
SCOTT ENVIRONMENTAL SERVICES, INC.
SESI
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Exploration and Production Land Footprints

- Lease Roads
- Drilling Pads
- Pipeline Right-of-Ways
- Frac Ponds
- Compressor Stations
- Drilling Wastes
  - Liquid Wastes
  - Solid Wastes

Drilling Waste

- Types of Drilling Waste
  - The various types of drilling waste are classified according to the mud that was used to drill the well. Therefore, there are three basic types of drilling waste. They are:
    - Water-Based Mud and Cuttings
      - Fresh-Water Mud and Cuttings (FWMC)
      - Saltwater Mud and Cuttings (SWMC)
    - Oil-Based Cuttings (OBC)
      - The mud is usually recycled.
    - Synthetic-Based Cuttings (SBC)
      - The mud is usually recycled.

Drilling Waste

- Contaminants
  - Salts
  - Hydrocarbons
  - Metals
    - Arsenic
    - Barium
    - Cadmium
    - Chromium
    - Lead
    - Mercury
    - Nickel
    - Zinc
  - pH

Drilling Waste

Characteristics of Different Mud Systems from Various Fields*

Characteristic	FWMC**	FWMC***	SWMC	OBC
pH (S.U.)	8.9	10	7.2	10.5
EC (mmhos/cm)	4.26	18	120,000	8.23
ESP (%)	1.3	61	Not Analyzed	2.23
TPH (mg/kg)	1570	114	61,000	156,000
Arsenic (mg/kg)	13.1	92.8	31	72.8
Barium (mg/kg)	5970	148	143	215
Cadmium (mg/kg)	0.343	0.511	0.342	1.22
Chromium (mg/kg)	30.9	72.6	27.6	15.5
Lead (mg/kg)	70.2	390	120	285
Mercury (mg/kg)	0.140	0.970	0.566	1.56
Selenium (mg/kg)	0.552	0.876	0.419	2.13

* This data is not intended to be considered an average of the specified analytes from the mud types.
** This FWMC was used on the top section of the hole through the fresh-water zone.
*** This FWMC was used during the entire hole depth.

Drilling Waste

- Regulation of Drilling Waste
  - Solid drilling waste is considered exempt from the Federal Resource Conservation and Recovery Act (RCRA). This means that states have primacy in regulating solid drilling waste.
  - There is a tremendous amount of variability in state rules regulating drilling waste. Some states are very stringent and others are more lax.

Drilling Waste

- Two-State Comparison of Drilling Waste Regulation
  - Regulation of Drilling Waste in Texas
    - The state agency in Texas responsible for regulating drilling waste is the Railroad Commission of Texas (RRC).
    - The RRC rule that governs how drilling waste is handled is referred to as “Rule 8.”

Drilling Waste

- Two-State Comparison of Drilling Waste Regulation Continued
  - Regulation of Drilling Waste in Louisiana
    - The state agency in Louisiana responsible for regulating drilling waste is the Louisiana Department of Natural Resources (LDNR).
    - The LDNR rule that governs how drilling waste is handled is referred to as “LA 29B.”

Drilling Waste

RRC “Rule 8” Summary

- Mud and cuttings from any type of mud can be legally disposed of by dewatering and backfilling the remaining solids **within the pit footprint,** without any additional RRC permit or landowner’s permission unless the lease agreement has language to the contrary. Because of the words bolded above, this option is rarely practical.
- Water-based mud and associated cuttings with chloride levels <3,000 mg/liter can be land applied on the lease where generated without any additional RCC permit, but this requires written permission of the landowner.
- Water-based mud and associated cuttings with chloride levels >3,000 mg/liter may be land applied, but this requires an additional RRC permit and written permission of the landowner.
- Oil-based mud cannot be land applied without an additional RRC permit and written permission of the landowner.
- Cuttings only from oil-based mud may be buried, but must be "dewatered" before burial. This action does not require an additional RRC permit and does not require landowner permission unless the lease agreement has language to the contrary.

Concentrations of petroleum hydrocarbons in any material land spread are restricted by RRC Rule 91 to a maximum of 5%, with a further requirement that petroleum hydrocarbon must be degraded to 1% within 1 year. Therefore, unless the TPH is initially reduced to <1%, further attention is required later to assure compliance with Rule 91.

Drilling Waste

LDNR “LA 29B” Selected Summary

Land Treatment

Parameter	Limitation
pH	6-9
Arsenic	≤10 mg/kg
Barium*	≤40,000 mg/kg
Cadmium	≤10 mg/kg
Chromium	≤500 mg/kg
Lead	≤500 mg/kg
Mercury	≤10 mg/kg
Selenium	≤10 mg/kg
Silver	≤200 mg/kg
Zinc	≤500 mg/kg
Oil and Grease	<10,000 mg/kg
Electrical Conductivity*	<4 mmhos/cm
SAR*	<12
ESP*	<15%
* Upland Values	

Burial

Parameter	Limitation
pH	6-9
Arsenic	≤10 mg/kg
Barium*	≤40,000 mg/kg
Cadmium	≤10 mg/kg
Chromium	≤500 mg/kg
Lead	≤500 mg/kg
Mercury	≤10 mg/kg
Selenium	≤10 mg/kg
Silver	≤200 mg/kg
Zinc	≤500 mg/kg
Oil and Grease	<30,000 mg/kg
Electrical Conductivity	<12 mmhos/cm
Moisture Content	<50% by weight
*Upland Value	

Drilling Waste

- Volume of Drilling Waste
  - The volume of the waste that is generated is dependent upon the number of wells drilled and their associated depths in a particular geographic region.
  - The American Petroleum Institute (API) has estimated that approximately 1.21 barrels of total drilling waste are generated for every foot drilled in the United States[1].
  - From past SESI experience, approximately 50% of this total drilling waste is solid drilling waste.

Drilling Waste

- Volume of Drilling Waste Continued
  - In 2008, approximately 43,898 wells were drilled onshore in the United States with an associated drilled footage of approximately 300,627,000 feet[2].
  - In 2009, approximately 23,197 wells were drilled onshore in the United States with an associated drilled footage of approximately 162,055,000 feet[3].
  - The approximate average between 2008 and 2009 would be 33,000 wells with an associated drilled footage of approximately 231,341,000 feet.

Drilling Waste

- Volume of Drilling Waste Continued
  - Using the estimate of total drilling waste generated and the average of total footage drilled between 2008 and 2009, approximately:
    - 139,961,305 barrels of liquid drilling waste are generated yearly, and
    - 139,961,305 barrels or 29,097,984 cubic yards of solid drilling waste are generated yearly.

Drilling Waste

- Potential Areal Impact of Drilling Waste
  - The RRC provides guidance for drilling waste that is low in salinity and hydrocarbons to be landspread at no more than 2,000 barrels per acre[4].
  - If all of the drilling waste generated yearly were low in salinity, hydrocarbons, metals, and pH and using the averages for yearly drilling waste totals and the waste was landspread, the United States would impact approximately 139,961 acres.
  - The number of acres above of approximated yearly areal impact would be greater if environmental contaminants were taken into consideration using stringent closure criteria.

Drilling Waste

Best Management Practices - Sustainability

- The RRC's and STRONGER's Waste Hierarchy in Descending Order of Preference for Evaluation of Waste Management and Disposal Options
  - Source Reduction
    - Avoiding waste generation, generating the least volume, or generating the least toxic waste possible.
  - Recycling/Reuse
    - Reclaiming useful constituents of a waste material or removing contaminants from a waste so that it can be reused. Also may involve the use of a waste as a substitute product for a commercial product.
  - Treatment
    - Any method, technique, or process that changes the physical, chemical, or biological character of a waste. However, it does not prevent the creation of pollutants.
  - Disposal
    - The discharge, deposition, injection, dumping, spilling, leaking, or placing of any waste into or on land, water, or air.

Drilling Waste

Best Management Practices – Sustainability

- The API has developed closure criteria for drilling waste based on well developed scientific information that addresses salts, hydrocarbons, metals, and pH[5].
- The API's closure criteria should always be based on testing the drilling waste before and after it is recycled/reused, treated, or disposed.

Drilling Waste

API Closure Criteria

Parameter	Criteria[5]	
	Land Application	Burial
pH (S.U.)	6-8	6-9
EC (mmhos/cm)	< 4	< 4
ESP (%)	< 15	N/A
TPH (mg/kg)	< 10,000	< 10,000
Arsenic (mg/kg)	< 41	< 41
Barium (mg/kg)	< 180,000	< 180,000
Cadmium (mg/kg)	< 26	< 26
Chromium	< 1,500	< 1,500
Lead	< 300	< 300
Mercury	< 17	< 17
Nickel	< 210	< 210
Zinc	< 1,400	1,400

Drilling Waste

Recommendations

- The adoption of standardized closure criteria by companies could reduce their environmental footprint and potential liability.
- Focusing on the waste hierarchy for drilling waste would promote sustainability.

Drilling Waste

SESI *Signature* Services

Service	Waste Hierarchy
Consulting	Focus on Source Reduction
Firmus®	Recycling/Reuse
Duro℠	Treatment
pHixit℠	Treatment
DBurial℠	Treatment/Disposal
TBury℠	Disposal
Sample & Test	Used for All Services

Drilling Waste

An Example of SESI's Firmus® Process

- SESI built a section of road using its Firmus® process on water-based mud and cuttings in conjunction with Texas A&M University's Global Petroleum Research Institute as a part of the Environmentally Friendly Drilling Systems Program to evaluate the reuse of mud and cuttings for load-bearing structures.
- The test of the Firmus® process on water-based mud and cuttings took place at the Pecos Research and Test Center (PRTC) outside of Pecos, Texas.
- The preliminary results indicated that the water-based mud and cuttings treated using SESI's Firmus® process created a superior construction material with minimal environmental impact from leachate.

Drilling Waste

An Example of SESI's Firmus® Process

Comparison of Untreated Material and Finally Treated Material		
Tested Characteristic	Analytical Value For:	
	Untreated Material	Finally Treated Material
pH (SU)	Not measured	11.9
UCS 7 day break (psi)	Not measured	379
Note: All of the following measurements are in milligrams per kilogram on a dry weight basis for the untreated material and in milligrams per liter of leachate for finally treated material.		
Arsenic	81.7	2.04×10^{-4}
Barium	8449	3.5×10^{-2}
Cadmium	1.16	5.88×10^{-5}
Chromium	269	2.49×10^{-2}
Lead	460	5.88×10^{-5}
Mercury	3.03	2.0×10^{-4}
Selenium	Not detected	2.3×10^{-4}
Silver	0.595	5.88×10^{-5}
TPH C6-C36	4880	7.70
Chloride*	2120	166
* Water soluble only for Untreated Material		

Drilling Waste

An Example of SESI's Firmus® Process

PRTC Road Before the Firmus® Process

PRTC Road After the Firmus® Process

Drilling Waste

References

1 ICF Consulting. (May 2000). "Overview of Exploration and Production Waste Volumes and Waste Management Practices in the United States." *The American Petroleum Institute,* 22.

2 "U.S. Well Starts by Depth Range, January 2008 to December 2008." (2008). *Rig Data.*

3 "U.S. Well Starts by Depth Range, January 2009 to December 2009." (2009). *Rig Data.*

4 "Summary of June 2009 Amendments to Minor Permit Guidelines for Landfarming and Landtreatment of Water Base Mud and Cuttings and Oily Waste Exempt from RCRA." Guidelines for Processing Minor Permits Associated with Statewide Rule 8. (December 2009). Guidelines Developed by Technical Permitting in Coordination with Field Operation. *Guidelines for Processing Minor Permits.*

5 "Environmental Guidance Document: Waste Management in Exploration and Production Operations." (February 1997). API E5 (2nd ed.) *American Petroleum Institute,* 31-33.

Drilling Waste

QUESTIONS?

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