground for daily visual inspection) to capture any releases before soil or groundwater is contaminated. |
| Filters | • Replace filters only as needed.<br>• Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>• Use stainless steel, reusable filters.<br>• Evaluate applicability of filterless centrifugal oil cleaning. (Use "spinners" to replace or lengthen oil filter life.)<br>• Install lubricating oil purification equipment to reduce frequency of conventional filter replacement.<br>• Before recycling spent filters, drain all free liquids from the cartridge or filter media into a container. Recycle free liquids back into production stream. |
| Tank bottom sludges | • Keep turbulent flow in tank to prevent sedimentation.<br>• Add appropriate chemical agents to reduce tank bottom. |
| Pigging wastes | • Use appropriate chemicals to reduce accumulation of paraffin. |

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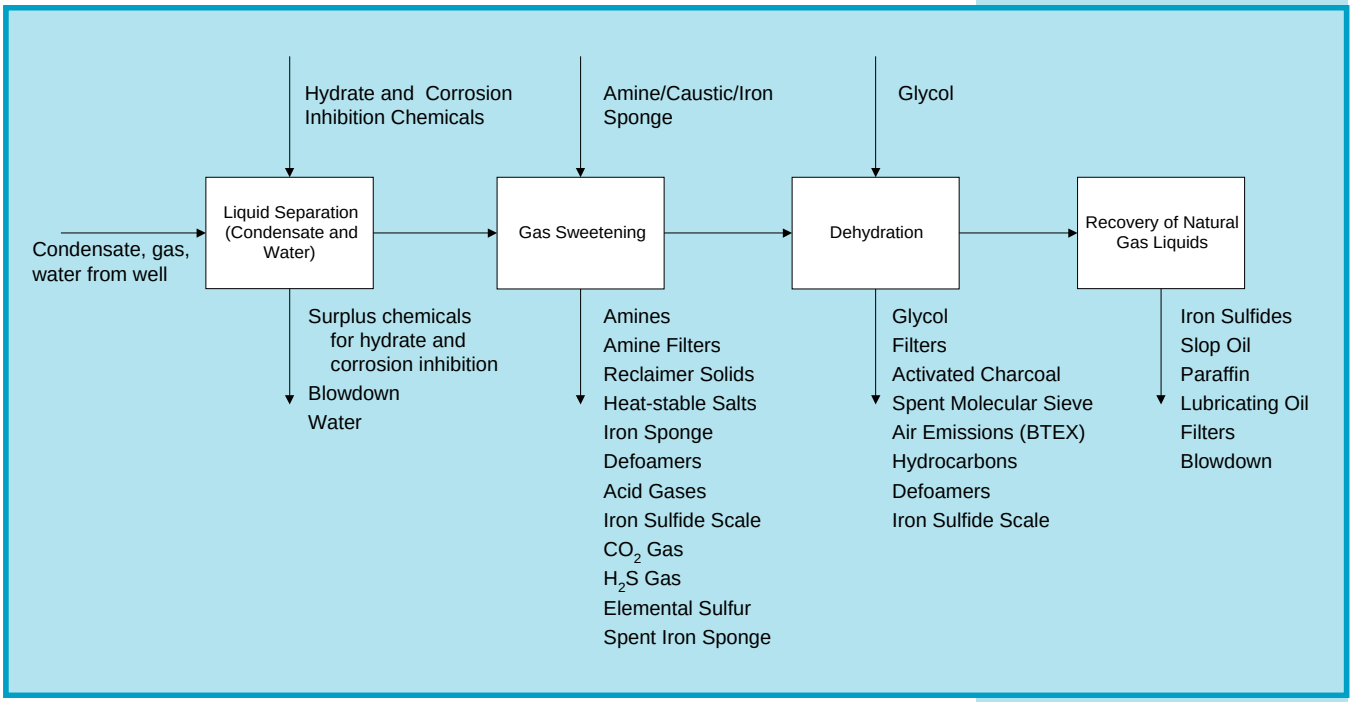
# Section 9.0

# Gas Processing

A gas processing plant processes condensate, gas, and water from a well to remove hydrocarbon products, dehydrate the mixture, recover natural gas liquids, and remove sulfur. Process Map 9-1 illustrates an example of a gas waste generating process map. This process map addresses gas processing at an off-site plant. Gas processing (separation and treatment) at the wellhead is an integral part of production (see Process Map 7-3) and is discussed in Section 7.0, Oil and Gas Exploration and Production. Following the process map is a description of typical waste streams from gas processing operations. Pollution prevention alternatives that would likely result from implementing the systems approach tools are presented for each stage of gas processing in Tables 9-1 through 9-5. The pollution prevention alternatives described in this section focus on source reduction and in-process recycling which are often process dependent. End-of-pipe recycling, treatment, and disposal alternatives (not process dependent) are discussed in Volume 2.




**Process Map 9-1. Gas Processing**

## Liquid Hydrocarbon Separation

Oil absorption plants remove hydrocarbon products from natural gas. Oil absorption plants include the following:

- Stage separators (economizers)
- Gas chillers
- Rich oil flash tanks
- Presaturators
- Accumulators
- Rich oil demethanizers

**Table 9-1. Liquid Hydrocarbon Separation Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Surplus chemicals | • Control inventory by accurately estimating amounts required or purchasing smaller quantities only as needed.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Use nonhazardous products.<br>• Store and maintain chemicals properly to prevent spills or leaks. Use impervious primary and secondary containment. |
| Blowdown | • Substitute brand of scale inhibitor for more effective brand (see Section 4.0, Case History 6).<br>• Recycle back into production stream.<br>• Operate cooling towers efficiently to minimize generation of blowdown.<br>• Cascade water use. |

***See Section 4.0, Case History 6 about processing plant wastewater.***

## Dehydration

Hydrocarbon fluids may retain water. Hydrates form when a gas or liquid containing free water is cooled below its hydrate temperature. A dehydration process is used to avoid free-water problems that cause the formation of hydrates. Dehydration is the removal of water from the produced natural gas and is accomplished by various methods.

Ethylene glycol (glycol injection) systems use filters to remove solids from solution prior to reboiling (which removes water), and use charcoal filters on glycol pump discharge if the glycol separator is not efficiently removing hydrocarbons. Triethylene glycol/diethylene glycol systems use an absorber tower (contactor tower).

Also, stripping gas is used for additional water removal to get a very high triethylene glycol concentration into the contactor tower. Excess stripping gas will increase triethylene glycol losses.

Excessively high reboiler temperatures may cause decomposition of glycol. Dry-bed dehydrators use desiccants for the adsorption of water, including the following:

- Silica gel
- Sorbead
- Activated alumina
- Molecular sieves

**Table 9-2. Dehydration Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Glycol | • Test regularly to avoid potential problems (e.g., corrosion).<br>• Optimize flow rates in the dehydration system.<br>• Maintain proper temperatures to avoid hydrocarbon contamination. |
| Filters | • Use filterless centrifugal oil cleaning to replace or lengthen oil filter life (see Section 4.0, Case History 7).<br>• Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>• Use reusable filters.<br>• When handling filters, take precautions to prevent oil spillage.<br>• Isolate all drained fluids in a resealable container for in-process recycling. |
| Activated charcoal | • Send to recycling facility. |
| Spent molecular sieve | • Install activated carbon upstream of the unit to remove corrosion inhibitors, amines, absorber oils, glycol, and other contaminants to extend the life of the sieve.<br>• Regenerate for reuse. |

***See Section 4.0, Case History 7 about host medium oil filters.***

## Recovery of Natural Gas Liquids

Natural gas liquids (e.g., propane) are used as refrigerants and fuels. Recovery of natural gas liquids is sometimes conducted at the gas plant. Cryogenics may be used to remove natural gas liquids. Filters are used in the gas preparation process (gas that is free of impurities is required). Electrostatic precipitators are sometimes used. Filtered substances include iron sulfide, crude oil, wax, and lube oil. Absorption may also be used to remove natural gas liquids. An absorption oil removes the heavier compounds from the process stream.

**Table 9-3. Recovery of Natural Gas Liquids Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Iron sulfides | • Consider alternative methods of removing hydrogen sulfide from gas stream.<br>• Treat production streams with biocide or scale inhibitor to reduce iron sulfide formation. |
| Slop oil | • Recycle back into production stream.<br>• Replace impeller-type pumps used for fluid transfer service with "canned" submersible pumps to eliminate leaks from impeller pump seals and gear boxes.<br>• Send slop oil that cannot be recycled into production to a state-permitted tank bottoms reclamation facility. |
| Paraffin | • Install magnetic fluid conditioner(s) to prevent paraffin formation (see Section 4.0, Case History 4).<br>• Use paraffin inhibitor chemicals.<br>• Use hot oil treatment to dissolve paraffin in well and flow lines. |
| Lubricating oil | • Test oil and extend its use based on wear versus accumulated operating hours (see Section 4.0, Case History 3). [Note: *Many lubricating oil suppliers offer testing service at no charge.*]<br>• Recycle in-process whenever possible. |
| Filters | • Use filterless centrifugal oil cleaning to replace or lengthen oil filter life (see Section 4.0, Case History 7).<br>• Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>• Use reusable filters.<br>• When handling filters, take precautions to prevent oil spillage.<br>• Isolate all drained fluids in a resealable container for in-process recycling. |
| Blowdown | • Substitute brand of scale inhibitor for more effective brand (see Section 4.0, Case History 6).<br>• Recycle back into production stream.<br>• Operate cooling towers efficiently to minimize the generation of blowdown.<br>• Cascade water use. |

***See Section 4.0, Case History 7 about filterless centrifugal oil cleaning.***

## Sulfur Compound Removal

Gas and product treating includes the removal of sulfur compounds, primarily hydrogen sulfide ($H_2S$) and carbon dioxide ($CO_2$), from gas through a process called "sweetening."

Amine adsorption is accomplished by passing the gas through the amine liquid where the impurity is dissolved or captured by chemical reaction. The amine can be regenerated. The most common systems use monoethanolamine (MEA) or diethanolamine (DEA). Lean amine is filtered. The reclaimer removes solids and heat-stable salts (amine degraded in the presence of air) and other MEA/DEA degradation products. Charcoal filters may be used to remove liquid contaminants when foaming is a problem. Defoamers may also be added to control foaming. The largest amine losses are usually due to carry-over from contactor due to foaming; continuous small leaks in piping, pump packing, and other fugitive emission points; and sulfur compounds.

Charcoal filter beds are used to remove corrosion inhibitors, amines, absorber oils, glycol, and other sieve contaminants.

**Table 9-4. Amine Absorption Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Amines | • Use an amine reclaimer in the system to allow reuse of amine and minimize the volume of waste generated.<br>• Use an amine filter to extend life of solution and maintain efficiency. |
| Filters (amine and charcoal) | • Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>• Use reusable filters.<br>• When handling filters, take precautions to prevent oil spillage.<br>• Isolate all drained fluids in a resealable container for in-process recycling. |
| Iron sponge and iron sulfide scale | • Consider alternative methods of removing hydrogen sulfide from gas stream.<br>• Treat production streams with biocide or scale inhibitor to reduce iron sulfide formation. |

Dry bed adsorption uses one of a variety of absorbent materials (iron sponge is commonly used) to selectively remove sulfur compounds and $CO_2$.

Sulfur is removed from the $H_2S$ recovered from the produced gas. The Claus process is typically used to remove elemental sulfur from the $H_2S$ (acid gas). Tail-gas cleanup systems remove remaining sulfur from the exhaust.

**Table 9-5. Dry Bed Absorption Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Air emissions (e.g., $SO_2$) | • Operate equipment efficiently to minimize air emissions.<br>• Inspect, monitor, and maintain equipment regularly.<br>• Install and maintain catalytic converters.<br>• Reduce horsepower demands to reduce emissions. |
| Catalysts (e.g., activated natural bauxite, aluminum oxide) | • Substitute a less hazardous catalyst.<br>• Use catalyst completely before removing from the system.<br>• Regenerate spent catalyst. |
| Blowdown | • Substitute brand of scale inhibitor for more effective brand (see Section 4.0, Case History 6).<br>• Recycle back into production stream.<br>• Operate cooling towers efficiently to minimize the generation of blowdown.<br>• Cascade water use. |

***See Section 4.0, Case History 6 about scale inhibitors.***

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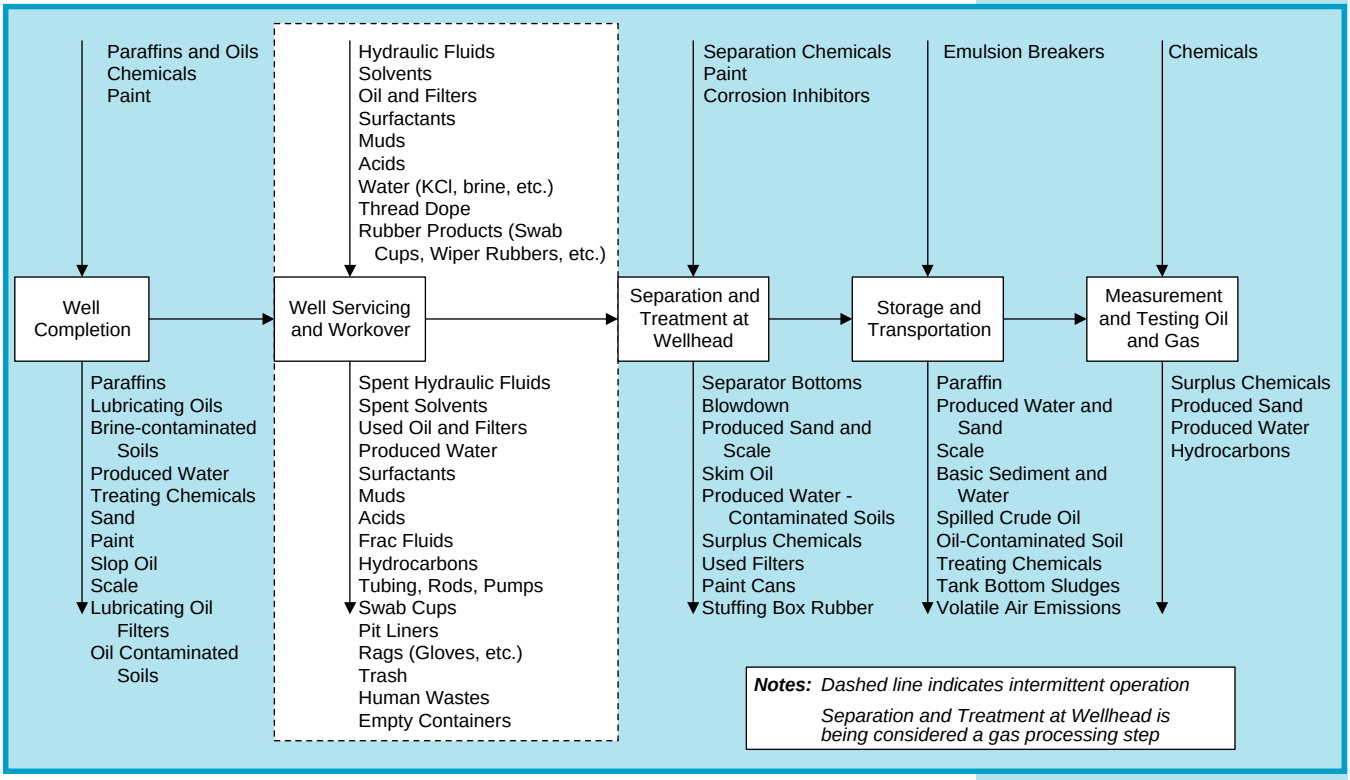
# Section 10.0

# Oil Field Services

Oil field services include the routine maintenance activities necessary to keep the oil and gas flowing and delivered. Examples of oil field service process maps are presented below. Process Map 10-1 illustrates how the first level process map, production, includes well servicing and workover. Process Map 10-2 illustrates that rig maintenance is part of exploration. Tables 10-1 through 10-8 list pollution prevention alternatives that would result from implementing the systems approach tools for typical oil field services waste streams. The pollution prevention alternatives described in this section focus on source reduction and in-process recycling which are often process dependent. End-of-pipe recycling, treatment, and disposal alternatives (not process dependent) are discussed in Volume 2.




**Process Map 10-1. Well Servicing and Workover (Production)**

Process Map 10-1 includes well servicing and workover as its second step. Well servicing operations include activities related to artificial lift installations, tubing string repairs, and work on other malfunctioning downhole equipment. A workover consists of more extensive repairs to increase or maintain production of a producing well.

**Table 10-1. Well Servicing and Workover Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Hydraulic fluids | • Introduce into production stream at facility where generated. |
| Spent solvents | • Use biodegradable, water-based solvents or soap cleaners.<br>• Substitute nonhazardous surfactants (soap) for hazardous solvents (mineral spirits) for equipment cleaning.<br>• Use up all solvent in containers; ensure that no residues remain.<br>• Minimize amount of solvent being lost during cleaning or maintenance (e.g., use drip pans to collect solvent for reuse).<br>• Clean equipment with high-pressure water, steam, or nontoxic solvents.<br>• Keep solvent containers tightly covered to decrease loss due to vaporization.<br>• Use inventory control to minimize volume of unnecessary solvent stored.<br>• Use dirty solvent for initial cleaning and clean solvent for final cleaning. |
| Used oil | • Minimize the volume of lubricating oil by extending its use.<br>• Test oil and extend its use based on wear versus accumulated operating hours. *(Note: Many lubricating oil suppliers offer testing service at no charge.)*<br>• Install lubricating oil purification equipment on engines to eliminate the need for lubricating oil changes.<br>• Practice preventative maintenance to reduce leaks and drips.<br>• Contract with service company to purify and regenerate oil for reuse rather than replacing with new lubricating oil.<br>• Consider use of synthetic oil.<br>• Use oil additives that improve engine and oil performance. |
| Used oil filters | • Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>• Use stainless steel, reusable filters.<br>• Evaluate applicability of filterless centrifugal oil cleaning. Use "spinners" to replace or lengthen oil filter life.<br>• Install lubricating oil purification equipment to reduce frequency of conventional filter replacement.<br>• Before recycling spent filters, drain all free liquids from the cartridge or filter media into a container. Recycle free liquids back into production stream. |
| Produced water | • Drill wells to minimize water production (e.g., horizontal wells, if feasible).<br>• Recycle water in hydrotesting of pipeline, equipment, and tanks. |
| Muds | • Use a closed-loop mud system whenever possible to reduce volumes of drilling fluid wastes.<br>• Optimize solids control (e.g., hydrocyclones or centrifuges) to minimize need to dilute mud.<br>• Use low solids, nondispersed muds whenever drilling conditions allow. |
| Acids | • Recycle by neutralizing excess caustics (see 40 CFR §264.1 (g)(6)). |
| Fracturing fluids | • Use "mix-on-the-fly" systems for fracturing fluids.<br>• Recycle unused fracturing oil back into production stream.<br>• Plan fracturing job carefully to avoid mixing unnecessary fluids. |

Well treatment and stimulation use various chemicals and products to improve the producing characteristics of a well.

**Table 10-2. Well Treatment Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Drums and containers | • Switch to purchase of materials and chemicals in bulk containers, reducing the amount of drums requiring handling. Added benefit: less drum handling results in fewer spills and releases requiring cleanup (of contaminated soil).<br>• Purchase materials in returnable/recyclable drums and containers. |
| Unused or spent chemicals | • Control inventory by accurately estimating amounts required, or ordering small quantities only as needed.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Determine whether nonhazardous or less hazardous products are available by asking manufacturers' representatives and trade groups. |
| Produced water | • Recycle water in hydrotesting of pipeline, equipment, and tanks. |
| Fracturing fluids | • Use "mix-on-the-fly" systems for fracturing fluids.<br>• Recycle unused fracturing oil back into production stream.<br>• Plan fracturing job carefully to avoid mixing unnecessary fluids. |

Enhanced oil recovery operations typically involve the injection of water into a producing formation, as well as injection of certain chemicals. Thermally enhanced oil recovery operations use injected steam for enhanced recovery of crude oil. Steam generators are fueled by crude oil, fuel oil, or natural gas. Feed water is conditioned (softened) to prevent scaling.

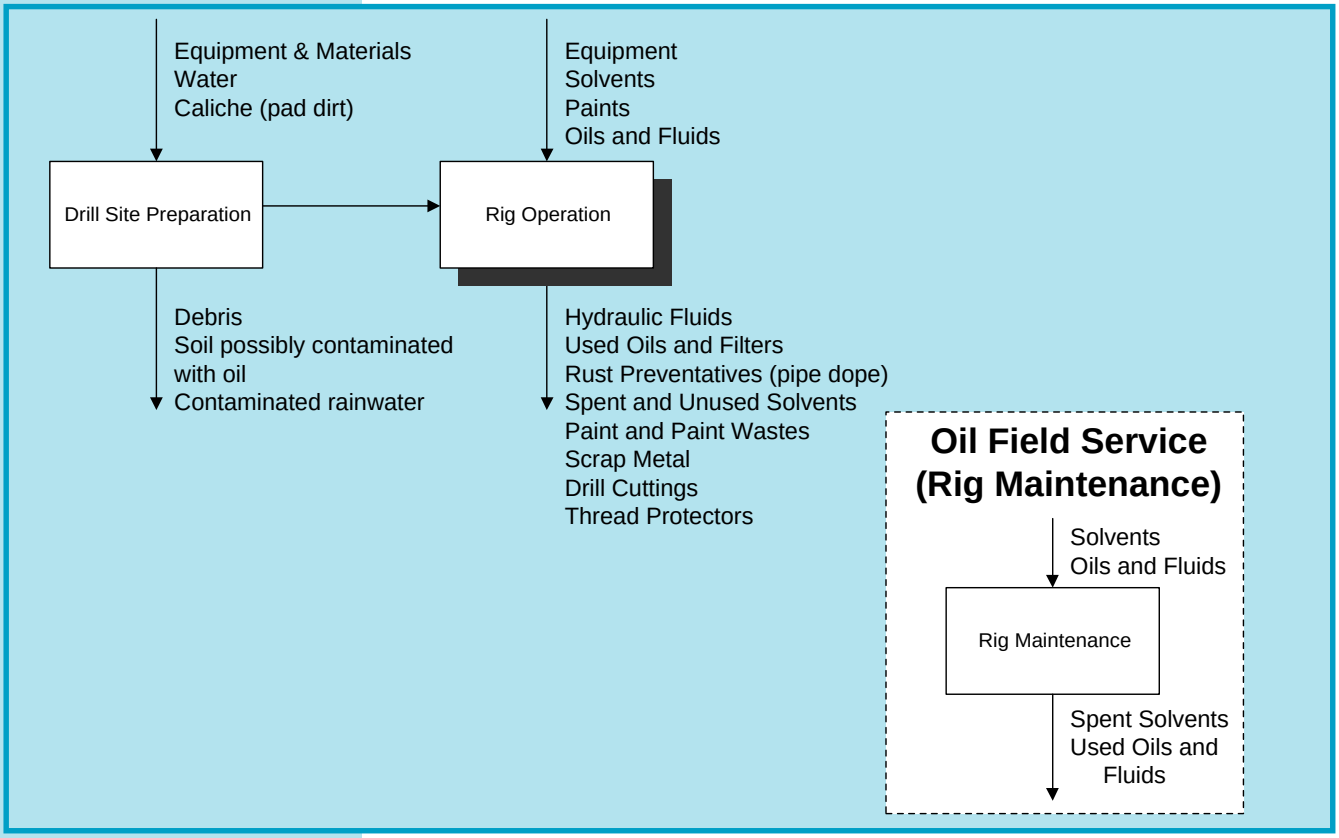
**Table 10-3. Oil Recovery Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Unused or spent chemicals | • Control inventory by accurately estimating amounts required, or ordering smaller quantities only as needed.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Determine whether nonhazardous or less hazardous products are available by asking manufacturers' representatives and trade groups. |
| Fuel oil filters | • Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>• Use stainless steel, reusable filters.<br>• Evaluate applicability of filterless centrifugal oil cleaning. Use "spinners" to replace or lengthen oil filter life.<br>• Install lubricating oil purification equipment to reduce frequency of conventional filter replacement.<br>• Before recycling spent filters, drain all free liquids from the cartridge or filter media into a container. Recycle free liquids back into production stream. |
| Spilled oil | • Sump placed at fill line (sump equipped with pump and level switch). |

Rig maintenance activities include cleaning and lubricating rotating equipment, cleaning walking surfaces, painting to reduce rust, and replacing parts (e.g., valves). Periodic rig inspections may find structural weaknesses that require repair or replacement of rig structure.

**Table 10-4. Rig Maintenance Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Unused or spent chemicals | • Control inventory by accurately estimating amounts required, or ordering smaller quantities only as needed.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Determine whether nonhazardous or less hazardous products are available by asking manufacturers' representatives and trade groups. |
| Fuel oil filters | • Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>• Use stainless steel, reusable filters.<br>• Evaluate applicability of filterless centrifugal oil cleaning. Use "spinners" to replace or lengthen oil filter life.<br>• Install lubricating oil purification equipment to reduce frequency of conventional filter replacement.<br>• Before recycling spent filters, drain all free liquids from the cartridge or filter media into a container. Recycle free liquids back into production stream. |




**Process Map 10-2. Exploration (First Level) Rig Maintenance**

Wellhead treatment activities include use of corrosion and hydration inhibitors, and management of produced sand and water, as described below.

Corrosion damage caused by acidic waters and gases, carbon dioxide, or oxygen is costly because it deteriorates or destroys oil well casing, tubing, and other metal parts. Corrosion inhibitors are chemicals used to counter the reaction between the acid in the gas and the iron of the tubing or other equipment. Usually it is accomplished at the wellhead, either by batch treatments or continuous injection. Many different chemicals can be used, depending on the cause of the corrosion.

Because the formation of hydrates can cause restriction or stoppage of product in separation and treatment process, hydrate inhibitors are used. Hydrate inhibition at the wellhead is accomplished by injecting glycol, ammonia, methanol, or brine, or the use of indirect heaters that use bath solutions containing calcium chloride or glycol.

Impurities such as sand and excessive amounts of water are sometimes separated at the wellhead.

**Table 10-5. Hydrate Inhibition Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Unused chemicals | • Control inventory by accurately estimating amounts required, or ordering smaller quantities only as needed.<br>• Offer (or exchange) unused chemicals to other facilities in lieu of recycling, treatment, or disposal.<br>• Determine whether nonhazardous or less hazardous products are available by asking manufacturers' representatives and trade groups. |
| Spilled chemicals | • Store and maintain chemicals properly to prevent spills or leaks.<br>• Only retain the smallest possible quantities. |

**Table 10-6. Separation Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Produced sand | • Improve gravel pack design.<br>• Optimize production rate to minimize sand production.<br>• Recycle as fill material (if uncontaminated). |
| Produced water | • Drill wells horizontally to minimize water production.<br>• Recycle water in hydrotesting of pipeline, equipment, and tanks. |

## Service Industry Truck Transportation

Service industry trucks haul a variety of things including but not limited to chemicals, fuel, lubricant, oil, produced water and equipment. Transportation of liquids involves tanker trucks connecting and disconnecting hoses and lines with the possibility of a worn or faulty line, valve, or connection leaking. Routine equipment inspections and replacements can be made to limit the possibility of leaks and spills thus limiting the environmental cleanup costs. Trucks can carry drip pans to place under connection points to catch any accidental release.

Trucks can be washed manually or by using a fixed wash bay system. Dry washing, using dry rags and a spray bottle, is an option to manual truck washing, which includes hand-held wash systems, and hand brushing with soap. Fixed bay washing operations involve fixed equipment, such as drive-through wash racks or gantry wash systems. Typically, wash bay systems include chemical storage facilities, chemical and water application arches, water reclamation systems, and wastewater treatment systems.

Fleet maintenance provides many pollution prevention alternatives. Truck maintenance includes replacing oil, tires, brake pads, air and oil filters, transmission fluid, brake fluid, and antifreeze. This requires storing new products and collecting waste. Parts washing solvents and residual liquids (such as petroleum distillates, mineral spirits, and naphtha) are all considered hazardous wastes due to their ignitability potential. Used filters may also be hazardous due to toxicity (presence of metals and/or benzene) and ignitability of the filtered materials. Even filters that are not hazardous may be unacceptable for landfill disposal due to hydrocarbon content.

Table 10-7 lists pollution prevention alternatives for transportation-related wastes.

**Table 10-7. Truck Transportation Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Rinse water | • Recycle wash and rinse water within a closed loop system (e.g., rinse water from the last rinse can be recycled as wash water for the cleaning step). |
| Spilled chemicals | • Store and maintain chemicals properly to prevent spills or leaks.<br>• Only retain the smallest possible quantities. |
| Oil Filters | • Keep good records of truck maintenance and replace filters as infrequently as possible to ensure maintenance.<br>• Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>• Use stainless steel, reusable filters.<br>• Evaluate applicability of filterless centrifugal oil cleaning. (Use "spinners" to replace or lengthen oil filter life.)<br>• Install lubricating oil purification equipment to reduce frequency of conventional filter replacement.<br>• Before recycling spent filters, drain all free liquids from the cartridge or filter media into a container. Recycle free liquids, if possible. |

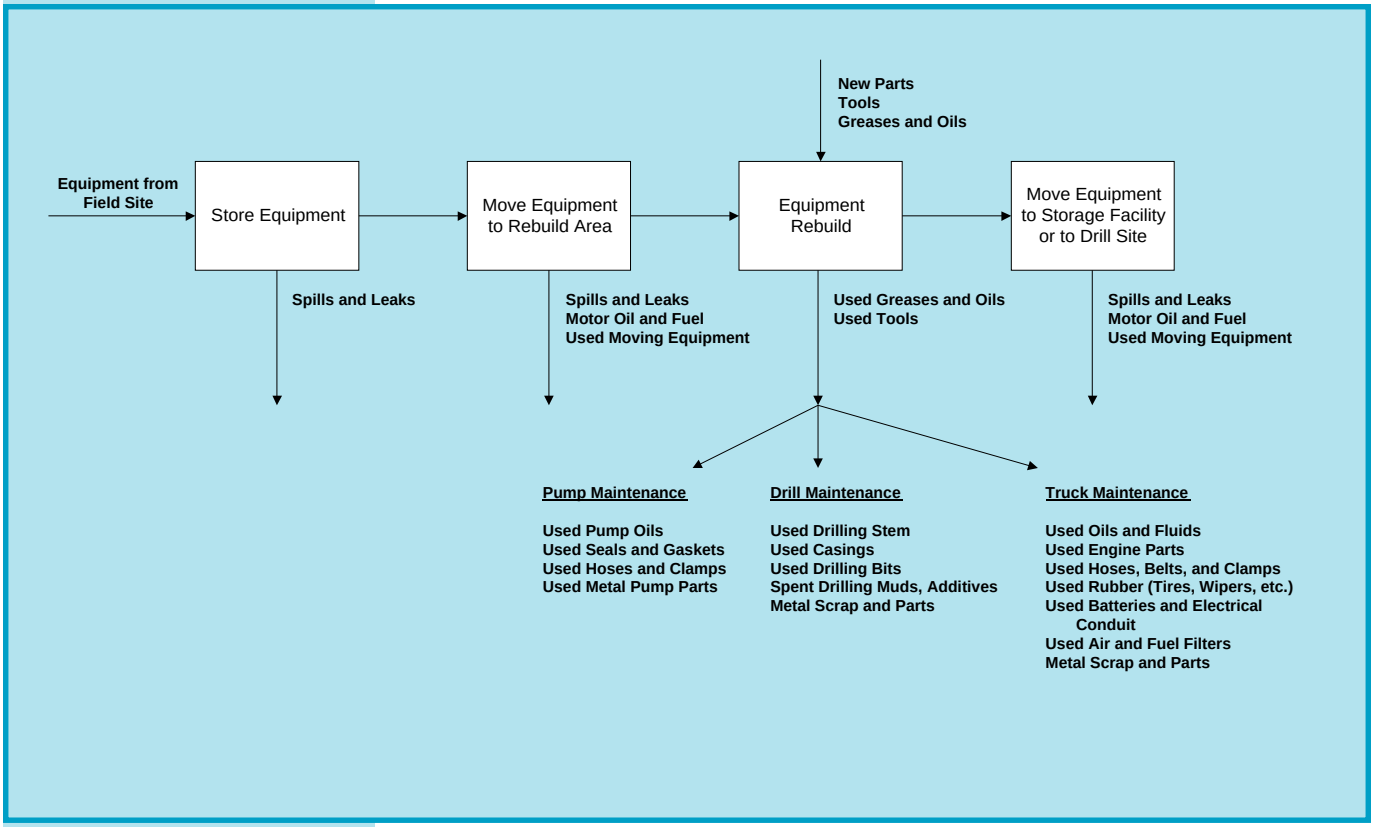
Accident avoidance and spill management provide other opportunities for pollution prevention. Table 10-8 lists pollution prevention alternatives for accident scenarios.

**Table 10-8. Accident Scenario Alternatives**

| Wastes | Pollution Prevention Alternatives |
|---|---|
| Spilled product | • Ongoing driver safety training<br>• Safe driver incentive programs<br>• Contingency plans and implementation training including: spill response, equipment use, waste management, reporting |

## Equipment Rebuild

Rebuilding, repairing, and reusing equipment is in itself an example of a responsible, cost-effective waste avoidance measure. However, waste can be generated during equipment rebuild activities. When possible, similar wastes should be accumulated and recycling options should be pursued. Otherwise, waste should be accumulated and stored responsibly, compacted if possible, and disposed of properly.




**Process Map 10-3. Equipment Rebuild at Oil Field Service Yards**

# ATTACHMENT 1

# POLLUTION PREVENTION TRACKING AND DOCUMENTATION

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# POLLUTION PREVENTION TRACKING AND DOCUMENTATION

Once all of the tools described in the manual are used and a pollution prevention action plan is generated, it is then incumbent on the team to think about how the pollution prevention activities will be tracked and documented (i.e., performance measures). The issues to contemplate when considering tracking and documentation are the following:

- Quantification – How much waste was minimized or how much pollution was prevented?
- Baselining – To what am I comparing it?
- Normalization – Was the "success" solely due to pollution prevention best management practices?

## Quantification

In many instances, goals that mention numerical pollution prevention goals are established (e.g., "We will reduce our air emissions by 20 percent over the next three years"). To determine whether that goal is being reached, quantifiable data need to be maintained by the facility or business. In many cases where the waste is treated or disposed by a contractor, careful records that track quantities of waste handled by the contractor need to be kept. However, other waste streams are not often tracked at a quantifiable level. Aqueous waste and air emissions are two examples since they are not often treated or disposed by contracting organizations where documentation and paperwork are critical. For wastes that are difficult to track quantifiably, a reasonable estimate will still be helpful. Having a complete process map will ensure that all waste streams that can be measured to demonstrate the success of a process change can be addressed.

## Baselining

Even if wastes can be quantifiably measured, the significant issue still remains of addressing with what it is being compared. For example, should generated waste be compared to that generated last year, or over the last three or five years? If it is a new process and pollution prevention has been integrated into the design, how is its success measured? Baselining is the process by which comparisons regarding pollution prevention success can be made. In the case of

an existing process, it is usually helpful to compare results to the average over the last several years. Often, waste data tracked as a function of time will have a number of spikes or dips due to changes in business activity. Comparisons regarding pollution prevention success should not be made when these spikes or dips have occurred. One way to resolve this potential problem is to average a baseline over a number of years so that the spikes and dips have less impact. For new activities, baselining cannot be practically compared by using data over the last few years from a process that did not exist. One way to baseline new processes is to compare the waste generated with the pollution prevention activities included in the design to the theoretical waste generated if pollution prevention had not been included in the design. So, the success would be measured by stating that the company achieved a 20 percent reduction in a particular pollutant or waste by introducing pollution prevention into the new process design.

## Normalization

Normalization addresses the interdependency between the waste and the process that generated the waste. In many companies, waste data are tracked with little information about the processes that generated the waste. If no process information is included, and waste data show (with appropriate baselining) that a 20 percent reduction in a particular pollutant or waste was realized, can pollution prevention best management practices be considered the sole reason? As businesses change to meet clients' needs and to adopt new markets, processes also change. If a company shuts down a production line for any reason, the waste resulting from that production line is going to necessarily be reduced. It is not practical to consider this a pollution prevention success. Pollution prevention success should be measured with respect to the process or processes that generated the pollution. One way to think about this is to identify unit processes (process maps can be used for this purpose). For a production facility, one can say that for every one unit of raw material, 10 percent of the output is waste. With pollution prevention success, for that same one unit of raw material, only five percent of the output is waste. In this way, changes in production would not be categorized as a pollution prevention success. If production is not the primary process that is being addressed, identifying the parameter or variable with which to compare waste generation is not trivial. Some possible parameters that can be used to normalize pollution prevention data are man-hours, energy input, and dollars spent. Individual companies will determine what parameters they will use to normalize pollution prevention success.

# ATTACHMENT 2

# POLLUTION PREVENTION INCENTIVES

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# POLLUTION PREVENTION INCENTIVES

Incentives to implement pollution prevention programs are often necessary in order to attain the commitments (e.g., time, money, etc.) required to implement an effective program. Unlike many other environmental initiatives that are enforced or mandated, pollution prevention does not have the same "regulatory hammer" that usually inspires compliance. In most instances, the primary regulatory requirement for pollution prevention is for organizations to set realistic goals within the regulatory framework and to develop a pollution prevention plan to help achieve those goals. As a result, without the compliance drivers dictating action, incentives are needed to propel action toward developing effective pollution prevention programs.

Two distinct levels of incentives can be applied in implementing pollution prevention programs: organizational and personnel. Organizational incentives are those that apply to an entire organization or business. These incentives can come from the marketplace or from the government. Personnel incentives come from the management. Both types of incentives are discussed in more detail below:

## Organizational Incentives - Regulatory

In certain instances, regulatory agencies will provide an incentive to businesses and organizations within their jurisdiction that are successful in developing and implementing pollution prevention programs. The typical regulatory incentive is to reduce the regulatory burden (i.e., permits and related documentation) by reducing the amount and/or toxicity of (or ideally eliminating) regulated wastes and materials managed by the organization. Regulatory agencies can pronounce that particular permits and requirements can be waived if particular pollution prevention programs are enacted and are successful. Reduction in regulatory burden will have positive impacts on the organization by saving cost, time, and resources. By using activity-based costing to illustrate the high cost of compliance to management, this incentive can be particularly helpful in convincing organizations that pollution prevention makes good business sense.

## Organizational Incentives - Marketplace Incentives

The marketplace often promotes the economic incentives to pollution prevention in a number of ways. The enhanced economic competitiveness brought about by a reduction in waste management costs and an increase in process efficiency can be translated directly into increased market share for products and services. The ISO 14000 environmental standards, which apply directly to pollution prevention programs, can enhance a company's ability to compete in overseas markets. The potential marketing benefit of "green" labeling is an additional public relations and promotional economic incentive to enacting pollution prevention programs. These and other economic incentives are dictated by the marketplace and their economic, environmental, or societal interest in pollution prevention and other environmentally-beneficial practices.


## Personnel Incentives - Bonuses, Awards, and other Rewards

Organizations committed to pollution prevention can provide bonuses, awards, and other rewards to employees who demonstrate through their work environment that they can carry out successful pollution prevention activities, provide leadership and mentoring to other employees, document the successes, and achieve economic benefits for the organization. These rewards often illustrate the breadth in many pollution prevention programs — from the most innovative technology to the "low-hanging fruit", the best ideas almost always come from the knowledgeable personnel who take a personal interest in their working environment.

# POLLUTION PREVENTION BEST MANAGEMENT PRACTICES

for the New Mexico Oil and Gas Industry

Volume 2


2000

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# Contents

## Tables



## Figure

# Section 1.0

# Introduction

Volume 2 of the Pollution Prevention/Best Management Practices Manual for the New Mexico Oil and Gas Industry focuses on common waste streams generated in the oil and gas industry. Volume 2 also includes a section addressing relevant state and federal regulations for the New Mexico oil and gas industry.

Although Volume 2 provides a handy source of waste management alternatives, it should not be used in lieu of Volume 1. Volume 1 describes the waste generating processes and focuses on identifying the best source reduction and in-process recycling opportunities. By using the systems approach tools also provided in Volume 1, a prioritized list of opportunities are generated that take into account factors such as cost, feasibility, and timetable to implement. Many waste management opportunities will not appear as high priority opportunities because they are not directly related to improving productivity or efficiency regarding the products or services that provide revenues. However, in some cases, waste management opportunities are preferred because they are often easy to implement, they may not require a suspension of operations to implement, or they may address a short-term regulatory concern.

The "Alternatives for Wastes Generated in Oil and Gas Operations" table in Volume 2 associates wastes with the four sectors discussed in Volume 1 (Exploration and Production, Transportation, Gas Processing, and Oil Field Services), Volume 2 provides examples of source reduction, recycling, treatment, and disposal alternatives for each waste stream, some pollution prevention opportunities, and best management practices. In some cases, special considerations are shown in the table for particular wastes. These special considerations relate to the use of special equipment, special procedures, or other handling issues that users of the pocket guide should know.

The table also includes Resource Conservation and Recovery Act (RCRA) information for each waste stream, specifically whether a particular waste is exempt or non-exempt from RCRA regulation. Section 3.0 explains in more detail the RCRA exemption for particular waste streams and other pertinent state and federal regulations and requirements. Each waste generator is responsible for establishing

contact with regulators to ensure that current regulatory requirements are being addressed. Information in this volume summarizes regulatory requirements. Below is a list of regulatory agencies that should be contacted for authoritative information on waste management requirements.

**NEW MEXICO OIL CONSERVATION DIVISION OF THE ENERGY, MINERALS, AND NATURAL RESOURCES DEPARTMENT**

**District1**
1625 N. French Dr.
Hobbs, New Mexico 88240
(505) 393-6161
FAX: (505) 393-0720

**District 2**
811 S. 1st Street
Artesia, New Mexico 88210
(505) 748-1283
FAX: (505) 748-9720

**District 3**
1000 Rio Brazos Road
Aztec NM 87410
(505) 334-6178
FAX: (505) 334-6170

**District 4**
1220 South St. Francis
Santa Fe, New Mexico 87505
(505) 476-3440
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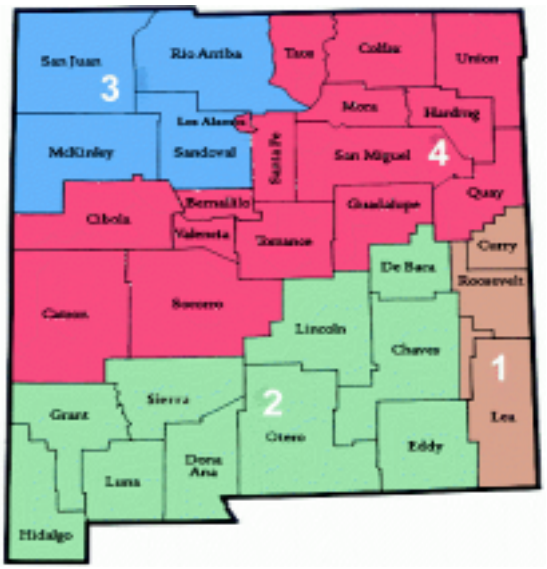


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## Section 2.0

## When All Else Fails — Waste Management

Implementation of the most aggressive pollution prevention and waste minimization best management practices cannot always eliminate the generation of wastes. Before applying any of the information in this section, ensure that each waste generated in your operation has been analyzed for opportunities to:

- Eliminate the waste stream by changing the process that creates it
- Reduce the volume generated during the process
- Reduce the toxicity during the process
- Recycle the waste at a recycling facility
- Reclaim reusable portions of the waste
- Reuse the waste in the process.

If waste is still generated, the next step to protect human health and the environment is to manage wastes properly. This section describes waste identification, characterization, and analysis methods so that appropriate waste management decisions can be made.

Prior to identifying waste, the following steps should be completed:

- Familiarize yourself with the regulations. Making responsible waste management decisions requires understanding how wastes are regulated. A summary of relevant waste management regulations is provided in later in this section. Remember that regulations are change periodically and should be monitored.
- Know your regulators. State regulatory agencies and regulators with jurisdiction over your activities should be contacted regularly for information about the regulations governing your wastes. Since wastes take many forms, (e.g., air emissions, waste waters, solid wastes, sludges, construction wastes) developing relationships with contacts at many agencies will be helpful.

- Train employees. Each employee generating and handling waste should be trained in pollution prevention awareness and waste handling requirements and best management practices. Provide opportunities for your employees to improve waste management practices.

Develop a waste management plan that describes the following:

- Each waste generated including type, amount, and frequency of generation
- How each waste is regulated (e.g., hazardous or non-hazardous and exempt or non-exempt from regulation as a hazardous waste under the RCRA; an air emission regulated under the Clean Air Act; or, a discharge regulated by the Clean Water Act.)
- How your business is regulated with regards to each waste (i.e., are you a small or large quantity generator?)
- How and where each waste is collected, stored, treated, and disposed
- Alternatives to how and where the waste is treated and disposed

## How Are You Regulated?

The questions and answers below will help you understand more about how you and wastes you generate are regulated. This information summarizes RCRA requirements. The OCD and NMED should be contacted for authoritative regulatory information.

Acknowledgment: The following information is based on information provided in U.S. EPA Office of Solid Waste's publication, "Understanding the Hazardous Waste Rules, A Handbook for Small Businesses, 1996 Update" [EPA ID Number: EPA530-K-95-001]. This publication is available on the EPA website at http://www.epa.gov/epaoswer/hazwaste/sqg/sqghand.htm, or by calling the EPA RCRA/Superfund Hotline 1-800-424-9346.

## Is the waste hazardous?

To determine what kind of waste you have, first consider the process that generates the waste. If the process is unknown, or if you suspect that the waste could be a hazardous waste, see if the waste meets any of these definitions of hazardous waste.

## Is it a waste?

A "waste" is any solid, liquid, or contained gaseous material that is discarded by being disposed of, burned or incinerated, or recycled. (There are some exceptions for recycled materials.) It can be the by-product of a manufacturing process or simply a commercial product that you use in your business—such as a cleaning fluid or battery acid—that is being disposed of. Even materials that are recyclable or can be reused in some way (such as burning used oil for fuel) may be considered waste.

## Is it a hazardous waste?

Is it one of the two types of hazardous waste listed below?

"Listed waste." Your waste is considered hazardous if it appears on one of four lists published in the 40 *Code of Federal Regulations* (CFR) Part 261. Currently, more than 400 wastes are listed. Wastes are listed as hazardous because they are known to be harmful to human health and the environment when not managed properly.

"Characteristic wastes." If your waste does not appear on one of the hazardous waste lists, it still might be considered hazardous if it demonstrates one or more of the following characteristics:

Ignitable: It catches fire under certain conditions. This is known as an "ignitable" waste. Examples are paints and certain degreasers and solvents.

Corrosive: It corrodes metals or has a very high or low pH. This is known as a "corrosive" waste. Examples are rust removers, acid or alkaline cleaning fluids, and battery acid.

Reactive: It is unstable and explodes or produces toxic fumes, gases, and vapors when mixed with water or under other conditions such as heat or pressure. This is known as a "reactive" waste. Examples are certain cyanides or sulfide-bearing wastes.

Toxic: It is harmful or fatal when ingested or absorbed, or it leaches toxic chemicals into the soil or ground water when disposed of on land. This is known as a "toxic" waste. Examples are wastes that contain high concentrations of heavy metals, such as cadmium, lead, or mercury.

You can determine if your waste is toxic by having it tested using the Toxicity Characteristic Leaching Procedure (TCLP), or by simply knowing that your waste is hazardous or that your processes generate hazardous waste.

## Finding Your Generator Category

Once you know that you generate hazardous waste, you need to measure the amount of waste you produce per month. The amount of hazardous waste you generate determines your generator category.

Many hazardous wastes are liquids and are measured in gallons – not pounds. In order to measure your liquid wastes, you will need to convert from gallons to pounds. To do this, you must know the density of the liquid. A rough guide is that 30 gallons (about half of a 55-gallon drum) of waste with a density similar to water weighs about 220 pounds; 300 gallons of a waste with a density similar to water weighs about 2,200 pounds (1,000 kg).

Table 2-1 describes three generator categories established by the U.S. Environmental Protection Agency (EPA), each of which is regulated differently. In many cases, businesses that fall into different generator categories at different times choose to satisfy the more stringent requirements to simplify compliance.

**Table 2-1. Generator Categories**

| Category | Definition |
|---|---|
| CESQGs: Conditionally Exempt Small Quantity Generators 40 CFR Part 261.5 | You are considered a CESQG if you generate no more than 220 lbs (100 kg) per month of hazardous waste. You are exempt from hazardous waste management regulations provided that you comply with basic requirements.<br><br>If you are a CESQG and you generate no more than 2.2 lbs (1 kg) of "acutely hazardous waste" (or 220 lbs (100 kg) of acutely hazardous waste spill residues) in a calendar month, and never store more than that amount for any period of time, you may manage the acutely hazardous waste according to the CESQG requirements. If you generate more than 2.2 lbs (1kg) of acutely hazardous waste, you must manage it according to the LQG requirements. |
| SQGs: Small Quantity Generators: | You are considered an SQG if you generate between 220 and 2,200 lbs (100 and 1,000 kg) per month of hazardous waste. SQGs must comply with EPA requirements for managing hazardous waste described in this document. |
| LQGs: Large Quantity Generators: | You are considered an LQG if you generate more than 2,200 lbs (1,000 kg) per month of hazardous waste. LQGs must comply with more extensive hazardous waste rules than those summarized in this handbook. See below for an overview. |

Once you have determined if you generate hazardous waste and you know how you are regulated, it is best to consult with the EPA or NMED on the requirements you must meet.

Regulations that apply to each waste stream in an inventory may be an important consideration in the waste minimization planning process. For example, an operator may wish to reduce all hazardous wastes at their sources. Therefore, an accurate classification of each waste is an important step. We will go through the steps of making a hazardous waste determination, which will result in our ability to classify oil and gas wastes as "Exploration and Production (E&P) exempt," "non-exempt" hazardous wastes, and "non-exempt" non-hazardous wastes.

## Relevant Regulations Pertaining to the Oil and Gas Industry

The Water Quality Control Commission (WQCC) delegates enforcement authority to the New Mexico Oil Conservation Division (OCD) for oil and gas activities regulated under the New Mexico Oil and Gas Act, the Geothermal Resources Act, and the Water Quality Act.

The New Mexico Oil and Gas Act (70-2-1 through 70-2-38, NMSA 1978) created the Oil Conservation Commission (OCC) in 1935. Exploration and production waste waters are covered exclusively under Oil and Gas Act authorized rules and orders. The New Mexico Water Quality Act (74-6-1 through 74-6-13, NMSA 1978) provides the statutory authority for OCD to regulate the disposition of wastes generated upstream (non-domestic wastes resulting from the exploration, development, production, or storage of crude oil or natural gas) and wastes generated downstream (non-domestic wastes resulting from the oil field service industry, the transportation of crude oil or natural gas, the treatment of natural gas or the refinement of crude oil) to protect public health and the environment.

Amendments to the Oil and Gas Act (Chapter 70-Pamphlet-1989 Cumulative Supplement, NMSA 1978 annotated) passed in 1995 specifically authorized OCD to regulate the disposition of wastes generated downstream to protect public health and the environment. Under the RCRA (1976), many waste streams derived from the exploration for and production of crude oil are exempt from hazardous waste regulations.

## RCRA and the Oil and Gas Exemption

Under RCRA, EPA is authorized to regulate the management of wastes resulting from industrial, commercial, mining, agricultural, and community activities. Subtitle C of RCRA contains a comprehensive program for the regulation of hazardous wastes. Nonhazardous wastes are subject to regulation under Subtitle D of the Act. Produced waters, drilling fluids, and other wastes associated with the exploration, development, or production of oil and gas are exempt from regulation as hazardous wastes under Subtitle C.

Exempt oil and gas wastes are unique. They are high in volume, but relatively low in toxicity. The waste is generated by a large number of individual oil and gas operators in New Mexico. Exempt oil and gas wastes are regulated by the OCD.

Recognizing the unique characteristics of oil and gas wastes, Congress specifically exempted drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of crude oil or natural gas or geothermal energy from regulation under RCRA Subtitle C as hazardous wastes. EPA continues to study these wastes. This exemption is commonly called the "Oil and Gas Exemption" or the "E&P Exemption."

## Scope of the Oil and Gas Exemption

On July 6, 1988, after performing the study of oil and gas wastes mandated by Congress, EPA published its Regulatory Determination (53 FR 25446). In its Regulatory Determination, EPA concluded that the exemption for produced water, drilling fluids, and associated wastes should continue. EPA also made its first efforts to define the scope of the exemption. EPA reviewed both the statutory language and the legislative history and determined that the exemption for wastes associated with the exploration, development, and production of oil and gas covers only those wastes uniquely associated with primary field operations. Primary field operations include primary, secondary, and tertiary production of oil or gas.

With respect to natural gas production, primary field operations are those activities occurring at or near the wellhead, production facility, or gas plant (including gathering lines to the plant), but before the point of transfer of the gas from an individual field facility, a centrally located facility, or a gas plant to a carrier for transport to

market, or before the point of manufacture (e.g., the fractionation of purified gas).

With respect to oil production, primary field operations include activities occurring at or near the wellhead or production facility, but before the point where the custody of the oil is transferred from an individual field facility or a centrally located facility to a carrier for transport to a refiner. In the event no custody transfer occurs, the primary field operation ends at the primary oil water separation. Crude oil stock tanks are considered separation devices for the purpose of defining areas of primary field operations.

In order to be covered under the E&P exemption, wastes from primary field operations must also be unique to E&P operations. Clearly, wastes such as produced water and drilling fluid are unique. However, other wastes commonly generated in E&P operations are used in other types of operations. For example, cleaning wastes, painting wastes, and waste lubricating oil are commonly generated in activities other than E&P activities and are, therefore, not covered by the E&P exemption.

In March 1993, EPA provided further clarification of the status of specific wastes (58 FR 15284). In that clarification, exempt waste was more precisely defined:

"In particular, for a waste to be exempt from regulation as a hazardous waste under RCRA Subtitle C, it must be associated with operations to locate or remove oil or gas from the ground or to remove impurities from such substances and it must be intrinsic to and uniquely associated with oil and gas exploration, development or production operations (commonly referred to as exploration and production or E&P); the waste must not be generated by transportation or manufacturing operations ... One common belief is that any wastes generated by, in support of, or intended for use by the oil and gas E&P industry ... are exempt. This is not the case; in fact, only wastes generated by activities uniquely associated with the exploration, development or production of crude oil or natural gas ... (i.e., wastes from down-hole or wastes that have otherwise been generated by contact with the production stream during the removal of produced water or other contaminants from the product) are exempt from regulation under RCRA Subtitle C."

In its March 1993 clarification, EPA also addressed the applicability of the RCRA exemption to wastes generated by crude oil reclaimers, service companies, gas plants and feeder pipelines, crude oil pipelines, and underground gas storage fields. The clarification included the following explanations of the RCRA exemption.

- For the purposes of defining transportation, the change of custody criterion refers to the transport of product (crude oil, natural gas), not waste.
- The off-site transport of exempt waste from a primary field site for treatment, reclamation, or disposal does not negate the exemption.
- Wastes derived from the treatment of an exempt waste, including any recovery of product from an exempt waste (e.g., crude oil reclamation from tank bottoms), generally remain exempt from the requirements of RCRA Subtitle C.
- Vacuum truck and drum rinsate from trucks and drums transporting or containing exempt wastes is exempt, provided that the trucks or drums only contain E&P-related exempt wastes and that the water or fluid used in the rinsing is not subject to RCRA Subtitle C (i.e., is itself non-hazardous).
- Wastes generated by a service company (e.g., unused frac or stimulation fluids and waste products) that do not meet the basic criteria listed in the Report to Congress (i.e., are not uniquely associated with oil and gas E&P operations) are not exempt from Subtitle C under the oil and gas exemption, just as wastes generated by a principal operator that do not meet these criteria are not exempt from coverage by RCRA.
- The production of elemental sulfur from hydrogen sulfide gas at a gas plant is considered treatment of an exempt waste.
- Wastes uniquely associated with operations to recover natural gas from underground gas storage fields are covered by the exemption.

EPA included a list of exempt wastes and a list of non-exempt wastes in its regulatory determination. These lists are not comprehensive. They were intended only to provide examples of the types of wastes that fall under the exempt or non-exempt categories. Generators will need to make individual determinations regarding the status of a number of other incidental wastes. The OCD or the EPA should be contacted for guidance in the event the regulatory status of a waste is in doubt.

## Exempt Wastes

Exempt wastes make up the bulk (over 99.9%) of all wastes that are regulated by the OCD. Table 2-2 includes a list of wastes designated as exempt by the OCD. It is a listing of most, but not all, oil and gas wastes that are exempt from hazardous waste regulation. Remember, for a waste to be exempt, it must unique to E&P operations and used in primary field operations.

Athough many oil and gas wastes are exempt from regulation as hazardous wastes under RCRA, OCD regulations do apply.

**Table 2-2. EPA Waste Classification for Oil and Gas Exploration and Production Wastes**

| What Is Exempt | What Is Not Exempt |
|---|---|
| *(Oil and natural gas exploration and production materials and wastes exempted by EPA from consideration as "Hazardous Wastes")* | *(Materials and wastes not exempted and may be a "hazardous Waste" if tests or EPA listing define as "hazardous")* |
| Produced water | Unused fracturing fluids or acids |
| Drilling fluids and cuttings | Cooling tower cleaning wastes |
| Rigwash | Painting wastes |
| Geothermal production fluids | Oil and gas service company wastes |
| Hydrogen sulfide abatement wastes | Vacuum truck and drum rinsate from trucks and drums transporting or containing non-exempt waste |
| Well completion and workover wastes | Refinery wastes |
| Basic sediment, water, and other tank bottoms facilities that hold exempt waste | Used lubrication oils |
| Accumulated materials from production impoundments | Waste compressor oil and filters |
| Pit sludges and contaminated bottoms from treatment, storage or disposal of exempt wastes | Used hydraulic fluids |
| Gas plant dehydration wastes | Waste solvents |
| Gas plant sweetening wastes | Transportation waste |
| Cooling tower blowdown | Caustic or acid cleaners |
| Spent filters, filter media, and backwash (assuming the filter itself is not hazardous and the residue in it is from an exempt waste stream) | Boiler cleaning wastes |
| Packing fluids | Incinerator ash |
| Produced sand | Laboratory wastes |
| Deposits removed from piping and equipment prior to transportation | Pesticide wastes |
| Hydrocarbon-bearing soil contaminated from exempt streams | Radioactive tracer wastes |
| Pigging wastes from gathering lines | Drums, insulation, and miscellaneous solids |
| Wastes from subsurface gas storage and retrieval | Industrial wastes from activities other than oil and gas exploration and production |
| Constituents removed from produced water | Manufacturing wastes |
| Liquid hydrocarbons and gases removed from the production stream but not from oil refining | Contamination from refined products. |
| Waste crude oil from primary field operations | |
| Light organics volatilized from exempt wastes | |
| Liquid and solid wastes generated by crude oil and crude tank bottom reclaimers | |
| Stormwater runoff contaminated by exempt materials | |
| Mixtures of exempt and non-exempt wastes pursuant to OCD mixture policy (see below) | |

Source: New Mexico Oil Conservation Division

## Non-Exempt Wastes

The wastes that EPA has determined are not covered under the exemption may be hazardous wastes subject to regulation under the federal RCRA Subtitle C. Table 2-2 includes a list of non-exempt waste. It is a listing of most, but not all, oil and gas wastes that are not exempt. The OCD, NMED Hazardous Waste Bureau or the EPA should be contacted for guidance in the event the regulatory status of a waste in doubt. Non-exempt wastes include:

- Wastes that are not uniquely associated with an exploration and production activity, such as cleaning wastes or lubricating oil.
- Wastes that are not associated with primary field operations, such as wastes associated with transportation or manufacturing activities.

Not all non-exempt wastes are hazardous wastes. For example, empty drums and insulation will probably not be hazardous waste. However, some wastes, such as paint wastes, spent solvents, unused fracturing materials that can no longer be used for their intended purpose, and contaminated media resulting from a spill from a transportation pipeline, may be hazardous. The following section, "Hazardous Oil and Gas Wastes," explains how an operator may identify a non-exempt waste as hazardous or non-hazardous. Figure 2-1 shows how exempt and non-exempt waste can be managed.

Implementing a waste minimization program could simplify compliance with the requirements of RCRA and may reduce costs and future liability for the disposal of hazardous and non-hazardous wastes.

## Hazardous Oil and Gas Wastes

RCRA required EPA to establish procedures for identifying wastes as either hazardous or non-hazardous, and promulgate requirements for the management of both. In order for a waste to be a hazardous waste, it must also be a solid waste as defined under federal law (40 CFR §261.2). A solid waste may be solid, semi-solid, liquid, or gaseous. A non-exempt solid waste is classified as a hazardous waste if EPA has specifically listed it as such or if it tests positive for one of four hazardous waste characteristics.

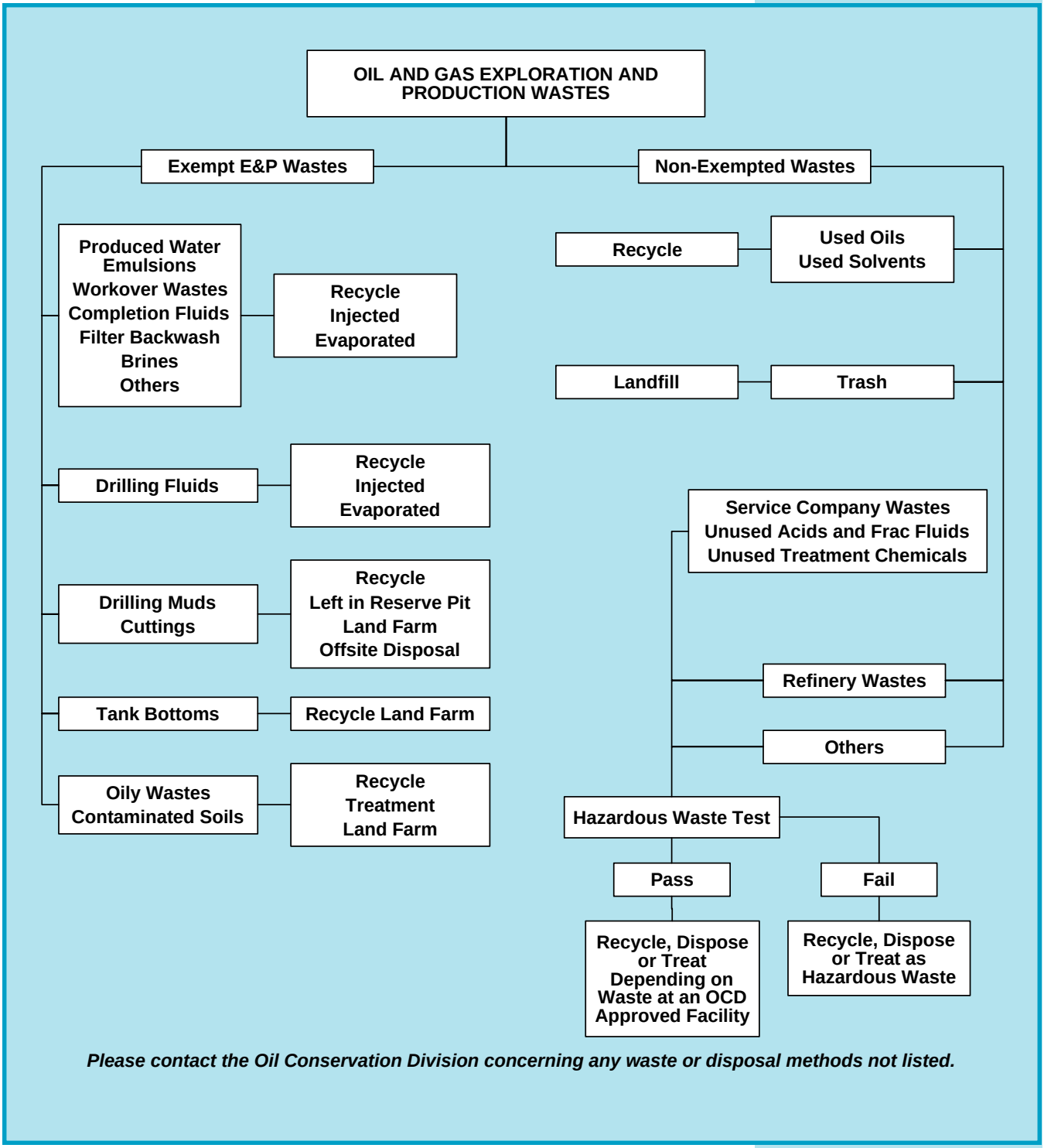


**Figure 2-1. New Mexico Oilfield Wastes Categories and Disposal Methods**

## Listed Hazardous Non-Exempt Oil and Gas Wastes

EPA has listed numerous types or classes of solid wastes as hazardous wastes because they:

- Typically exhibit one or more of the characteristics of hazardous waste
- Have been shown to meet certain human toxicity criteria
- Contain any one of the chemical compounds or substances listed by EPA as hazardous constituents.

EPA's regulations contain four lists of listed hazardous wastes (refer to Table 2-3, Listed RCRA Hazardous Oil and Gas Wastes). Some are considered acutely hazardous wastes, which are wastes that EPA has determined to be so dangerous that small amounts of them are regulated the same way as larger amounts of other hazardous wastes.

**Table 2-3. Listed RCRA Hazardous Oil and Gas Wastes**

| EPA List | Type of Waste | Examples of Oil and Gas Wastes That Might Be Found On EPA Lists * |
|---|---|---|
| F List | Hazardous wastes from non-specific sources, see 40 CFR § 261.31 | Spent solvents (trichloroethylene, methylene chloride, tetrachloroethylene, xylene, acetone, benzene, ethyl benzene, methyl ethyl ketone, n-butyl alcohol, methanol, toluene, and solvent mixtures/blends that contain more than 10% of these solvents) |
| K List | Hazardous wastes from specific sources, see 40 CFR § 261.32 | None identified |
| P List | Acute Hazardous Wastes products that become acute hazardous waste when disposed of), see 40 CFR § 261.33 | Acrolein, beryllium, carbon disulfide, (commercial chemical parathion) |
| U List | Toxic Hazardous Wastes (Commercial chemical products that become toxic wastes when disposed of), see 40 CFR § 261.33 | Acetone, benzene, carbon tetrachloride chloroform, chrysene, formaldehyde, formic acid, hydrogen fluoride, hydrogen sulfide, lindane, mercury, methanol, methyl ethyl ketone, methyl isolbutyl ketone, methylene chloride, naphthalene, toluene, xylene |

Note: The examples given are not a complete list. Additional oil and gas wastes may be found on one of the four lists, depending upon the operations.

If a non-exempt oil and gas waste is identified on any of these four lists, the waste must be managed as a listed hazardous waste. For example, waste solvent from use of the solvent as a degreaser on

surface equipment is non-exempt; if it is found to be a "listed" hazardous waste, it must be managed as such. Remember, however, that the same solvent used to remove paraffin in a well is an exempt oil and gas waste when it is recovered. If an oil and gas waste fits the RCRA E&P exemption, it is an exempt waste even if it appears on one of the four lists. However, though the waste is not subject to regulation as a hazardous waste, good waste management practices (including waste minimization) should be employed.

## Characteristically Hazardous Non-exempt Oil and Gas Wastes

Of more common concern to operators of oil and gas exploration and production facilities are those non-exempt wastes that are classified as hazardous if they exhibit any one of four hazardous waste characteristics. These four characteristics are:

- Ignitability
- Corrosivity
- Reactivity
- Toxicity.

Table 2-4 provides a description of the four hazardous waste characteristics.

The generator can either test the waste material using an accepted EPA analytical method or can apply process knowledge in determining whether the waste in question is characteristically hazardous. A generator who relies on process knowledge in determining if a waste is characteristically hazardous must document this determination and should be prepared to demonstrate that this determination is reasonable in terms of the materials and process used. If there is any reasonable doubt as to whether a non-exempt oil and gas waste exhibits one or more hazardous waste characteristics, the generator is encouraged to verify the waste classification by testing so that the waste may be properly managed. It is prudent to determine whether or not a waste exhibits hazardous characteristics any time a change is made in process or materials. Waste streams must be characterized according to the hazardous waste regulations or the generator is subject to civil and criminal penalties.

### Table 2-4. RCRA Hazardous Waste Characteristics

| | |
|---|---|
| IGNITABILITY<br>(40 CFR § 261.21) | Liquids with a flash point less than 140 F<br>- Ignitable compressed gas<br>- Materials other than liquids that at standard conditions are capable of causing fire by spontaneous chemical changes, by absorption of moisture, or through friction.<br>Examples: certain cleaning solvents (may also be listed hazardous wastes), certain degreasers, certain transportation-pipeline pigging wastes, certain paint wastes |
| CORROSIVITY<br>(40 CFR § 261.22) | Aqueous materials with a pH of less than or equal to 2.0 or greater than or equal to 12.5.<br>Examples: certain acid or caustic cleaning wastes, unused well acidizing fluids (that have not been down the borehole), certain rust removers, waste battery acid |
| REACTIVITY<br>(40 CFR § 261.23) | Any waste that reacts violently with water, forms explosive mixtures with water, or generates any toxic fumes with water<br>- Any waste that is explosive at standard conditions or if heated<br>- Any waste that contains cyanide or sulfide at a concentration that will emit toxic cyanide or sulfide gases when exposed to a pH of 2.0 to 12.5.<br>Examples: certain waste oxidizers |
| TOXICITY<br>(40 CFR § 261.24) | Potential to contaminate ground water by leaching as determined in a laboratory using the Toxicity Characteristic Leaching Procedure (TCLP) Test. TCLP leachable components that cause a waste to test hazardous are in Table 2-5. |

### Table 2-5. Toxicity Characteristics, Constituents, and Regulatory Levels

| | | Regulatory Level (mg/l) | EPA HW No. |
|---|---|---|---|
| Volatiles: | Benzene | 0.5 | D018 |
| | Carbon tetrachloride | 0.5 | D019 |
| | Chlorobenzene | 100.0 | D021 |
| | Chloroform | 6.0 | D022 |
| | 1,2-Dichloroethane | 0.5 | D028 |
| | 1,1-Dichloroethylene | 0.7 | D029 |
| | Methyl ethyl ketone | 200.0 | D035 |
| | Tetrachloroethylene | 0.7 | D039 |
| | Trichloroethylene | 0.5 | D040 |
| | Vinyl chloride | 0.2 | D043 |
| Semi-Volatiles: | o-Cresol | 200.0 | D023 |
| | m-Cresol | 200.0 | D024 |
| | p-Cresol | 200.0 | D025 |
| | Cresol | 200.0 | D026 |
| | 1,4-Dichlorobenzene | 7.5 | D027 |
| | 2,4-Dinitrotoluene | 0.13 | D030 |
| | Hexachlorobenzene | 0.13 | D032 |
| | Hexachlorobutadiene | 0.5 | D033 |
| | Hexachloroethane | 3.0 | D034 |
| | Nitrobenzene | 2.0 | D036 |
| | Pentachlorophenol | 100.0 | D037 |
| | Pyridine | 5.0 | D038 |
| | 2,4,5-Trichlorophenol | 400.0 | D041 |
| | 2,4,6-Trichlorophenol | 2.0 | D042 |
| Pesticides: | Chlordane | 0.03 | D020 |
| | Endrin | 0.02 | D012 |
| | Heptachlor (& its epoxide) | 0.008 | D031 |
| | Lindane | 0.4 | D013 |
| | Methoxychlor | 10.0 | D014 |
| | Toxaphene | 0.5 | D015 |
| Herbicides: | 2,4-D | 10.0 | D016 |
| | 2,4,5-TP (Silvex) | 1.0 | D017 |
| Metals: | Arsenic | 5.0 | D004 |
| | Barium | 100.0 | D005 |
| | Cadmium | 1.0 | D006 |
| | Chromium | 5.0 | D007 |
| | Lead | 5.0 | D008 |
| | Mercury | 0.2 | D009 |
| | Selenium | 1.0 | D010 |
| | Silver | 5.0 | D011 |

A characteristically hazardous waste is hazardous only as long as it evidences the hazardous characteristic. However, the dilution of a waste material for the purpose of eliminating the characteristic is prohibited. Dilution is not considered by EPA to be a proper treatment method for characteristically hazardous waste.

## Mixing Exempt and Non-Exempt Wastes

Mixing exempt and non-exempt wastes create a special set of problems. Whenever possible, mixing non-exempt wastes with exempt wastes should be avoided because the resulting mixture may become a hazardous waste and require management under RCRA Subtitle C regulations. Furthermore, mixing a characteristically hazardous waste with a non-hazardous or exempt waste for the purpose of rendering the hazardous waste non-hazardous or less hazardous is considered by EPA to be a treatment process; it is subject to the appropriate RCRA Subtitle C hazardous waste regulations and permitting requirements.

Below are the OCD Mixture Policy guidelines.

As of September 1997, the OCD has adopted the following mixture policy:

A mixture of exempt and non-exempt waste will be considered exempt ONLY if it meets all of the following conditions:

- The non-exempt portion of the waste is non-hazardous through testing.
- The total non-exempt portion of the waste constitutes no more than 5 percent by volume of the final mixture unless an exception is granted by the director.
- The mixture is the result of an incidental and unavoidable part of an OCD approved process.
- Both the exempt and non-exempt portion of the waste are generated as a result of exploration and production of oil and gas, processing of gas or the transportation of natural gas prior to processing.

If a waste which is classified as hazardous by testing or listing is mixed with any other waste, the entire resultant volume will be considered hazardous.

The following OCD regulated facilities may be subject to hazardous waste rules for disposal of wastes and contaminated soils containing benzene:

- Oil and gas service companies having wastes such as vacuum truck, tank, and drum rinsate from trucks, tanks and drums transporting or containing non-exempt waste.
- Transportation pipelines and mainline compressor stations generating waste, including waste deposited in transportation pipeline-related pits.

Source: Federal Register, Thursday, May 29, 1990, p.11,798 - 11,877.

In April 1991, EPA clarified the status of oil and tank bottom reclamation facilities:

- Those wastes that are derived from the processing by reclaimers of only exempt wastes from primary oil and gas field operations are also exempt from the hazardous waste requirements. For example, wastes generated from the process of recovering crude oil from tank bottoms are exempt because the crude storage tanks are exempt.

- Those reclaimer wastes derived from non-exempt wastes (e.g., reclamation of used motor oil, refined product tank bottoms), or that otherwise contain material which are not uniquely associated with or intrinsic to primary exploration and production field operations would not be exempt. An example of such non-exempt wastes would be waste solvent generated from the solvent cleaning of tank trucks that are used to transport oil field tank bottoms. The use of solvent is neither unique not intrinsic to the production of crude oil.

Source: EPA Office of Solid Waste and Emergency Response letter opinion dated April 2, 1991, signed by Don R. Clay, Assistant Administrator

## Management of Nonhazardous Oil and Gas Wastes

In New Mexico, non-hazardous oil and gas wastes must be managed in accordance with OCD rules and guidelines. The OCD regulates both exempt and non-exempt oil and gas wastes and governs transportation, storage, and disposal of non-hazardous oil and gas wastes, cleanup requirements for crude oil spills, permitting requirements for underground injection, and reclamation of E&P tank bottoms and other exempt hydrocarbon waste.

## Management of Hazardous Oil and Gas Wastes

Hazardous oil and gas wastes are those oil and gas wastes that are not RCRA-exempt and that are listed hazardous wastes or characteristically hazardous under RCRA Subtitle C. The NMED Hazardous Waste Bureau regulates hazardous waste under the New Mexico Hazardous Waste Management Regulation (20.4.1 NMAC). Regulations require operators who generate hazardous, non-exempt RCRA wastes to register as hazardous oil and gas generators.

## Naturally Occurring Radioactive Material (NORM)

Naturally occurring radioactive material (NORM) was addressed as Case No. 11391, Order NO. R-10609 by the OCD, Oil Conservation Commission, on April 11, 1996. Copies of the order of the Oil Conservation Commission are available from the OCD. The hearing concluded the following:

- NORM is not a hazardous waste regulated under Subtitle C of the RCRA
- Regulated NORM has a concentration of greater than 30 picocuries per gram of radium 226 above background, or NORM with a maximum radiation exposure reading at any accessible point that is greater than 50 microroentgens per hours, including background levels.

Regulated NORM contained in any oilfield soils, equipment, sludges or any other materials related to oil field operations or processes exceed the radiation levels above, are regulated under 19 NMAC 15.A.7, “Disposal of Regulated Naturally Occurring Radioactive Material (NORM).”

If any oilfield operations encounter suspected regulated NORM, the operator should understand and comply with the applicable regulations including requirements for radiation survey instrument, protection of workers during operations, protection of the general populations from releases of radioactivity , disposal and transfer of regulated NORM for disposal, radiation survey requirements, storage requirements and licenses requirements. Questions about these topics should be addressed to the OCD.

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# Section 3.0

## Waste Management Table

The following table provides pollution prevention and waste management information for common oil and gas waste streams cross-referenced by the four sectors discussed in Volume 1 (Exploration and Production, Transportation, Gas Processing, and Oil Field Services). Special considerations for particular wastes are also provided.

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Absorbent materials ❶ ❷ ❸ ❹ | Exempt (if contaminated with exempt waste) | S: Prevent spills and leaks by practicing preventive maintenance and good housekeeping.<br>R: Recover and contain used absorbent pads for recycling.<br>R: Return used absorbent pads to vendor for recycling.<br>T:<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific material. |
| Acid, spent ❶ ❹ | Exempt | S: Micro-meter solutions to minimize unused acid (continuous mix versus batch mix).<br>R: Use to neutralize excess caustics (see 40 CFR 264.1 (g)(6)).<br>T:<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific acid. |
| Acid, unused ❶ ❹ | Nonexempt<br>If hazardous, EPA Uniform Hazardous Waste Manifest | S: Purchase only quantity needed.<br>R: Return unused portion to vendor.<br>R: Register unused portion with a chemical exchange program.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific acid. |
| Activated charcoal filter media ❶ ❷ ❹ | Exempt | R: Send to recycling facility.<br>T:<br>D: Send to an approved, OCD-approved surface waste management facility. |
| Aerosol can ❶ ❷ ❸ ❹ | Nonexempt<br>Nonhazardous Waste Manifest<br>(if empty)<br>(if not?) | S: Use non-aerosol containers whenever possible.<br>Use all contents; do not dispose of until empty.<br>R: Recycle metal cans at appropriate recycling facility.<br>T:<br>D: Send empty containers to state-permitted municipal solid waste landfill.<br>**Special considerations:** Do not puncture. |

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❶ Oil and Gas Exploration and Production
❷ Pipeline
❸ Gas Processing
❹ Oil Field Services

# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Air emissions<br>Includes: Nitrogen oxides ($NO_x$), sulfur oxides ($SO_x$), hydrocarbons, BTEX, carbon monoxide, particulates, halons, mercury, chlorofluorocarbons, refrigerants, VOCs, and fugitive emissions.<br>❶ ❷ ❸ ❹ | Classify depending upon source | S: Design and operate to minimize air emissions. Use regular preventative maintenance and monitoring procedures.<br>S: Install and maintain catalytic converters.<br>S: Use low $NO_x$ burners.<br>S: Convert engines to lean-burn. Maintain and run all engines to be the most fuel efficient.<br>S: Install pre-combustion chambers on engines.<br>S: Install electronic ignition systems on engines.<br>S: Use natural gas engines instead of engines fueled by diesel or other fuels.<br>S: Tighten connections and replace packing to minimize leaks and fugitive emissions.<br>S: Reduce emissions of unburned hydrocarbons in new facility design (e.g., route emissions to flare, route dehydrator still emissions to first stage compression, use electric drivers for compressors, use shorter piping runs with fewer flanges, use welded rather than screwed or bolted fittings).<br>S: Reduce horsepower demands to reduce emissions.<br>S: Maintain tank thief hatch seals.<br>S: Route dehydrator still emissions to reboiler, firebox, first stage compression, or flare.<br>S: Lower glycol circulation rate - avoid over dehydrating (vapor recovery).<br>S: Eliminate use of sparge or stripping gas in dehydrators.<br>S: Buy solvents and liquid chemical in bulk and keep containers covered.<br>S: Buy less volatile solvents and liquid chemicals.<br>S: Use dust control techniques at facilities.<br>S: Eliminate the use of halon fire extinguishing materials.<br>S: Revise test procedures so halon is not released.<br>R: Use waste heat recovery opportunities where possible.<br>R: Use vented or flared gas as fuel.<br>R: Collect vented or flared gas, compress, and sell as product.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Amines, used ❶ ❸ | Exempt<br>EPA Uniform Hazardous Waste Manifest (spills) | S: Use an amine reclaimer in the system to allow reuse of amine and minimization of the volume of waste amine generated.<br>S: Use an amine filter to extend life of solution and maintain efficiency.<br>S: Operate and maintain at proper temperatures to avoid hydrocarbon contamination.<br>S: Maintain a testing program to avoid problems (e.g., corrosion).<br>R: Return to vendor.<br>R: Send to recycler.<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** Rich amine contains hydrogen sulfide, avoid skin contact, use PPE and consult MSDS for guidance. |
| Amine sludge, precipitated ❶ ❸ | Exempt<br>EPA Uniform Hazardous Waste Manifest (spills) | S: Maintain appropriate pH to reduce the contribution of heavy metals to the sludge as a result of corrosion.<br>S: Substitute potassium hydroxide for sodium hydroxide for pH control to reduce sodium content of sludge.<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific material. |
| Ammonium hydroxide, spent (copy machine use) | Nonexempt | S: Convert to copiers that do not require ammonium hydroxide.<br>T:<br>D: Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Avoid eye and skin contact. Consult MSDS for additional guidance. |
| Antifreeze ❶ ❷ ❸ ❹ | Nonexempt | S: Use a less toxic substitute for ethylene glycol (e.g., propylene glycol).<br>R: Regenerate on site by filtration (if not thermally degraded).<br>R: Send to a recycler.<br>T:<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance |
| Asbestos, asbestos-containing material ❶ ❷ ❸ ❹ | Nonexempt<br>Regulated by OSHA, State of New Mexico, NESHAPS | S: Purchase asbestos-free products and equipment.<br>S: Maintain asbestos-containing materials to keep friable (brittle) asbestos from becoming exposed (e.g., encapsulation). Mark materials that contain asbestos according to state special waste regulations.<br>D: Asbestos must be removed by licensed operators and disposed of in state-permitted landfill approved for asbestos disposal.<br>**Special considerations:** Asbestos must be handled by licensed operators |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Batteries, lead acid ❶ ❸ ❹ | Nonexempt<br>Nonhazardous Waste Manifest (recycling)<br>EPA Uniform Hazardous Waste Manifest (disposal) | S: Use other sources of electrical current whenever possible.<br>R: Return to vendor. When batteries are permanently taken out of service, send for recycling as soon as possible.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. Temporarily store used batteries in a leak-proof container in a dry area. |
| Batteries<br>Includes nickel-cadmium, lithium alkali, and lead-acid ❶ ❸ ❹ | Nonexempt<br>Regulated as university waste<br>EPA Uniform Hazardous Waste Manifest | S: Use other sources of electrical current whenever possible.<br>S: Purchase long-life batteries to decrease the number needed.<br>S: Use rechargeable batteries.<br>R: Return to vendor or manufacturer.<br>R: When batteries are permanently taken out of service, send to recycler as soon as possible.<br>T: Remove electrolyte.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility. Nonhazardous: Send to a state-permitted municipal waste landfill.<br>**Special consideration:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. Temporarily store used batteries in a leak-proof container in a dry area. |
| Biocides, herbicides, insecticides, and all other pesticides (used for site or facility maintenance) | Nonexempt | S: Use a licensed commercial pesticide application service.<br>S: Properly store and label containers to prevent degradation and contamination.<br>S: Use all contents/material and then triple rinse the container. Use rinsate as originally intended for the material.<br>S: Practice good inventory control. Use excess at another facility.<br>R: Return unused chemicals to vendor for recycling.<br>R: Send unusable chemicals to a recycler.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility. Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use all pesticides in accordance with label instructions. Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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❶ Oil and Gas Exploration and Production ❷ Pipeline
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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Blasting sand/media ❶ ❷ ❸ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Use coatings that do not require sandblasting.<br>S: Use alternative methods to reduce unnecessary sandblasting (e.g., use a paint that does not require sandblast preparation, cathodic protection from corrosion rather than paint, use tanks constructed of materials that do not need to be painted).<br>S: Brush-blast and paint instead of blasting to base metal.<br>S: Reduce blasting/painting frequency.<br>S: Substitute suitable wastes (e.g., copper slag) for virgin blast media.<br>S: Use dry ice pellets or recyclable media for some applications.<br>S: Use lead-free paint or paints with lower levels of other metals.<br>S: Buy in bulk hoppers to minimize sacks and pallets.<br>S: Insure that purchased sandblast grit does not contain metal or other contaminants.<br>S: Do not allow contractors to conduct unnecessary sandblasting and painting of their equipment on site.<br>R: If permissible, send to a cement kiln as a substitute for feedstock.<br>R: Separate from blasted paint waste and reuse blast media.<br>R: Use as aggregate in road mix, if permissible.<br>R: If uncontaminated and permissible, use on site as a substitute for virgin fill material.<br>D: Hazardous: send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>D: Nonhazardous: send to a state-permitted municipal waste landfill.<br><br>**Special considerations:** Test sandblast medium for TCLP heavy metals. If RCRA hazardous waste, it is regulated by DOT. Use appropriate PPE. Avoid eye and skin contact. |
| Blowdown, cooling tower ❶ | Exempt<br>Nonhazardous Waste Manifest (solids) | S: Operate cooling towers efficiently to minimize the generation of blowdown.<br>S: Cascade water use.<br>S: Substitute more acceptable biocides such as isothiazoline and amines for biocides such as pentachlorophenols and formaldehyde releasing compounds.<br>S: Substitute corrosion inhibitors such as sulfite and organic phosphates for inhibitors that contain chromates.<br>R: Recycle free liquids back into production stream.<br>D: For material that cannot be recycled, send to an approved, OCD-approved surface waste management facility.<br><br>**Special considerations:** May contain hydrogen sulfide and/or other harmful chemicals. Use appropriate PPE. Consult MSDS for additional guidance for specific chemicals. |
| Blow-out preventer test fluids ❶ ❹ | Exempt | S: Collect leakage to avoid soil contamination.<br>R: Return test fluids to system if uncontaminated.<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Consult MSDS for additional guidance for specific chemicals. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Catalyst, spent<br>(e.g., sulfur recovery process)<br>❸ | Exempt | S: Substitute a less hazardous catalyst.<br>S: Use catalyst completely before removing from system.<br>S: Operate the system to prevent contamination.<br>R: Regenerate spent catalyst.<br>R: Certain types of catalysts can be sent to pulp and paper mills for reuse.<br>R: Send to recycler for metals recovery.<br>R: If permissible, send to cement kiln as a substitute feedstock.<br>R: If uncontaminated and permissible, use on site as fill material.<br>D: Send to an approved, OCD–authorized surface waste management facility. |
| Caustics, used<br>(e.g., gas treatment or drilling fluids)<br>❶ ❸ | Exempt<br>Nonhazardous Waste Manifest<br>Non-exempt if resulting from a spill<br>Regulated as NM Special Waste (solids)<br>EPA Uniform Hazardous Waste Manifest | S: For gas treatment, consider alternate recyclable products.<br>S: Plan drilling operation to minimize volume of fluid, thereby reducing caustic requirements.<br>S: Use inventory control; e.g., a surplus chemicals exchange network that offers unused chemicals to other company facilities in lieu of disposal.<br>R: Return unused caustic to vendor.<br>R: Reuse to neutralize excess acids (see 40 CFR 264.1 (g)(6)).<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Exempt: Send to an approved, OCD-approved surface waste management facility.<br>Non-exempt, Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>**Special considerations:** May be reactive or corrosive. Use appropriate PPE. Consult MSDS for additional guidance for specific material. |
| Cement returns<br>❶ ❷ ❸ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Calculate cement needs carefully to excess cement mixture.<br>S: Use cement in other projects, such as erosion prevention.<br>S: Require vendors to use nonhazardous cement additives.<br>R: Return unused dry cement to vendor.<br>R: Solid cement may be reclaimed if not contaminated.<br>D: Send to state-permitted landfill (Class A, B, or C) for disposal.<br>**Special considerations:** Use appropriate PPE. Avoid skin contact and inhalation of dust. Consult MSDS for additional guidance. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Chemicals, surplus or unusable ❶ ❷ ❸ ❹ | Nonexempt<br>(May be hazardous)<br>If hazardous, EPA Uniform Hazardous Waste Manifest | S: Use inventory control; e.g., a surplus chemicals exchange network that offers unused chemicals to other company facilities in lieu of recycling, treatment or disposal.<br>S: Label and store chemicals properly (e.g., protect containers from weather and keep covered).<br>S: Purchase chemicals in bulk with supplier retaining ownership of containers.<br>S: Calculate chemical needs carefully to avoid surplus.<br>S: Use the entire product. Transfer for use at other sites or find alternate uses.<br>S: Use nonhazardous products whenever possible.<br>S: Minimize the use and variety of similar-use chemicals when one chemical is suitable.<br>R: Return surplus to vendor.<br>R: Donate surplus laboratory chemicals to a high school or college.<br>R: Send to a recycler.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>D: Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Consult MSDS for guidance for specific chemical. Keep labels on all containers. Do not dispose of chemicals in mud or workover pits. |
| Cleaning wastes ❶ ❷ ❸ ❹ | Nonexempt | S: Minimize drips, leaks and spills by practicing good housekeeping.<br>S: Wipe with recyclable rags rather than washing with cleanser or chemical.<br>R: Regenerate cleansers or cleaning solvents for reuse.<br>R: Send to a recycler.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Compressor oil, filters, and blowdown waste ❶ ❸ ❹ | Nonexempt | S: Use stainless steel, reusable filters.<br>S: Isolate all drained fluids in a resealable container. (See Oil, Lube.)<br>S: When handling filters, take precautions to prevent oil spilling.<br>S: Change oil and filters only when necessary. Lab testing of oil and differential pressure gauge will indicate the need for filter replacement. (Note: Many lubricating oil vendors provide a testing service at no charge.)<br>S: Evaluate applicability of filterless centrifugal oil cleaning.<br>R: Before recycling spent filters, drain all free liquids from the cartridge or filter media into a container. Recycle back into production stream.<br>R: Send used oil to a recycling facility.<br>R: Introduce used oil into production stream.<br>D: Send to an approved, OCD-approved landfarming facility.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Completion, workover, and well treatment fluids ❶ ❹ | Exempt | S: Plan the job carefully to reduce excess fluids.<br>S: Use less toxic substitutes for chemicals and products.<br>S: Use improved acidizing technology and inhibition technology to decrease the frequency of well workovers and formation treatments.<br>S: Use leftover, excess fluids on other jobs.<br>R: Return all unused treatment fluids to the supplier.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Consult MSDS for additional guidance for specific chemicals. |
| Condensate ❸ | Exempt | S: Prevent releases by complete regular inspection and maintenance of all surface lines and facilities.<br>S: Treat as a product.<br>R: Condensate should be recycled back into production stream.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Highly flammable. Use appropriate PPE. Respiratory protection may be required. Consult MSDS for additional guidance. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Construction/ demolition debris<br>Includes: Spoil, vegetation, wood, scrap metal<br>❶ | Nonexempt | S: Plan site to minimize size.<br>S: Minimize demolition requirements.<br>S: Consider portable pads or skid-mounted equipment.<br>S: Use high-density polyethylene liners rather than concrete.<br>R: Crush uncontaminated concrete for use as aggregate.<br>R: Compost vegetation and use as soil supplement. Chip uncontaminated wood to use as mulch.<br>R: Sell or offer for reuse.<br>R: Send scrap metals to a recycler.<br>D: Hazardous: Send debris contaminated with hazardous material to an approved, state-permitted RCRA, hazardous waste treatment and disposal facility.<br>Nonhazardous: Send to a state-permitted municipal landfill. |
| Copier toner, developer, solutions and cartridges | Nonexempt | S: Buy recycled cartridges.<br>S: Buy what you need and use what you buy<br>R: Return empty containers and used components to the supplier or manufacturer.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste facility or send to a state-permitted municipal landfill. |
| Debris and soil, contaminated by used chemicals<br>❶ ❷ ❸ ❹ | Nonexempt<br>If hazardous, EPA Uniform Hazardous Waste Manifest | S: Use proper containers, keep lids on containers and store properly to prevent overflow or spillage.<br>S: Install containment to allow for better recovery of spills.<br>D: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: send to a state-permitted municipal waste landfill.<br>**Special considerations:** Consult MSDS for guidance for each known chemical. |
| Debris, crude oil soaked<br>(if contaminated within production system, i.e., before point of sale)<br>❶ ❷ ❸ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Develop operational procedures that prevent contamination with crude oil by keeping areas clear of debris.<br>S: Use leak-proof storage containers.<br>T: Segregate oily wastes to allow them to weather before putting them in a trash bin.<br>D: Send to an approved, OCD-approved surface waste management facility.<br>D: Send to state-permitted municipal landfill for disposal.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Handle as crude oil; consider a fire hazard. |

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| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Debris, lube oil contaminated ❶ ❷ ❸ ❹ | Nonexempt<br>If hazardous, EPA Uniform Hazardous Waste Manifest | S: Develop operational procedures that prevent contamination with lube oil by keeping areas clear of debris.<br>S: Store all lube-oil contaminated debris in a properly labeled, sealed container.<br>R: Contractors are available to pick up & clean used rags for reuse.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. |
| Debris, uncontaminated ❶ ❷ ❸ ❹ | Nonexempt<br>Nonhazardous Waste Manifest | S: Store in labeled containers/dumpsters.<br>S: Do not mix with material that is contaminated or may be hazardous.<br>R: Recycle paper, metal, cardboard, aluminum cans whenever possible.<br>D: Send to an approved, state-permitted municipal landfill. |
| Domestic refuse, uncontaminated<br>Includes: Food waste, packaging material, paper, plastic, styrofoam, cooking oils and greases, and other trash ❶ ❷ ❸ ❹ | Nonexempt | S: Reduce packaging; buy in bulk.<br>S: Purchase and prepare only what is needed; avoid surplus.<br>S: Purchase higher quality materials with longer use cycles.<br>S: Use washable mugs, cups, plates, and utensils.<br>S: Prepare fewer fried foods.<br>S: Copy on both sides of the paper (duplex copying).<br>S: Purchase recycled/recyclable materials.<br>S: Use microbes and enzymes to control grease in traps.<br>R: Obtain agreements to send packaging waste back to the vendor for reuse or recycling.<br>R: Set up recycle bins for wood, paper, newspapers, plastic, glass, cardboard, aluminum, and other metals (i.e., food cans).<br>R: Reuse waste paper or styrofoam as packaging materials and fillers.<br>R: Send used cooking oils, grease and fat to a rendering or reclamation facility for reuse.<br>R: Compost food and other biodegradable waste to use as soil additive.<br>D: Send to an approved, state-permitted municipal solid waste landfill for disposal. |
| Domestic and sanitary wastewater ❶ ❷ ❸ ❹ | Nonexempt | S: Use low flow and low water use toilets, showers and faucets.<br>S: Repair or replace leaking equipment.<br>R: Use treated water as facility washdown water or to water grasses, plants, etc.<br>R: Use digested sewage sludge for agricultural purpose, if permissible.<br>T: Send to an approved, state-permitted wastewater treatment facility.<br>D: Discharge under NPDES permit<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. |

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| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Drilling fluids and additives, used ❶ ❹ | Exempt<br>Nonhazardous Waste Manifest (Water-based mud) | S: Use a closed-loop mud system whenever possible to reduce volumes of drilling fluid wastes.<br>S: Use solids control technology (e.g., chemically enhanced centrifuge) to recover water from drilling mud and reserve pit.<br>S: Optimize solids control (e.g., hydrocyclones or centrifuges) to minimize need to dilute mud.<br>S: Use low solids, non-dispersed muds whenever drilling conditions allow it.<br>S: Use an inside-diameter wiping tool for drill pipe to minimize loss of drilling fluid (can save approximately 0.4 barrels of drilling fluid per 1,000 feet of drill pipe).<br>S: Use inventory control and careful planning to avoid unused materials.<br>S: Use the entire product whenever possible.<br>S: Transfer unused additives for use at other sites.<br>S: Use products low in toxicity whenever possible.<br>S: Carefully screen barite weighting agents for naturally occurring concentrations of heavy metals, particularly mercury and cadmium.<br>S: Substitute organic additives, polymers, or biodegradable additives for oil-based mud to reduce toxicity.<br>S: Use lubricants such as lubra beads and gilsonite-based additives for spotting fluids, rather than diesel oil.<br>R: Have a drilling mud recycler pick up waste drilling mud for reconditioning and reuse.<br>R: Reuse waste drilling mud for upcoming well spudding or plugging operations.<br>R: Return surplus additives to vendor.<br>R: Return oil-based mud to vendor for recycling.<br>R: Reuse water-based mud whenever possible.<br>T/R: Condition mud for reuse in drilling your next well.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific material. |
| Drilling cuttings/solids ❶ ❹ | Exempt | S: Minimize hole size (if feasible) when drilling.<br>S: Drill horizontal holes if feasible to reduce number of wells required.<br>S: Carefully design and monitor drilling mud programs to minimize caving, etc.<br>S: Substitute organic additives, polymers, or biodegradable additives for oil-based mud to reduce costs associated with cleanup of oil-based drill cuttings.<br>T:<br>D: Dispose of oil-based drill cuttings at an OCD-approved disposal facility. |

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❶ Oil and Gas Exploration and Production ❷ Pipeline
❸ Gas Processing ❹ Oil Field Services

# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Drums/containers, containing unused chemicals or lube oil ❶ ❷ ❸ ❹ | Nonexempt<br>If hazardous, EPA Uniform Hazardous Waste Manifest<br>If nonhazardous, Nonhazardous Waste Manifest | S: Use the remaining chemical or lube oil for its intended propose whenever possible before disposing of drum. (See Chemicals, surplus.)<br>S: Switch to purchase of chemicals in bulk containers, reducing the amount of drums requiring handling. Added benefit: less drum handling reduces the chance of spills and releases requiring cleanup of contaminated soil or debris.<br>R: Return unused chemical, in original drum/container (properly sealed and labeled), to vendor.<br>R: If drum can be properly emptied: triple rinse, and recycle drum (add the rinse water to the chemical stream).<br>R: Recycle empty drums/containers whenever possible.<br>D: Hazardous: send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>D: Nonhazardous: Send to an approved, OCD-approved landfarming facility.<br>D: Nonhazardous: Send to a state-permitted municipal waste landfill.<br>**Special considerations:** Consult MSDS for guidance for a specific chemical. Use appropriate PPE. Do not mix remaining contents with different chemicals. Do not dispose of chemicals in mud or workover pits. Keep labels on all containers. |
| Drums/containers, empty ❶ ❷ ❸ ❹ | Nonexempt<br>Nonhazardous Waste Manifest | S: Switch to purchase of materials and chemicals in bulk containers, reducing the amount of drums requiring handling. Added benefit: less drum handling reduces the chance of spills and releases requiring cleanup (of contaminated soil).<br>S: Purchase materials in returnable/recyclable drums and containers.<br>R: Return undamaged drums/containers to vendor or send to a drum reconditioner/recycler.<br>R: Reuse uncontaminated drums for other purposes (e.g., storage and transfer of nonhazardous waste.<br>R: Send damaged, uncontaminated drums to a metal recycler.<br>T: Acutely hazardous work: Triple rinse.<br>D: Crush uncontaminated drums/containers and send to an approved, state-permitted municipal waste landfill.<br>**Special considerations:** Drums/containers are empty if they contain the lesser: 1 inch of solid or liquid material or 3% by weight. Empty drums/containers may be explosive or flammable. Collection and proper disposal of rinsate may be regulated. |
| Electrical equipment, oil-filled (less than 50 parts per million polychlorinated biphenyl content) and out of service<br>Includes: Capacitors, transformers, switches, heat transfer fluids ❶ ❷ ❸ ❹ | Nonexempt | S: If putting back into service, do not refill or service with oils containing more than 50 ppm PCBs.<br>R: Refurbish and reuse or sell for reuse.<br>R: Recycle oils into production stream.<br>R: Send scrap equipment to a metal recycler.<br>R: Burn oil for energy recovery if permissible (PCB content may prohibit this option; check appropriate regulations).<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility. Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Filters, lube oil ❶ ❷ ❸ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: When handling filters, take precautions to prevent oil spillage and the contamination of soil, etc.<br>S: Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>S: Use stainless steel, reusable filters.<br>S: Evaluate applicability of filterless centrifugal oil cleaning. (Use "spinners" to replace or lengthen oil filter life.)<br>S: Install lubricating oil purification equipment to reduce frequency of conventional filter replacement.<br>R: Isolate all drained fluids in a resealable container for recycling. (See Oil, Lube.)<br>R: Before recycling spent filters, drain all free liquids from the cartridge or filter media into a container. Recycle back into production stream.<br>R: Send to a recycling facility.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. When handling filters, take precautions to prevent oil spills. Store all drained fluids in a reusable container. Oil filters are no longer accepted at state-permitted municipal landfills. Lube oil filters are considered a RCRA hazardous waste and must be managed as such. |
| Filters, process ❶ ❷ ❸ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Use or retrofit with stainless steel, reusable filters to reduce the volume of filters requiring recycling or disposal.<br>S: Change filters only when necessary. Use differential pressure as an indicator of needed change.<br>S: Evaluate applicability of filterless centrifugal oil cleaning. (Use "spinners" to replace or lengthen oil filter life.)<br>R: Before disposing of spent filters, drain all free liquids from the cartridge or filter media into a container. Recycle back through production stream, on the lease from which the filters are generated.<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific material. |
| Fire fighting agents ❶ ❷ ❸ ❹ | Nonexempt | S: Convert to less toxic alternatives.<br>S: Eliminate the use of halon extinguishers.<br>S: Avoid the use of dry agents when water will suffice.<br>R: Contract with vendor to maintain fire fighting equipment and take back all unused fire fighting agents.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Fracturing fluids, unused | Nonexempt | S: Use "mix-on-the-fly" systems for frac fluids.<br>S: Recycle unused frac oil back into production stream.<br>S: Plan frac job carefully to avoid mixing unnecessary fluids.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Glycol ❸ | Exempt | S: Maintain a testing program to avoid problems (e.g., corrosion).<br>S: Optimize flow rates in the dehydration system.<br>S: Operate and maintain at proper temperatures to avoid hydrocarbon contamination.<br>R: Regenerate for reuse.<br>R: Send to a recycling facility.<br>T:<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Consult MSDS for guidance for specific material. Use appropriate PPE. Ethylene glycol or triethylene glycol may contain high levels of hydrocarbon, making it DOT regulated. Before transporting, analytical testing must be conducted to determine the flashpoint. |
| Hydrocarbon liquids ❶ ❷ ❸ ❹ | Exempt<br>if from primary operations; otherwise nonexempt | R: Reclaim and manage as product.<br>R: Blend with product.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Hydrates ❶ ❷ ❸ ❹ | Exempt<br>if from primary operations; otherwise nonexempt | S: Inject methanol or glycol to inhibit hydrate formation.<br>S: Melt in place.<br>R: Return to water treating system to recover any contained hydrocarbons.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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|---|---|---|
| Hydraulic fluids ❶ ❷ ❸ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Introduce into production stream at facility where generated.<br>S: Practice preventive maintenance to reduce leaks and drips.<br>R: Recycle whenever possible.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Hydrotest water from gathering lines (in primary field operations) ❶ ❷ ❸ ❹ | Exempt | S: Conduct tests only when necessary. Use of "smart pigs" or ultrasonic devices to test wall thickness or holidays may enable better targeting of pipeline sections requiring pressure testing or replacement.<br>S: Efficiently pig and pre-clean pipelines prior to hydrotesting to reduce the toxicity of the hydrotest water.<br>S: Use produced water for hydrotesting rather than fresh water (reduction in use of water).<br>R: Reuse hydrotest water in other tests.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Iron sponge and Iron sulfide scale, spent ❶ ❷ ❸ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Consider alternative methods of removing hydrogen sulfide from gas stream.<br>S: Treat production streams with biocide or scale inhibitor to reduce iron sulfide formation.<br>D: Send to approved, state-permitted disposal facility<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical.<br>Dry iron sulfide and iron sponge will auto ignite; in confined space with adequate oxygen, it may explode. Contact with acid will release hydrogen sulfide. Always keep it wet. Spread iron sponge out on bare ground in an open, fenced area. Allow a minimum of 1 week for material to oxidize and cool to air temperature before transporting off site. Do not mix with acid or acidic water. |
| Laboratory samples ❶ ❷ ❸ ❹ | Dependent upon source of sample and test method | S: Collect only the amount necessary for analysis.<br>S: Minimize testing; sample and analyze no more often than required.<br>S: Use test methods/procedures which generate no or less waste (e.g., colorimetric testing).<br>S: Use process knowledge instead of testing.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Laboratory waste | Nonexempt | S: Segregate waste chemicals (i.e., keep hazardous and nonhazardous waste chemicals separate) to reduce the amount of hazardous waste for management.<br>S: Buy only the amount and size necessary.<br>S: Use test methods that generate less or no waste.<br>R: Sell or exchange excess unused chemicals.<br>R: Send laboratory wastes to a recycler.<br>R: Provide excess laboratory chemicals to schools for their use.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Consult MSDS for guidance for specific material. |
| Lubricating oil ❶ ❷ ❸ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Minimize the volume of lube oil by extending its use.<br>S: Test oil and extend its use based on wear vs. accumulated operating hours. (Note: Many lubricating oil suppliers offer testing service at no charge.)<br>S: Install lubricating oil purification equipment on engines to eliminate the need for lubricating oil changes.<br>S: Practice preventative maintenance to reduce leaks and drips. Label containers appropriately.<br>S: Contract with service company to purify and regenerate oil for reuse rather than replacing with new lubricating oil.<br>S: Consider use of synthetic oil.<br>S: Use oil additives that improve engine and oil performance.<br>R: Recycle back into production stream on facility where generated. (Note: Ensure that no conflict arises with purchaser or refiner.)<br>R: Send to an approved state-permitted recycling facility.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Used oil for disposal is assumed hazardous unless analytical testing determines it to be nonhazardous. Use appropriate PPE. Avoid eye and skin contact. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Mercury, free<br>❷ ❸ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Replace mercury manometers, level switches, flow meters and gas meters with electronic (digital) instruments.<br>S: Do not use mercury in operations.<br>R: Send to mercury recycler.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>**Special considerations:** Highly toxic. Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance. |
| Metal, scrap<br>❶ ❷ ❸ ❹ | Nonexempt<br>Nonhazardous Waste Manifest | S: If clean, re-use for structural steel.<br>R: Sell to salvage/scrap dealer (metal recycler).<br>D: Send to an approved, state-permitted disposal facility.<br>**Special considerations:** Check for naturally occurring radioactive material (NORM) before disposal. |
| Methanol, used<br>❷ ❸ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Use all of the product whenever possible.<br>R: Send to an approved, state permitted recycling facility.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Highly flammable. Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for guidance. |
| Molecular sieve, spent<br>❶ ❷ ❸ ❹ | Exempt | S: Install activated carbon upstream of the unit to remove corrosion inhibitors, amines, absorber oils, glycol, and other contaminants to extend the life of the molecular sieve.<br>S: Regenerate molecular sieves for reuse.<br>R: Before disposing of spent filters, drain all free liquids from the sieve media into a container. Recycle back through production stream, on the lease from which the sieves are generated.<br>D: Send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific material. |
| Naturally Occurring Radioactive Materials (NORM), NORM-containing materials<br>❶ ❹ | May be subject to DOT regulation (>2nCi/g)<br>Nonhazardous Waste Manifest | S: Periodic monitoring for accumulations of NORM may minimize potential risks and liabilities.<br>S: Use scale inhibitors where NORM scale accumulates. Circulate inhibitor in well or inject inhibitor into producing formation.<br>S: Avoid mixing incompatible produced waters that will result in scale formation.<br>S: Design facility to reduce locations prone to scale formation (e.g., large pressure drops and unnecessary pipe elbows).<br>S: Do not mix NORM with other materials.<br>S: Dually complete oil zone and water zone to allow water to be produced simultaneously but separately from oil and to allow control of water coning. (Research indicates that water production may be reduced by as much as |

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| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| | | half, thereby reducing exposure to NORM of production equipment carrying the oil stream.)<br>S: Use polymer injection to reduce permeability to water in the production zone, thereby reducing the volume of radionuclide-containing water produced.<br>S: Use rock plugging with gel slugs to block off water production in completions where there is a discernible separation of the oil and water zones.<br>S: Carefully design gravel packs and other well screening procedures to reduce the volume of NORM-contaminated formation sand (coated by NORM scale) that is produced.<br>S: Coat material surfaces with chemicals at critical points in the production system to reduce the availability of nucleation points for NORM-containing scale formation. |
| Naturally Occurring Radioactive Materials (NORM), NORM-containing materials ❶ ❹ (continued) | | S: Reinject NORM-containing produced water (containing scale inhibitors) for enhanced recovery, (preferably into the same zone from which it was produced), as soon as possible after initial production to increase the amount of NORM returned to the subsurface and decreasing the potential for the precipitation of NORM-containing scale in surface equipment.<br>S: Store NORM-contaminated waste in either tanks or lined pits which will accommodate the eventual recovery and proper disposal of the NORM-contaminated waste. The contamination of soils with NORM may be averted by not storing NORM containing produced water or other waste in earthen pits, thereby decreasing the volume of NORM-contaminated waste.<br>S: Provide NORM management procedures training for employees involved with the operation and maintenance of affected production facilities.<br>R: Clean NORM-contaminated scale from pipe and equipment to minimize the volume of NORM- contaminated waste requiring disposal and allow the recycling of the pipe and equipment. However, restrictions on the level of radioactivity of the NORM-contaminated waste may be imposed.<br>R: Use of NORM-contaminated waste (metals) as feedstock at smelters may be a potential method of recycling. However, restrictions on the level of radioactivity of the NORM-contaminated waste may be imposed.<br>D: Send to licensed radioactive waste land disposal facility.<br>**Special considerations:** Use appropriate PPE. Consult MSDS for additional guidance. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Oil, slop<br>❶ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Recycle back into production stream.<br>S: Install a mechanical stirrer inside slop oil tank to keep sediment in suspension.<br>S: Implement the use of canned submersible pumps to replace conventional impeller type pumps used for fluid transfer service.<br>S: Eliminates leaks from impeller pump seals and gear boxes.<br>R: Send slop oil that cannot be recycled into production stream to a state-permitted tank bottoms reclamation facility.<br>T:<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** May contain hydrogen sulfide and/or NORM. Use appropriate PPE. Avoid eye and skin contact. Handle as crude oil; consider fire hazard. |
| Oil, weathered<br>❶ ❹ | Exempt<br>Nonhazardous Waste Manifest (contaminated soil for disposal) | S: Pick up spilled liquids or solids as soon as possible after the spill is contained. Recycle back into production stream.<br>S: Prevent spills or waste whenever possible.<br>D: Send to an approved, state-permitted disposal facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Handle as crude oil. |
| Paint and paint wastes<br>❶ ❷ ❸ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Paint less frequently; only when necessary.<br>S: Buy in bulk and only the volume needed. Use all of the product before it becomes unusable.<br>S: Size paint batches systematically to specific jobs.<br>S: Eliminate the use of lead paint; use waterbase, lead-free paint or high-solids coatings.<br>S: Purchase less toxic, less volatile paints and solvents. Purchase paints with greater durability.<br>S: Paint contractor should be responsible for the proper management of unused paint, solvents, and empty containers.<br>S: Reduce and control overspray. Use a brush for small jobs rather than spraying.<br>S: Keep containers closed to reduce evaporation.<br>S: Ensure paint containers are completely emptied and dried.<br>S: Use separate solvents and/or containers for each paint color. When solvent is spent use it as a thinner for that particular color.<br>R: Regenerate solvents for reuse.<br>R: Send to a recycler.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Dried paints are not regulated by DOT. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Pallets<br>❶ ❷ ❸ ❹ | Nonexempt | S: Buy materials in skid-mounted bulk hoppers or containers.<br>S: Purchase recycled plastic pallets which have a longer life than wooden pallets.<br>R: Reuse pallets.<br>R: Return pallets to the vendor.<br>R: Send wooden pallets to a pallet or wood recycler.<br>R: Chip uncontaminated wooden pallets and use as mulch.<br>D: Dispose in state-permitted municipal solid waste landfill. |
| Paraffin<br>❶ ❷ ❸ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Collect solidified paraffin in tanks, mix with paraffin solvent, and recycle back into production stream.<br>S: Investigate the feasibility of installing magnetic fluid conditioner(s) to prevent paraffin formation.<br>S: Use paraffin inhibitor chemicals.<br>S: Use hot-oil treatment to dissolve paraffin in well and flow lines; send to production.<br>R: Send mechanically removed paraffin to a recycler.<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. |
| PCB, oil<br>❶ ❷ ❸ ❹ | Subject to TSCA and RCRA regulation | S: Replace any electrical equipment that is determined to be PCB containing with non-PCB containing, electrical equipment.<br>D: Hazardous: Send to an approved, state-permitted RCRA/TSCA hazardous treatment and waste disposal facility.<br>**Special considerations:** Cleanup of PCB spills and contaminated soils is regulated by both RCRA and TSCA. Special Handling: *Contact your Health and Safety Coordinator immediately!* |
| Pesticides<br>❶ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Use rinse water in original application whenever possible.<br>S: Use inventory control; e.g., a surplus chemicals exchange network that offers unused pesticides to other company facilities in lieu of disposal.<br>S: Use a licensed commercial pesticide application service.<br>S: Properly store and label containers to prevent degradation and contamination.<br>S: Use all contents/material and then triple rinse the container. Use rinsate as originally intended for the material.<br>S: Practice good inventory control. Use excess at another facility.<br>R: Return unused chemicals to vendor for recycling.<br>R: Send unusable chemicals to a recycler.<br>T:<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility. Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Highly regulated substances. Use licensed applicators/contractors. Avoid eye and skin contact. Read warning labels; consult MSDS for additional guidance. Triple rinse drums/containers before disposal. Manage rinse water as hazardous unless reused. |

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| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Pigging wastes from gathering lines ❷ | Exempt<br>Nonhazardous Waste Manifest | S: Minimize paraffin accumulation (see paraffin). Add appropriate chemical agents to reduce accumulation of paraffin.<br>S: Reduce accumulation of hydrates (see hydrates).<br>S: Reduce accumulation of scale (see scale).<br>R: If possible, reuse pigs.<br>R: Recycle paraffin whenever possible. (See Paraffin.)<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** May contain hydrogen sulfide; use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance. |
| Pigging wastes from transportation pipelines ❸ | Nonexempt | S: Minimize paraffin accumulation (see paraffin). Add appropriate chemical agents to reduce accumulation of paraffin.<br>S: Reduce accumulation of hydrates (see hydrates).<br>S: Reduce accumulation of scale (see scale).<br>R: If possible, reuse pigs.<br>R: Recycle paraffin whenever possible. (See Paraffin.)<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Pipe dope, used ❶ ❹ | Exempt if nonhazardous<br>Nonexempt is hazardous<br>EPA Uniform Hazardous Waste Manifest | S: Choose biodegradable, lead-free pipe dope.<br>S: Use all of the product whenever possible.<br>S: Minimize waste, conserve compound for use at the next job.<br>S: All drilling, well servicing, pipeline, and other contractors should be responsible for unused and waste pipe dope and containers.<br>D: Send empty containers to an approved, state-permitted disposal facility.<br>Send excess pipe dope waste to OCD-approved surface waste management facility.<br>**Special considerations:** Pipe dope must be TCLP tested for lead to determine if it is a RCRA hazardous waste and therefore subject to DOT requirements. |

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❶ Oil and Gas Exploration and Production ❷ Pipeline
❸ Gas Processing ❹ Oil Field Services

# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Pit wastes<br>Includes: waste in reserve pits and emergency pits<br>❶ ❷ ❹ | Exempt if nonhazardous<br>Nonexempt if hazardous | S: Use rig wash judiciously. Install high-pressure, low-volume spray nozzles with automatic cutoffs.<br>S: Segregate fresh water, salt water, and oil-based fluids and solids. Use the "reserve pit management system."<br>S: Remove oil as soon as possible to minimize contamination of pit.<br>S: Locate and eliminate all sources of water leaks.<br>S: Grade site and use diversion structures to prevent or minimize stormwater run-on volume.<br>S: Use a closed-loop drilling fluid system if feasible.<br>S: Design pit and pit system to minimize waste. For example, use the "V" shaped pit or the "reserve pit management system."<br>S: Size and construct pits to accommodate only the necessary volumes anticipated plus an adequate freeboard.<br>S: Use tanks/vacuum trucks rather than earthen pits for workovers.<br>R: Stabilized, uncontaminated solids may be suitable for use as daily cover at landfills.<br>R: Recover and reuse weighting materials and drilling fluids. Waste drilling mud can be reused at other locations for spudding or plugging and abandoning operations.<br>R: Contract a drilling mud recycler to take waste drilling mud.<br>D: Hazardous: send to an approved, state-permitted RCRA hazardous waste disposal facility.<br>D: Nonhazardous: send to a state-permitted municipal solid waste landfill. |
| Plastic liners<br>❶ ❹ | Nonexempt<br>Nonhazardous Waste Manifest (for disposal) | S: Use reusable steel pits or portable tanks whenever possible.<br>S: Purchase liners constructed of recycled plastic.<br>R: Send to a plastic recycler.<br>D: Hazardous: send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>D: Nonhazardous: Send to an approved, OCD-approved landfarming facility.<br>D: Nonhazardous: send to a state-permitted municipal solid waste landfill. |
| Produced sand<br>❶ ❹ | Exempt | S: Improved gravel pack design.<br>S: Optimize production rate to minimize sand production.<br>S: Design perforations in completion to minimize sand production.<br>R: Use as fill material, if uncontaminated<br>R: Send to cement kiln as a substitute for feedstock, if permissible.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Produced water ❶ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Assess the feasibility of treating the producing formation with polymers that decrease the permeability of the formation for water, while the permeability of hydrocarbons remains unchanged.<br>S: Use rock plugging with gel slugs to block off water production in completions where there is a discernible separation of the oil and water zones.<br>S: Dually complete oil zone and water zone to allow water to be produced simultaneously but separately from oil and to allow control of water coning. (Research indicates that water production may be reduced by as much as half.)<br>S: Investigate feasibility of dually completing gas/water producing zone and injection (Class II) disposal zone (water phase separates and is not produced at surface).<br>S: Carefully planned well completions.<br>S: Reperforate well to reduce water production.<br>S: Drill wells to minimize water production (e.g., horizontal wells when feasible).<br>S: Optimize production rate to minimize the influx of water (e.g., coning).<br>R: Create a system that distributes produced water to various waterfloods in area. Results: reduction in volume of produced water requiring disposal and reduction of the amount of make up water purchased. Also, the need for water storage tanks for suction at water injection stations is eliminated by pumping directly from the water separation tanks to provide pressured water to the high pressure injection pumps. This reduces cost associated with operating charge pumps at the water station.<br>R: Use produced water for hydrotesting of pipelines, equipment and tanks.<br>R: Desalinate for use in other E&P operations if water supply is scarce and the process is cost effective.<br>D: Send to an approved, state-permitted disposal facility.<br>**Special considerations:** May contain flammable or combustible compounds and hydrogen sulfide. Produced water that is oil-free is not regulated by DOT. |
| Rags, oily ❶ ❹ | Exempt<br>(if soaked with crude oil or other exempt waste) | S: Maintain equipment and facilities to prevent drips, leaks, and spills which would require cleanup.<br>S: Use drip pans or other containment devices to collect leaks, drips or accidental spills. Empty containment devices properly.<br>R: Keep separate from other wastes and wash for reuse.<br>R: Send to recycler.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Rigwash<br>❶ ❹ | Exempt | S: Prudent use of water in rig maintenance.<br>S: Use high-pressure, low-volume hose nozzles with automatic cutoffs.<br>S: Set up a regular maintenance program for water systems to reduce leaks and drips.<br>S: Remove paint solids from water arrestor holding tanks with a centrifuge or cyclone system.<br>S: Reduce rigwash use by sweeping or other dry cleaning when feasible.<br>S: Collect rigwash in tanks rather than earthen pits.<br>R: Collect and reuse rigwash for subsequent rig washdowns or for first stage washing of equipment.<br>R: Use as make-up water in drilling and completion operations.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Sandblast media - see Blasting sand, media<br>❶ ❷ ❸ ❹ | | |
| Scale, pipe and equipment<br>❶ ❷ ❸ ❹ | Exempt<br>(If generated in primary field operations) | S: Use scale inhibitors. Circulate inhibitor in well or inject inhibitor into producing formation.<br>S: Avoid mixing incompatible produced waters which will result in scale formation.<br>S: Design facility to reduce locations prone to scale formation (e.g., large pressure drops and unnecessary pipe elbows).<br>S: Dually complete oil zone and water zone to allow water to be produced simultaneously but separately from oil and to allow control of water coning. (Research indicates that water production may be reduced by as much as half, thereby reducing scale formation in production equipment carrying the oil stream.)<br>S: Use polymer injection to reduce permeability to water in the production zone, thereby reducing the volume of water produced which is the source of scale.<br>S: Use rock plugging with gel slugs to block off water production in completions where there is a discernible separation of the oil and water zones.<br>S: Coat material surfaces with chemicals at critical points in the production system to reduce the availability of nucleation points for scale formation.<br>R: Clean scale from pipe and equipment and recycle the pipe and equipment.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Scrubber wastes | Exempt | S: Convert to natural gas as a fuel to avoid generating $SO_2$ and flyash.<br>R: Remove solids through gravity separation, filtration, etc., and send liquids to water softening for steam generation or direct injection for enhanced recovery.<br>R: Use as an oxygen scavenger.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Silver-containing waste (e.g., film developing process) | Nonexempt | S: Minimize the number of film reproductions.<br>S: Install on-line equipment to remove silver from process liquids.<br>R: Recover silver from the film/developing solution before disposal and recycle.<br>R: Send waste liquids to a recycler.<br>R: Send waste solids and film to a recycler.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Dispose of silver-containing liquids in state-permitted wastewater treatment facility allowed to accept trace metals.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility. |
| Soils, unused-chemical contaminated ❶ ❷ ❸ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Develop operational procedures that prevent contamination of soils. For example, use containment devices in chemical storage areas to prevent contamination of soils.<br>S: Install fencing around chemical storage to discourage losses due to vandalism.<br>R: Recover free liquids and recycle.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Send to an approved, OCD-approved landfarming facility or send to a permitted-municipal landfill.<br>**Special considerations:** Chemical spills on soils may produce a hazardous waste . Consult MSDS for guidance for each chemical. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Soils, crude oil contaminated (in primary field operations) ❶ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Pick up free liquid or solids spilled as soon as possible after the spill is contained. Recycle back into production stream.<br>S: Develop operational procedures that prevent contamination of soils. For example, preventative maintenance on flowlines and containment under tank battery load-line connections.<br>S: Use impervious secondary containment. Use pit liner material around and under production facilities.<br>S: Consider use of magnetic ion coating technology for stuffing box packing rubbers, valve stems and other friction and wear points that may provide a source of leakage.<br>S: Prepare and implement Spill Prevention, Control and Countermeasures (SPCC) Plans for each facility.<br>S: Use cathodic protection or coated pipe to reduce leaks caused by corrosion.<br>S: Consolidate produced fluid separation and well testing facilities.<br>S: Use "canned submersible pumps" to replace conventional impeller type pumps use for fluid transfer service.<br>R: Recover free crude oil and return to production stream.<br>D: Send to an approved, OCD-approved surface waste management facility.<br>**Special considerations:** Handle as crude oil. Use appropriate PPE. Avoid eye and skin contact. |
| Soils, lube oil contaminated ❶ ❷ ❸ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Pick up spilled liquid or solids as soon as possible after the spill is contained and recycle.<br>S: Develop operational procedures that prevent contamination of soils. For example, preventative maintenance on lubricating oil system and containment under system.<br>S: Use impervious secondary containment. Use pit liner material around and under lubricating oil systems.<br>R: Recover free lubricating oil and recycle.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to an approved, OCD-approved landfarming facility.<br>**Special considerations:** Test for heavy metals (TCLP) to determine if hazardous. Use appropriate PPE. Avoid eye and skin contact. Lube-oil contaminated soil is assumed to be RCRA hazardous waste, unless analytical testing indicates it is nonhazardous. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Soil, produced water-contaminated ❶ ❹ | Exempt | S: Develop operational procedures that prevent contamination of soils. For example, preventative maintenance on flowlines and containment under tank battery load-line connections.<br>S: Use impervious secondary containment. Use pit liner material around and under production facilities.<br>S: Consider use of magnetic ion coating technology for stuffing box packing rubbers, valve stems and other friction and wear points that may provide a source of leakage.<br>S: Use cathodic protection or coated pipe to reduce leaks caused by corrosion.<br>S: Consolidate produced fluid separation and well testing facilities.<br>S: Use "canned submersible pumps" to replace conventional impeller type pumps use for fluid transfer service.<br>S: Pick up spilled liquid as soon as possible after the spill is contained.<br>S: Use smaller injection pumps at each injection well for secondary recovery projects and supply water by gravity drainage (low pressure lines) from a central water storage tank.<br>S: Prepare and implement Spill Prevention, Control and Countermeasures (SPCC) Plans for each facility.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Solvents (organic solvents used in cleaning and degreasing equipment) ❶ ❷ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Use water-based solvents or soap cleaners that are biodegradable whenever possible.<br>S: Substitute nonhazardous surfactants (soap) for hazardous solvents (mineral spirits) for equipment cleaning.<br>S: Use up all solvent in container, ensuring no residue remains.<br>S: Minimize amount of solvent being lost during cleaning or maintenance; for example, use drip pans to collect solvent for reuse.<br>S: Use high-pressure water, steam or other non-toxic solvents to clean equipment.<br>S: Keep solvent containers tightly covered when not in use to decrease loss due to vaporization.<br>S: Use inventory control to minimize volume of unnecessary solvent stored.<br>S: Use dirty solvent for initial cleaning and clean solvent for final cleaning.<br>R: Send to a recycler.<br>R: Filter/clean or regenerate solvents and reuse.<br>R: Use spent solvent for paraffin removal.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** May be highly flammable. Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for guidance for a specific solvent. Can be tested to determine hazard status. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Stormwater ❶ ❷ ❸ ❹ | Refer to Mixture Rules | S: Improve work process and properly maintain equipment and facilities to reduce leaks, spills, etc.<br>S: Cover facilities to eliminate contamination of stormwater.<br>S: Segregate stormwater drainage from liquid storage, loading/unloading facilities and, operations areas from unimpacted areas.<br>S: Clean up spills and leaks promptly to minimize stormwater contamination.<br>R: Use stormwater as make-up water in the process. For example, use contaminated stormwater for first stage washing of equipment, use stormwater as make-up water in drilling/completion operations, and use stormwater for process water and agricultural purposes.<br>D: Discharge under NPDES permit |
| Sulfur recovery unit wastes, including sulfur-contaminated ❷ | Exempt | S: Substitute a less hazardous catalyst in the Scot Tailgas process of a sulfur recovery plant. Nonhazardous spent catalyst waste can result, thereby resulting in disposal cost savings.<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |
| Tank bottoms (basic sediment and water) ❶ ❹ | Exempt<br>Nonhazardous Waste Manifest | S: Recycle back through treatment system, with no additional requirements.<br>S: Keep turbulent flow in tank to prevent sedimentation whenever possible. The use of mechanical stirring devices in oil storage tanks will eliminate build-up of tank bottom sediments and reduce chemical storage.<br>S: Add appropriate chemical agents to reduce tank bottom accumulation.<br>S: Treat light oil tank bottoms with high temperature in heavy oil dehydration facilities.<br>S: Recover product by recycling light oil tank bottoms through heavy oil dehydration facilities. Results: added revenue and substantial cost savings through reduction of waste disposal.<br>S: Use cone bottom stock tanks and run bottoms through heater-treater more frequently than normal.<br>S: Reduce the number of tanks by consolidating produced fluid storage facilities.<br>S: Keep a gas blanket on tanks to reduce oxygen and formation of iron oxides. A gas blanket can also reduce risk of explosion and subsequent leakage due to lightning strikes.<br>S: Identify and minimize the source of solids.<br>R: Send tank bottoms to crude oil reclamation plants. (Call OCD for current list of permitted crude oil reclamation plants.)<br>R: Send to a refinery coker.<br>R: Use a centrifuge or filter press to recover oil and water from tank bottoms.<br>D: Send to an approved, state-permitted disposal facility.<br>**Special considerations:** May contain hydrogen sulfide. Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Thread protectors ❶ ❷ ❸ ❹ | Nonexempt<br>Nonhazardous Waste Manifest | S: Avoid using excess pipe dope.<br>S: Return to vendor.<br>R: Reuse in operations or sell for re-use.<br>R: Send to a reclamation facility that removes pipe dope and markets the thread protectors for reuse.<br>R: Send to a scrap metal or plastic recycler.<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to an approved, OCD-approved landfarming facility. Send cleaned, crushed, nonhazardous thread protectors to municipal solid waste landfill.<br>**Special considerations:** Considered hazardous waste if pipe dope is present and intended for disposal. Use gloves. |
| Tires ❶ ❷ ❸ ❹ | Nonexempt | S: Rotate tires and align regularly.<br>S: Maintain proper inflation pressure.<br>S: Purchase tires with greater road-wear abilities.<br>R: Send to a tire recycler.<br>R: Purchase retreaded tires if feasible.<br>D: Send to an approved, state-permitted municipal solid waste landfill. |
| Vacuum truck rinsate ❶ ❹ | Nonexempt | S: Use chemicals and products that are less hazardous or toxic.<br>S: Avoid mixing nonhazardous and hazardous wastes in vacuum truck.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical.<br>Dangerous fumes may collect inside the tank. Use appropriate PPE. Avoid eye and skin contact. |

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# ALTERNATIVES FOR WASTES GENERATED IN O&G OPERATIONS

| WASTE | RCRA CLASSIFICATION* FORMS | ALTERNATIVES |
|---|---|---|
| Well completion, treatment, and stimulation fluids, unused ❶ ❹ | Nonexempt<br>EPA Uniform Hazardous Waste Manifest | S: Recycle unused frac oil back into production stream.<br>S: Use all of the product whenever possible; e.g., use excess frac oil, acid, stimulation fluids, and xylene in other wells.<br>S: Use inventory control; e.g., a surplus chemicals exchange network that offers unused chemicals to other company facilities in lieu of disposal.<br>S: Return unused portion to vendor.<br>T: Hazardous: Treat to meet 40 CFR 268.40 standards<br>D: Hazardous: Send to an approved, state-permitted RCRA hazardous waste treatment and disposal facility.<br>Nonhazardous: Obtain OCD approval and send to an OCD-approved surface waste management facility.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for guidance for specific material. Can be tested to determine hazard status. |
| Workover wastes, used ❶ ❹ | Exempt | S: Place into production stream whenever possible.<br>R: Recycle free liquids back into production stream.<br>T:<br>D: Obtain OCD approval and send to an OCD-approved surface waste management facility or send to a state-permitted municipal landfill.<br>**Special considerations:** Use appropriate PPE. Avoid eye and skin contact. Consult MSDS for additional guidance for specific chemical. |

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# ATTACHMENT

# COMMERCIAL SURFACE WASTE MANAGEMENT FACILITIES IN NEW MEXICO

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| Company Name | Address and Telephone | Waste Type |
|---|---|---|
| ARTESIA AERATION L.L.C. | P.O. Box 248<br>Artesia, NM 88210<br>(505) 746-9037 | LF |
| B&K LANDFARM | P.O. BOX 398<br>Jal, NM 88252<br>(505) 395-3264 | LF |
| BASIN DISPOSAL, INC. | P.O. Box 100<br>Aztec, New Mexico 87410<br>(505) 325-6336 | PW, TP |
| C&C LANDFARM | Box 55<br>Monument, NM 88265<br>(505) 397-2045 | LF |
| CHAPARRAL TREATING PLANT | P.O. Box 1769<br>Eunice, New Mexico 88231<br>(505) 394-2545 | PW, TP, S, M |
| CONTROLLED RECOVERY, INC. | P.O. Box 388<br>Hobbs, New Mexico 88241<br>(505) 393-1079 | PW, TP, S, M |
| DD LANDFARM | 317 W. Blanco<br>Hobbs, NM 88242<br>(505) 397-4785 | LF |
| DOOM LANDFARM | Box 168<br>Jal, NM 88252<br>(505) 395-2877 | LF |
| ENVIRONMENTAL PLUS, INC. | P.O. Box 1558<br>1324 N. Main<br>Eunice, New Mexico 88231<br>(505) 394-3481 | LF |
| ENVIROTECH, INC. | 5796 U.S. Highway 64-3014<br>Farmington, New Mexico 87401<br>(505) 632-0615 | LF |
| GANDY CORP. | 1109 East Broadway<br>P.O. Box 827<br>Tatum, New Mexico 88267<br>(505) 398-4960 | PW, TP, LF |
| GANDY MARLEY, INC. | P.O. Box 1658<br>Roswell, New Mexico 88202<br>(505) 625-9206 | LF |
| GOO YEA | 300 Broadway NE<br>Albuquerque, NM 87401<br>(505) 242-6464 | LF |

| Company Name | Address and Telephone | Waste Type |
|---|---|---|
| J & L LANDFARM, INC. | P.O. BOX 356<br>Hobbs, NM, 88241-0356<br>(505) 393-9697 | LF |
| JENEX OPERATING | P.O. Box 308<br>Hobbs, New Mexico 88241<br>(505) 397-3360 | TP |
| KELLY MACLASKEY OILFIELD SERVICES, INC. | P.O. Box 580<br>Hobbs, New Mexico 88241<br>(505) 393-1016 | PW, TP, M |
| KEY ENERGY SERVICES | P.O. Box 900<br>Farmington, New Mexico 87499<br>(505) 327-0416 | PW, TP |
| LOCO HILLS WATER DISPOSAL, INC. | Box 68<br>Loco Hills, NM 87255<br>(505) 677-2118 | PW |
| POOL CO. TEXAS LTD. | P.O. Box 5208<br>Hobbs, NM 88241<br>(505) 392-2577 | TP |
| RHINO ENVIRONMENTAL | 300 Broadway NE<br>Albuquerque, NM 87401<br>(505) 242-6464 | LF |
| SOUTH MONUMENT SURFACE WASTE FACILITY L.L.C | 834 W. Gold<br>Hobbs, New Mexico 88240<br>(505) 392-1180 | LF |
| SUNDANCE SERVICES, INC. | P.O. Box 1737<br>Eunice, New Mexico 88231<br>(505) 394-2511 | PW, TP, S, M |
| TNT ENVIRONMENTAL | HCR 74 Box 115<br>Lindrith, New Mexico 87029<br>(505) 774-6663 | PW, LF, M |
| TIERRA ENVRONMENTAL COMPANY, INC. | P.O. Drawer 15250<br>Farmington, N.M. 87410<br>(505) 334-8894 | LF, TP, S, M |
| WATSON TREATING PLANT, INC. | P.O. Box 75<br>Tatum, New Mexico 88267<br>(505) 398-3490 | TP |

PW – Produced Water
TP – Waste Oil Treating Plant
S – Solids
LF – Landfarm (Solids)
M – Drilling Muds

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# REFERENCES

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20 NMAC 6.2. "Environmental Protection, Water Quality, Ground and Surface Water Protection," New Mexico Water Quality Control Commission.

40 *Code of Federal Regulations* (CFR) 261. "Identification and Listing of Hazardous Waste."

53 *Federal Register* (FR) 25446. July 6, 1988. "RCRA Regulatory Determination for Oil and Gas and Geothermal Energy Exploration, Development, and Production Wastes."

55 FR, 11798. May 29, 1990. "Toxicity Characteristics Rule."

58 FR 15284. March 22, 1993. "Oil, Gas, and Geothermal Energy Wastes Regulatory Clarification."

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