Data Summary of Offshore Drilling Waste Disposal Practices

prepared for:

U.S. Environmental Protection Agency
Engineering and Analysis Division

and

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Introduction

The U.S. Environmental Protection (EPA) announced in December 1997 that it would revise the offshore oil and gas effluent limitations guidelines to incorporate discharge requirements for synthetic-based drilling muds (SBMs). The process to be used would be an expedited "presumptive rulemaking" process that would require cooperation between EPA, other government agencies, the regulated industry, and other interested stakeholders. To allow the process to proceed at a rate much faster than normal, industry formed several work groups to generate new data. The U.S. Department of Energy (DOE) offered to assist EPA in additional data gathering efforts. On September 2, 1998, Joseph Daly, the EPA project manager for the SBM rulemaking, wrote to Nancy Johnson, DOE's Director of Planning and Environmental Analysis in the Office of Fossil Energy, outlining the types of information he hoped that DOE could provide. This report summarizes the data collected to answer three of Mr. Daly's questions:

1. What percentage of wells utilize discharge to the sea, hauling to shore, injection, or recycling for disposal of the different types of muds and cuttings? This is broken out by geographical region (Gulf of Mexico outer continental shelf [OCS], California OCS, North Slope Alaska, and Cook Inlet Alaska).

2. What is the cost of the different types of disposal?

3. What fuel is used to generate the electricity to power solids-handling equipment on the platforms?

Methods

This information was collected through telephone conversations with offshore oil and gas operators. In some cases operators provided responses directly over the telephone, and in other cases, a list of questions was faxed or e-mailed to the operators, who later provided the information.

Given the time constraints, it was impractical to contact all Gulf of Mexico offshore operators. Approximately 15 Gulf of Mexico operators were contacted and 14 of these provided data; 11 are majors and 3 are independents. All active operators in the California OCS (5 operators plus 1 company operating in state waters), North Slope Alaska (1 operator), and Cook Inlet Alaska (3 operators) were contacted and all provided information. In an effort to protect the identity of individual operators, each company is identified only by a code letter (Company A, Company B, etc.). Companies operating in more than one geographic region were assigned a separate code letter for each region in which they operate. The information from these contacts is presented in a standardized format in Tables 1-24.

Not every company provided a complete set of data. For example, only a few companies provided disposal cost information. The cost estimates cover a wide range,

primarily because different operators report different portions of the total cost attributable to waste disposal. Some operators reported only the cost for disposing wastes at a commercial disposal company while other operators included transportation, boat and cuttings box rental fees, cuttings box cleanup charges, and cleanup water disposal costs. In an effort to collect more information on disposal costs, six commercial disposal companies were also contacted. This included the two onshore disposal companies that receive the majority of all offshore wastes brought to shore and four companies that come to an operator's platform and dispose of the waste by slurry injection into the operator's injection well. The information collected form these contacts is summarized in a later section.

Discussion of Data from Operators

Gulf of Mexico

Nearly all water-based muds (WBMs) and cuttings are discharged. The WBMs and cuttings that do not meet the permit limits are brought back to shore for disposal. Companies D and J report that a small percentage of WBMs are recycled, while Company M discharges 50% of WBMs and recycles 50%. None are injected. Four companies reported disposal costs, which range from $7.50/bbl to $150/bbl. It is highly probably that these costs do not cover the same items and are therefore not comparable.

Most oil-based muds (OBMs) are recycled and most OBM cuttings are disposed of onshore. Most companies reported onshore disposal costs ranging from $10/bbl to $40/bbl, but two companies that included more cost components in their estimates reported $107/bbl and $350/bbl. Four companies dispose of some portion of their OBM cuttings by injection. The percentage disposed by injection ranges from 5% to 50%. Costs for injection range from $5/bbl to $250/bbl. One company disposes of 10% of its OBMs through injection. No OBMs or OBM cuttings are discharged.

Most SBMs are recycled, and most SBM cuttings are discharged. Some of the operators reported that a fraction of the SBMs were discharged. This was intended to indicate that some of the SBMs adhere to the cuttings particles that are discharged. Other operators did not report in that manner, but noted that all SBMs are recycled. Two companies reported that very small percentages of SBMs are disposed of onshore. The costs reported for this are $9.50/bbl to $100/bbl. One company indicated that the cost of hauling SBMs to shore and recycling them is $40/bbl. One company reported that all of its SBM cuttings are disposed of onshore. No SBMs or SBM cuttings are injected.

Nine of the 14 companies reported that electricity is generated through diesel generators. Two companies use a mix of diesel and natural gas and two companies did not provided any indication of fuel type.

California

Nearly all WBMs and cuttings are discharged. The WBMs and cuttings that do not meet the permit limits are brought back to shore for disposal. Company P reported that all WBM cuttings are brought to shore for disposal. Three of the five companies operating in the California OCS reported that they use only WBMs.

Two of the five companies also used OBMs. All OBMs and OBM cuttings are taken to shore for disposal. Disposal costs for these two companies range from $4/bbl to $17/bbl. Company R previously tried injection of cuttings but found that it didn't work well.

SBMs are not currently used in the California OCS.

Data were provided by a company located in the state waters of California (within 3 miles of shore) for comparison. This company uses both WBMs and OBMs. All drilling wastes are injected at this location.

Electricity comes from a variety of sources. Two companies receive power through a cable attached to shore. One company uses natural gas, and another uses diesel. The fifth company did not indicated how it gets electricity.

North Slope Alaska

Only one company is currently operating in offshore areas in the northern part of Alaska. This company injects all of its WBMs, WBM cuttings, and OBM cuttings into a dedicated injection well. The capital cost of the injection facilities was $5 million, and the annual operations and maintenance cost is $2 million. The volume of drilling wastes injected is about 105,000 bbl/year. Assuming that the annual cost of capital is 1.7 million, the total annual cost is then $3.7 million and the cost for injection is about $35/bbl. The OBMs are all recycled.

No SBMs are used in the North Slope area.

Electricity is generated through diesel generators during start up and new drilling, and through natural gas when the field is up and running.

Cook Inlet Alaska

Two of the three companies operating in Cook Inlet indicated that they use WBMs and OBMs. The third company, which is no longer in the drilling mode, indicated that they used only OBMs, although they probably also used WBMs. Company Y discharges all of its WBMs and WBM cuttings, and Company W discharges most of its WBMs and WBM cuttings. The 5% of WBMS and WBM cuttings not discharged are disposed of onshore at a cost $200/bbl.

All three companies employ injection for disposal of OBM cuttings. Costs range from $418/bbl to $450/bbl. Companies X and Y recycle OBMs, while Company W injects the muds.

SBMs are not being used in Cook Inlet at this time.

Only one of the three facilities indicated how they generate electricity. This company uses natural gas.

Company Y, which agreed to be identified (it is Phillips), has experienced difficulty in dealing with its drilling wastes other than WBMs and WBM cuttings. The comments section of Table 22 summarizes these problems as provided by Mickey Carter of Phillips.

Information from Disposal Companies

Onshore Disposal

Newpark Resources - Newpark Resources operates a series of oil field waste disposal facilities in Louisiana and Texas. Newpark also operates several marine transfer facilities, at which operators can unload drilling wastes from work boats to barges. Because it has these transfer facilities, Newpark receives the majority of offshore wastes. Newpark charges $7.50/bbl for disposing of WBM cuttings and from $8.50/bbl to $11/bbl for disposal of OBMs and OBM cuttings. If wastes are delivered to the transfer stations, there is an additional offloading fee of $3/bbl - $3.50/bbl. Typically the operators' drilling waste containers must be washed out and the resulting washwater must be disposed of too. This step adds several dollars per barrel to the total cost.

U.S. Liquids - U.S. Liquids also operates a series of oil field wastes disposal facilities in Louisiana and Texas. U.S. Liquids used to own the marine transfer stations now operated by Newpark. Because it no longer operates marine transfer stations, U.S. Liquids receives a smaller fraction of the offshore wastes brought to shore than it used to. U.S. Liquids charges similar prices to Newpark at its Louisiana facilities. WBMs and WBM cuttings cost $7.50/bbl to $8.75/bbl for disposal, and OBMs and OBM cuttings cost $9.50/bbl to $10.75/bbl. At its Texas facility, the prices are somewhat lower. WBMs and WBM cuttings are $6.25/bbl to $7/bbl, and OBMs and OBM cuttings are $6.67/bbl to $8.25/bbl. Washwater costs several dollars per barrel for disposal.

Onsite Slurry Injection

Apollo Services - Apollo offers two methods of drilling waste disposal for its customers. Most customers opt for slurry injection. In the past year, Apollo estimates that it has injected cuttings at 38 wells in the Gulf of Mexico OCS. Apollo charges a daily rate for rental of its equipment. An estimated total cost for slurry injection is about $20/bbl. If a customer prefers, Apollo also will box up drilling wastes and haul them to shore and take them to Newpark for disposal. Apollo estimated that presently about 20% of all OBM cuttings from the Gulf of Mexico are injected and 80% are disposed of onshore.

National Injection Services - National Injection Services provides slurry injection service to its customers. Last year, National Injection Services worked on 18 wells in the Gulf of Mexico OCS. Total cost figures provided for three recent injection jobs ranged from $3.30/bbl

to $11.30/bbl. National Injection Services expressed the opinion that historically about 10-15% of Gulf of Mexico wells used slurry injection, but the percentage is now beginning to increase.

The following text is part of an e-mail sent by Gene Kraemer, CEO of National Injection Services to the author. It provides a good indication of the many cost components that need to be considered for drilling waste disposal. Not surprisingly, given Mr. Kraemer's affiliation, the text points out the many cost components of onshore disposal but not those for slurry injection.

"Zero-Discharge - Disposal Using Vacuums and Cuttings Boxes

A. Cuttings Boxes.
1. Cuttings box rental charges - average per well is 80 to 100 Boxes @ $25.00/day [$25.00/box/day] or $2000.00 to $2500.00/Day.
2. Cuttings box cleaning charge.
3. Box repair cost when damaged.
4. Shipping manifests/analytical reports - stored forever by operator
5. Transportation charges

a. Transportation of boxes from rental facility to dock via 18 wheeler truck.
b. Continuous transportation of boxes to and from rig via workboat.
c. Continuous transportation of boxes from dock to waste disposal facility via 18 wheeler truck.
d. Transportation of boxes from waste disposal facility back to rental facility via 18 wheeler truck.

6. Workboat fuel surcharges for special trips on box delivery to and from rigs.

B. Vacuum Expenses.
a. Mob/demob charge.
b. Rig up charges.
c. Requires 2 - 75 Hp Vacuums per job. (One for back-up)
d. Requires 2 - vacuum box lids.
e. Requires miscellaneous PVC hoses, suction hoses, etc.

C. Personnel Expenses.
a. Requires 2 crane operators per day continually moving cuttings boxes from workboat to rig, moving boxes on rig, moving boxes from rig to workboat.

b. Requires 4 to 8 roustabouts during top hole and 2 to 4 after tophole; 2 to 4 on the rig and 2 to 4 on the workboat per day.
c. Requires 3 vacuum personnel on tophole, 2 thereafter.
d. Time spent on company personnel filling out shipping manifests for boxes.
e. Time spent on company personnel filling analytical reports, shipping manifests.

D. Analytical Expenses.
a. DNR UIC-28 regulations
b. Analytical reports must be stored .

E. Loss Time.
   a. Loss of rig maintenance due to roustabouts needed to work on moving boxes.
   b. Overtime pay of crane operators and roustabouts when 2 boats

F. Equipment Maintenance.
   a. Excessive crane use causes addition wear and tear.
   b. Excessive wear and tear on wire slings used to lift cuttings boxes.

G. Safety.
   a. Increased chance of workers being hurt due to the excessive amounts of lifting of boxes required while using the cuttings box disposal method.
   b. Cuttings box lids are heavy and can be a safety hazard.
   c. Additional safety meetings must be given on cuttings boxes

H. Space requirement.
   a. Cuttings boxes take up an excessive amount of rig space.

I. Environmental Liability.
   a. Oil & gas corporations are the owners of the waste produced from drilling operations even though it is placed in a landfarm. Future legal action for remediation is possible.
   b. Public disapproval of any type of waste site on land has risen in recent years.
   c. Landfarms have liners to protect the waste from leaching into the soil and groundwater - but for how long and what are the guarantees?
   d. Health hazards - air and water - recent lawsuits in Grand Bois, Louisiana, for instance."

Brandt-MSD - Brandt-MSD conducted slurry injection on three Gulf of Mexico OCS wells in the last year. Disposal costs for solids are estimated at $5/bbl to $7/bbl and for liquids at $2/bbl to $3/bbl. Brandt-MSD estimates that a typical total cost for hauling waste to shore for disposal is $30/bbl to $40/bbl.

Safeguard Disposal-SWACO - Safeguard Disposal-SWACO has conducted slurry injection on two Gulf of Mexico OCS wells in the last year. The daily equipment rental cost is about $2,000/day; no average cost/bbl was provided. Safeguard Disposal-SWACO estimated that a typical total cost for hauling waste to shore for disposal is $30/bbl.

Stratavault - According to Apollo Services, Stratavault also performs slurry injection. Apollo estimated that Stratavault performed five or six injection jobs last year.

Percentage of Wells Using Injection for Drilling Waste Disposal in Gulf of Mexico OCS

This is a difficult question to answer. Sixty-six Gulf of Mexico OCS slurry injection jobs were performed in the past year by the five disposal companies noted above. In an October 13, 1998 conference call, Mike Parker of Exxon, representing the industry work

group on SBMs, reported that industry records indicate that about 185 wells were drilled in the Gulf of Mexico OCS in 1996 and 1997 using SBMs (average of 92 per year). Mr. Parker also noted that about 15% to 20% of the wells in the Gulf of Mexico OCS are drilled with OBMs or SBMs. Assuming that 1,000 wells are drilled each year in the Gulf of Mexico OCS, about 150-200 of them will be drilled using OBMs or SBMs. If 92 of these are drilled using SBMs, about 58-108 are drilled using OBMs (assume 100 per year). If that figure is correct, approximately two-thirds of all wells drilled with OBMs use injection for OBM cuttings disposal. This percentage is not borne out by the data in Tables 1-14, which show that only four companies use injection and none of them use it exclusively. Likewise, this figure does not mesh with the estimates provided by Apollo Services (about 20%) and National Injection Services (10-15% and climbing). This appears to be an area that needs additional research.

Acknowledgments

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Table 1 - Drilling Waste Data for Company A

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	95	5	a			
water-based cuttings	100					
oil-based muds						
oil-based cuttings						
synthetic-based muds	20	5	b			75
synthetic-based cuttings	100					

Comments:
a - disposal cost for muds - $7.50/bbl and for washwater - $7.64/bbl
b - disposal cost for muds - $9.50/bbl and for washwater - $6.81/bbl

fuel - diesel

Table 2 - Drilling Waste Data for Company B

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds						100
oil-based cuttings		100				
synthetic-based muds						100
synthetic-based cuttings	100					

Comments: use diesel as base fluid for OBMs

fuel - diesel

Table 3 - Drilling Waste Data for Company C

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds		5	10	5	10	90
oil-based cuttings		50	10	50	10	
synthetic-based muds	12-15					85-88
synthetic-based cuttings	100					

Comments:

fuel - diesel

Table 4 - Drilling Waste Data for Company D

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	80		10-11			20
water-based cuttings	100					
oil-based muds		<10				>90
oil-based cuttings		100	14			
synthetic-based muds						100
synthetic-based cuttings		100				

Comments:
disposal costs - $2-$4/bbl for transportation and $12-$20/bbl for disposal

fuel - diesel

Table 5 - Drilling Waste Data for Company E

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds						100
oil-based cuttings		50-65	30-40	35-50	5-10	
synthetic-based muds						100
synthetic-based cuttings	100					

Comments: This company has recently begun to shift from onshore disposal of oil-based cuttings to injection. The contact person thought this trend would continue.

fuel - diesel

Table 6 - Drilling Waste Data for Company F

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds						100
oil-based cuttings		100				
synthetic-based muds						100
synthetic-based cuttings	100					

Comments:

fuel - ?

Table 7 - Drilling Waste Data for Company G

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	>90		<10			
water-based cuttings	>90		<10			
oil-based muds		100				
oil-based cuttings		100				
synthetic-based muds						100
synthetic-based cuttings	100					

Comments: The waste taken to shore is transferred from workboats to barges. The workboats must be washed out. About 3 bbl of washwater per 1 bbl of waste is generated.

Injection appears to be cost prohibitive because of the extra cost of paying the day rate for the equipment even on non-drilling days.

fuel - diesel

Table 8 - Drilling Waste Data for Company H

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds		100				
oil-based cuttings		100				
synthetic-based muds						100
synthetic-based cuttings	100					

Comments: Unclear whether OBMs are being recycled or disposed.

fuel - >75% diesel and <25% natural gas

Table 9 - Drilling Waste Data for Company I

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	95	5	150 - a			
water-based cuttings	100					
oil-based muds			40 - b			100
oil-based cuttings		85	350 - a	15	250 -c	
synthetic-based muds			40 -b			100
synthetic-based cuttings	100					

Comments:
a - These are total costs including on-platform solids handling, transportation, washwater, and disposal costs. These costs are probably not comparable to those provided by other companies because they include on-platform dedicated equipment costs.

b - This cost includes transportation to shore and recycling costs.

c - This cost includes the cost of developing and preparing a dedicated injection well. The contact person noted that injection costs will be lower if you already have a dedicated injection well at or near your drilling site and you are drilling multiple wells back-to-back.

fuel - diesel

Table 10 - Drilling Waste Data for Company J

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	93	5	100			2
water-based cuttings	100					
oil-based muds						
oil-based cuttings						
synthetic-based muds	29	1 - a	100			70
synthetic-based cuttings	100					

Comments:
a - This is washwater resulting from boat cleanup.

fuel - diesel

Table 11 - Drilling Waste Data for Company K

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds		100				
oil-based cuttings		100				
synthetic-based muds						100
synthetic-based cuttings	100					

Comments:

fuel - mainly diesel

Table 12 - Drilling Waste Data for Company L

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds						100
oil-based cuttings		100	24 - a			
synthetic-based muds						100
synthetic-based cuttings	100					

Comments:

a - About half of the cost is for transportation and half is for disposal.

fuel - ?

Table 13 - Drilling Waste Data for Company M

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	50 - a					50
water-based cuttings	100					
oil-based muds						100
oil-based cuttings		95	107 - c	5	74 - b	
synthetic-based muds						100
synthetic-based cuttings	100					

Comments: a - A typical 50% discharge for WBM is reported to reflect mud for surface hole section drilled prior to riser installation from floating drilling vessels, dilution for rheological maintenance and disposal. Some WBM can be reused from well to well.

b- The cost to inject cuttings is based on one sidetracked well. The total cost to inject 1,700 barrels of cuttings with the associated mud residue on the cuttings, associated wash water, and any OBM washed off or overflow from the solids control equipment was $125,000, for an average cost of $74/bbl. Note that a total of 6,700 bbls of slurry were injected as a result of the seawater dilution to slurrify the OBM cuttings.

c - The cost to haul cuttings to shore shown on the table is an average of $128/bbl for the drilled wells average and $86/bbl for the sidetrack drilled wells. Note that these costs are typically over $0.5 million per drilled well and about $150,000 per sidetrack. The cost to haul to shore incorporates many costs for equipment and services to safely do the job. These include rental of cuttings transport boxes, rental of the vacuum cuttings transfer system, technicians, on-shore trucking, cleaning of rental boxes, disposal of water after cleaning, extra supply boat to ship the cuttings boxes, extra fuel for the supply boat transportation, and the OBM cuttings disposal fee. Not included is the potential delay if the weather is too rough to safely load the cuttings boxes on the boats.

fuel - diesel

Table 14 - Drilling Waste Data for Company N

Location: Gulf of Mexico

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds						
oil-based cuttings						
synthetic-based muds						100
synthetic-based cuttings	100					

Comments:

fuel - 93% diesel and 7% natural gas

Table 15 - Drilling Waste Data for Company P

Location: California

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings		100				
oil-based muds						
oil-based cuttings						
synthetic-based muds						
synthetic-based cuttings						

Comments:

electricity comes from shore by cable

Table 16 - Drilling Waste Data for Company Q

Location: California

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	95-98	2-5				
water-based cuttings	95-98	2-5				
oil-based muds		100				some ?
oil-based cuttings		100				
synthetic-based muds						
synthetic-based cuttings						

Comments: Onshore cost for disposal of liquids is $5-$15/bbl and for dry materials is $15-$65/ton ($ 4-$17/bbl). The procedure used for solids is to put the waste into 3-4 cu.yd. bins on the platform. A crane moves them into 10 cu. yd. bins on the workboats or barges. Liquids are held in tanks on the platform and are then pumped to a vacuum tank on a barge for transportation to shore. On shore, the liquids are transferred to a vacuum truck.

Electricity comes from shore by cable.

Table 17 - Drilling Waste Data for Company R

Location: California

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	>90	<10				
water-based cuttings	>90	<10				
oil-based muds		100				
oil-based cuttings		100				
synthetic-based muds						
synthetic-based cuttings						

Comments: This company previously tried injection of drilling wastes into Class II wells but it didn't work.

OBMs and cuttings come to shore in 6 cu. yd boxes and are then transferred to 15 cu. yd boxes for transportation to a landfill. The disposal cost is about $30/ton (= $8/bbl) and the full cost of disposal including transportation is about $50-$60/ton ($13 - $16/bbl).

No information on power supply.

Table 18 - Drilling Waste Data for Company S

Location: California

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds				100		
water-based cuttings				100		
oil-based muds				100		
oil-based cuttings				100		
synthetic-based muds						
synthetic-based cuttings						

Comments: ***This company's facilities are located in state waters, not in federal waters***. This sheet is included for information purposes only.

Table 19 - Drilling Waste Data for Company T

Location: California

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds						
oil-based cuttings						
synthetic-based muds						
synthetic-based cuttings						

Comments:

Fuel - natural gas

Table 20 - Drilling Waste Data for Company U

Location: California

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds						
oil-based cuttings						
synthetic-based muds						
synthetic-based cuttings						

Comments:

fuel - diesel

Table 21 - Drilling Waste Data for Company V

Location: North Slope Alaska

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds				100		
water-based cuttings				100		
oil-based muds						100
oil-based cuttings				100		
synthetic-based muds						
synthetic-based cuttings						

Comments: Injection facility uses ball mills to grind materials and then injects as a slurry into Class I wells.

Costs: Capital cost is $5 million and the annual O&M cost is $2 million. The volume of drilling wastes injected is about 105,000 bbl/year. For estimation purposes (not any sophisticated economic modeling) I assumed that the annual cost of capital was $1.7 million. The total annual cost is then $3.7 million, and the cost per barrel is about $35/bbl.

Fuel - diesel during start up and new drilling and natural gas when the field is up and running

Table 22 - Drilling Waste Data for Company W

Location: Cook Inlet Alaska

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	95	5	200			
water-based cuttings	95	5	200			
oil-based muds				100	418	
oil-based cuttings				100	418	
synthetic-based muds						
synthetic-based cuttings						

Comments:

Fuel - 90% natural gas and 10% diesel

Table 23 - Drilling Waste Data for Company X

Location: Cook Inlet Alaska

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds						
water-based cuttings						
oil-based muds						100
oil-based cuttings				100		
synthetic-based muds						
synthetic-based cuttings						

Comments: This company is not in the drilling mode now.

fuel - natural gas

Table 24 - Drilling Waste Data for Company Y

Location: Cook Inlet Alaska

Waste Stream	% discharged	% hauled to shore	cost ($/bbl)	% injected	cost ($/bbl)	% recycled
water-based muds	100					
water-based cuttings	100					
oil-based muds						100
oil-based cuttings				100		
synthetic-based muds						
synthetic-based cuttings						

Comments: Company Y is Phillips. Mickey Carter of Phillips consented to divulge the company's identity in sharing the following information:

"Tyonek Deep Prospect

Phillips Petroleum Co. (Phillips) and ARCO Alaska, Inc. reached an agreement that cleared the way for additional delineation drilling and potential development of the deep oil zone beneath the Phillips operated Tyonek production platform in Alaska's North Cook Inlet. Phillips planned to utilize Water Based Muds (WBMs) for the top of the hole to a depth of approximately 4,000 feet. Due to the geology, WBMs were not feasible for drilling at depths greater than 4,000 feet. Therefore, the following options were considered for depths from 4000 feet to total depth of well of approximately 17,000 feet:

Water based muds (WBMs) – infeasible due to increased rig time and estimated down time.

Oil based muds (OBMs) – Disposal options were investigated. Land disposal of cuttings were investigated. There were no land disposal options available in Alaska requiring transportation to the lower 48 states. Infeasible due to high transportation and disposal costs.

Synthetic Based Muds (SBMs) – Feasible only if cuttings associated with SBMs could be discharged. Three letters were sent to EPA by Phillips (February 3, 1997, March 17, 1997 and June 10, 1997) requesting approval. EPA responded to each letter that the discharge was not authorized by the permit.

Oil based muds – Disposal via grinding and injection into a Phillips or non-Phillips operated injection well. This option was chosen as the most feasible since approval to discharge cuttings associated with SBMs was not granted by EPA. A non-Phillips operated injection well was not available so Phillips permitted an annular injection well into the only zone available. The zone met the requirements of an exempt freshwater aquifer. The State has since notified Phillips in writing and verbally that this is no longer an option for any future wells.

Cost Estimates

Cuttings volumes generated in drilling Tyonek deep prospect.

Assume:

26" hole to 2600'
17-1/2" hole to 4000'
12-1/4" hole to 14,400'
8-1/2" hole to 15,700'
6" hole to 17,000'

WBMs to 4000', OBMs from 4000' to TD

26" hole = 1700 bbls volume x 3.0 expansion factor for shallow WBM holes = 5100 bbls cuttings bulk volume

17-1/2" hole = 420 bbls x 3.0 expansion factor for shallow WBM holes = 1260 bbls cuttings bulk volume;

12-1/4" hole = 1520 bbls x 2.0 expansion factor for OBM holes = 3040 bbls cuttings bulk volume

8-1/2" hole = 90 bbls x 2.0 expansion factor for OBM holes = 180 bbls cuttings bulk volume

6" hole = 45 bbls x 2.0 cuttings expansion factor OBM = 90 bbls cuttings bulk volume

OBMs or SBMs starting at 4000', the total cuttings generated would be = 6360 bbls WBM cuttings, plus = 3,410 bbls OBM or SBM cuttings
These numbers are fairly conservative.

Note that if we inject OBM cuttings, we will inject 3-4 bbls of seawater along with every bbl of OBM cuttings we inject.

There are currently no commercial land disposal facilities permitted in Cook Inlet. As a result, the only commercial land disposal facilities available to Phillips are located in the lower 48 states. Based on 1993 data (Development Document for Effluent Limitations Guidelines and

Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category), a unit disposal cost of $203 per barrel was assumed or $692,230 per well. In evaluating the drilling program in 1997, costs were estimated of $450 per bbl or $1,534,500 per well.

Land disposal would also require water transportation to shore which is not available during Winter months. Storage on the platform is not available on a long term basis.

Summary

As noted above, the only options in Cook Inlet, Alaska for Phillips is use of OBMs with land disposal of cuttings or grinding and injection of the cuttings or use of SBMs and discharge of the cuttings. Land disposal of OBMs is cost prohibitive. Grinding and injection of OBMs is no longer an option because there is no available zone of injection. Discharge of cuttings associated with SBMs has not been authorized by EPA at this time. Therefore, at this time Phillips has no plans to drill any more wells from Tyonek. If the discharge of SBMs are authorized in the NPDES permit, Phillips may reconsider and continue the drilling program.

If you have any questions, please contact me at 713-669-7075 (e-mail: mwcarte@ppco.com)"