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# **Oil and Gas Exploration and Production Waste Management**

## **Survey Report**

**March 2015**

**Prepared by the**

**Beneficial Use Task Force of the  
ASTSWMO Materials Management Subcommittee**

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## ACKNOWLEDGEMENTS

The ASTSWMO Beneficial Use Task Force of the Materials Management Subcommittee thanks all those who helped complete this Oil and Gas Exploration and Production (E&P) Waste Management survey. Without their cooperation, this report would not be possible. The Task Force takes full responsibility for the information and conclusions presented in this report.

Information from this survey has provided a better understanding of how individual States manage the disposal and beneficial use of E&P wastes. The Task Force will use this information to assist States in their approach to E&P waste management.

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## TABLE OF CONTENTS

Title	Page
I. Introduction .....	4
a. Background .....	4
b. BUTF Survey Scope .....	4
c. Survey Waste Categories .....	5
II. Regulation of E&P Wastes By States.....	6
III. Management of Disposal of Oil and Gas E&P Wastes By States .....	8
a. Definitions of Petroleum E&P Waste.....	8
b. Relative Quantities of Waste Generated .....	9
c. Methods of Disposal and Supporting Criteria.....	10
d. Limitations on Disposal – Processing or Analytical Requirements .....	14
IV. Management of Radiological Constituents in E&P Wastes by States.....	17
V. Management of Beneficial Use of E&P Wastes By States .....	18
a. Approved Beneficial Uses by Waste Type .....	18
b. Disapproved Beneficial Uses.....	19
VI. Conclusions and Recommendations for Action.....	21
a. Recommendations for Additional Study of Waste Management of TENORM Impacted E&P Waste .....	21
b. Recommendations for the Additional Study of Beneficial Uses of High Volume E&P Wastes .....	21

## **I. INTRODUCTION**

The Beneficial Use Task Force (BUTF) of the Materials Management Subcommittee of ASTSWMO undertook the task to survey the States and Territories (States) regarding management of exploration and production wastes (E&P wastes) from development of oil and gas resources in the United States. The reason for this project is the significant increase in domestic oil and gas E&P activities due to technological advancements, which has resulted in a significant increase in the volume of waste that is being generated.

### **a. Background**

Domestic oil and gas resources have been developed since the nineteenth century, and technology has evolved for drilling, fracturing (“fracking”), extraction, transport of crude oil or unprocessed gas for further refinement, and management of waste streams generated by these activities. New techniques of horizontal drilling and fracturing, allowing the extraction of gas and oil from previously inaccessible geologic formations, have led to a resurgence of petroleum and natural gas extraction in the U.S., both from areas where oil and gas-bearing formations had “played out”, i.e., become unprofitable to develop, and in formations that had not been technologically accessible.

Producers have conducted fracturing of oil and gas-bearing rock formations in the past to increase the yield of new wells, or reinvigorate older wells, by means of explosives or injection of fluids (air or water) at high pressure. However, newer methods, popularly termed “fracking”, combine horizontal drilling and the fracturing to allow for development of much lower permeability rock formations such as shale. These methods use higher volumes of fracturing fluid, with chemical additives and a proppant (usually sand), to create and hold open permeable fractures in the petroleum-bearing rock.

The increased amount of oil and gas development in the U.S., and increased use of the high-volume fracking techniques, has raised many regulatory challenges for the States, including challenges related to permitting, riparian rights, air quality, transport and safety concerns, mineral rights, and waste management, particularly in States where oil and gas exploration and development have not previously occurred or have been dormant. The increased number of development sites, and the higher volumes of waste generated, pose a special challenge for the proper management of these wastes, whether by disposal (with or without treatment) or beneficial use.

### **b. BUTF Survey Scope**

Based on these issues, starting in 2013, the BUTF surveyed the States on the challenges associated with E&P waste management, and how States are managing these challenges. The survey was sent to State solid waste programs, which are within ASTSWMO’s membership. For some States, the BUTF received input from additional programs or agencies with responsibility for managing oil and gas E&P waste. It is the BUTF’s hope that the results of this survey may provide helpful information to individual States and the U.S. Environmental Protection Agency (EPA).

The questions in this survey were developed by the BUTF to cover various aspects of E&P waste management. This report provides a summary and discussion of answers to the various questions posed to States. Forty States ultimately responded to the survey, which opened on September 10, 2013 and

closed on December 6, 2013, with additional follow-up in early 2014 to States that did not respond to the survey before, with the final date for response being March 7, 2014.

The survey scope included the following:

- State regulatory schemes and agencies involved
- State definitions of E&P waste
- Relative quantities of various wastes generated
- Management of disposal methods and limitations on disposal
- Management of radiological constituents
- Management of beneficial use

**c. Survey Waste Categories**

The survey posed questions regarding the regulation of several waste-related activities, including Beneficial Use, Drilling Permits, Generation Records of Waste, Storage or Processing of Waste, Waste Generated at a Production Facility, Transportation of Waste, and Disposal of Waste.

The waste disposal option was further subdivided into waste types, including Drill Cuttings, Produced Water, Oil-Based Drilling Fluid, Water-Based Drilling Fluid, Spent Fracking Fluid, Basic Sediment, Servicing Fluid, and Other. These streams, for purposes of this survey, are understood to include the following materials:

**Drill Cuttings:** Chips of rock cut by the drill bit and brought to the surface by the drilling fluid, including surface-hole gravel.

**Produced Water:** Natural salt water from oil- or gas-bearing rock formations, separated at oil and gas wells.

**Oil-Based Drilling Fluid:** Petroleum-based drilling mud or other drilling fluids other than fracking fluid and spent lubricant.

**Water-Based Drilling Fluid:** Aqueous-based drilling mud or other drilling fluids other than fracking fluid and spent lubricant.

**Spent Fracking Fluid:** The flow-back mixture of fracturing fluid and fracturing sand (proppant); this fluid is typically of different composition than drilling fluid since it must convey significant amounts of proppant into the fractures formed in low-permeability rock under high pressures.

**Basic Sediment:** Oil and gas production storage impurities, particularly sediment from produced oil collected from storage tanks.

**Servicing Fluid:** Oil and gas production well maintenance/work-over fluids

**Other:** Other wastes generated, such as waste generated from "pigging" pipes; or sediment/sludge from the treatment of spent fracking, production or drilling fluids. Survey responders were asked to specify waste streams in this category in a comment box.

## **II. REGULATION OF E&P WASTES BY STATES**

The opening questions of the survey asked whether States A) generate, and/or B) regulate, oil and gas E&P wastes. Of the 40 States that supplied a response to the survey, 27 reported yes to this question of waste generation with 13 responding no. Thirty-one (31) reported that yes their State does regulate E&P wastes with nine reporting that they do not. It is not clear from this question if the nine that indicated they do not regulate E&P wastes were speaking for their individual agencies or the State as a whole. According to the survey, an overwhelming majority of States which regulate oil and gas E&P waste also generate it; the scenario of non-generating States regulating the treatment and/or disposal of E&P waste from out of State was confirmed in only two instances. However, some respondents in States that currently neither generate nor regulate E&P wastes caveated their response by indicating that if such wastes were transported into their State, the State would regulate it under existing applicable rules and/or statutes.

Oil and gas activities are regulated in various ways among the States. Regulatory entities may include the States' environmental control department (including solid waste program or water quality program), a separate oil and gas regulatory department or program (program may be within the environmental control department, natural resources department, or a separate oil and gas department), and a very few cases, the State department of transportation or radiation program. Since the focus of this survey is on waste management, other State departments involved in oil and gas regulation, such as revenue, are not included in the results.

The jurisdiction for various oil and gas activities among States differs. Of the 29 States that responded to questions about regulatory jurisdiction, 16 States (55%) reported oil and gas regulation in multiple departments, 7 States (24%) reported oil and gas regulation by multiple programs within one department, and 6 States (21%) reported that only one program is responsible for oil and gas regulation.

For the purpose of analyzing the results, State Programs were classified into the following: 1) State Solid Waste Program (SW); 2) State Water Quality Program (Water); 3) State Oil and Gas Program (O&G); 4) State Department of Transportation (DOT); and 5) State Radiation Program (RAD). Since States do have various organization structures, it was sometimes difficult to determine the scope of some programs, due to the name of the program. Table 1a shows the results of regulatory jurisdiction over various E&P waste management activities, and Table 1b shows the results of waste disposal jurisdiction over various waste types.

**Table 1a – Oil and Gas Regulatory Jurisdiction for E&P Waste Management Activities**

Activity	States Reporting	Regulatory Agency with Jurisdiction					Split*
		SW	Water	O&G	DOT		
Beneficial Use	24	13	1	4	0	6	
		54%	4%	17%	0%	25%	
Drilling Permits	26	2	0	24	0	0	
		8%	0%	92%	0%	0%	
Generation Records of Waste	21	5	0	11	0	5	
		24%	0%	52%	0%	24%	
Storage or Processing of Waste	24	7	1	14	0	2	
		29%	4%	58%	0%	8%	
Waste Generation at Production Facility	21	14	0	4	0	3	
		67%	0%	19%	0%	14%	
Transportation of Waste	20	8	1	6	4	1	
		40%	5%	30%	20%	5%	
Waste Disposal**	27	5	0	3	0	19	
		19%	0%	11%	0%	70%	

\*More than one agency has jurisdiction in State  
 \*\* 10 States reported that waste disposal jurisdiction is different for disposal on-pad (on-lease) versus off-pad

**Table 1b – Oil and Gas Regulatory Jurisdiction for Various E&P Waste Disposal Categories**

Waste Type	States Reporting	Regulatory Agency with Jurisdiction						On-Pad**
		SW	Water	O&G	Rad	Split*		
Drill Cuttings	24	9	0	5	0	10	6	
		38%	0%	21%	0%	42%		
Produced Water	25	4	3	8	0	10	4	
		16%	12%	32%	0%	40%		
Drilling Fluid – Oil Based	23	5	0	6	0	12	5	
		22%	0%	26%	0%	52%		
Drilling Fluid – Water Based	25	6	3	6	0	10	5	
		24%	12%	24%	0%	40%		
Spent Fracking Fluid	24	5	4	6	0	9	5	
		21%	17%	25%	0%	38%		
Basic Sediment	24	7	0	5	0	12	6	
		29%	0%	21%	0%	50%		
Servicing Fluid	23	6	0	6	0	11	6	
		26%	0%	26%	0%	48%		
Other	22	6	1	6	1	8	4	
		27%	5%	27%	5%	36%		

\*More than one agency has jurisdiction in State  
 \*\*Jurisdiction over activity is different for on-pad (on-lease) disposal versus off-pad disposal

The following generalizations can be drawn from the results: 1) Regulatory structures for oil and gas activities vary significantly across the States; 2) For waste disposal, more often than not, multiple agencies or programs have jurisdiction over disposal of wastes. Furthermore, this jurisdiction changes for waste disposal activities on a well pad or lease, versus off of the drill pad. In such cases, the jurisdiction for regulatory activities on the drill pad is normally held by the State oil and gas regulatory agency, and off-site normally by the State's environmental control department.

### **III. MANAGEMENT OF DISPOSAL OF OIL AND GAS E&P WASTES BY STATES**

#### **a. Definitions of Petroleum E&P Waste**

The survey requested information on State definitions of E&P waste. The question was intended to cover solid wastes generated by E&P activities (e.g., cuttings, spent fluids or brine, as defined in Section I). However, a few States provided definitions of E&P waste which pertained to loss of excess or unused oil and gas resources, which is known in the oil and gas industry as "physical waste". The BUTF did not foresee this interpretation at the time that the survey questions were prepared, but is now aware that this question may need to be clarified in any future surveys or questions. For the purposes of this survey, the BUTF focused on responses specific to solid waste, as opposed to physical waste.

A total of 18 States provided responses to the request for State definitions of E&P waste. Several States have a stand-alone definition of E&P waste (or Exploration and Production Waste, or Drilling Waste); while for others, E&P wastes are included under definitions of waste categories such as residual waste, special waste, or exempt waste. Several States without a specific regulatory definition of E&P wastes adopt the federal hazardous waste rules, which include the exclusion from Subtitle C under 40 CFR 261.4(b)(5).

#### **State Interpretations of 40 CFR 261.4(b)(5) – Exclusion of E&P Waste from RCRA Subtitle C Definition of Hazardous Waste**

Oil, gas, and geothermal wastes are excluded from the definition of hazardous waste. States have implemented this by either regulating these wastes as solid waste within their State, or exempting these wastes from solid waste regulation entirely, or some combination of the two, depending on what type of E&P waste has been generated.

#### **Oil and Gas E&P Wastes and Materials Generated from E&P Wastes that are Not Solid Waste:**

Of the 20 States that responded to this question, 7 States (35%) reported having specific materials generated from E&P wastes that are not considered solid waste. For one State, all E&P wastes are not considered solid waste. Another State specifies that exploration and production wastes are not solid waste except as such wastes may be deposited at a commercial solid waste facility or recycling site and facility. One State lists materials not considered solid waste as drill cuttings not in contact with refined oil-based materials. Still another State lists those E&P wastes not considered solid waste as liquids, hazardous waste or materials that do not exceed ten times the State's maximum contaminant level (MCL) by the Toxicity Characteristic Leaching Procedure (TCLP). One State adopted the federal exclusion from the definition of hazardous waste for oil and gas E&P waste.



One State, while considering E&P wastes a solid waste, could exempt them from permitting requirements when approved for beneficial use.

**Oil and Gas E&P Wastes and Materials Generated from E&P Wastes that are Exempt as Solid Waste:**

The BUTF’s intent with this question was to determine whether there are certain waste streams that are exempt from some solid waste requirements, such as separate requirements if a waste stream is managed on the drill site versus off of the drill site (as indicated in Tables 1a and 1b). Of the 20 States that responded to this question, 8 States (40%) reported managing E&P wastes as exempt as solid waste. Some of the E&P waste materials managed as exempt as solid waste include E&P waste taken to a commercial recycling facility that is processed/treated to meet industry reuse specifications or discharge standards, and uncontaminated drill cuttings buried on a well site. One State exempts these wastes from being regulated as “industrial” waste. Two States exempt them as solid waste because of the 40 CFR 261.4 exemption. One State exempts drilling fluids, produced wastes, and other wastes associated with the exploration, development, or production of crude oil, natural gas, or geothermal energy because they are covered by oil and gas regulations.

The BUTF notes that this question could have been better written, to avoid some misunderstanding of its intent, but examples given by States do highlight differences in how some States regulate portions of this waste stream.

**b. Relative Quantities of Waste Generated**

Of the 40 State agencies responding, 16 reported that their State generates high volumes of waste from oil and gas exploration and production activities. While the BUTF purposefully did not define “high volume” in this survey question, “high volume” was intended by the BUTF to reflect quantities of solids or liquids from drilling and production that would pose special challenges for waste management, stretching existing resources for treating or disposing of these materials. The results are summarized in Table 2 by waste type.

**Table 2: High Volume Oil and Gas E&P Waste Streams Reported by States**

Type of Waste	Number of Agencies Reporting
Drill cuttings	13
Produced water	14
Drilling fluid waste – oil based	6
Drilling fluid waste – water based	12
Spent fracking fluid waste	7
Basic sediment	5
Servicing fluid	7
Other	2

### c. Methods of Disposal and Supporting Criteria

Although beneficial use of oil and gas drilling and production wastes has been approved and conducted in some States, as discussed further in this report, the survey confirmed that most E&P wastes in the U.S. are subject to disposal by various means.

The BUTF sought to determine methods by which States are allowing the disposal of various types of drilling waste. (See Section I categories of E&P wastes identified in the survey.) Of the 40 States that responded to the survey, 22 States provided specific information on how wastes are disposed of in their State. Figures 1 through 8 show the frequency of various methods of oil and gas E&P waste disposal by responding States, for several waste streams. These categories of disposal methods included the following:

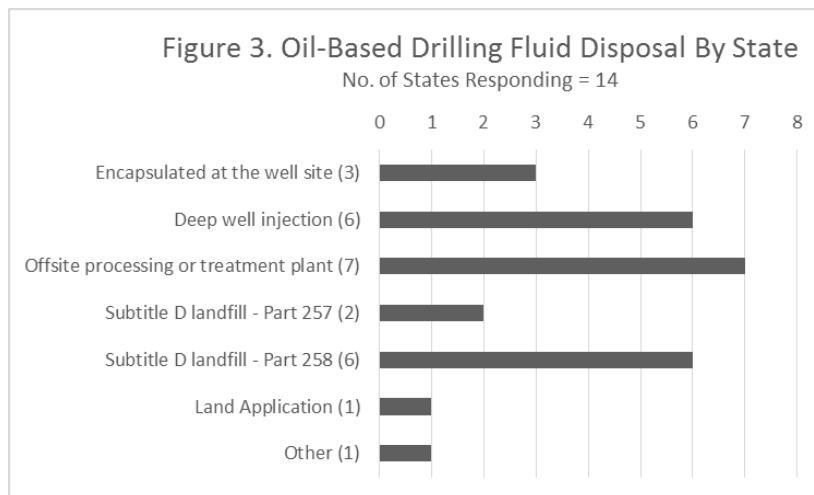
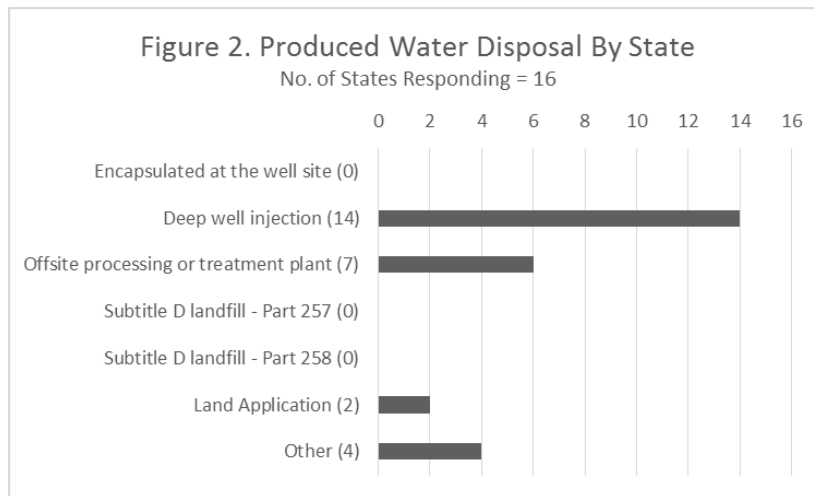
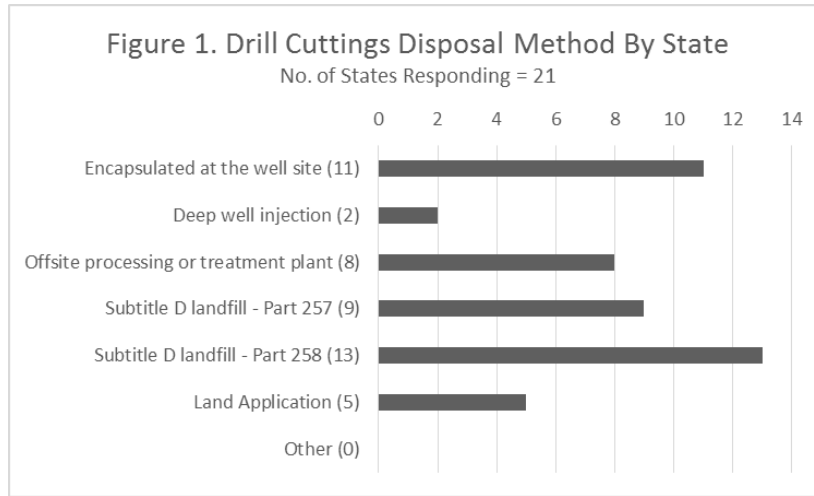
- Encapsulation at the well site (solidification and burial at well site)
- Deep well injection
- Off-site processing or treatment (public or private plant)
- Subtitle D Landfill – Part 257 (non-municipal landfill)
- Subtitle D Landfill – Part 258 (municipal solid waste landfill)
- Land Application
- Other (Disposal methods named by States as “Other” included sending wastes to out-of-State treatment or disposal facilities; recovery of petroleum or other useful constituents from wastes; thermal treatment; and road application. Road application could be considered a beneficial use).

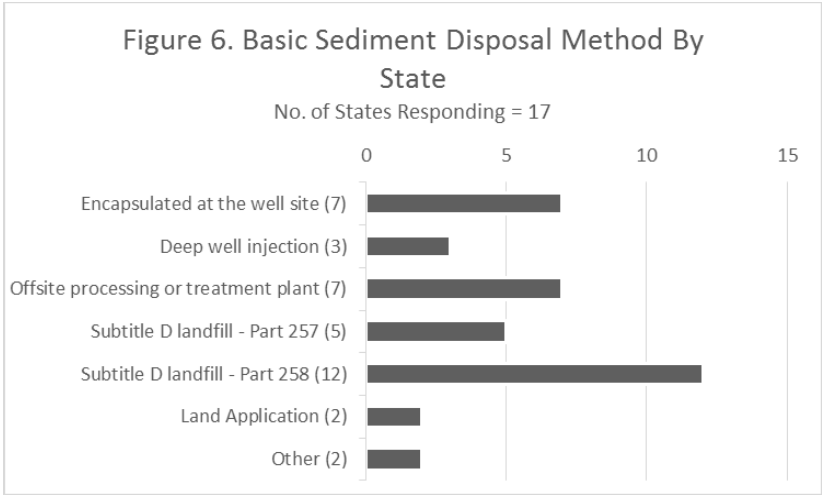
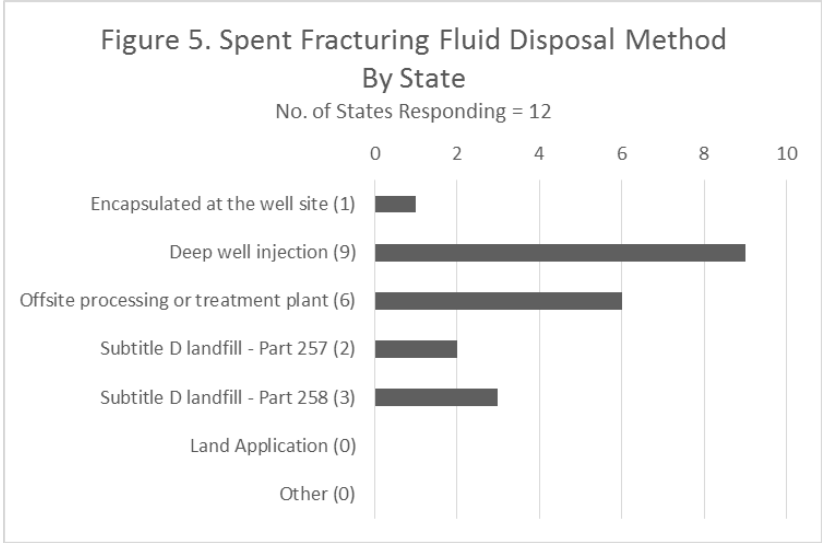
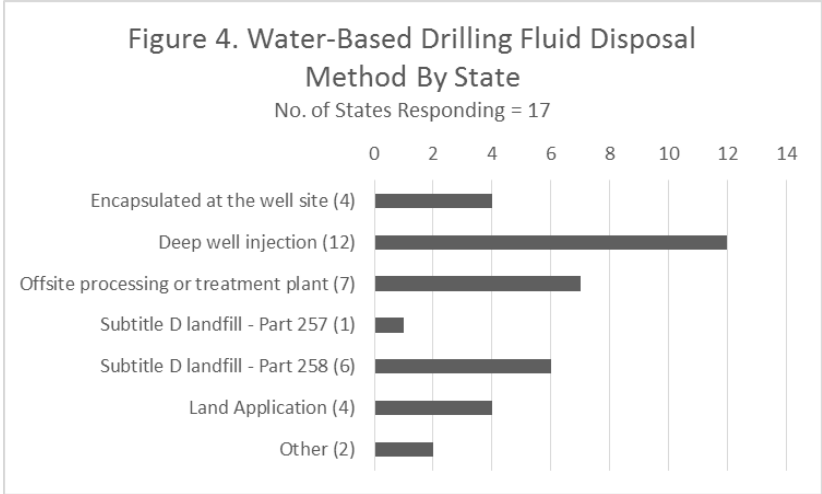
In many instances, States reported multiple disposal options for a given waste stream. A lesser number of States reported a single disposal method for each waste stream. In some instances, a State reported a disposal method or methods for one waste stream, but not for the other waste streams in the survey question.

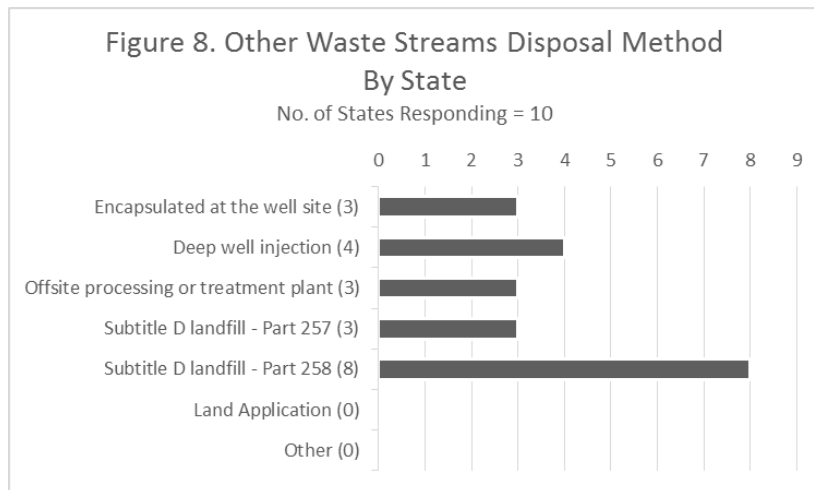
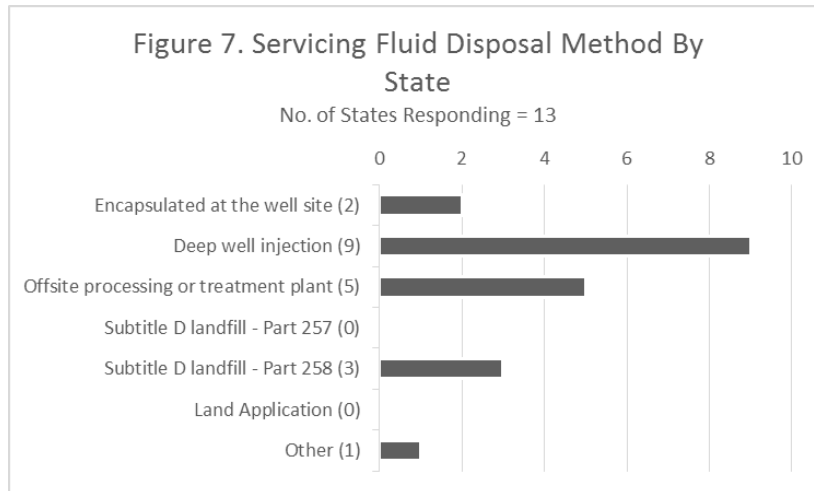
In reviewing the data for the survey questions related to disposal, it should be noted that States were not asked to report the *volume* of waste associated with each disposal option.

Figures 1 through 8 show the general trend that liquid waste streams, such as produced water, oil or water-based drilling fluid, and fracturing fluid, are more likely to be managed by deep well injection or off-site processing or treatment, while drill cuttings are more likely to be disposed by landfilling or encapsulation at the well site.

**Figures 1 to 8: Oil and Gas E&P Waste Disposal by State**







Some States provided additional information, clarifying their disposal requirements, including the following:

- Drilling mud shall be disposed of by either recycling or commercial off-site disposal.
- Solids can be managed through on-site disposal in a disposal pit which meets certain requirements, otherwise they may be sent off-site for disposal.
- Pigging waste is typically handled as hazardous waste and is not subject to the federal exclusion in 40 CFR 261.4(b)(5).
- Sludges from treatment plants for E&P waste are usually sent to RCRA Subtitle D landfills.
- Drill cuttings must meet inert waste definition and other requirements to be encapsulated at the well site.
- Disposal options depend on the characteristics of the waste/wastewater.

- Any liquids going to Subtitle D landfills require solidification.
- All liquid waste must pass the paint filter test before disposal in a Subtitle D landfill.
- Fluids can be land applied on-site if they meet the State groundwater standards and other requirements, or sent off-site for disposal.
- Certain water-based mud may be disposed of by evaporation and subsequent leveling of the pits, subject to additional specific requirements.

**d. Limitations on Disposal – Processing or Analytical Requirements**

The BUTF also inquired whether States limit disposal of E&P wastes by either requiring solidification prior to disposal, or limiting disposal based on analytical results.

The BUTF asked whether States require solidification for any method of disposal. Table 3 shows the results of this request, and shows that solidification is required most often for drill cuttings prior to disposal, versus other waste streams.

**Table 3 – Solidification Requirements for Disposal**

Waste Stream	Solidification Required?		Number of States Responding
	Yes	No	
Drill Cuttings	11	7	18
Produced Water	1	5	6
Drilling Fluid – Oil-Based	2	9	11
Drilling Fluid – Water-Based	3	7	10
Spent Fracturing Fluid	0	4	4
Basic Sediment	3	5	8
Servicing Fluid	2	4	6
Other Waste	1	1	2

States were asked whether disposal is limited based on analytical parameters, and if so, which parameters. Analytical parameters which were included in this question include heavy metals, petroleum hydrocarbons, radiological parameters and/or general chemistry (pH, oil & grease, alkalinity, total solids, etc.)

Of the forty States who responded to the survey, 18 indicate they do limit disposal options based on results of testing for these and/or other parameters. With two exceptions, these were all States who indicated they generate E&P wastes.

Tables 4a through 4g indicate the number of States that limit disposal for various disposal methods based on analytical results. The results in each table include each of the waste streams that were the focus of this survey. A review of these results indicates that, in general, more States limit disposal based on analytical parameters for land disposal or off-site processing than for other disposal methods.

Furthermore, analytical limitations were more often cited for drill cuttings disposal, versus other waste streams.

**Tables 4a – 4g: Analytical Requirements for E&P Waste Streams (By Number of States)**

**Table 4a – Analytical Requirements: Disposal by Encapsulation at the Well Site**

Waste Stream	Metals	Organic Chemicals	General Chemistry	pH	Radiological	Other
Drill Cuttings	4	2	5	3	2	0
Produced Water	0	0	0	0	0	0
Drilling Fluid – Oil-Based	0	0	0	0	1	1
Drilling Fluid – Water-Based	0	0	0	0	0	0
Spent Fracking Fluid	0	0	0	0	0	0
Basic Sediment	1	1	1	1	1	0
Servicing Fluid	0	0	0	0	0	0
Other Waste	0	0	0	0	0	0

**Table 4b – Analytical Requirements: Disposal by Deep Well Injection**

Waste Stream	Metals	Organic Chemicals	General Chemistry	pH	Radiological	Other
Drill Cuttings	1	1	1	1	2	0
Produced Water	2	2	2	2	1	0
Drilling Fluid – Oil-Based	1	1	2	2	1	0
Drilling Fluid – Water-Based	1	0	1	1	0	0
Spent Fracturing Fluid	1	1	1	1	1	0
Basic Sediment	1	0	1	1	0	0
Servicing Fluid	1	1	1	1	1	0
Other Waste	1	1	1	1	1	0

**Table 4c – Analytical Requirements: Disposal by Off-site Processing or Treatment**

Waste Stream	Metals	Organic Chemicals	General Chemistry	pH	Radiological	Other
Drill Cuttings	7	5	6	6	7	0
Produced Water	3	3	3	4	3	0
Drilling Fluid – Oil-Based	4	5	4	5	5	0
Drilling Fluid – Water-Based	4	4	5	5	5	1
Spent Fracturing Fluid	3	4	3	4	2	0
Basic Sediment	5	3	4	4	3	1
Servicing Fluid	4	4	3	4	3	0
Other Waste	2	2	2	2	1	0

**Table 4d – Analytical Requirements: Disposal at Subtitle D Landfill – Part 257**

Waste Stream	Metals	Organic Chemicals	General Chemistry	pH	Radiological	Other
Drill Cuttings	7	5	5	7	5	2
Produced Water	0	0	0	0	0	0
Drilling Fluid – Oil-Based	2	2	2	2	3	0
Drilling Fluid – Water-Based	2	2	2	2	3	0
Spent Fracking Fluid	1	1	1	1	2	0
Basic Sediment	3	3	3	3	4	0
Servicing Fluid	1	1	2	1	1	0
Other Waste	1	1	1	1	1	1

**Table 4e – Analytical Requirements: Disposal at Subtitle D Landfill – Part 258**

Waste Stream	Metals	Organic Chemicals	General Chemistry	pH	Radiological	Other
Drill Cuttings	7	6	6	10	8	1
Produced Water	0	0	0	0	0	0
Drilling Fluid – Oil-Based	3	2	3	4	3	1
Drilling Fluid – Water-Based	4	3	5	4	4	1
Spent Fracturing Fluid	1	1	1	1	1	0
Basic Sediment	6	5	7	6	4	0
Servicing Fluid	2	2	2	2	2	0
Other Waste	1	2	1	2	1	0



**Table 4f – Analytical Requirements: Disposal by Land Application**

Waste Stream	Metals	Organic Chemicals	General Chemistry	pH	Radiological	Other
Drill Cuttings	6	4	6	6	5	0
Produced Water	2	0	2	1	0	0
Drilling Fluid – Oil-Based	2	1	2	2	1	1
Drilling Fluid – Water-Based	1	1	1	1	1	1
Spent Fracturing Fluid	0	0	0	0	0	0
Basic Sediment	3	2	2	3	1	1
Servicing Fluid	1	1	1	1	1	0
Other Waste	0	0	0	0	0	0

**Table 4g – Analytical Requirements: Disposal by Other\***

Waste Stream	Metals	Organic Chemicals	General Chemistry	pH	Radiological	Other
Drill Cuttings	0	0	1	1	2	0
Produced Water	0	0	0	0	1	0
Drilling Fluid – Oil-Based	0	0	0	0	0	0
Drilling Fluid – Water-Based	0	0	0	0	0	0
Spent Fracturing Fluid	0	0	0	0	0	0
Basic Sediment	1	0	0	0	0	0
Servicing Fluid	0	0	0	1	1	0
Other Waste	0	0	0	0	0	0

\*Disposal methods named by States as “Other” included sending wastes to out-of-State treatment or disposal facilities; recovery of petroleum or other useful constituents from wastes; thermal treatment; and road application (potentially a mode of beneficial use).

#### **IV. MANAGEMENT OF RADIOLOGICAL CONSTITUENTS IN E&P WASTES BY STATES**

A unique element of petroleum E&P wastes is the potential presence of naturally-occurring radioactive material (NORM). When concentrated through the handling of extracted petroleum products or the handling of wastes, radiological constituents become Technologically-Enhanced NORM (TENORM). Examples of TENORM in gas and oil production include pipe scale from condensed moisture in pipes conveying gas from production wells. In some jurisdictions, TENORM may trigger regulatory requirements that NORM does not.

Twelve of the 38 States who responded to the survey questions about radiological testing listed maximum limits of radiological parameters for disposal in RCRA Subtitle D landfills. Five of these twelve States reported maximum limits to be used for beneficial use of E&P waste. A few States remarked that while they had not promulgated any specific concentration or activity limit for NORM or TENORM, they evaluated the impact of disposal or beneficial use of these materials on a case-by-case basis considering the volume of material and mass or activity loading of radiological constituents to the site, including cumulative contribution to the site (in particular, a Subtitle C or D landfill).

The most frequent activity concentration reported in the survey was 5 picocuries per gram (pCi/g) above background levels of radiation, with two States citing 30 pCi/g and three States, 50 pCi/g. Typically radium-226 is specified as the isotope of concern, but one State mentioned a separate, higher allowable limit for uranium.

## **V. MANAGEMENT OF BENEFICIAL USE OF E&P WASTES BY STATES**

Beneficial use or recycling of various E&P wastes is an option that generators have proposed, and that States have had the opportunity to review. The BUTF anticipates that there will be an increased amount of proposals for beneficial uses of certain E&P wastes, since the increasing volume of waste generated is creating challenges related to disposal. The BUTF chose to focus on learning more about which beneficial uses have been proposed and have either been approved or denied by States.

The advantages of beneficial use, if safe, include providing an effective substitute for a virgin or conventional material, reducing space needed for disposal, conserving energy that would otherwise be needed to mine or create conventional materials, and realization of cost savings for both procuring conventional materials and avoiding disposal of the drilling waste.

Thirteen States reported approving beneficial uses, or reuse or recycling of oil and gas E&P wastes, while eleven States indicated that they had not approved these activities.

### **a. Approved Beneficial Uses by Waste Type**

**Drill Cuttings:** Nine States approved beneficial use or recycling of this waste stream with the following uses:

- On-site well pad maintenance
- Landfill cover
- Manufacture of concrete (Jersey) barriers
- On-site and off-site grade adjustment
- Use to make asphalt at well sites and brownfield sites
- Road base application

**Produced Water:** Eight States approved beneficial use or recycling of this waste stream with the following uses:

- Make-up water for new well drilling
- Recycled as fracturing liquid /reused in downhole operations

- Road de-icing
- Dust Suppressant

**Drilling Fluids – Oil Based:** Three States approved beneficial use or recycling of this waste stream with the following uses:

- Use as road base
- Reuse as drilling fluid

**Drilling Fluids – Water Based:** Five States approved beneficial use or recycling of this waste stream with the following uses:

- Recycled as fracturing liquid
- Use in concrete

**Spent Hydraulic Fracturing Fluid:** Four States approved beneficial use or recycling of this waste stream with the following use:

- Reuse at other drilling sites to formulate fracturing fluid

**Basic Sediment:** Two States approved beneficial use or recycling of this waste stream with the following use:

- Road application

**Servicing Fluid:** Two States approved beneficial use or recycling of this waste stream with the following use:

- Reuse for same purpose at another well

**Other Wastes:** One State approved beneficial use or recycling of other wastes not identified in this survey with the following use:

- Oil-based pigging wastes are often reprocessed by operators

**b. Disapproved Beneficial Uses**

The BUTF also queried whether States had *rejected or disapproved* specific E&P waste streams for beneficial use, and why these proposals were rejected. Twenty-three States responded to this question, with 11 States responding that they had rejected beneficial uses, along with what was disapproved and why.

**Land Application:** States reported denying land application of several types of E&P waste; however, most frequently this involved liquid wastes such as produced waters or spent fluids. States reported denying land application requests for some beneficial purpose (e.g., dust suppression in the case of liquid wastes, or as fill in the case of solid wastes). The reasons cited by States included:

- Excess total dissolved solids
- Excess salt content
- High concentrations of potentially harmful metals or organic compounds

The potential impact on soil quality, ground water, and nearby surface water was noted by some States. One State noted it uses the metal concentration limits for hazardous waste in the Toxicity Characteristic Leaching Procedure (TCLP) as a basis for rejecting land or road application or other beneficial use of E&P wastes.

**Application to Roadways:** For application of liquid E&P wastes to roadways for de-icing, States reported denying proposed applications due to one or more of the following reasons:

- Two States noted that they have minimum concentrations of beneficial salt constituents, such as sodium and calcium chloride, which were not met in some cases.
- The same States require that harmful, non-beneficial constituents such as sulfates, oil and grease, or barium must not exceed certain maximum concentrations.

Additional limitations reported on application of E&P wastes to roadways include the following:

- One State, which allows produced water use for roadway de-icing and dust suppression, disallows the use of flowback and drilling fluids for similar application to roads.
- Two States mentioned NORM as a concern leading to restriction of certain uses where radiological constituents exceeded action limits at receiving sites or could accumulate to exceed limits, e.g., through repeated applications of production water to a road or land area.

**Use as Fill Material:** Drill cuttings, which are the most frequently-identified E&P waste stream considered for beneficial use, were noted as being rejected at times for use as construction fill or for mine reclamation. The reasons given include the following:

- Excessive salts, oil and grease, organic compounds or metals that exceed background or risk-based concentrations.
- Radiological constituents similarly posed concern in cuttings used as fill as they do for some uses of produced waters.

**Other Denied Beneficial Uses:**

- One State mentioned the issue of the grain size distribution of typical cuttings being unsuitable for use of cuttings in place of conventional aggregate in asphalt pavement and in Portland cement concrete, which resulted in denial of proposed beneficial uses in the State.
- Excessive total petroleum hydrocarbons was noted by one State as the basis for rejecting use of cuttings as alternate daily cover in a landfill – consistent with this State’s position that cuttings can be disposed in any landfill unless they contain excess crude oil.

## **VI. CONCLUSIONS AND RECOMMENDATIONS FOR ACTION**

This survey supports the conclusion that significant challenges exist for disposal and beneficial use of E&P wastes. Reuse of fluids for well drilling and development purposes, and on-site disposal of wastes, is practiced but can address only a limited quantity of waste generated. Technologies to specifically treat E&P wastes through the destruction of potentially harmful constituents where feasible, or removal and concentration of these to reduce their volume, with solidification or chemical stabilization for landfill disposal, may permit a wider use of treated solid materials; for example, cuttings to replace commercial fill or aggregate, or liquids such as produced water to replace brine.

### **a. Recommendations for Additional Study of Waste Management of TENORM Impacted E&P Waste**

The resurgence of oil and gas drilling in the U.S., and the potential for TENORM to be associated with certain E&P wastes, is an issue that needs additional analysis, as State approaches vary significantly. There does not appear to be any clear federal direction on this issue, as this issue falls outside of the scope of the Nuclear Regulatory Commission. Additional analysis of this issue is recommended.

### **b. Recommendations for the Additional Study of Beneficial Uses of High Volume E&P Wastes**

The BUTF anticipates that there will be an increased number of requests for beneficial reuse of various waste streams associated with E&P activities in the future, due to the limitations and costs associated with disposal of these waste streams. This survey did not go into depth regarding details of beneficial use, or limitations to beneficial use, of E&P wastes. The BUTF feels that value can be added by further exploring options for beneficial use of the highest volume E&P waste streams. Additional focused study of beneficial uses and limitations for the highest volume E&P wastes (Drill cuttings, Produced water, and Water-based drilling fluid/mud) is recommended.