# Compilation of Publicly Available Sources of Voluntary Management Practices for Oil and Gas Exploration & Production (E&P) Wastes As They Address Pits, Tanks, and Land Application

US Environmental Protection Agency
Office of Solid Waste and Emergency Response
Office of Resource Conservation and Recovery

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# Executive Summary

The Office of Resource Conservation and Recovery (ORCR) conducted a literature review/internet search of voluntary management practices for oil and gas exploration and production (E&P) wastes. This review did not include state regulations, which are addressed in a separate document titled "Review of State Oil and Natural Gas Exploration, Development, and Production (E&P) Solid Waste Management Regulations," or federal regulations, such as the Spill Prevention, Control, and Countermeasure rules. Rather, the focus of the review was on such voluntary practices as they address pits, tanks, and land application/disposal. Based on the results of the review, EPA agrees with the recommendation of the Shale Gas Production Subcommittee of the Secretary of Energy Advisory Board (SEAB) that the federal government should encourage the development of additional and improved "best practices." It should be noted that these voluntary management practices are typically referred to (by the organizations that develop them or those that use them) as "Best Management Practices" or "BMPs." However, in this document the use of the phrase "best management practices" is limited to the where the documents themselves use these terms, or otherwise where EPA is quoting another source, and is not intended to connote EPA approval of particular practices, nor any determination that such practices will protect human health and the environment.

The SEAB Shale Gas Production Subcommittee defines "best practices" as "improvements in techniques and methods that rely on measurement and field experience."[1] The Subcommittee favors a national approach including regional mechanisms that recognize differences in geology, land use, water resources, and regulation.[2] The Bureau of Land Management (BLM) of the U.S. Department of the Interior defines Best Management Practices (BMPs) as "state-of-the-art mitigation measures applied to oil and natural gas drilling and production to help ensure that energy development is conducted in an environmentally responsible manner." BLM also states that, "**BMPs should be matched and adapted to meet the site-specific requirements of the project and local environment.**"[3]

In August, 2012, ORCR conducted a literature review/internet search and developed a list of over 80 publicly available sources of voluntary management practices for oil and gas E&P wastes as they relate to pits, tanks, and land application/disposal. From this list, ORCR focused on 14 key sources that are currently widely used and developed summaries of the pit, tank, and land application-related voluntary management practices contained in the 14 selected sources. It is important to note that EPA did not evaluate the

[1] U.S. DOE, Secretary of Energy Advisory Board, *Shale Gas Production Subcommittee Second Ninety Day Report*, November 18, 2011, http://www.shalegas.energy.gov/resources/111811_final_report.pdf
[2] U.S. DOE, Secretary of Energy Advisory Board, *Shale Gas Production Subcommittee 90-Day Report*, August 18, 2011, http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf
[3] U.S. DOI Bureau of Land Management, BMPs website, http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices.html

adequacy or protectiveness of any of the voluntary management practices summarized in this document. Rather, the point of the review was to determine the range of voluntary management practices that are currently available, the extent to which such practices cover a broad cross-section of geographic conditions, and the source of such management practices.

Based on the review of existing voluntary management practices, ORCR determined that there is much existing guidance developed and being used by industry, federal, state, and non-governmental organizations. The scope ranges from local to state, regional, national, and international. The guidance documents/websites compiled in this review are readily available to the public. In addition, there are ongoing efforts by the various stakeholder groups to continuously develop additional guidances and improve existing ones.

**The literature search is current as of April 1, 2014. The website addresses are current as of April 1, 2014, but are subject to change.**

# 1. Introduction and Purpose of Review

The Office of Resource Conservation and Recovery (ORCR) conducted a literature review/internet search of voluntary management practices (also referred to in industry as "Best Management Practices," or "BMPs") for oil and gas exploration and production (E&P) wastes. The focus of the review was on such voluntary management practices as they address pits, tanks, and land application/disposal. This review did not include state regulations, which are addressed in a separate document titled "Review of State Oil and Natural Gas Exploration, Development, and Production (E&P) Solid Waste Management Regulations," or federal regulations, such as the Spill Prevention, Control, and Countermeasures rules. Based on the results of the review, EPA agrees with the recommendation of the Shale Gas Production Subcommittee of the Secretary of Energy Advisory Board (SEAB) that the federal government should encourage the development of additional and improved "best practices."

The SEAB Shale Gas Production Subcommittee defines "best practices" as "improvements in techniques and methods that rely on measurement and field experience."[4] The Subcommittee favors a national approach including regional mechanisms that recognize differences in geology, land use, water resources, and regulation.[5] The Bureau of Land Management (BLM) of the U.S. Department of the Interior defines BMPs as "state-of-the-art mitigation measures applied to oil and natural gas drilling and production to help ensure that energy development is conducted in an environmentally responsible manner." BLM also states that, "**BMPs should be matched and adapted to meet the site-specific requirements of the project and local environment.**"[6]

This report contains six sections covering the (1) introduction; (2) methodology; (3) a list of publicly available sources of voluntary management practices for oil and gas E&P wastes as they relate to pits, tanks, and land application/disposal; (4) a list of selected guidance documents or websites for further analysis; (5) summaries of the relevant practices in the selected guidances; and (6) our findings. It is important to note that EPA did not evaluate the adequacy or protectiveness of any of the voluntary management practices summarized in this document. Rather, the purpose of the review was to determine the range of voluntary management

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[4] U.S. DOE, Secretary of Energy Advisory Board, *Shale Gas Production Subcommittee Second Ninety Day Report*, November 18, 2011, http://www.shalegas.energy.gov/resources/111811_final_report.pdf
[5] U.S. DOE, Secretary of Energy Advisory Board, *Shale Gas Production Subcommittee 90-Day Report*, August 18, 2011, http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf
[6] U.S. DOI Bureau of Land Management, BMP website, http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices.html

practices that are currently available, the extent to which such practices cover a broad cross-section of geographic conditions; and the source of such practices.

The summaries in Section 5 contain the following information for each document:  sponsoring organization, document/website title, date of publication, website location, general description, and excerpts of the specific sections that concern pits, tanks, and/or land application.  Note that **the literature search is current as of April 1, 2014**; however, there are ongoing efforts to continuously develop additional voluntary management practices and improve existing ones.  **The website addresses are current as of April 1, 2014, but are subject to change.**

# 2. Methodology

**Step 1**

ORCR conducted a literature review/internet search and developed a list of publicly available sources of voluntary management practices for oil and gas exploration and production (E&P) wastes as they relate to pits, tanks, and land application/disposal. This information is presented in Section 3. Table 3-1 is a sampling of sources of voluntary management practices from industry, federal/state/local government, and non-governmental organizations. It is *not* intended to serve as a comprehensive list of voluntary management practices.

Eighty-two voluntary management practice documents and 3 website directories were identified, along with relevant background material. The management practices are organized by scope: National/International, State/Provincial, or Regional. Of the 82 documents, 23 are national in scope, 6 are international, 37 are state-wide, 2 apply to a Canadian province, and 14 are regional. The website directories consist of 1 national and 2 regional in scope.

ORCR has not assessed all of the documents/websites identified in Table 3-1. Rather, this list was intended to assist ORCR in determining which documents/websites to examine in further detail.

**Step 2**

From the Table 3-1 list of sources of voluntary management practices developed under Step 1, ORCR focused on 12 key documents and 2 website directories. Table 4-1 contains a list of the 14 items with descriptions of their contents. EPA chose to focus on the key documents and websites that are currently widely used. The selection also was intended to provide a sampling of national, state, and regional voluntary management practices that were developed by industry, federal, state, and non-governmental organizations. Of the 12 documents, 8 are national, 3 are state, and 1 is regional in scope. Of the 2 website directories, 1 is national and 1 is regional.

**Step 3**

ORCR developed summaries of the 14 selected voluntary management practices sources identified in Step 2. Section 5 contains the following information for each source: the sponsoring organization, document/website title, date of publication, website location, general description, and the specific sections that concern pits, tanks, and/or land application.

# 3. Sources of Voluntary Management Practices for Oil & Gas E&P Wastes

## Overview

- ORCR identified 85 publicly available sources of voluntary management practices for oil and gas E&P wastes, especially as related to wastewater pits, tanks and land application/disposal used in deep shale gas hydraulic fracturing.
- Table 3-1 is *not* intended to serve as a comprehensive list of voluntary management practices documents or website directories.
- This list is a sampling of sources of voluntary management practices from industry, federal, state, and non-governmental organizations.
- The primary selection criterion for inclusion in this list is the potential relevance to E&P wastewater pits, tanks, and land application/disposal.
- The list is organized by the scope of the management practices: National/International, State/Provincial, or Regional.
- Eighty-two voluntary management practices documents and 3 website directories are identified, along with relevant background material.
- The 82 documents consist of 23 national/6 international, 37 state/2 provincial, and 14 regional.
- The 3 website directories consist of 1 national and 2 regional.
- Thirteen of the sources were developed by industry, 6 by federal agencies, 39 by states or local governments, and 27 by non-governmental organizations.
- Fifty-nine of the sources apply to oil & gas E&P in general, and 26 apply specifically to hydraulic fracturing or shale gas development.
- ORCR has not assessed the documents identified on the list. This list was intended to assist ORCR in determining which documents/websites to examine in further detail.
- The subset of 14 key sources on which EPA focused (see Sections 4 and 5) are marked in **bold-type** in Table 3-1.
- Note: **The literature search is current as of April 1, 2014**, however, there are ongoing efforts to continuously develop additional and improve existing voluntary management practices. **The website addresses are current as of April 1, 2014, but are subject to change.**

It is important to note, as stated in BLM's BMP web site, that "**BMPs should be matched and adapted to meet the site-specific requirements of the project and local environment.**"[7]

[7] U.S. DOI Bureau of Land Management, BMP website, http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices.html

| Table 3-1. SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **WEB SITE** |
| ***NATIONAL/INTERNATIONAL SCOPE*** | | |
| American Petroleum Institute (API) | *Overview of Industry Guidance/Best Practices on Hydraulic Fracturing (HF)*, October 21, 2011 | http://www.api.org/policy/exploration/hydraulicfracturing/upload/Hydraulic_Fracturing_InfoSheet.pdf |
| | Presentation: *API Introduction and API HF Standards for the Oil and Natural Gas Industry,* presented to DOE SEAB Shale Gas Subcommittee, July 2011 | http://www.shalegas.energy.gov/resources/071311_api.pdf |
| | **API Guidance Document HF3: *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing*, January 2011** | http://www.shalegas.energy.gov/resources/HF3_e7.pdf |
| | **API Guidance Document HF2: *Water Management Associated with Hydraulic Fracturing*, June 2010** | http://www.shalegas.energy.gov/resources/HF2_e1.pdf |
| | **API Recommended Practice 51R: *Environmental Protection for Onshore Oil and Gas Production Operations and Leases*, July 2009** | http://www.shalegas.energy.gov/resources/51R_e1.pdf |
| | *Onshore Access to Oil and Natural Gas Resources,* 2009 | http://www.api.org/policy/exploration/upload/onshore_access_primer.pdf |
| | *Considering Good Neighbor Practices*, 2008 | http://www.api.org/policy/exploration/upload/Good_Neighbor_Guidelines.pdf |
| | **API G00004: *Guidelines for Commercial Exploration and Production Waste Management Facilities*, March 2001** | http://www.api.org/environment-health-and-safety/environmental-performance/environmental-stewardship/waste-management-facilities |
| | API E5: *Environmental Guidance Document: Waste Management in Exploration and Production Operations*, February 1997 | http://global.ihs.com/doc_detail.cfm?currency_code=USD&customer_id=21254E2B2C0A&oshid=21254E2B2B0A&shopping_cart_id=2925583F2A4A2028415A5D5F260A&rid=API1&input_doc_number=%20&country_code=US&lang_code=ENGL&item_s_key=00257647&item_key_date=021031&input_doc_number=E5&input_doc_title= |
| | *API 302: Waste Minimization in the Petroleum Industry: A Compendium of Practices, 1991* | http://global.ihs.com/doc_detail.cfm?currency_code=USD&customer_id=21254C2B2C0A&oshid=21254C2B2B0A&shopping_cart_id=2925583F2A4A204C4F5A2D33260A&rid=API1&input_doc_number=302&country_code=US&lang_code=ENGL&item_s_key=00137956&item_key_date=081231&input_doc_number=302&input_doc_title= |
| | Additional related standards, recommended practices and technical reports (includes design, inspection, maintenance, testing, repair of E&P equipment (e.g., tanks), specifications for E&P materials (e.g., drilling muds), remediation technologies, etc.) – See *Overview of Industry Guidance/Best Practices on Hydraulic* | http://www.api.org/Publications/ http://www.api.org/policy/exploration/hydraulicfracturing/upload/Hydraulic_Fracturing_InfoSheet.pdf |

| Table 3-1. SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **WEB SITE** |
| | *Fracturing (HF)*, October 21, 2011 | |
| Chesapeake Energy | *Best Management Practices* [Web-based] | http://www.chk.com/Operations/Best-Management-Practices/Pages/information.aspx |
| Earthworks - Oil & Gas Accountability Project (OGAP) | ***Best Practices Overview*** **(includes "Alternatives to Pits"** | http://www.earthworksaction.org/ogapbestprac.cfm |
| | *Oil and Gas at Your Door? A Landowner's Guide to Oil and Gas Development,* 2nd Edition 2005 | http://www.earthworksaction.org/library/detail/oil_and_gas_at_your_door_2005_edition/ |
| Houston Advanced Research Center - Environmentally Friendly Drilling Systems Program (EDF) | ***Hydraulic Fracturing BMPs*** **[Website Directory]** | http://efdsystems.org/index.php/best-management-practices |
| | Presentation:: *Environmentally Friendly Drilling*, presented to DOE SEAB Shale Gas Subcommittee, June 28, 2011 | http://www.shalegas.energy.gov/resources/062811_efd_presentation.pdf |
| | Article: *Best Practices Database Reduces Impact of Drilling, Production*, E&P Magazine, April 12, 2010 | http://www.netl.doe.gov/kmd/RPSEA_Project_Outreach/08122-35_HARC_Environmentally_Friendly_Drilling_article.pdf |
| Interstate Oil and Gas Compact Commission | *Adverse Impact Reduction Handbook: Reducing Onshore Natural Gas and Oil Exploration and Production Impacts Using a Broad-Based Stakeholder Approach*, 2008 | http://iogcc.myshopify.com/collections/frontpage/products/adverse-impact-reduction-handbook |
| | *A Guide to Practical Management of Produced Water from Onshore Oil & Gas Operations in the United States*, 2006 | http://iogcc.myshopify.com/collections/frontpage/products/a-guide-to-practical-management-of-produced-water-from-onshore-oil-gas-operations-in-the-united-states-2006 |
| Investor Environmental Health Network | *Extracting the Facts: An Investor Guide to Disclosing Risks from Hydraulic Fracturing Operations,* December 2011 | http://www.iehn.org/documents/frackguidance.pdf |
| | *Overview: Hydraulic Fracturing for Natural Gas and Oil Development,* 2014 | http://www.iehn.org/overview.naturalgashydraulicfracturing.php |
| U.S. DOE/NETL/ Argonne National Lab | Drilling Waste Management Information System (DWMIS) | http://web.ead.anl.gov/dwm/index.cfm |
| | *Drilling Waste Management Technology Identification Module* | http://web.ead.anl.gov/dwm/tim/index.cfm |
| | *Drilling Waste Management Technology Descriptions* | http://web.ead.anl.gov/dwm/techdesc/index.cfm |
| | *Fact Sheet – Onsite Burial* | http://web.ead.anl.gov/dwm/techdesc/burial/index.cfm |
| | *Fact Sheet – Land Application* | http://web.ead.anl.gov/dwm/techdesc/land/index.cfm |
| | *Fact Sheet – Commercial Disposal Facilities* | http://web.ead.anl.gov/dwm/techdesc/commercial/index.cfm |
| U.S. DOI | Presentation: *DOI Forum to Examine Best Practices for Hydraulic Fracturing in Oil and Natural Gas Production,* December 6, 2010 | https://www.youtube.com/watch?v=fsk4wydSBxE |

**Table 3-1. SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES**

| ORGANIZATION | DOCUMENT TITLE | WEB SITE |
|---|---|---|
| U.S. DOI/Bureau of Land Management (BLM) | ***The Gold Book: Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*, 4th edition revised 2007** | http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices.html%20 |
| | *BLM BMP Information Sheets*, August 30, 2004 | http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/bmps.Par.73748.File.dat/WO1_WO_BMPs_Technical_Information_Sheets.pdf |
| | BLM Field Reference Guide: *Visual Resource Management BMPs for Fluid Mineral*, June 2007 | http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/bmps.Par.72572.File.dat/Visual%20Resource%20Management%20for%20Fluid%20Minerals%20-%20Field%20Refer.pdf |
| | Presentation: *BLM Introduction to BMPs for Fluid Minerals*, May 2006 | http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/bmps.Par.37252.File.dat/WO1_Introduction_BMP_Slideshow.ppt#277,1,Slide%201.pdf |
| | Presentation: *BLM Management Practices for Fluid Minerals: Production Operations*, November 2006 | http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/technical_information.html |
| | Presentation: *Best Management Practices in BLM Planning, Leasing and Permitting,* BLM Northwest Colorado District, presented at NRDC workshop, Oct. 14, 2009 | http://www.oilandgasbmps.org/workshops/BMPcommunity2009/presentations/connell.ppt |
| | Presentation: *BLM Briefing to DOE SEAB Shale Gas Subcommittee*, May 19, 2011 | http://www.shalegas.energy.gov/presentations/blm_briefing_051911.pdf |
| U.S. DOI/Fish & Wildlife Service | *Management of Oil & Gas Activities on National Wildlife Refuge System Lands*, April 2012 | http://www.fws.gov/policy/ManagementofOilandGasActivitiesHandbook.pdf |
| U.S. DOI/National Park Service | ***Operators Handbook for Nonfederal Oil and Gas Development in Units of the National Park System*, October 2006** | http://www.nature.nps.gov/geology/oil_and_gas/op_handbook.cfm |
| University of Pittsburgh | *Shale Gas Roundtable: Deliberations, Findings, and Recommendations - Appendix E: Standards and Best Management Practices for Shale Oil and Gas Development,* August 2013 | http://www.iop.pitt.edu/shalegas/PDF/appendix-E.pdf Full Report: http://www.iop.pitt.edu/shalegas/PDF/90696%20SHALE%20GAS%20FULL%20REPORT-final.pdf |
| STRONGER (State Review of Oil and Natural Gas Environmental Regulations) | ***Guidelines for the Review of State Oil and Natural Gas Environmental Regulatory Programs (2010 Draft Revision)*** | http://www.strongerinc.org/ |

| Table 3-1. SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **WEB SITE** |
| Canadian Association of Petroleum Producers (CAPP) | Guiding Principles and Operating Practices for Hydraulic Fracturing, December 2012 | http://www.capp.ca/canadaIndustry/naturalGas/ShaleGas/Pages/Default.aspx#operating |
| Environmental Studies Research Funds [Canada] | *Considerations in Developing Oil and Gas Industry Best Practices in the North [Canada]*, April 2009 | http://www.esrfunds.org/pdf/175.pdf |
| E&P Forum/UNEP | E&P Forum (Oil Industry International Exploration and Production Forum)/UNEP (United Nations Environment Programme Industry and Environment Centre: *Joint E&P Forum/UNEP Technical Publication - Environmental Management in Oil and Gas Exploration and Production*, 1997 | http://www.ogp.org.uk/pubs/254.pdf |
| | The E&P Forum Report No. 2.58/196: *Exploration and Production Waste Management Guidelines*, Sept. 1993 | Contact the United Nations Environment Programme for copies: http://www.unep.org/ |
| International Energy Agency (IEA) | *Golden Rules for a Golden Age*, May 2012 | http://www.worldenergyoutlook.org/media/weowebsite/2012/goldenrules/WEO2012_GoldenRulesReport.pdf |
| International Finance Corp.-World Bank Group | Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development, April 30, 2007 | http://www1.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/sustainability+framework/environmental%2C+health%2C+and+safety+guidelines/ehsguidelines |
| ***STATE/PROVINCIAL SCOPE*** | | |
| State of CALIFORNIA | *Drilling and Operating Oil and Gas Wells in California*, 2002 | ftp://ftp.consrv.ca.gov/pub/oil/publications/pr6s.pdf |
| State of COLORADO | *Surface Owner Brochure: Oil and Gas Well Notification, Consultation, and Reclamation Rules – Information for Oil and Gas Operators, Surface Owners and Surface Tenants*, August 25, 2006 | http://cogcc.state.co.us/General/Surface%20Owners%20Brochure.pdf |
| State of ILLINOIS | *Best Management Practices for Oil Exploration and Extraction* | http://www.epa.state.il.us/p2/fact-sheets/bmp-oil-exploration.html |
| State of MARYLAND | *Maryland Marcellus Shale Safe Drilling Initiative Study Part II: Best Practices,* August 2013 Draft for Public Comment | http://www.mde.state.md.us/programs/Land/mining/marcellus/Pages/MSReportPartII_Draft_for_Public_Comment.aspx |
| University of MARYLAND Center for Environmental Science, Frostburg, MD | *Recommended Best Management Practices for Marcellus Shale Development in Maryland: Final Report Submitted to Maryland Dept. of the Environment,* February 18, 2013 | http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Eshleman_Elmore_Final_BMP_Report_22113_Red.pdf |

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|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **WEB SITE** |
| State of NEW MEXICO | *Oil and Gas Manual*, April 2011 | http://www.nmstatelands.org/Manual_Oil_and_Gas.aspx |
| | ***Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry*, 2000** | http://www.emnrd.state.nm.us/ocd/documents/2000PollutionPreventionBMPs.pdf |
| | *Pollution Prevention Pocket Guide for the New Mexico Oil and Gas Industry*, June 1999 | http://www.emnrd.state.nm.us/ocd/documents/pocketguide_003.pdf |
| | *Oil Conservation Division Environmental Handbook* | http://www.emnrd.state.nm.us/OCD/EnvironmentalHandbook.htm |
| | *Permit Requirements for Energy and Minerals in New Mexico*, June 2002 | http://www.emnrd.state.nm.us/OCD/documents/guide.pdf |
| | *Oil Conservation Division Enforcement Guidelines* | http://www.emnrd.state.nm.us/OCD/documents/Enforcement_guidelines.pdf |
| Earthworks - Oil & Gas Accountability Project (OGAP) | *Doing It Right: Best Oil & Gas Development Practices for New Mexico*, January 18, 2004 | http://www.earthworksaction.org/library/detail/doing_it_right_best_oil_gas_development_practices_for_new_mexico/ |
| State of OHIO | *Fact Sheet: Drilling for Natural Gas in the Marcellus and Utica Shales: Environmental Regulatory Basics*, January 2014 | http://oilandgas.ohiodnr.gov/portals/oilgas/pdf/EPA-fact-sheets/DrillingforNaturalGasintheMarcellusandUticaShales_EnvironmentalRegulatoryBasics.pdf |
| | *ODNR Best Management Practices for Oil and Gas Well Site Construction*, June 2013 | http://www.ohiodnr.com/Portals/11/publications/pdf/BMP_OIL_GAS_WELL_SITE_CONST.pdf |
| | *Fact Sheet: Environmental Safety at the Well Site* | http://oilandgas.ohiodnr.gov/portals/oilgas/pdf/Safety-at-well.pdf |
| | *ODNR Guidelines for Waste Substance Facilities*, December 18, 2013 | http://oilandgas.ohiodnr.gov/industry/guidelines-for-waste-substance-facilities |
| | *OEPA/ODNR Ohio's Regulations: A Guide for Operators Drilling in the Marcellus and Utica Shales*, March 2012 | http://www.epa.state.oh.us/Portals/0/general%20pdfs/Ohio%20Regulations%20-%20A%20Guide%20for%20Operators%20Drilling%20in%20the%20Marcellus%20and%20Utica%20Shales.pdf |
| | *ODNR Oil & Gas Best Management Practices* | http://oilandgas.ohiodnr.gov/industry/best-management-practices#GEN |
| | *ODNR BMP's and Recommendations for Oil and Gas Activities on State of Ohio Lands, Version R2.0*, January 30, 2012 | http://ohiodnr.com/portals/11/pdf/leasingbmp.pdf |
| | *Fact Sheet: Wastewater (Flowback) from Hydraulic Fracturing* | http://oilandgas.ohiodnr.gov/portals/oilgas/pdf/Wastewater-flowback.pdf |
| | *ODNR Bioremediation of Crude Oil Spills: A Non-Technical Field Guide*, 2006 | http://oilandgas.ohiodnr.gov/portals/oilgas/pdf/Bioremediation.pdf |

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| **ORGANIZATION** | **DOCUMENT TITLE** | **WEB SITE** |
| | *ODNR Spreading Oil Field Brine for Dust and Ice Control in Ohio – A Guidance for Local Authorities*, September 2004 | http://oilandgas.ohiodnr.gov/portals/oilgas/pdf/Brine.pdf |
| Harvard Law School | *An Ohio Landowner's Guide to Hydraulic Fracturing: Addressing Environmental and Health Issues in Natural Gas Leases,* June 16, 2011 | http://www.law.harvard.edu/academics/clinical/elpc/publications/elpc-ohio-leasing-guide-v2-june-2011-web.pdf |
| State of OKLAHOMA | Presentation: *Draft Report on Best Practices Public Meeting,* August 7, 2013 | file:///C:/Documents%20and%20Settings/HP_Administrator/My%20Documents/EPA/O&G/BMPs/BMP%20Docs/MD%20Best_Practices_PublicMeeting.pdf |
| Oklahoma Water Survey | Presentation: *COGCC Hydraulic Fracturing*, May 2011 | http://cogcc.state.co.us/Announcements/Hot_Topics/Hydraulic_Fracturing/COGCC_FRACING_briefing_052011.pdf |
| State of PENNSYLVANIA | *PDCNR Guidelines for Administering Oil and Gas Activity on State Forest Lands*, April 26, 2011 | http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_004055.pdf |
| | *PDCNR Managing Impacts of Shale Gas Development on State Forest Lands* | http://www.dcnr.state.pa.us/forestry/NaturalGas/managingimpacts/index.htm |
| State of TEXAS | ***Surface Waste Management Manual*, December 15, 2010** | http://www.rrc.state.tx.us/forms/publications/SurfaceWasteManagementManual/ |
| | *Waste Minimization in the Oil Field*, July 2001 | http://www.rrc.state.tx.us/forms/publications/wasteminmanual/index.php |
| | *Annotated Bibliography of Waste Minimization Technology for Crude Oil and Natural Gas Exploration, Production, and Pipeline Transportation Operations*, July 2004 | http://www.rrc.state.tx.us/environmental/environsupport/wastemin/wasteminbibliography.php |
| | *Waste Minimization in Drilling Operations* | http://www.rrc.state.tx.us/forms/publications/wasteminmanual/wastemindrillingops.php |
| | *Waste Minimization in Production and Workover Operations* | http://www.rrc.state.tx.us/forms/publications/wasteminmanual/wasteminproduction.php |
| | *Waste Minimization Case Histories – Drilling Operations* | http://www.rrc.state.tx.us/environmental/environsupport/wastemin/wasteminchdrillingops.php |
| Earthworks - Oil & Gas Accountability Project (OGAP) | *Drill-Right Texas: Best Oil & Gas Development Practices for Texas*, February 24, 2010 | http://www.earthworksaction.org/library/detail/drill-right_texas/ |
| State of UTAH | *Best Management Practices for the Oil and Gas Industry,* March 2014 | http://www.deq.utah.gov/Business_Assistance/$mart_business/guides/oilgas/index.htm |

| Table 3-1. SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **WEB SITE** |
| U.S. BLM Utah State Office | Presentation*: BMPs Used to Mitigate Environmental Impacts from Large-Scale Oil and Gas Projects,* November 12, 2012 | https://www.youtube.com/watch?v=pSpxN_txOB0 |
| State of WEST VIRGINIA | *West Virginia DEP Industry Guidance – Gas Well Drilling/Completion,* January 8, 2010 | http://www.dep.wv.gov/oil-and-gas/GI/Documents/Marcellus%20Guidance%201-8-10%20Final.pdf |
| | *West Virginia Erosion and Sediment Control Field Manual*, March 1992 | http://www.wvsoro.org/resources/SoilErosionSedimentControlManual.pdf |
| State of WYOMING | *Guideline for Closure of Unlined Production Pits*, December 2002 | http://wogcc.state.wy.us/craig/pitclose.htm |
| | *Guideline for Reclamation of Surface Areas Disturbed by Oil and Gas Drilling or Production Operations*, December 2002 | http://wogcc.state.wy.us/craig/RECLAMATION2A.htm |
| | *Approved Pit Treatment Companies* | http://wogcc.state.wy.us/craig/pittreaters.htm |
| | *Guidelines Commercial Oilfield Wastewater Disposal Facilities* | http://deq.state.wy.us/wqd/www/Permitting/Downloads/Produced%20Water/Oil-Field-Pits_Active.pdf |
| BRITISH COLUMBIA OIL & GAS COMMISSION (BOGC) | *Well Drilling Guideline, Version 1.6,* September 2013 | http://www.bcogc.ca/document.aspx?documentID=919&type=.pdf |
| | *Well Completion, Maintenance and Abandonment Guideline, Version 1.12,* April 2013 | http://www.bcogc.ca/document.aspx?documentID=920&type=.pdf |
| ***REGIONAL SCOPE*** | | |
| *Marcellus Shale/Appalachian Region* | | |
| Appalachian Shale Recommended Practices Group (ASRPG) | *ASRPG Recommended Standards and Practices*, April 2012 | http://media.marketwire.com/attachments/201204/44703_ASRPGStandardsandPracticesDocumentApril302012.pdf |
| Center for Sustainable Shale Development | *Performance Standards,* March 2013 | https://www.sustainableshale.org/performance-standards/ |
| Marcellus Shale Coalition (MSC) | *Recommended Practices: Site Planning, Development and Restoration (MSC RP 2012-1)*, June 20, 2013 | http://marcelluscoalition.org/wp-content/uploads/2013/07/RP_Site_Planning.pdf |
| | *Recommended Practices: Drilling and Completions (MSC RP 2013-3),* September 24, 2013 | http://marcelluscoalition.org/wp-content/uploads/2013/10/Recommended-Practice-Drilling-and-Completions-Sep-2013.pdf |

| Table 3-1. SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **WEB SITE** |
| The Nature Conservancy | Paper: Scott Bearer, et. al. (2012). *Environmental Reviews and Case Studies: Evaluating the Scientific Support of Conservation Best Management Practices for Shale Gas Extraction in the Appalachian Basin.* Environmental Practice, 14, pp 308-319 | http://dx.doi.org/10.1017/S1466046612000385 |
| Penn State University | *Marcellus Shale Electronic Field Guide – Best Management Practices* | http://marcellusfieldguide.org/index.php/guide/best_management_practices_in_use/ |
| Pennsylvania Environmental Council | *Marcellus Shale Lease Guide*, June 27, 2011 | http://www.pagreenlease.org/ |
| Pinchot Institute for Conservation | *The Marcellus Shale: Resources for Stakeholders in the Upper Delaware Watershed Region,* December 15, 2010 | file:///C:/Documents%20and%20Settings/HP_Administrator/My%20Documents/Downloads/Pinchot_Marcellus_Shale_BMPs.pdf |
| Western Pennsylvania Conservancy | *Conservation Guidance for Landowners on Natural Gas Development*, June 2010 | http://www.waterlandlife.org/assets/Conservation_Guidance_for_Landowners-06032010.pdf |
| *Fayetteville Shale* | | |
| University of Arkansas | *Fayetteville Shale: Reducing the Environmental Impact of Natural Gas Development* [Website Directory] | http://lingo.cast.uark.edu/LINGOPUBLIC/ |
| U.S. Fish and Wildlife Service (Arkansas Field Office) | ***Best Management Practices for Fayetteville Shale Natural Gas Activities*, April 2007** | http://www.fws.gov/arkansas-es/docs/AR_Natural_Gas_Pipeline_BMPs_v2_April_2007.pdf |
| *Rocky Mountains* | | |
| Natural Resources Law Center - Intermountain Oil and Gas BMP Project | ***Intermountain Oil and Gas BMP Project* [Website Directory]** | http://www.oilandgasbmps.org/index.php |
| | Presentation: *Intermountain Oil and Gas BMP Project*, October 14, 2009 | http://www.oilandgasbmps.org/workshops/BMPcommunity2009/presentations/mutz.ppt |
| | Presentation: *BMPs for Minimizing Environmental Impacts: A Resource for Communities, Government and Industry (SPE 147503)*, Abstract of paper presented at Society of Petroleum Engineers (SPE) 2011 Annual Technical Conference, October 2011 | http://www.spe.org/atce/2011/pages/schedule/tech_program/documents/spe147503%201.pdf |
| State of COLORADO | *Pit Design, Construction and Monitoring Requirements Within ¾ Mile of the Rim of the Roan Plateau*, June 12, 2008 | http://cogcc.state.co.us/RR_Docs_new/Policies/RoanCliffsNTO-06-12-2008.pdf |
| | *Information on Hydraulic Fracturing* | http://cogcc.state.co.us/ |
| Town of Erie, CO | *Oil & Gas Operations,* August 2012 | http://www.erieco.gov/index.aspx?NID=129 |

| Table 3-1. SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **WEB SITE** |
| Cottonwood Resource Council, Montana | *A Community Approach to Oil & Gas Development: Creating a Partnership for the Future,* February 2013 | https://www.northernplains.org/wp-content/uploads/2013/08/FINALScenariosBMPS_2013-02-15.pdf |
| Earthworks - Oil & Gas Accountability Project (OGAP) | *Preserving Our Public Lands: A Citizen's Guide to Understanding and Participating in Oil and Gas Decisions Affecting Our Public Lands,* Wyoming Outdoor Council and OGAP, 2002 | http://www.earthworksaction.org/publications.cfm?pubID=92 |
| Government of Yukon, Canada | *Yukon Oil & Gas Best Management Practices*, October 22, 2013 | http://www.emr.gov.yk.ca/oilandgas/best_management_practices.html |

# 4. Selected Sources of Voluntary Management Practices for Oil & Gas E&P Wastes

## Overview

- From the list of sources of voluntary management practices in Table 3-1, ORCR selected 14 key sources for further analysis.
- Table 4-1 contains a list of the 14 items with descriptions of their contents.
- Table 4-1 is *not* intended to serve as a comprehensive list of voluntary management practices sources, but was intended to provide a sampling of sources from industry, federal, state, and non-governmental organizations.
- EPA focused on the key voluntary management practices documents that EPA believes are currently widely used.
- This list is organized by the scope of the voluntary management practices: National, State, or Regional.
- Table 4-1 contains 12 documents and 2 website directories that were selected for review.
- Of the 12 documents, 8 are national, 3 are state, and 1 is regional in scope.
- Of the 2 website directories, 1 is national and 1 is regional.
- Five of the 14 sources were developed by industry, 3 by federal agencies, 3 by states, and 3 by non-governmental organizations.
- Ten of the sources apply to oil & gas E&P in general, and 4 apply specifically to hydraulic fracturing.
- Note: **The literature search is current as of April 1, 2014**; however, new voluntary management practices documents are constantly being developed. **The website addresses are current as of April 1, 2014, but are subject to change.**

| Table 4-1. SELECTED SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **DESCRIPTION** |
| **NATIONAL** | | |
| STRONGER (State Review of Oil and Natural Gas Environmental Regulations) | *Guidelines for the Review of State Oil and Natural Gas Environmental Regulatory Programs (2010 Draft Revision)* http://www.strongerinc.org/ | • Original guidelines were developed in 1990 by the Interstate Oil and Gas Compact Commission (IOGCC).<br>• 2010 draft revision developed by STRONGER using a multi-stakeholder process. The draft will be made available for public comment, revised, and submitted for acceptance by IOGCC.<br>• Provides guidance to the states on the formulation, development, and evaluation of oil and gas environmental regulatory programs.<br>• Recommends elements of a state oil and gas exploration and production (E&P) waste management regulatory program.<br>• State oil and gas E&P programs are reviewed in comparison with these guidelines.<br>• Provides recommendations for general and administrative criteria, including permitting, compliance evaluation, contingency planning and spill prevention, public participation, financial assurance, data management, personnel.<br>• Provides technical criteria for waste characterization, waste management hierarchy, pits, land applications, tanks, and centralized and commercial disposal facilities.<br>• Provides guidelines for developing regulatory programs for abandoned sites, oil field NORM (naturally occurring radioactive material), stormwater management, and hydraulic fracturing. |
| American Petroleum Institute (API) | API Guidance Document HF3: *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing*, January 2011 http://www.shalegas.energy.gov/resources/HF3_e7.pdf | • Identifies and describes practices currently used within the industry, with the intent to minimize potential surface environmental impacts associated with hydraulic fracturing operations.<br>• Primary focus is on issues associated with operations in deep shale gas developments. |
| | API Guidance Document HF2: *Water Management Associated with Hydraulic Fracturing*, June 2010 http://www.shalegas.energy.gov/resources/HF2_e1.pdf | • Identifies and describes many current management practices used to minimize environmental and societal impacts associated with the acquisition, use, management, treatment, and disposal of water and other fluids associated with hydraulic fracturing.<br>• Focuses primarily on deep shale gas development issues, but also describes the important distinctions related to hydraulic fracturing in other applications.<br>• Includes fluid handling and storage considerations. |
| | API Recommended Practice 51R: *Environmental Protection for Onshore Oil and Gas Production Operations and Leases*, July 2009 http://www.shalegas.energy.gov/resources/51R_e1.pdf | • Identifies recommended practices for domestic onshore oil and gas production operations.<br>• Includes evaluation of existing pits and planning for new pits used for completion, stimulation, and workover operations; fluid handling and storage; site selection; design; waste and residual management; cleanup; closure and abandonment of facilities; Annex A – "Good Neighbor Practices." |

| Table 4-1. SELECTED SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **DESCRIPTION** |
| | API G00004: *Guidelines for Commercial Exploration and Production Waste Management Facilities*, March 2001 http://www.api.org/environment-health-and-safety/environmental-performance/environmental-stewardship/waste-management-facilities | • Developed by an E&P Waste Management Facility Guidelines Workgroup, coordinated by API.<br>• Cooperative effort among representatives of oil & gas industry, commercial waste management facilities, and state governments.<br>• Identifies design, construction, and operational options that may be used, depending on site-specific conditions, at facilities with the goal of protecting human health and the environment.<br>• Flexible; due to diversity of settings, it is designed to offer options or alternatives rather than prescribe recommended practices.<br>• Concludes that facility operators, working with state regulators where appropriate, are best positioned to determine the appropriate design, operation, and environmental protection measures for a specific facility.<br>• Includes siting, design, and operating considerations for surface impoundments, ponds, land application, tanks, etc.<br>• Includes mitigation options for surface impoundments, ponds, land treatment, controlling releases to water, etc. |
| U.S. DOI/Bureau of Land Management (BLM) | *The Gold Book: Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*, 4th edition revised 2007 http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices.html%20 | • Provides guidance on requirements for obtaining permit approval and conducting oil & gas E&P operations on Federal lands and on private surface over Federal minerals.<br>• Identifies existing requirements for construction and maintenance of oil & gas-related infrastructure, including reserve pits.<br>• Recommends general operating standards for onshore drilling and production operations, including wastewater pits.<br>• Recommends reclamation and abandonment practices, including pit reclamation, intended to minimize environmental impacts. |
| U.S. DOI/National Park Service | *Operators Handbook for Nonfederal Oil and Gas Development in Units of the National Park System*, October 2006 http://www.nature.nps.gov/geology/oil_and_gas/op_handbook.cfm | • For nonfederal oil & gas operators in units of the National Park System<br>• Includes overview of regulations and plan of operations permitting process<br>• Recommends "BMPs" for geophysical exploration, drilling and production operations, directional drilling, well closure, surface reclamation, spill control. |
| Earthworks - Oil & Gas Accountability Project (OGAP) | *Best Practices* (includes "Alternatives to Pits") http://www.earthworksaction.org/ogapbestprac.cfm | • Presents alternatives used during the drilling and completion phase, including alternatives to pits, closed-loop drilling systems, redesigned pits, directional drilling, flareless completions, minimizing waste.<br>• Recommends "BMPs" for minimizing impacts during the production phase: surface disturbance, visual impacts, noise, air pollution.<br>• Discussion of alternative management practices by other organizations: Intermountain Oil and Gas BMP Project (described in "Regional BMPs" section of this table) |
| Houston Advanced Research Center - | *Hydraulic Fracturing BMPs* [Website Directory] | • Program operated by Houston Advanced Research Center and Texas A&M University, with industry sponsors and stakeholders, government agencies. |

| Table 4-1. SELECTED SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **DESCRIPTION** |
| Environmentally Friendly Drilling Systems Program (EDF) | http://efdsystems.org/index.php/best-management-practices | • Goal is to integrate "advanced technologies into systems that significantly reduce the impact of petroleum drilling and production in environmentally sensitive areas."<br>• Goal is to identify, develop, and transfer "critical, cost effective, new technologies."<br>• Website contains EDF research information and publications on BMPs. |
| **STATE** | | |
| OKLAHOMA | *Pollution Prevention at Exploration and Production Sites in Oklahoma: BMPs for Prevention and Control of Erosion and Pollution*, Water Quality Series E-940, April 2002 http://www.occeweb.com/og/E-940.pdf | • BMPs for road construction, erosion control, and pollution prevention at typical exploration and production sites in Oklahoma.<br>• Includes sections on containment for tank batteries and pits, surface stabilization, drillsite pads and disposal of drilling mud, and closure of pits.<br>• References Oklahoma Corporation Commission rules. |
| NEW MEXICO | *Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry*, 2000 http://www.emnrd.state.nm.us/ocd/documents/2000PollutionPreventionBMPs.pdf | • Includes case studies and alternatives for wastes generated in oil & gas operations.<br>• Includes pocket guide that can be used in the field quickly. |
| TEXAS | *Surface Waste Management Manual*, December 15, 2010 http://www.rrc.state.tx.us/forms/publications/SurfaceWasteManagementManual/ | • Technical guidelines for management of nonhazardous oil and gas wastes.<br>• Includes chapters on pits, discharges and land disposal, and commercial surface waste disposal and treatment facilities. |
| **REGIONAL** | | |
| U.S. Fish and Wildlife Service (Arkansas Field Office) | *Best Management Practices for Fayetteville Shale Natural Gas Activities*, April 2007 http://www.fws.gov/arkansas-es/docs/AR_Natural_Gas_Pipeline_BMPs_v2_April_2007.pdf | • Developed by a multi-agency workgroup.<br>• Provides guidance for natural gas exploration, drilling, and production operations in the Fayetteville Shale area in Arkansas.<br>• Includes guidance on endangered species and migratory birds; wetlands; geophysical activities; construction activities (including reserve pits); disposal of produced water, drilling fluids, fracturing fluids; workover operations; reclamation and abandonment. |
| Natural Resources Law Center - Intermountain Oil and Gas BMP Project | *Intermountain Oil and Gas BMP Project* [Website Directory] http://www.oilandgasbmps.org/index.php | • Free-access website of BMPs for oil and gas development in the Rocky Mountain Region (Intermountain West).<br>• Searchable database addresses surface resources affected by oil and gas development.<br>• Database includes mandatory and voluntary BMPs currently used or recommended for responsible resource management in the states of Colorado, Montana, New Mexico, Utah, and Wyoming.<br>• Not intended to represent a consensus on the BMPs for specific applications.<br>• Database describes each BMP, documents the BMP source, provides a link to |

| Table 4-1. SELECTED SOURCES OF VOLUNTARY MANAGEMENT PRACTICES FOR OIL & GAS E&P WASTES | | |
|---|---|---|
| **ORGANIZATION** | **DOCUMENT TITLE** | **DESCRIPTION** |
| | | the BMP source, and provides supplemental information.<br>• Website background material includes federal, state, and local laws. |

# 5. Summary of Selected Voluntary Management Practices for Oil and Gas E&P Wastes as They Address Pits, Tanks, and Land Application

## Overview

- ORCR developed summaries of the 14 selected voluntary management practices documents and website directories identified and described in Table 4-1.
- The summaries contain the following information for each document:
    - sponsoring organization
    - document/website title
    - date of publication
    - website location
    - general description
    - excerpts of specific sections that concern pits, tanks, and/or land application
- This list is organized by the scope of the management practices: National, State, or Regional.
- Note: **The literature search is current as of April 1, 2014**; however, new voluntary management practices documents are constantly being developed. **The website addresses are current as of April 1, 2014, but are subject to change.**

# List of Selected Sources of Voluntary Management Practices

**NATIONAL**

1 STRONGER (State Review of Oil and Natural Gas Environmental Regulations, Inc.) - *Guidelines for the Review of State Oil and Natural Gas Environmental Regulatory Programs*, 2010 Draft Revision

2 American Petroleum Institute (API) Guidance Document HF3 - *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing,* January 2011

3 American Petroleum Institute (API) Guidance Document HF2 - *Water Management Associated with Hydraulic Fracturing*, June 2010

4 American Petroleum Institute (API) Recommended Practice 51R - *Environmental Protection for Onshore Oil and Gas Production Operations and Leases*, July 2009

5 American Petroleum Institute (API) G00004 - *Guidelines for Commercial Exploration and Production Waste Management Facilities*, March 2001

6 U.S. Bureau of Land Management (BLM) - *The Gold Book: Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*, 4th edition revised 2007

7 National Park Service (NPS) - *Operators Handbook for Nonfederal Oil and Gas Development in Units of the National Park System*, October 2006

8 Earthworks - Oil & Gas Accountability Project (OGAP) - *Best Practices*

9 Houston Advanced Research Center - Environmentally Friendly Drilling Systems Program (EDF) - *Hydraulic Fracturing BMPs* [website directory]

**STATE**

10 Oklahoma Corporation Commission - *Pollution Prevention at Exploration and Production Sites in Oklahoma: BMPs for Prevention and Control of Erosion and Pollution*, Water Quality Series E-940, April 2002

11 New Mexico Energy, Minerals, and Natural Resources Department - *Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry*, 2000

12 Railroad Commission of Texas - *Surface Waste Management Manual*, December 15, 2010

**REGIONAL**

13 U.S. Fish and Wildlife Service (Arkansas Field Office) - *Best Management Practices for Fayetteville Shale Natural Gas Activities*, April 2007

14 Natural Resources Law Center - *Intermountain Oil and Gas BMP Project* [website directory]

## 1. STRONGER (State Review of Oil and Natural Gas Environmental Regulations, Inc.) - *Guidelines for the Review of State Oil and Natural Gas Environmental Regulatory Programs*, 2010 Draft Revision

**Website:** http://www.strongerinc.org/

**General Description:**

This document provides guidance to the states on the formulation, development, and evaluation of oil and gas environmental regulatory programs. It recommends elements of a state oil and gas exploration and production (E&P) waste management regulatory program. Although the guidelines are not considered voluntary management practices, the comprehensive technical criteria contained in the guidelines could be used as a basis for developing a voluntary management practices document. Therefore, this document is included in this report.

The original guidelines were developed in 1990 by the Interstate Oil and Gas Compact Commission (IOGCC). The current 2010 draft revision was developed by STRONGER using a multi-stakeholder process. The draft will be made available for public comment, revised, and submitted to IOGCC for review. A presentation on the STRONGER program was given to the SEAB Shale Gas Production Subcommittee.[8]

**Specific Sections that Concern Pits, Tanks, and/or Land Application:**

Section 5. Technical Criteria

5.1. General (pp. 39-40)

"These technical criteria for E&P waste management practices address waste characterization, waste management hierarchy, pits, land applications, tanks and centralized and commercial facilities. In most cases, these criteria are general in scope. The states should establish and implement specific performance standards and design specifications based on site-specific or regional differences in geology, hydrology, climate, and waste characteristics. State E&P waste management programs should include the following general provisions as requirements:

a. Facilities and sites used for the storage or disposal of wastes derived from the exploration and production of oil and natural gas should be operated and managed at all times to prevent contamination of groundwater and surface water, soil and air, protect public health, safety and the environment, and prevent property damage.

[8] STRONGER, Inc., *The State Review Process*, Presentation to the Secretary of Energy Advisory Board (SEAB) Shale Gas Production Subcommittee, July 13, 2011, http://www.shalegas.energy.gov/resources/071311_stronger.pdf

b. Facilities and sites operated specifically for the storage or disposal of exempt E&P wastes should not receive, collect, store, or dispose of any wastes that are listed or defined as hazardous wastes and regulated under Subtitle C of RCRA, except in accordance with state and federal hazardous waste laws and regulations.

c. Disposal of E&P wastes into landfills may be considered. If such disposal is allowed, it should only be allowed where the landfill is designed to contain such wastes, and the E&P wastes contain no free liquids and are not mixed with non-exempt wastes prior to disposal.

d. Technical criteria for siting, construction, and operation of E&P waste disposal facilities should be flexible enough to address site-specific or regional conditions based on findings by the regulatory agency.

e. Siting Criteria

i. States should incorporate siting requirements in statewide rules for pits, landspreading, landfilling and burial, and waste reclamation facilities. Area-wide rules or site-specific permits may contain additional siting conditions.

ii. No E&P waste management facility should be located in a flowing or intermittent stream.

iii. Where necessary to protect human health, new E&P waste management facilities should not be located in close proximity to existing residences, schools, hospitals or commercial buildings. The need for minimum distance criteria from residences or other buildings to the boundary of E&P waste management facilities should be considered.

iv. Generally, applicable siting requirements should address such factors as depth to and quality of groundwater, wetlands, floodplains, topography, proximity to existing drinking water supplies and wells, geology, geologic hazards, and other environmentally sensitive areas.

v. Siting of E&P waste management facilities should be consistent with applicable land-use requirements."

## Specific Sections that Concern Pits

### Section 4. Administrative Criteria

### 4.2.2. Public Participation

### 4.2.2.1. Notice and Records (p. 27)

"Agency records related to this program should generally be available for review by the public. Such records are to include waste disposal and pit locations and any required analytical data."

### 4.3. Personnel and Funding

### 4.3.1.3. Technical (p. 37)

“In support of field inspectors, technical personnel should be capable of mapping hydrologically sensitive areas and areas containing treatable water, and provide support in determining pit construction requirements and guidance in waste handling.”

## Section 5. Technical Criteria

### 5.5. Technical Criteria for Pits

#### 5.5.1. Definitions (p. 45)

“a. Reserve Pits
Pits used: (a) to store additional drilling fluids for use in drilling operations; and/or (b) to dispose of wastes generated by drilling operations and initial completion procedures.

b. Production Pits
i. Skimming/Settling: Pits used to provide retention time for settling of solids and separation of residual oil.
ii. Produced Water: Pits used for storage of produced water prior to injection for enhanced recovery or disposal, off-site transport, or surface-water discharge.
iii. Percolation: Pits used to dispose of waste liquids via drainage or seepage through the bottom and/or sides of the pits into surrounding soils.
iv. Evaporation: Lined pits used to contain produced waters which evaporate into the atmosphere by natural thermal forces.

c. Special Purpose Pits
i. Blowdown: Pits used for collecting material resulting from the emptying or depressurization of wells or vessels.
ii. Flare Pits: Pits used exclusively for flaring gas.
iii. Emergency Pits: Pits used to contain liquids on a temporary basis due to process upset conditions.
iv. Basic Sediment: Lined pits used for temporary storage of production wastes from tank batteries or production vessels which may contain residual oil.
v. Workover: Pits used to contain liquids during the performance of remedial operations on a producing well in an effort to increase production.“

#### 5.5.2. Permitting (pp. 45-46)

“a. A permitting or review process should be in place for all pits. Pits may be authorized by rule, general permit, individual permit, or as a part of an operational permit or program.

b. Pits may be permitted by rule based upon specific requirements in areas where geologic, topographic, hydrologic or other conditions are similar.

c. Authorization for a pit may be included in operational, facility, or other environmental permits (e.g., drilling, workover, gas plant, NPDES discharge). The permit application process may have to be expanded to include certain additional information concerning the pit (i.e., intake volume, soil type, fluid makeup, topography, geology, hydrology, climatology, and such other factors as may be necessary to protect human health and the environment).

d. Construction and use of rule-authorized pits should require prior notification of the appropriate regulatory agency to ensure that proper construction, operation, and closure methods are used to protect human health and the environment.

e. State programs should include provisions to accommodate approval of pits for emergency situations. “

## 5.5.3. Construction (pp. 46-47)

“General standards for construction of pits should be included in area or statewide regulations and should address the following items:

a. Size should be sufficient to ensure adequate storage until closure, taking into account historical precipitation patterns.

b. Depth should be such that the bottom does not penetrate groundwater or such that the pit contents do not adversely impact groundwater or surface water. A review of available information or a study should be made of the area where the pit is to be located to determine if aquifers are present and should be protected.

c. Berm height, slope, and material should be such that the pit is structurally sound and that pit integrity is not compromised by terrain or breached by heavy rains, winds, seepage, or other natural forces.

d. If a salt section is anticipated or oil-based muds are used during a drilling program, reserve pits should be designed to accommodate those fluids.

e. Construction standards for pits may differ depending upon the wastes they receive, the length of time they are used, and site-specific conditions.

> i. The use of production pits is declining nationally because of concerns about potential contamination of air, soils, and groundwater. In many instances, equipment consolidation, process modifications, or tanks can be used in lieu of pits. The use of alternatives is generally encouraged. Where production pits are used, they should generally be lined, except as provided below in subsection 5.5.3.e.v.
>
> ii. In the case of reserve and workover pits, liners should be required in certain instances based upon fluid type and site-specific characteristics (e.g., unconsolidated soils and/or hydro-geologic conditions that create a potential for adverse impact to surface water or groundwater, and proximity to environmentally sensitive areas).
>
> iii. Special purpose pits and other pits such as dehydration, tank drain, pipeline drip collector, and compressor scrubber pits should be lined.
>
> iv. Blowdown, flare and emergency pits may be unlined where the removal requirement of Section 5.5.4.k. will prevent adverse groundwater quality impacts.
>
> v. Variances to the above liner requirements should only be provided, and percolation pits should only be used, where it is clearly demonstrated there is minimal potential to affect adversely groundwater quality.
>
> vi. Liners can consist of natural or synthetic materials, should meet accepted engineering practices, and should be compatible with expected pit contents.

f. Requirements for fencing, netting, and caging, or any other method to secure a pit, should be set by area or statewide regulations, as necessary, to protect the public, domestic animals, and/or wildlife. Netting of a pit is recommended as the preferred method to protect wildlife in circumstances, among others, where pits have oil on the surface, where pits are used for long periods, and/or where pits are located in areas with arid climates.

g. Where feasible, reserve pits should be placed to directly receive the discharge from solids separation equipment and to collect rigwash water, spills, and leaks from drilling equipment.”

## 5.5.4. Operational Requirements (pp. 47-49)

“a. Specific restrictions on the type of wastes that can be placed in the different types of pits should be included in area or statewide regulations. Restrictions should consider salinity, hydrocarbon content, pH, radionuclides associated with oil-field NORM, or other characteristics which may be detrimental to the environment.

b. General security guidelines should protect the public, the environment, and wildlife.

c. Liquids should be maintained at a freeboard level determined by the state that takes into account extreme precipitation events or other possibilities and prevents overtopping or un-permitted discharges.

d. Lined pits should be operated in a manner that ensures liner integrity.

e. Inspections and monitoring should be conducted at regular intervals or as necessary to ensure that pits meet all operating and structural integrity requirements and to ensure that pit contents do not adversely impact groundwater or surface water.

f. Hydrocarbons which inadvertently accumulate in an unlined reserve pit should be skimmed off the pit at the cessation of drilling and completion operations.

g. Separated oil or accumulated wastes should be periodically removed from unlined skimming/settling pits.

h. Produced water pits should be used only for storage of produced water prior to injection or off-site transport.

i. Percolation pits should be used only for disposal of produced waters and only when area or statewide restrictions established under Section 5.5.4.a. above are met.

j. Evaporation pits should be periodically inspected for compliance with permitted input volumes and liner integrity. Evaporation pits should be skimmed as necessary to maintain an optimum evaporation rate.

k. Blowdown, flare, and emergency pits should not be used for long-term storage or disposal. The regulatory agency should be notified promptly of the use of emergency pits. Fluids diverted to emergency pits should be removed as quickly as practical following the end of the emergency.

l. Unlined basic sediment pits should not be used for storage of oily wastes; they should be replaced by lined pits or tanks.

m. Workover pits should be open only for the duration of workover operations and should be closed within 120 days after workover operations are complete.

n. Pit wastes that exhibit oilfield NORM above regulatory action levels should be managed in accordance with the criteria of Section 7 and any other applicable criteria of these guidelines.”

## 5.5.5. Closure (p. 49)

“a. Pits should be closed in accordance with local, state, and federal regulations and, if on private property, consistent with lease obligations.

b. Reserve pits should be closed as soon as practical but no later than 12 months after cessation of drilling operations. However, the closure of reserve pits beyond 12 months after cessation of drilling operations may be allowed in unusual circumstances if good cause can be demonstrated.

c. Pit liquids should have free oil removed and, when appropriate, should be sampled prior to closure for salinity, hydrocarbon content, pH, radionuclides associated with oil-field NORM, or other characteristics which may be detrimental to the environment. On-site disposal of pit contents should be conducted in accordance with the landspreading, burial, and landfilling criteria of Sections 5.6. and 5.7, or by NPDES or UIC permit.

d. Liquid and nonliquid materials not satisfying the on-site criteria for landspreading or burial (Sections 5.6. and 5.7.) should be disposed in federal or state approved disposal facilities.

e. Pit sites should be capped, compacted, contoured, and vegetated where necessary, and in accordance with applicable state or area regulations to ensure ground support stability and to prevent erosion and ponding.

f. Records should be permanently kept by the regulatory agency of all pit locations and should be available to the public for inspection and copying. A permit to drill may serve as adequate record keeping for the location of all pits within 200 feet of the well location."

## Section 6. Abandoned Sites

### 6.6.2. Site Remediation (p. 66)

"When reclaiming a pit, the state should determine the contents of the pit and how the pit can best be remediated. Once emptied, cleaned and tested as appropriate, pits should be backfilled and contoured to prevent erosion from or ponding of surface water."

## Section 8. Stormwater Management

### 8.3.4. Restoration and Reclamation (p. 76)

"Where appropriate, stormwater management criteria should be developed for the removal of equipment, restoration of pits, disconnection and abandonment of pipelines, backfilling and grading, and access road reclamation."

## Section 9. Hydraulic Fracturing

### 9.2. General

#### 9.2.1. Standards (p. 77)

"Surface controls, such as dikes, pits or tanks, should meet Sections 5.5 and 5.9 of the guidelines."

## 5.10. Technical Criteria for Commercial and Centralized Disposal Facilities

## 5.10.2. Technical Standards and Regulatory Requirements (p. 56)

"Commercial and centralized off-site disposal facilities should meet the technical and regulatory requirements of this section and the general standards of Section 5.1 of these criteria. Compliance with these requirements should be demonstrated in the permit application required in subsection 5.10.2.a. Because commercial disposal facilities use advanced methods of *waste* treatment and disposal, the regulatory agency should establish, where applicable, numerical requirements for the design of pond liners and leachate collection systems, for landfarming operations (i.e., repeated land applications), and for E&P waste reclamation facilities. The requirements of this section are intended to furnish the regulatory agency with sufficient and meaningful information such that permitting decisions will lead to no environmental impact or public health impact once the facility has commenced operations and following its closure."

## 5.10.2.2. Permitting Requirements (pp. 57-61)

"a. Any new or existing commercial or centralized facility should be required to obtain a permit from the regulatory agency to commence operation or to continue to operate. An individual permit should be required for E&P waste reclaimers and other commercial facilities where waste is placed on the land (e.g., in pits and in landfarms). A permit should be issued only upon compliance with the general requirements of Section 5.1 and the technical requirements of this section, and upon submittal and approval of an application that contains a Siting Plan, Construction Plan, Operating Plan, and Closure Plan. Operation of a facility should comply with the terms and conditions of the permit. The regulatory agency may tailor the technical requirements for all existing facilities and for centralized disposal facilities to the conditions present at the locations of such facilities. In the case of centralized facilities, the regulatory agency may adjust the requirements of Section 5.10.2.2.a. b. and c. in the light of the volume and characteristics of wastes received by the facility."

"c. Construction Plan. In general, commercial and centralized disposal facilities should be constructed to prevent or minimize releases of wastes or waste byproducts to surface water, groundwater, soils, and air. Design should allow for the segregation, separation and containment of free oil to minimize emissions, where appropriate. The need for additional protective measures ( e.g., barriers) at facilities in close proximity to residences, schools, hospitals, or commercial buildings should be considered. Pits at these facilities should at least meet the construction requirements of Section 5.5.3.e. In the case of E&P waste reclamation facilities, construction requirements to prevent or minimize releases should also apply to wastes stored before and after reclamation. For commercial facilities, detailed engineering drawings and diagrams of engineered disposal facilities should be required; for centralized or one-owner facilities, such extensive construction details may not be needed. Construction should follow guidelines and rules adopted by the regulatory agency."

"d. Operating Plan. Applications for permits for existing or new facilities should be accompanied by an Operating Plan that describes the wastes that will be accepted at the facility and the methods by which those wastes will be managed and disposed…The Operating Plan should contain the following information:

i. Volume, rate of application, and type of material to be disposed at the facilities and the facilities that will be used to dispose of each waste stream (i.e., unlined or lined pits, above- or below-grade tanks, etc.)"

"iii. Plan for routine inspection, maintenance, and monitoring to ensure and demonstrate compliance with permit requirements. At commercial and centralized facilities where wastes are placed on the land, such as in pits or landfarms, groundwater monitoring should be required in the absence of site-specific or facility-specific conditions that minimize the potential for adverse impacts to groundwater. Specific plans for preventing or minimizing air emissions from sources such as (1) the volatilization of organic materials in the waste; (2) particulate matter (dust) carried by the wind; and (3) chemical reactions (e.g., production of hydrogen sulfide from sulfur-bearing wastes) should be considered. Monitoring to ensure organic wastes are treated effectively should also be required for landfarming operations. "

**Specific Sections that Concern Tanks:**

## Section 5. Technical Criteria

### 5.9. Technical Criteria for Tanks

#### 5.9.1. Scope (p. 53)

“a. This section applies to permanently installed E&P waste tanks and to produced water storage tanks located at enhanced recovery operations. Where some waste tanks are regulated under the Spill Prevention Control and Countermeasures (SPCC) requirements of the federal Clean Water Act, states may defer to the SPCC requirements for those tanks.”

“b. Except as provided in Section 5.9.3.b., this section does not apply to:
i. condensate and crude oil tanks;
ii. process vessels, such as separators, heater treaters, dehydrators or freewater knockouts, except that stacks or vents on such vessels should be equipped, where necessary, to protect migratory birds and other wildlife; and
iii. tanks used temporarily in drilling and workover operations.”

“c. The regulatory agency may adjust or exempt from the requirements of this section small-capacity tanks.”

#### 5.9.2. General Requirements (pp. 53-54)

“a. States should have information, where available, on the locations, use,
capacity, age and construction materials (e.g., steel, fiberglass, etc.) of tanks as needed to administer and enforce state program requirements effectively. Such information may be obtained through registrations, inventories, or other appropriate means.”

“b. Tanks covered by this section should not be located in a flowing or intermittent stream and should be sited consistent with applicable local land-use requirements.”

“c. Tanks should be subject to spill-prevention, preventive maintenance and inspection requirements, including those of Sections 5.3.1.c. and 5.3.3. of these guidelines.”

#### 5.9.3. Construction and Operation Standards (p. 54)

“a. A principal goal of construction and operation standards for tanks is to minimize the occurrence of and the environmental impacts from spills and leaks.
i. New tanks should be constructed in a manner that provides for corrosion protection consistent with the intended use of the tanks. All tanks covered by this section should be operated in a manner that provides for corrosion protection consistent with the use of the tanks.
ii. Tanks should exhibit structural integrity consistent with their intended use. Wooden tanks should receive increased scrutiny in this regard.
iii. Tanks should be operated in a manner that protects against overtopping.

iv. Secondary containment systems or other appropriate means, such as leak detection, should be employed to minimize environmental impacts in the event of releases.”

“b. Covered tanks are preferred to open tanks. Open E&P waste and product tanks should be equipped to protect migratory birds and other wildlife in a manner consistent with the wildlife-protection criterion of Section 5.5.3.f.”

“c. Tanks located in populated areas where emissions of hydrogen sulfide can be expected should be equipped with appropriate warning devices.”

### 5.9.4. Tank Removal and Closure (pp. 54-55)

“a. Tanks should be emptied prior to their retirement and the resulting materials should be managed properly.”

“b. Tanks and associated above ground equipment should be removed upon cessation of operations. For good cause, a state may allow tanks to be removed as soon as practical thereafter. Site reclamation should meet all landowner and lease obligations and any other applicable requirements.”

“c. Prior to removal, closure, or release for unrestricted use, tanks and associated piping and equipment should be surveyed for NORM as provided for in Section

7. When regulatory action levels are exceeded, NORM and the equipment containing NORM should be managed in accordance with the state's NORM regulatory program (see Section 7 of these guidelines).”

## Specific Sections that Concern Land Application:

### Section 5. Technical Criteria

### 5.6. Technical Criteria for Landspreading

### 5.6.1. Definition and Applicability (pp. 49-50)

“a. Landspreading is a method of treatment and disposal of low toxicity wastes in which the wastes are spread upon and sometimes mixed into soils to promote reduction of organic constituents and the dilution and attenuation of metals. Landfarming or multiple applications are covered under Section 5.10.

b. These criteria apply to waste disposal at or near E&P locations and do not apply to commercial disposal operations. Commercial facilities used for disposal of E&P wastes are covered in Section 5.10.

c. On-site landspreading of E&P wastes containing NORM above regulatory action levels should be prohibited.”

## 5.6.2. Regulatory Requirements (p. 50)

"When landspreading practices are used at E&P sites, they should be conducted consistent with local, state, and federal regulations, and lease and landowner obligations. General standards for landspreading should be included in area or state regulations and should address the operational requirements of Section 5.6.3."

## 5.6.3. Operational Requirements (pp. 50-51)

"a. Free oil should be removed from the wastes by mechanical means such as skimming or filtration before the wastes are landspread.

b. Landspread liquids should have a pH of 6 to10 S.U. Where needed, liquids should be neutralized to obtain this range.

c. Solid wastes should be spread evenly and disked into the soil.

d. E&P wastes should be subject to loading rates, location restrictions, and/or other appropriate requirements that promote biodegradation of organic constituents; will not result in waste pooling, ponding, or runoff; will prevent the contamination of groundwater or surface waters; and will protect air quality.

e. Where enhancement of biodegradation is desired, nitrogen and other nutrients should be added to the soil before disking. Nutrient application can be repeated over time.

f. Amounts of waste added to soil during landspreading are generally limited by the electrical conductivity (EC), exchangeable sodium percentage (ESP), and sodium absorption ratio (SAR). The state should determine its criteria based on site-specific and waste-specific conditions. For example, some plants tolerate higher or lower salt levels, higher rainfall areas encourage salt movement out of the root-zone, or shallow groundwater may severely limit application.

g. After landspreading of hydrocarbon containing waste, the waste-soil mixture should not exceed one percent by weight oil and grease, unless the state regulatory agency approves a less or more stringent requirement where circumstances warrant.

h. Salt- and hydrocarbon-loading criteria apply to the final waste-soil mixture and are not an application standard. The operator should be required to demonstrate that these criteria are met within 12 months of cessation of drilling or production. If these criteria are not met, remediation will be required. Nothing in this paragraph is intended to delay any requirement for erosion control and/or site reclamation or re-vegetation.

i. Soil analyses should be performed prior to landspreading and again upon closure of the site. Upon site closure, waste constituents should not be present at levels that pose a significant risk to human health and the environment.

j. Enhanced techniques, such as repetitive disking and nutrient addition, may be needed to meet the salt and hydrocarbon criteria of the final waste-soil mixture.

k. Under special or abnormal conditions, additional limitations and analysis requirements should be considered for wastes that may contain toxic constituents derived from formation liquids, cuttings, drilling muds, or drilling-mud activities. Records should be permanently maintained by the agency of all waste analyses conducted pursuant to such additional requirements."

See also under **Specific Sections that Concern Pits,** section 5.10. Technical Criteria for Commercial and Centralized Disposal Facilities.

## 2. **American Petroleum Institute (API) Guidance Document HF3 - *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing*, January 2011**

**Website:** http://www.shalegas.energy.gov/resources/HF3_e7.pdf

**General Description:**

These national voluntary management practices were developed by the trade industry organization, the American Petroleum Institute. This document identifies and describes practices currently used within the industry, with the intent to minimize potential surface environmental impacts associated with hydraulic fracturing operations. The primary focus is on issues associated with operations in deep shale gas developments. A presentation on the API hydraulic fracturing standards for the oil and natural gas industry was given to the SEAB Shale Gas Production Subcommittee.[9]

**Specific Sections that Concern Pits and/or Tanks:**

Executive Summary (p. viii)

"7) Surface impoundments, including those used for storing fracture fluids, must be constructed in accordance with existing regulations. Depending on the fluids being placed in the impoundment, the duration of the storage and the soil conditions, impoundment design and construction should be impervious to prevent infiltration of fluids into the subsurface. All surface impoundments must be properly closed in accordance with all local, state and/or federal regulations. Materials removed from impoundments should be reclaimed, recycled or disposed."

Chapter 10. Water Management

10.3. Surface Impoundments and Storage Tanks (p. 11)

"Fluids used for hydraulic fracturing operations will generally be stored on-site in tanks or lined surface impoundments. Returned fluids, or flowback fluids, may also be directed to tanks or impoundments."

"All surface impoundments, including those used for temporarily storing fracture fluids, must be constructed in accordance with existing state and federal regulations. In some states, an impoundment requires prior authorization from one or more regulatory agencies; and in some, a separate permit is required specifically for the impoundment's functional use [10]. In addition, documentation should be kept on all materials placed in surface impoundments."

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[9] David L. Miller, *API Introduction and API HF Standards for the Oil and Natural Gas Industry*, Presentation to the Secretary of Energy Advisory Board (SEAB) Shale Gas Production Subcommittee, July 13, 2011, http://www.shalegas.energy.gov/resources/071311_api.pdf

"Larger centralized impoundments must be designed and constructed to provide structural integrity for the life of their operation, taking into consideration their size and extended use. Proper design, installation and operation are imperative to preventing a failure or unintended discharge off the site."

"Depending on the fluids being placed in the completion impoundment, the duration of the storage and the soil conditions, liners may be necessary to prevent infiltration of fluids into the subsurface. In most states, impoundments must have a natural or artificial liner designed to prevent the downward movement of fluids into the subsurface. Typically, liners are constructed of compacted clay or synthetic materials like polyethylene or treated fabric that can be joined using special equipment. Impoundments used for long-term storage of fluids should be sited in accordance with state stream setback distances from surface water to prevent unauthorized discharge to surface waters."

"Additional information may be required by regulatory authorities for centralized surface impoundments for fracture fluids. For such facilities, requirements may include an initial review of site topography, geology and hydrogeology, in addition to inspection and maintenance procedures—especially if such impoundments are within defined distances of a water reservoir, perennial or intermittent stream, wetland, storm drain, lake or pond, or a public or private water well or domestic supply spring."

"In some cases, impoundments used to hold freshwater for supply purposes may be retained by the landowner for their future use. Otherwise, all surface impoundments should be properly closed in accordance with local, state and/or federal regulations. Materials removed from surface impoundments should be reclaimed, recycled or properly disposed. Refer to API Environmental Guidance Document E5, *Waste Management in Exploration and Production Operations*, Second Edition, February 1997 [11] for additional guidance on fluid impoundments and practices on minimizing waste generation in the upstream sector."

"In addition to surface impoundments, some operators store fluids used in, and produced from, fracturing operations in tanks. These tanks must meet applicable state and federal standards."

## 10.1. General (p. 9)

"Using hydraulic fracturing fluids in an environmentally safe way means that the water and chemicals are sourced, transported, prepared, pumped into the formation, returned from the formation and disposed of in a way in that is in full compliance with all federal, state, and local regulations, and that minimizes impacts…."

"…water is stored in tanks or impoundments on the wellsite while waiting to be pumped…"

"…after the fracture treatment is finished, fracture fluid must be flowed back into storage tanks, lined impoundments, production equipment or other suitable containers…"

## 10.2. On-site Fluid Handling (p. 10)

"The job planning process should consider the possibility of unforeseen circumstances that may delay the fracture operations and provide a plan for proper material management. This includes management of fluids that remain in lines, tanks and other containment devices after the fracturing has been completed."

"Operators should maintain information about their fluid management and storage at the site. Such information may include:
— site design and capacity of storage impoundments and/or storage tanks;
— information about the number, as well as the individual and total capacity of, receiving impoundments and/or tanks on the well pad;

— description of planned public access restrictions, including physical barriers and distance to edge of the well pad; and
— description of how liners are to be installed to prevent possible leakage from impoundments, in locations where liners are required by state or local regulations."

## 10.4. Spill Prevention and Control (p. 12)

"When bringing fracturing materials on site, they should be stored in such a way to prevent any accidental release to the environment. These fluids may include both solid and liquid components. Primary containment methods commonly used include tanks, hoppers, blenders, sand separators, lines and impoundments. It is recommended these primary containers be visually inspected before and during the fracturing operation to ensure integrity."

"Operators should evaluate the potential for spills and damages and use this information to determine the type and size of primary and secondary containment necessary."

"Some methods to control and contain spilled substances, particularly oil, include:
— retaining walls or dikes around tanks…"
"— secondary catchment basins designed to prevent the spread of fluids that escape the primary wall or dike…"

## Chapter 8. Transport of Chemicals and Other Materials (p. 8)

"The use of multi-well pads make the use of central water storage easier, reduces truck traffic, and allows for easier and centralized management of flow back water."

"In order to make truck transportation more efficient, cost effective and less impactful operators may want to consider constructing storage ponds and drilling source wells in cooperation with private property owners. The opportunity to help a private landowner by constructing or improving an existing pond, drilling a water well, and/or improving the roads on their property can be a win-win situation for the operator and the landowner. It provides close access for the operator to a water source, and adds improvements to the property that benefit the landowner."

## Chapter 11. Maintaining Equipment and Facilities

## 11.5. Pipeline Maintenance (p. 15)

"Tanks should be checked for uneven settlement of the foundation, corrosion and leaks."

## Chapter 12. Minimizing Surface Disturbance

## 12.2. Mitigating Impacts Associated with Site Selection (pp. 15-16)

"…equipment and materials should be positioned and stored to minimize disturbance to the environment."

“Subsurface soil conditions should be considered for adequate foundation support of buildings, pumps, engines, tanks and equipment used during hydraulic fracturing operations.”

## Chapter 15. Mitigating Noise Impacts (p. 17)

“Other examples of noise mitigation techniques that can be considered with regard to hydraulic fracturing operations include:
— the placement of tanks, trailers, topsoil stockpiles or hay bales between the noise sources and receptors…”

## 3. American Petroleum Institute (API) Guidance Document HF2 - *Water Management Associated with Hydraulic Fracturing*, June 2010

**Website:** http://www.shalegas.energy.gov/resources/HF2_e1.pdf

**General Description:**

These national voluntary management practices were developed by the trade industry organization, the American Petroleum Institute. This document identifies and describes many current practices used within the industry, with the intent to minimize environmental and societal impacts associated with the acquisition, use, management, treatment, and disposal of water and other fluids associated with hydraulic fracturing. The primary focus is on issues associated with operations in deep shale gas developments. This document does not address other water management issues associated with oil and gas exploration, drilling, and production.

**Specific Sections that Concern Pits and/or Tanks:**

Executive Summary (p. vii)

"Operators should review and evaluate practices regarding waste management and disposal from the process of hydraulic fracturing, including: The preferred disposition (e.g. treatment facility, disposal well, potential reuse, centralized surface impoundment or centralized tank facility) for the basin; treatment capabilities and permit requirements for proposed treatment facilities or disposal wells; and the location, construction and operational information for proposed centralized flow back impoundments."

Chapter 5. Water Use and Management Associated with Hydraulic Fracturing

5.1. Water Use and Management Associated with Hydraulic Fracturing – General (p. 9)

"The water may arrive over a period of days or weeks and may be stored on site in tanks or lined pits."

"…upon completion of the fracturing operation, recovered fracture fluids in the flow back water must be separated, contained, treated, disposed of, and/or reused."

5.2. Planning Considerations (p. 10)

"Storage—What requirements and constraints exist for water storage on site, and how do source water considerations and fracture fluid requirements affect storage requirements?"

## Chapter 6. Obtaining Water Supply for Hydraulic Fracturing

### 6.1. General (p. 13)

"Operators should conduct a detailed, documented review of the identified water sources available in an area that could be used to support hydraulic fracturing operations. Considerations factoring in this review should include:
— evaluating source water requirements,
— fluid handling and storage…"

### 6.2.1. Evaluating Source Water Requirements – Surface Water (p. 15)

"One alternative that could be considered and that may be acceptable to local water management authorities is water withdrawal programs that make use of seasonal changes in river flow, in order to capture water when surface water flows are greatest. This would likely involve the use of large-scale water diversion and storage impoundments (see Figure 6)."

"As described in more detail below, additional regulatory requirements are likely to be associated with such facilities. Diverting water to storage impoundments during periods of high flow allows withdrawals at a time of peak water availability which avoids impacts to municipal drinking water supplies or to aquatic or riparian communities. However, operators need to keep in mind that this approach will normally require the development of sufficient water storage capabilities to meet the overall requirements of drilling and hydraulic fracturing plans over the course of a season, year, or perhaps even over a multi-year period (to plan for possible periods of drought)."

"Another alternative to ensuring water supply is to use abandoned surface coal mining pits for the storage of water. Having more permanent facilities such as this may provide for the installation of a comprehensive water distribution system that can be matched to development plans. Of course, the water quality in such impoundments must meet with operational requirements and will likely vary depending on the nature of the exposed overburden present in such areas. Moreover, these pits must meet all regulatory requirements for such surface impoundments."

"Another simple method that can be used is to excavate low lying areas and allow for rain water harvesting. The potential use of such a method requires planning as it may take a long time for the excavation to fill up, depending on precipitation conditions. This option should be discussed with state, regional, or local water management authorities to ensure compliance with stormwater runoff program elements."

"Figure 6—Example of Diversion Pond Construction"

### 6.3. Fluid Handling and Storage Considerations – General (p. 18)

"Operators may be required to provide information about their water management and storage operations at the site. Such information may include the following:
— information about the design and capacity of storage impoundments and/or tanks;
— information about the number, individual and total capacity of receiving tanks on the well pad for flow back water;
— description of planned public access restrictions, including physical barriers and distance to edge of well pad;
— how liners are to be placed to prevent possible leakage from such impoundments."

## 6.3.2. Storage in Surface Impoundments (pp. 18-19)

“If lined impoundments or pits are used for storage of fracture fluids or flow back water, the pits must comply with applicable rules, regulations, good industry practice, and liner specifications. However, it is important to recognize that storage impoundments containing fluids associated with fracturing operations will likely contain significantly larger volumes of fluids than from conventional operations. To enhance efficiency and limit the number of impounds, some operators are considering the use of centralized impoundments to manage flow backwater. Thus, these impoundments will be designed and constructed in such a manner as to provide structural integrity for the life of their operation. Proper design and installation is imperative to the objective of preventing a failure or unintended discharge.”

“All surface impoundments, including those used for storing fracture fluids, will be constructed in accordance with existing state and federal regulations. In some states, use of such an impoundment requires a prior authorization from the regulatory agency; and in some, a separate permit is required specifically for the pit’s explicit functional use.”

“Depending upon the fluids being placed in the impoundment, the duration of the storage and the soil conditions, an impound lining may be necessary to prevent infiltration of fluids into the subsurface. In most states, pits must have a natural or artificial liner designed to prevent the downward movement of pit fluids into the subsurface. Pits used for long term storage of fluids should be placed an appropriate distance from surface water to prevent unlikely overflows from reaching the surface water.”

“In addition, to ensure the safe operation and maintenance of any impoundment, an inspection and maintenance plan should be followed.”

“Additional information may be required by regulatory authorities for centralized surface impoundments for fracture fluids. For such facilities, requirements may include an initial review of site topography, geology and hydrogeology, especially if such impoundments are within defined distances of a water reservoir; perennial or intermittent stream, wetland, storm drain, lake or pond, or a public or private water well or domestic supply spring.”

## 6.3.3. Storage in Tanks (p. 19)

“Many operators store fluids used in and produced from fracturing operations in steel tanks, in addition to or rather than earthen pits. These tanks must meet appropriate state and federal standards, which may be specific to the use of the tank (e.g. use for temporary tank flow back water or more permanent production tank batteries).”

## Chapter 7. Water Management and Disposal Associated with Hydraulic Fracturing

## 7.1. General (p. 20)

“In general, well permits will specify that all fluids, including fracture fluids and flow back water, must be removed from the well site. In addition, any temporary storage pits used for fracturing fluids must be removed as part of reclamation.”

“Operators should prepare for proper management and disposal of fluids associated with hydraulic fracturing operations. Considerations for fluid management should include……planned disposition (e.g. treatment facility, disposal well, reuse, centralized surface impoundment or centralized tank facility);…..and the location and construction and operational information for any proposed centralized flow back water surface impoundment.”

**4. American Petroleum Institute (API) Recommended Practice 51R - *Environmental Protection for Onshore Oil and Gas Production Operations and Leases*, July 2009**

**Website:** http://www.shalegas.energy.gov/resources/51R_e1.pdf

**General Description:**

These national voluntary management practices were developed by the trade industry organization, the American Petroleum Institute. This guidance identifies recommended management practices for domestic onshore oil and gas production operations.

**Specific Sections that Concern Pits and/or Tanks:**

Chapter 5. Lease Roads

5.3. Design and Construction (p. 6)

"5.3.15 Areas of excavation should be approved before the start of construction. Permits are required for opening pits on federal land and may be required on other public lands. Pit layout and restoration should be planned before opening of the pit."

"5.3.16 Environmental impacts during coarse/fine borrow material extraction should be minimized. The following should be considered:
…e) maintaining a buffer of undisturbed vegetation between borrow pits and highways or other sites."

5.5. Maintenance (p. 7)

"5.5.5 Borrow and surface materials should be readily accessible to be utilized during maintenance operations. Pits opened during construction should be used as a source for maintenance material, where feasible."

Chapter 6. Producing, Injection/Disposal Wells

6.1. Completion, Stimulation, and Workover Operations

6.1.1. Planning (pp. 8-9)

"For a new well site, an effective planning process should be carried out and should incorporate the latest guidelines for waste management, pit location and construction, handling of water discharges, and waste disposal. The location and size of new pits and pads for completion and workover equipment should be selected so as to minimize disruption of the surface resources and retain the potential for reclamation of the site. Refer to *API Environmental Guidance Document: Onshore Solid Waste Management in Exploration and Production Operations* for environmental aspects of reserve pit construction, operation and closure."

"For an existing well site, the planning process is just as important to provide for safe and environmentally acceptable completion and workover operations. Existing facilities, such as pits and production equipment, should be reviewed and assessed to determine whether the facility is suitable in its present condition for the intended well operations or if modifications are required. For both new and existing well sites, a waste management plan for handling and storing all waste materials generated during completion and workover activities should be developed. Refer to *API Environmental Guidance Document: Onshore Solid Waste Management in Exploration and Production Operations*, for information on how to develop such a plan."

## 6.1.6. Selection, Use, and Storage of Fuels and Completion Fluids (p. 10)

"Wherever practical, tanks or existing drilling pits should be used for completion and workover operations. Completion brines and other potential pollutants should be kept in lined pits, steel pits, or storage tanks. If a new earthen pit is necessary, it should be constructed in a manner that prevents contamination of soils, surface water, and groundwater, both during the construction process and during the life of the pit. Consideration should be given to the use of tanks or lined pits to protect soil and groundwater, especially for brines and oil-based fluids."

"Normal operations should preclude oil in pits. However, in the event that well completion operations dictate use of pits containing oil for a brief period of time, they should be fenced, screened, netted and/or flagged, as appropriate, to protect livestock, wild game, and fowl. Refer to the Migratory Bird Treaty and Enforcement Improvement Act for additional guidance. Oil accumulated in pits should be promptly removed and recovered, recycled, or disposed."

"All liquids and other materials placed in pits should be recovered, recycled, or disposed in an environmentally acceptable manner (determined by the constituents in the material and the environmental sensitivity of the location)."

"When operations are completed, pits not required for well operation should be closed in accordance with the environmental sensitivity of the location. The surface area should be restored to a condition compatible with the uses of the adjacent land area. Any pit retained should be of minimum size commensurate with well operations. Refer to *API Environmental Guidance Document: Onshore Solid Waste Management in Exploration and Production Operations* for additional information and permitting requirements."

## 6.1.7. Stormwater Runoff (p. 10)

"Natural drainage patterns of the area should be considered in the location of equipment, pads, and pits so that stormwater runoff does not create an environmental hazard by erosion of base material, which could lead to equipment instability, or by flooding of pits, which could cause a discharge of oil or other fluids into the local surface waters."

## 6.3. Well Testing

## 6.3.2. Flare Pits (p. 12)

"Flare pits, sometimes called blowdown or emergency pits, should not be used for storage or disposal. The primary purpose of a flare pit is to catch any incidental fluid that might be associated with the gas stream that does not burn. Fluids in a flare pit should be removed daily, or as quickly as practical."

“Siting and construction of flare pits should minimize the risk of surface and groundwater contamination. The size of the flare pit should be proportionate to the volume of liquid effluent that might be expelled from the gas flare. Use of a knockout vessel should be considered.”

## 6.4. Plugging and Abandonment

### 6.4.3. Surface

#### 6.4.3.2. Cleanup and Remediation (p. 14)

“Pits should be emptied and reclaimed to a condition similar to the rest of the reclaimed pad area. Pits should be allowed to dry or be solidified in situ before filling. The pit area may be mounded to allow for settling. Before removing or abandoning pipelines or flowlines, fluid displacement and line purging should be considered and fluid reclaimed, recycled, or properly disposed of according to fluid type.”

#### 6.4.3.3. Soil Erosion (p. 14)

“Disturbed areas, such as roads, pits, and well sites, may need to be further remediated depending on lease agreements.”

# Chapter 7. Lease Gathering and System Lines

## 7.3. Design (p. 16)

“7.3.2 Lease gathering and system line design should consider the following.
….i) Optimum location for blowdown tanks, valves, etc…”

## 7.5. Operation and Maintenance (p. 17)

“7.5.4 Proper maintenance practices should be exercised with respect to … blowdown tanks…”

# Chapter 8. Production Water Handling Facilities

## 8.1. Requirement Determination (Preplanning Considerations) (p. 18)

“Water handling facilities are typically located adjacent to, or within, production facilities. Initial planning for these facilities within a field should consider future development potential in order to minimize surface disturbance. When practical and economic, central field locations should be considered to avoid the use of multiple facilities. Facility sizing should consider future throughput increases to minimize the need for additional tankage and treating vessels.”

“Production and water handling facilities should be planned to utilize the smallest practical surface area consistent with safe, prudent, and economic operations. In addition, produced water may be saline and corrosive. Therefore, special care should be taken to minimize the possibility of environmental damage due to equipment upsets, spills, and leaks.”

## 8.2. Site Selection Considerations

### 8.2.4. Subsurface Soil Conditions (p. 19)

“Subsurface soil conditions should be considered for adequate foundation support of … tankage...”

“Soil characteristics should be evaluated for construction of dikes, firewalls, and emergency containment areas. Lining of containment areas with compacted clay or synthetic liners should be considered where porous soil conditions exist or groundwater could be impacted.”

## 8.3. Facility Design

### 8.3.1. Equipment Sizing, Specifications, and Design (pp. 20-23)

f) “3) Fired lease vessels should not be located immediately adjacent to oil, gas, or any other flammable or explosive storage facilities. Facilities should have a grade established so that releases of flammable fluid drain away from fired equipment.
NOTE Some states have minimum distance requirements between fired vessels and storage facilities.”

“g) The following items should be considered in installing bulk storage and loading facilities.”

“1) Adequate fire/retaining walls or other containment measures should be provided around tanks, where necessary to comply with regulatory requirements, in order to contain accidental discharges and prevent environmental damage…”

“2) Installation of impervious foundations or liners under storage tanks should be considered to allow detection and containment of fluid releases.”

“3) Installation of high-level alarms and/or monitors should be considered on tankage.”

“i) The following items should be considered in planning, installing, and using pits, firewalls, and dikes.

1) Whenever practical, tanks should be used instead of pits.
2) Existing pits should be minimized and alternate means considered, where feasible. Pits should only be used for the purpose they were intended. Personnel should be advised on the specific use of the pit and what substances are allowed in the pit.
3) During the design and construction of pits and firewalls, necessary precautions should be taken to protect ground and surface water, crops, trees, livestock, and wildlife.
4) Pits should be designed and constructed to have sufficient freeboard, or provide adequate reserve capacity, to prevent overflow under maximum anticipated operating requirements and precipitation.
5) Pits should be fenced or otherwise equipped, as necessary, for public safety and to protect livestock and wildlife.

6) Netting of pits should be considered to protect migratory birds from exposure to the pit contents if there is a potential for the pit to have an oily surface or to contain potentially harmful substances.
7) Burn pits should be located where prevailing winds will reduce fire hazards and smoke nuisance.
8) Storage vessels for liquid hydrocarbons, saltwater, chemicals, or other fluids that are not acceptable to be discharged into the local environment should have dikes constructed around their perimeters.
9) Dikes and firewalls should be constructed of material to prevent the release of fluids to the local environment during an accidental or emergency discharge from their original containment.
10) Consideration should be given to designing dikes and firewalls with a sufficient perimeter and wall height to contain the maximum volume of the largest vessel or tank contained within, and with sufficient freeboard for maximum rainfall and snow melt. Any drain lines through dikes should be equipped with valves/blinds that are normally closed and locked."

j) "3) storage facilities should not be located under or near major electrical transmission lines…"

## 8.3.2. Equipment Location (p. 24)

"a) Production and water handling facilities should be located where they do not present a fire hazard to nearby facilities. Fired vessels, IC engines, flares, or other equipment that produce sparks or flames should be appropriately separated from oil and gas storage facilities..."

## 8.4. Construction Considerations

## 8.4.2. Inspection and Testing (p. 25)

"The following inspection and testing steps must be taken before initiating construction…."
"b) Upon completion, equipment and facilities should be inspected for possible leaks. If necessary, equipment should be pressure tested in accordance with applicable codes. If fluids are used to pressure test, collect and dispose of the fluids, refer to *API Environmental Guidance Document: Onshore Solid Waste Management in Exploration and Production Operations* for applicable information."

"c) X-raying of welds should be considered in critical areas where extreme pressure or corrosiveness is anticipated or where potential risk to the local environment is of great concern."

## 8.5. Operation and Maintenance

## 8.5.4. Corrosion Monitoring and Treatment (pp. 26-27)

"Monitoring should be considered if produced fluids are suspected of being corrosive. If produced fluids are determined to be corrosive, a corrosion abatement program should be considered. This is especially important in populated or environmentally sensitive areas. Operating procedures should provide for early identification of potential corrosion problems in failure-prone equipment. Refer to NACE MR 0175."

## 8.6. Waste and Residual Management

### 8.6.5. Disposal (pp. 28-29)

“The final option for management of a waste, after source reduction, recycling, and treatment options have been considered and incorporated, is disposal. The operator should take into consideration the long-term fate of the waste and its constituents before disposal…”

“These criteria will help determine a waste disposal option that protects human health and the environment and limits future liability for the operator. Examples of waste disposal options that can be considered are:

a) landspreading,
b) roadspreading,
c) on-site burial,
d) on-site pits,
e) annular injection,
f) underground injection wells,
g) regulated and permitted discharge of fluid,
h) incineration,
i) off-site commercial facility.”

## 8.7. Spill Prevention, Response, and Cleanup

### 8.7.3. Mitigation (p. 30)

“c) tanks should be checked for uneven settlement of the foundation, corrosion, and leaks…”

### 8.7.5. Control and Containment (p. 30)

“Some methods which can be used to control and contain discharged substances, particularly oil, include:

a) retaining walls or dikes around tanks and other spill prone equipment,
b) secondary catchment basins designed to prevent the spread of oil if it escapes the primary wall or dike…”

“Operators should evaluate the potential for spills and damages and use this information to determine the type and size of primary and secondary containment necessary.”

## 8.9. Closure and Abandonment of Facilities

### 8.9.1. Purging and Flushing of Equipment Before Removal (p. 31)

"All equipment such as tankage, separation vessels, meter runs, flow lines, and pumps should be purged and flushed, as appropriate. Whenever possible, materials recovered should be recycled, reclaimed, or disposed. Refer to *API Environmental Guidance Document: Onshore Solid Waste Management in Exploration and Production Operations* for additional information."

### 8.9.2. Equipment Removal (p. 32)

"a) Tanks, separation vessels, meter runs, surface lines, pumps, and any other exposed surface equipment should be removed. Removal of the associated equipment foundations should be considered."

### 8.9.3. Pit Closure (p. 32)

"All pits and surface impoundments should be properly closed after they are dry and free of waste; then they should be backfilled and graded to conform to the surrounding terrain. Closure must also be in accordance with any local and/or state regulations. The location of closed pits should be documented. Materials removed from pits should be reclaimed, recycled or disposed. Refer to *API Environmental Guidance Document: Onshore Solid Waste Management in Exploration and Production Operations* for additional information. Documentation should be kept on disposed materials."

### 8.9.4. Land Reclamation and Restoration (p. 32)

"Infrastructure associated with formerly producing leases, including water impoundments, power lines, metering buildings, compression facilities and tank batteries must be removed and the footprints or lands disturbed by these facilities and associated foundations reclaimed unless the surface owner requests that items such as impoundments or water wells be kept."

## 5. American Petroleum Institute (API) G00004 – *Guidelines for Commercial Exploration and Production Waste Management Facilities*, March 2001

**Website:** http://www.api.org/environment-health-and-safety/environmental-performance/environmental-stewardship/waste-management-facilities

**General Description:**

These national voluntary management practices were developed by an E&P Waste Management Facility Guidelines Workgroup, coordinated by the trade industry organization, the American Petroleum Institute. This Workgroup was a cooperative effort among representatives of the oil & gas industry, commercial waste management facilities, and state governments. Although most E&P wastes are managed on-site, according to this document, approximately one percent of these wastes are managed by commercial and centralized waste management facilities located off-site. This document identifies design, construction, and operational options that may be used, depending on site-specific conditions, at these facilities with the goal of protecting human health and the environment.

**Specific Sections that Concern Pits/Surface Impoundments:**

Chapter 2. Siting, Design, and Operating Considerations

2.2. Basic Construction and Technical Considerations

2.2.3. Evaporation ponds and other surface impoundments (pp. 13-14)

"Where climate allows, evaporation ponds and surface impoundments can be very effective for managing certain waste types. In designing and operating evaporation ponds or surface impoundments, it may be appropriate to consider the amount of salt, oil and grease, and metals in the waste streams managed in this manner, and how they may affect the dried, residual material and/or liner, if applicable. Wastes with a high oil or hydrocarbon content may be inappropriate for treatment in evaporation ponds or other surface impoundments unless the hydrocarbons are removed prior to placement in the impoundment."

"Design considerations. Evaporation ponds and other impoundments should be designed to minimize the potential leakage of waste material or leachate from the treatment unit and to prevent migration of wastes into nearby water resources. Appropriate measures include proper siting of the facility (*section 2.1*) and consideration of site-specific characteristics. In de signing the facility, an appropriate combination of the following protective measures should be considered:

- Dikes, berms, and freeboard;
- Clay or synthetic liners;
- Leachate collection and removal systems;
- Leak detection systems;
- Groundwater monitoring to identify leachate migration (where deemed appropriate); and/or
- Wildlife protection measures (*see section 2.3.4*)."

"Operating considerations. Evaporation ponds and surface impoundments should be operated in a manner that prevents off-site migration of waste or waste components from the treatment unit. Facility operators should consider the need for:

- Routine visual inspection of the treatment units to assure adequate freeboard and that wildlife protection measures are intact (where applicable); and
- Routine skimming operations to remove floating waste components, thereby reducing volatilization of free hydrocarbons."

## 2.2.4. Percolation ponds (p.14)

"Percolation ponds are used to allow produced water to percolate into the ground. The pond should act only as a holding facility while gravity allows the water to percolate or seep through the soil or other unconsolidated medium. Percolation ponds are allowed in only a few states; check applicable state regulations for information on their design. Typically, states will permit percolation ponds only in areas where groundwater is quite deep or absent, or separated by geologic barriers, such as clay or shale zones, to minimize the potential for impact from the produced water."

# Chapter 4. Water Issues

## 4.1. Introduction (pp. 34-35)

"Figure 4.1 provides a qualitative assessment matrix of the factors that may increase risks of surface water or groundwater contamination."

"Figure 4.1: Qualitative Assessment of Exposure Probabilities and Magnitudes from Potential E&P Waste Management Facility Releases to Water"

## 4.2. Mitigation Options Available for Controlling Releases to Water

## 4.2.2. Containing waste and waste leachate (pp. 36-38)

"Liners. A liner is a continuous barrier that covers the area likely to be in contact with waste so that the constituents in the waste are prevented from migrating to surrounding native soils. Liners may be used to control or prevent seepage out of or into a structure. Liners are made either from earthen materials (*e.g.*, clay, bentonite) or synthetic materials (*e.g.*, plastic). Liners made of natural materials are relatively inexpensive in comparison to those made of synthetic materials, but may be inappropriate depending upon the site-specific characteristics of the facility. Liners made from natural materials typically exhibit low permeability characteristics and will effectively contain most types of material. However, some wastes or site conditions may necessitate an impermeable synthetic liner."

"Single or multiple layers of liners can be installed at a facility, based on the facility's potential to contaminate water resources. State regulations may specify the thickness and composition of liners. A number of factors affect the selection of liner materials and the number of liner layers at a site, including permeability of naturally occurring soils, chemical compatibility with waste leachate, aging and durability characteristics, stress and strain characteristics, ease of installation, and facility potential to affect groundwater resources based on its topography. For example, if a facility is in a low groundwater vulnerability region, a natural clay liner could be appropriate to protect water resources. If a facility operates in a high groundwater vulnerability area, a double liner system may be more appropriate to ensure protection of water resources."

"Given the diverse operating environments of E&P waste management sites, liners may not be necessary at all facilities. If installed, liner systems should extend under the entire treatment unit area. The visible portion of liners should be checked periodically to assure that it is not damaged or torn. Whenever wastes are removed from the impoundment, the liner should be checked for visible damage before new wastes are placed into the impoundment. A liner's overall effectiveness depends on its thickness and permeability, as well as other factors discussed above."

"Dikes, berms, and levees. Open-cell treatment units should be designed to prevent storm water run-on and the flow of liquids over the top of a unit (overtopping). This can be accomplished by constructing and maintaining dikes, berms, or levees. These containment structures should be constructed of materials that are resistant to seepage and erosion, and that have favorable compaction characteristics. Organic soils are not suitable because of high compression, low strength, and unpredictable permeability."
"Secondary containment. Secondary containment consists of placing a barrier – such as a vault, leakproof liner, or double-walled structure – around a tank or container that stores, treats, or handles waste. To ensure that E&P waste management sites present minimal release potential to water resources, one of the following secondary containment devices can be used:

¨ Dikes, berms, and levees, or a concrete pad with a curb;
¨ An external liner that completely surrounds the tank with an impermeable material;
¨ A vault (the tank rests in an underground chamber usually constructed with concrete floors and walls and an impermeable cover); and/or
¨ A double-walled tank (the tank is completely enclosed inside another tank with a leak detection monitoring system installed between the two).

Requirements can vary depending on geography, proximity to groundwater and surface water resources, and the type of waste being stored or treated. Secondary containment devices may be built with native soils, clays, bentonite, or synthetic materials."

"Leachate collection and removal. Leachate collection and removal systems can differ greatly in design and numbers of components depending on the location in which the facility operates. A double leachate system, which may be appropriate in some cases, has two liners with a leachate collection system on top of each liner. The top system rests on the top liner, and the second between the top and bottom liner. Figure 4.2 illustrates this type of system, which would normally be used at an E&P facility only in cases of substantial leachate volume and very high groundwater contamination risk. A single leachate collection system may be appropriate in many situations to prevent liquids from seeping through a liner."

"Figure 4.2: Illustration of a Double Liner and Leachate Collection System"

"In some lower risk areas, liners may not be necessary to protect groundwater resources and may be prohibitively expensive. In these areas, a system of drains (such as that shown in Figure 4.3) to prevent contact of the waste and the water table may be adequate."

"Figure 4.3: Illustration of a Drainage System"

## 4.2.3. Applying overflow protection measures (p. 39)

"Adequate freeboard. Overflow from open-cell treatment units can be prevented through the use of dikes and berms (*see* section *4.2.2*), in conjunction with ensuring a minimum distance (called freeboard) between the surface and the top of the unit. Freeboard is designed to prevent overflow during high winds or rainstorms. Freeboard should generally be capable of retaining the contents of the open-cell treatment unit during a particularly heavy rainfall event (*e.g.*, a 100-year storm)."

"In-series cells. Where space is available, another overflow protection option is a series of cells connected by piping. The second or subsequent cells would normally be empty, but would receive excess material via piping when the first cell reached capacity. This method is suitable for liquid wastes or cases where the excess volume is due to heavy rainfall."

## Appendix B: Summary of State Regulations Related to E&P Waste Management Facilities

Surface Impoundment regulations:

- California – p. 50 of API document
- Colorado – p. 52 of API document
- Louisiana – p. 54 of API document
- New Mexico – p. 56 of API document
- Oklahoma – p. 58 of API document
- Texas – p. 60 of API document
- Utah – p. 61 of API document
- Wyoming – p. 62 of API document

## Appendix D: Glossary

"Evaporation Pond- Any unit specifically designed for the holding and evaporation of water. This type of disposal results in the concentration of salts, metals, and residual hydrocarbons." (p. 70)

"Impoundments- A facility or unit consisting of a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), designed to hold an accumulation of liquid or solid waste. Runoff and containment areas are also considered to be surface impoundments." (p. 71)

"Mixing basin- A surface impoundment used to homogenize the liquid and solid phases of waste prior to separating the liquids and solids for further treatment or disposal." (p. 71)

"Percolation ponds- A type of unit used to dispose of liquids, usually produced water. Percolation ponds allow the liquids to drain or seep into the sides or through the bottom of the pond into the surrounding soils for disposal. These are only used in areas where the groundwater is very deep or nonexistent." (p. 72)

Note: Chapter 3 Air Emissions and Related Issues (pp. 24-31) includes mitigation options designed to control air emissions from aerated surface impoundments, evaporation ponds, mixing basins, etc.

**Specific Sections that Concern Tanks:**

## Chapter 2. Siting, Design, and Operating Considerations

### 2.2. Basic Construction and Technical Considerations

#### 2.2.8. Tank storage (pp. 15-16)

“Tanks are stationary devices (as opposed to portable containers) used to store or treat waste. Tanks are widely used for liquid waste storage or accumulation. Tanks can be aboveground or underground, although aboveground tanks are preferred because they are easier to inspect and maintain. In order to ensure that a tank system can hold waste for the tank’s intended lifetime, the facility should ensure that the tank is properly designed. The tank system and its components should be designed with adequate foundation, structural support, and corrosion protection to prevent it from collapsing or leaking. Leak detection and prevention provisions – such as a concrete base, leak detecting bottom, or a raised foundation – should also be considered.”

“Installation considerations. New tank systems should be inspected prior to use to ensure that the tank was not damaged before or during installation. All new tanks and ancillary equipment should be tested to make sure that there are no leaks; any leaks discovered must be repaired before the tanks are covered, enclosed, or placed in use.”

“Design/Operating considerations. Tanks should always be operated in a manner that minimizes or eliminates releases. Waste characteristics should be consistent with the design of the tank (e.g., wastes that may react with the tank components should not be placed in the tank). Because the loading or filling of tanks may create the potential for spills or releases of waste into the environment, the following prevention or containment measures should be considered:

¨ Spill prevention controls (such as valves) designed to prevent the backflow of waste during filling;
¨ Overfill prevention controls, such as alarms that sound when the waste level in the tank exceeds a specified point, or valve systems that automatically close when overfill is likely;
¨ When appropriate, emissions controls, such as vapor recovery units or flares;
¨ Sufficient space within an uncovered tank between the surface of the waste and the top of the tank (minimum freeboard);
¨ Secondary containment (dikes or berms) that is capable of containing the entire volume of the tank; and/or
¨ Regular inspection of site security measures.”

“Where tanks contain wastes or liquids that may be flammable (regardless of whether they are exempt E&P wastes under RCRA), facilities should consider state and local fire regulations that may affect tank operations.”

## Chapter 4. Water Issues

### 4.2. Mitigation Options Available for Controlling Releases to Water

#### 4.2.2. Containing waste and waste leachate (p. 36)

“Tanks. Tanks can be used to replace surface impoundments that may pose higher risks to human health and the environment. For information on proper installation and design/operating considerations, see section 2.2.8.”

#### 4.2.3. Applying overflow protection measures (p. 39)

“Overfill protection. Overfill protection controls for tanks, such as high-level alarms, can reduce the likelihood of spills. Several controls are available to facilities. For example, some systems have backflow protection to prevent waste from flowing out of tanks. Similarly, automatic shut-off valves will close when a tank becomes too full and an overflow is imminent. Visual and/or audible high-level alarms may be employed alone or in conjunction with these valve-based overflow controls.”

## 4.2.4. Installing leak detection methods (p. 39)

"Leak detection devices can be highly effective in alerting a facility operator to problems with the integrity of a storage tank. Leak detection can be monitored on either a continuous or periodic basis, as appropriate for the age of the tank, the material in the tank, and site-specific conditions."

"Continuous leak detection monitoring. Common continuous leak detection monitoring provisions for tanks include a concrete base, leak detecting bottom, and raised foundation. More sophisticated leak detection methods available for both tanks and liners include alarms, inventory control, acoustic emissions testing, volumetric measurement, and interstitial space monitoring (interstitial methods range from a simple dip stick to a continuous automated vapor or liquid sensor that is permanently installed in the system). Leak detection systems are most effective when integrated with leak containment systems and should be done so based on the site-specific characteristics present at a given facility. Leak detection systems by themselves only alert the facility operators to the existence of a discharge. When combined with leak containment structures, however, it is less likely that waste or leachate will be discharged to the environment. Trained and experienced installers should be consulted when employing continuous leak detection systems."

"Periodic leak detection monitoring. If a facility decides continuous leak detection monitoring systems are not feasible, periodic leak detection should be considered. Periodic leak detection involves checks or tests at regular intervals to assess the potential for waste discharge or tank bottom failure. Visual inspection is the most common form of periodic leak detection. When used, facilities should ensure that written records are maintained, interpreted, and reviewed. One drawback to visual inspection is the inability of operators to visually inspect the bottoms of many types of tanks. In these cases, other techniques that do not require tank entry, such as acoustic emissions monitoring, may be appropriate."

**Specific Sections that Concern Land Application:**

## Chapter 2. Siting, Design, and Operating Considerations

## 2.2. Basic Construction and Technical Considerations

## 2.2.1. Traditional land treatment (pp. 12-13)

"Land treatment includes land farming, land spreading, and other similar waste application methods. Land treatment units generally utilize biodegradation to treat waste. Except in certain circumstances, traditional land treatment may be inappropriate for liquid wastes. Where biodegradation is important to the treatment process, the treatment unit must be designed and operated properly to facilitate the biodegradation process."

"Design considerations. Land treatment units should be equipped with controls to prevent rain water and other liquids from running onto the unit (creating leachate) and to prevent leachate from running off the unit and carrying waste components into surrounding soils and nearby waters. Controls to prevent wind gusts from blowing small particles off land treatment units into the air and onto surrounding property and surface water should also be employed. As part of these efforts, facilities should consider the following:

¨ Wind dispersal controls (*e.g.*, decreased agitation, sprinkler system [*see section 3.2*]);
¨ Run-on and runoff controls (*e.g.*, adequate freeboard, dikes, berms [*see section 4.2*]); and/or

¨ Proper moisture content in the soil-waste matrix.”

“Operating considerations. Several operational activities are key to the successful operation of a land treatment unit. Land treatment units should be operated considering the following:

¨ Preventing pooling of oily liquids;
¨ Controlling the rate and method of waste application;
¨ Controlling soil chemistry and moisture content; and
¨ Enhancing microbial, chemical, and physical reactions appropriate for proper waste treatment.”

“The American Petroleum Institute has developed several publications that may be helpful in establishing operational considerations for land treatment units. These include “Evaluation of Limiting Constituents Suggested for Land Disposal of E&P Wastes” (API Pub. No. 4527), “Criteria for pH in Onshore Solid Waste Management in E&P Operations” (API Pub. No. 4595), and “Metals Criteria for Land Management of E&P Wastes” (API Pub. No. 4600). These publications may be ordered by calling API at 202-682-8000 or through the API web site at *www.api.org/cat*.”

## 2.2.2. Hybrid land treatment (p. 13)

“Hybrid land treatment is a technique that involves the placement of E&P waste in an excavated cell, washing the waste with freshwater to remove salts, injecting the resulting water into a Class II well, and then drying the remaining solids. The primary objective of this treatment method is the reduction of total chlorides to below regulatory criteria to allow the waste to be reclassified as reuse material. Some biodegradation of hydrocarbons in the waste also occurs, but this is not the primary objective of this treatment method. This technique is used most frequently in the State of Louisiana.”

“Design considerations. To facilitate the washing process, the treatment cell should be lined with a leachate collection system. The liner material and thickness should be appropriate to the hydrologic conditions at the site. Where wastes with higher hydrocarbon content are accepted, the need for additional separation prior to loading wastes or skimming of free oil during the washing process should be considered.”

## Appendix B: Summary of State Regulations Related to E&P Waste Management Facilities

Land Treatment regulations:

- California – p. 51 of API document
- Colorado – p. 52 of API document
- Louisiana – p. 55 of API document
- New Mexico – p. 57 of API document
- Oklahoma – p. 58 of API document
- Texas – p. 60 of API document
- Utah – p. 61 of API document
- Wyoming – p. 62 of API document

## Appendix D: Glossary

“Hybrid land treatment- A modification of land treatment whereby freshwater is used in the process to remove salts from the waste. Once the freshwater has been mixed with the waste, the salt-containing water is removed from the land treatment area for injection or discharge in accordance with applicable permits. This process may be repeated until the desired level of salt concentration is reached in the waste.” (p. 71)

“Land farming- This term is typically used for a process similar to that defined as land spreading, but where multiple applications of waste are made to the same parcel of land over time. To assure appropriate biodegradation of the hydrocarbons in waste, the waste or soil is often amended with fertilizer and may be tilled periodically.” (p. 71)

“Land spreading- A one-time, controlled application of waste to the land whereby the waste is spread over a wide area of land surface and is subsequently degraded, transformed, or immobilized and left in place.” (p. 71)

“Land treatment- A dynamic process involving the controlled application of nonhazardous E&P waste onto or into the aerobic surface soil horizon, accompanied by continued monitoring and management to alter the physical, chemical, and biological state of the waste. Site, soil, climate, and biological activity interact as a system to degrade and immobilize waste constituents thereby rendering the area suitable for the support of vegetative growth and providing for beneficial future land use.” (p. 71)

“Road spreading or mixing- The practice of applying certain E&P wastes onto roadways or mixing with excavated native materials to form road paving materials.” (p. 72)

Note: Chapter 3 Air Emissions and Related Issues (pp. 24-31) includes mitigation options designed to control air emissions from land treatment units (land spreading, land farming, road mixing).

**6. U.S. Bureau of Land Management (BLM) - *The Gold Book: Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*, 4th edition revised 2007**

**Website:** http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices.html%20

**General Description:**

This document developed by BLM provides operators with a combination of guidance and standards for ensuring compliance with agency policies and operating requirements. It includes requirements and voluntary management practices for conducting oil & gas exploration and production operations on Federal lands and on private surface over Federal minerals.

**Specific Sections that Concern Pits and/or Tanks:**

Chapter 1. Introduction

Environmental Best Management Practices (pp. 2-3)

"Environmental Best Management Practices (BMPs) are state-of-the-art mitigation measures designed to provide for safe and efficient operations while minimizing undesirable impacts to the environment. Proper planning and consultation among the operator, surface management agency, and non-Federal surface owner, and the proactive incorporation of environmental Best Management Practices into the APD [Application for Permit to Drill or Reenter] Surface Use Plan of Operations by the operator, will typically result in a more efficient APD and environmental review process, increased operating efficiency, reduced long-term operating costs, reduced final reclamation needs, and less impact to the environment."

Chapter 3. Permitting and Approval of Lease Operations

Surveying and Staking (p. 9)

"When an APD is submitted, staking must include the…reserve pit…unless a variance is granted."

"The well location plat must describe the location of the surface disturbances and their proximity to the nearest section lines, lease lines, ownership, or special use area boundaries…"

Chapter 4. Construction and Maintenance (p. 15)

"Construction and maintenance must be performed to standards that ensure the long-term health and productivity of the land. The operator's representative must ensure compliance with all plans and designs. The representative should be designated prior to construction; be accessible to the surface management agency authorized officer; have immediate access to an approved copy of the Application for Permit to Drill (APD), including all maps, drawings, templates, and construction standards; and have the authority to make changes at the request or order of the BLM or surface management agency."

## Well Sites

### Site Selection and Design (p. 15)

"To the extent permitted by the geologic target, well spacing, and drilling and production technology, the locations selected for well sites, tank batteries, pits, and compressor stations should be planned so as to minimize long-term disruption of the surface resources and existing uses, and to promote successful reclamation. Design and construction techniques and other practices should be employed that would minimize surface disturbance and the associated effects of proposed operations and maintain the reclamation potential of the site."

"The site layout should be located and staked in the most level area, off narrow ridges, and set back from steep slopes, while taking into consideration the geologic target, technical, economic, and operational feasibility, spacing rules, natural resource concerns, and safety considerations."

"Operations should also be avoided or properly mitigated in riparian areas, floodplains, playas, lakeshores, wetlands, and areas subject to severe erosion and mass soil movement."

"The advantages gained by a good well site or tank battery location should not be negated by the adverse effects of the access road location."

### Construction (p. 16)

"The drill rig, tanks, heater-treater, and other production equipment are not to be placed on uncompacted fill material. The area used for mud tanks, generators, mud storage, and fuel tanks should be at a slight slope, where possible, or a suitable alternative, such as ditching, should be used to provide surface drainage from the work area to the pit."

"To reduce erosion and soil loss, it may be appropriate to divert storm water away from the well location with ditches, berms, or waterbars above the cut slopes and to trap well location runoff and sediments on or near the location through the use of sediment fences or water retention ponds."

### Reserve Pits (pp. 16-18)

"Reserve pits are generally used for storage or disposal of water, drill mud, and cuttings during drilling operations. The pit should normally be located entirely in cut material. Avoid constructing reserve pits in areas of shallow groundwater. Reserve pits should not be constructed in natural watercourses. Water courses include lake beds, gullies, draws, streambeds, washes, arroyos, or channels that are delineated on a 1:24,000 USGS quadrangle map or have a hydrologic connection to streams, rivers, or lakes.

For reserve pit construction on sloping sites, the preferred method is to locate the pit on the drill pad next to the high wall. Pits are constructed totally in cut at such locations. If this is not possible, at least 50 percent of the reserve pit should be constructed below original ground level to help prevent failure of the pit dike. Fill dikes should be properly compacted in lifts. The necessary degree of compaction depends on soil texture and moisture content. The pit should be designed to contain all anticipated drilling muds, cuttings, fracture fluids, and precipitation while maintaining at least 2 feet of freeboard.

Pits improperly constructed on slopes or poor soil types may leak along the plane between the natural ground level and the fill. There is a significant potential for pit failure in these situations. When constructing dikes for pits or impoundments with fill embankment, a keyway or core trench should be excavated to a minimum depth of 2 to 3 feet below the original ground level. The core of the embankment can then be constructed with compacted, water-impervious material.

To prevent contamination of ground water and soils or to conserve water, it is recommended that operators use a closed-loop drilling system or line reserve pits with an impermeable liner, particularly when it is anticipated that pits will contain moderate or high levels of hydrocarbons and chloride, or the pits are located in areas of shallow groundwater or porous soils over fractured bedrock aquifers.

Pits can be lined with synthetic liners or other materials such as bentonite or clay. Impermeable liners should have a permeability of less than 10-7cm/sec. Liners must be installed so that they will not leak and must be composed of materials compatible with all substances to be placed in the pit. Synthetic liners with a minimum thickness of 12 mils and resistance to ultraviolet radiation, weathering, chemicals, punctures, and tearing are most commonly used, although some States may require liners that are thicker. Suitable bedding material, such as sand, clay, or felt liners should be used in areas where the base rock might puncture the liner.

Depending on the proposed contents of the pit and sensitivity of the environment, the surface management agency may require a leak detection system or the use of self-contained mud systems with the drilling fluids, mud, and cuttings being transported to approved disposal areas.

Reserve pits should be appropriately fenced to prevent access by persons, wildlife, or livestock. During drilling in active livestock areas, the reserve pit must be fenced with an exclosure fence on three sides and then fenced on the fourth side once drilling has been completed. Refer to Figure 1 for recommended fence construction standards in active livestock areas. In areas where livestock will not be present, other types of fences may be appropriate.

The fence should remain in place until pit reclamation begins. After cessation of drilling and completion operations, any visible or measurable layer of oil must be removed from the surface of the reserve pit and the pit kept free of oil. In some situations and locations, precautions, such as netting, may be required in order to prevent access and mortality of birds and other animals.”

## Chapter 5. Drilling and Production Operations

### Subsequent Well Operations (p. 37)

“Operations requiring the prior approval of BLM’s authorized officer include: deepening, plugging back, non-routine fracturing jobs, recompletion in a different interval, and conversion to a service well. If there is additional surface disturbance, the proposal must include a Surface Use Plan of Operations. A subsequent report of operations must also be filed for these operations following completion of the work.”

“Operations, such as routine fracturing or acidizing jobs or recompletion in the same interval, do not require prior approval if such operations do not involve additional surface disturbance and conform to standards of prudent operating practice. However, a subsequent report of operations must be filed for these operations.”

### Approval Procedures (p. 38)

“When additional surface disturbance is proposed that was not previously authorized for the well pad or right-of-way, a description of any subsequent new construction, reconstruction, or alteration of existing facilities, including roads, dam sites, flowlines and pipelines, pits, tank batteries, or other production facilities on any lease, must be submitted to the authorized officer for environmental reviews and approval.”

## Measurement of Production (p. 38)

"No oil is to be diverted to a pit except in emergency situations or with prior approval from the authorized officer. Oil in the pit must be recovered promptly, and the pit must be kept reasonably free from surface accumulations."

## Disposal of Produced Water (pp. 38-39)

"Produced water from leasehold operations will be disposed of by subsurface injection, lined or unlined pits, surface discharge into channels or impoundments, or other methods, including beneficial use, acceptable to the authorized officer and in accordance with the requirements of Onshore Order No. 7, Disposal of Produced Water, and other Federal or State regulations."

"In cases of water disposal into pits or other impoundments, the structures must conform to approved construction requirements in accordance with Onshore Order No. 7, BLM Manual 9172, and applicable State agency requirements."

"Pits, water impoundments, and surface discharges that present a potential hazard to humans, livestock, wildlife, and other resources should be subject to appropriate mitigation, such as fencing, netting, caging, or covers, as appropriate. Refer to Figure 1 for exclosure fence construction standards."

## Pollution Control/Hazardous Waste (p. 39)

"Containment structures sufficiently impervious to prevent a discharge to waters of the United States, such as containment dikes, containment walls, drip pans, or equivalent protection actions are to be constructed and maintained around all qualifying bulk oil storage facilities, including tank batteries, consistent with the Environmental Protection Agency's Spill Prevention, Control, and Countermeasure (SPCC) regulation (40 CFR 112). The containment structure must have sufficient volume to contain, at a minimum, the content of the largest storage tank containing liquid hydrocarbons within the facility/battery and sufficient freeboard to contain precipitation, unless more stringent protective requirements are deemed necessary by the authorized officer. Drip pans should be routinely checked and cleaned of petroleum or chemical discharges and designed to prevent access by wildlife and livestock."

"Containment dikes are not to be constructed with topsoil or coarse, insufficiently impervious spoil material. Containment is strongly suggested for produced water tanks."

## Noise Control (p. 40)

"The placement of tank batteries and other facilities offsite and the use of remote well monitoring systems can reduce vehicle traffic in the field and the associated noise."

## Visual/Scenic Resources (p. 41)

"Other considerations in more visually sensitive areas may include … using…low-profile tanks; avoiding the placement of tanks on the ridgeline…."
.

Placement of Production Facilities (p. 41)

"Consider centralizing production facilities offsite in an area that is out of important wildlife habitat or is screened from view by vegetation or topography."

Chapter 6. Reclamation and Abandonment

Reclamation Plan

Pit Reclamation (p. 44)

"All pits must be reclaimed to a safe and stable condition and restored to a condition that blends with the rest of the reclaimed pad area. If it was necessary to line the pit with a synthetic liner, the pit must not be breached (cut) or filled (squeezed) while still containing fluids. Pits must be free of oil and other liquid and solid wastes prior to filling. Pits may be allowed to air dry or may be solidified in place with BLM or FS approval. The pit liner must be removed to the solids level or treated to prevent its reemergence to the surface or its interference with long-term successful revegetation. If necessary, the pit area should usually be mounded slightly to allow for settling and positive surface drainage. "

"The concentration of nonexempt hazardous substances in the reserve pit at the time of pit backfilling must not exceed the standards set forth in the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 USC 9605, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), PL 99-499. All oil and gas drilling-related CERCLA hazardous substances removed from a location and not reused at another drilling location must be disposed of in accordance with applicable Federal and State regulations. {(Refer to 42 USC 9601(14)(Definition of "hazardous substances"); 42 USC 6921(2)(A)(exclusion of certain wastes associated with exploration and production); EPA 530-95-003, Crude Oil and Natural Gas Exploration and Production Wastes: Exemption from RCRA Subtitle C Regulation (May 1995)}."

Well Site Reclamation

Final Reclamation (p. 47)

"All excavations and pits must be closed by backfilling when they are dry and free of waste and graded to conform to the surrounding terrain."

Reclamation of Other Associated Facilities (p. 49)

"Other facilities and areas of surface disturbance associated with Federal oil and gas lease development, including water impoundments, power lines, metering buildings, compression facilities, and tank batteries must be removed and reclaimed in accordance with the standards identified previously and with the requirements of the surface management agency or surface owner."

## 7. National Park Service (NPS) - *Operators Handbook for Nonfederal Oil and Gas Development in Units of the National Park System*, October 2006

**Website:** http://www.nature.nps.gov/geology/oil_and_gas/op_handbook.cfm

**General Description:**

This document developed by NPS provides guidance for nonfederal oil and gas operators in units of the National Park System. It includes an overview of regulations and voluntary management practices for exploration, development, and production operations on NPS lands.

**Specific Sections that Concern Pits and/or Tanks:**

Chapter 4. Drilling & Production Operations

Table 4.2. Recommended Mitigation Measures for Drilling and Production Operations on NPS Lands (pp. 69, 74-81)

"Table 4.2 lists mitigation measures for drilling and production operations. Use of mitigation measures shown in the table are recommended by the NPS to ensure compliance with the NPS approval standard to utilize
"… technologically feasible methods least damaging to the federally owned or controlled lands, waters and resources of the unit while assuring the protection of public health and safety" (36 C.F.R. §.9.37(a)(1)). Many of the mitigation measures are derived from environmental guidelines and publications developed by the oil and gas industry and environmental professionals and may not address every environmental topic or risk that may be encountered during oil and gas operations. These tables are intended to be a tool to be used during project planning. An operator can look through the tables to see which measures would apply to an operation and select the most appropriate measures to include in his/her plan. An operator has the discretion to select the most appropriate mitigation to meet the NPS least damaging approval standard." (p. 69)

"When possible, adding fill is preferable to grading and excavation to construct roadways, wellpads, berms, secondary containment, etc. All reasonable attempts should be made not to disrupt the hydrology and adjoining wetlands." (p. 75)

"Construct a berm or ring levee around the drilling location. Install impermeable liners underneath the drilling rig and associated equipment including fuel storage and transfer areas. Install the liner to direct fluids to a collection point(s) for recycling or disposal." (p. 75)

"Use secondary containment (impermeable liner) around fuel, crude, and brine tanks, vessels, and under tank battery load-line connections to collect leaks, drips, and spills. Design secondary containment to eliminate or minimize collection of precipitation." (p. 77)

"Use secondary containment under tank battery load-line connections." (p. 79)

"Set storage tanks and other equipment on elevated and aerated base to prevent corrosion." (p. 79)

"Store NORM-contaminated waste in above ground tanks for proper disposal." (p. 79)

"Empty storage tanks and fill with water in preparation for flooding or major storm events (*i.e.*, hurricanes)." (p. 79)

## Drilling Pad Design

### Strategies to Reduce Environmental Risks (p. 86)

"Use impervious liners under all of the rig equipment, mud tanks, pipe racks, and other sources of spills to prevent soil contamination and to provide for effective stormwater management."

"Build a berm and/or ring levee around the entire location to provide backup should a spill escape from the lined area under the rig components. The fill for the pad should be relatively impermeable so not much seepage should occur if a spill escapes the lined areas."

## Environmental Precautions During Drilling Operations

### Earthen Reserve Pits Versus Steel Tanks (p. 88)

"The NPS no longer allows the use of earthen pits, even lined pits, inside a park. Depending on state requirements, wells drilled from surface locations outside the park may use earthen pits provided the operator constructs and maintains the pit to prevent migration of its contents. However, if damage occurs to park resources in the event of a spill, the operator will be liable for that damage."

"Inside a park unit an operator must use a fully containerized, closed-loop drilling fluid system in place of an earthen reserve pit system. This technique drastically reduces the potential for soil and water contamination. The closed-loop system usually needs less area than an average reserve pit so the operator can reduce the overall drill site area and area of potential impact."

"This earthen reserve pit would no longer be appropriate for operations inside a park. Pits create more surface disturbance and are more likely to leak contaminants to the environment."

"Steel tanks that hold water, reserve mud, and cuttings replace the need for traditional earthen reserve pits."

### Well Cuttings and Mud Disposal (p. 89)

"Use an efficient mud cleaning system and catch cuttings in steel tanks."

## Well Servicing and Workover Operations

### Strategies for Clean Well Servicing and Workover Operations (p. 93)

"Use a synthetic liner and board matting under rig components and construct berms/trenches to direct liquids to cellar."

"Use steel tanks to hold workover fluids and all liquids and solids returned from the well until they can be removed from the site."

"A small pump can be used to move liquids that might accumulate in the cellar to appropriate tanks or containers for reuse or disposal."

## Berm Design and Construction (p. 96)

"Berms should be constructed with materials sufficiently impervious to contain spills."

"Berms should be designed and constructed with sufficient perimeter and height to hold 1.5 times the volume of the largest tank."

"Containment systems constructed with corrugated galvanized steel are commercially available as an alternative to earthen dikes."

## Tanker Truck Loading (p. 97)

"Loading box located inside the tank's bermed, lined area adds another level of protection."

## Chemical Handling

## Strategies for Sound Chemical Handling (pp. 100-101)

"Use secondary containment under chemical drums and bulk containers."

"A bulk storage tank and the chemical injection pump, a common source of leaks and drips, are mounted over secondary containment."

"The operator in this photo uses bulk chemical storage and places them inside the storage tank's lined and bermed area."

## Chapter 5. Directionally Drilling a Well from Outside Park Boundaries to Inside a Park Unit

## Table 5.1. Suggested Mitigation Measures to Minimize Potential Threats to Park Resources and Values from Directional Drilling Operations Outside a NPS Unit (p. 118)

"Use closed loop containerized mud system or lined reserve pits."

"Use secondary containment around fuel, crude, and brine tanks and vessels."

"Fence and net open pits if they attract wildlife."

National Park Service Well Plugging Guide for Nonfederal Oil and Gas Wells (p. 145)

"All fluids and solids returned to the surface from the wellbore should be collected in metal tanks and disposed of at an approved disposal site outside of the park."

Table 7.2. Well Plugging and Surface Reclamation Recommended Mitigation Measures (p. 171-173)

"Collect all fluids and solids returned to the surface from the wellbore in metal tanks and dispose of them in an approved disposal facility outside of the park."

"To ensure successful reclamation of the site, an operator should:….
• Properly design and construct berms and liners to guard against contamination of the site. In a park, the mud system would have been a closed loop containerized mud system instead of earthen pits."

Site Reclamation (p. 174)

"Dewater pit contents (this would only apply to operations outside of a park)."

## 8. Earthworks - Oil & Gas Accountability Project (OGAP) - *Best Practices*

**Website:** http://www.earthworksaction.org/ogapbestprac.cfm

**General Description:**

This web-based document presents compiled information regarding various recommended practices that can be used with the goal of minimizing impacts during oil and gas operations.

**Specific Sections that Concern Pits and/or Tanks:**

Best Practices Overview
http://www.earthworksaction.org/issues/detail/best_practices_overview

> "There are better, cleaner, more efficient ways to extract and produce oil and gas.
>
> In some cases these "best" practices are developed and used by companies to save money.
>
> In other cases alternative practices, or best management practices (BMPs), are required by regulatory requirement."

Voluntary Best Practices

> "Some oil and gas companies innovate and improve their systems to cut costs. By cutting air emissions, reducing water use, controlling erosion, and employing other practices that increase revenue, they also reduce impacts on communities and the environment.
>
> Closed loop/pitless waste disposal
>
> For example, technologies have been developed that allow oil and gas operators to forego digging earthen waste pits. Instead, they used "close loop" systems where wastes enter steel tanks. For more information on this process and the benefits and profits that it brings to the industry, see Alternatives to Pits.
>
> Natural Gas STAR
>
> Through Natural Gas STAR, a voluntary EPA program, participating companies implement approximately 150 cost-effective technologies and practices that reduce emissions of air pollution from oil and gas development. In the process, they reduced emissions by 114 billion cubic feet (bcf) in 2008.
>
> By capturing and selling gas that would have otherwise leaked into the atmosphere, U.S. companies gained revenue of more than $802 million."

## Required Best Practices

“Oil and gas production regulations vary in stringency from state to state. If states with the most rigorous (in terms of protecting communities and the environment) rules – the “best practices” -- still have an active oil and gas industry, it demonstrates that companies can be better actors and still be competitive.

When these best practices are first codified industry will often challenge the new rules. They invariably argue that the cost of implementing the best practices will force them to go elsewhere.”

Colorado’s Pit Rule

“This happened in 2008 when the Colorado Oil and Gas Conservation Commission updated its rules.

One update required the disposal of pit liners in accordance with solid waste regulations -- using certified landfills or recycling them. Previously, operators were allowed to bury potentially toxic pit liners at the drilling site.

The Colorado Petroleum Association initially objected to the rule, but ultimately reconsidered. Meanwhile, one company, Williams, developed innovative ways to work with the rule – by “turning the waste into a resource.” Williams bales the liner and sells them to industries that recycle them into non-food-grade industrial products like bumpers or pallets; and by circumventing the need for drilling pit liners by switching to closed loop drilling systems.”

For more information:

“Earthworks has compiled information regarding various best, better or alternative practices that can be used to minimize impacts during oil and gas operations.

- Alternatives to pits
- Closed-loop drilling systems
- Directional drilling
- Flareless (green) completions
- Minimizing waste
- Surface disturbance
- Visual impacts
- Noise
- Air pollution

Other resources:

Oil and Gas BMPs - general

- Intermountain Oil and Gas Best Management Practices (BMP) Project. The Natural Resources Law Center at the University of Colorado has developed a “searchable BMP database” that has examples of voluntary and required best practices in the Intermountain West (Colorado, Wyoming, Montana, Utah and New Mexico).
- The federal Bureau of Land Management has compiled BMPs for road construction, visual resource management, wildlife, air resources, and general oil and gas operations.
- The Western Governor's Association has developed a handbook of Best Management Practices for Coalbed Methane Development.

Surface Owner and Wildlife Protections

- *Doing it Right: Best Oil and Gas Development Practices for New Mexico*. This EARTHWORKS fact sheet includes a framework for protecting surface owner rights, soil air and water, and wildlife habitat; and responsible energy development in New Mexico.
- *Drill-Right Texas*. This EARTHWORKS publication provides a reasonable and planned approach to reduce the long-term impacts of oil and gas development in Texas.
- *Doing it Right - Protecting our water, farms and ranches, and communities from irresponsible coal bed methane development*. This guide, written by Northern Plains Resource Council, outlines a strategy for ensuring that coal bed methane is developed responsibly in Montana.
- ALL Consulting. 2002. *Handbook on Best Management Practices and Mitigation Strategies for Coal Bed Methane in the Montana Portion of the Powder River Basin.*

Other

- Colorado Oil and Gas Conservation Commission's Outstanding Oil and Gas Operation Awards may give landowners a sense of what some companies have done to set them apart from the rest of the industry.
- Petroleum Technology Transfer Center (PTTC) - Environmental and Water Case Studies.”

## Alternatives to Pits

http://www.earthworksaction.org/index.php/issues/detail/alternatives_to_pits

### Closed containment systems

“Pits are used to store oil and gas wastes such as produced water, fracking flowback and other liquids not captured for sale during oil and gas production. There are many potential problems from pits -- leaky liners and overflows can lead to soil and water contamination, pits can produce odors and toxic air contaminants, and pits can be a hazard for birds and wildlife.

If pits are used to store oil and gas wastes, they should have, at minimum:

- two layers of liners,
- a leak detection system between the liner layers,
- fences tall and strong enough to keep out wildlife, and
- nets or other devices installed to prevent birds from coming in contact with the wastes.

Pits aren't necessary

There are more environmentally friendly alternatives to using pits (even lined pits):

- Closed containment systems (tanks)
- Closed-loop drilling systems
- Closed-loop drilling case studies"

## Closed Containment Systems
http://www.earthworksaction.org/index.php/issues/detail/alternatives_to_pits#TANKS

"Oil and gas operators can use closed containment systems (e.g., tanks that are not open on top) in place of various production pits.

As with pits, it is important that tanks be enclosed by fences and nets. Otherwise, birds, wildlife and livestock may still be attracted to the liquid in the tanks.

Tanks have a tendency to corrode with time and develop leaks. And they may overflow if their capacity is not adequate to hold the wastes (and any precipitation if the tanks are not enclosed).

The New Mexico Oil and Conservation Division's document *Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry* suggests the following measures to prevent contamination from tanks. [1]

- All above ground tanks that 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.
- All below grade tanks. . . must have secondary containment and leak detection.

The photo of the system above (credited to USFWS) does not have adequate secondary containment. If a leak were to develop underground the wastes would seep into the soil, contaminating the soil and possibly the groundwater. The lid does adequately prevent wildlife and birds from accessing the wastes. The pipe coming out of the lid allows venting of any built-up gases in order to prevent explosions.

The tank in the photo to the right has a steel-mesh lid to keep out wildlife and birds. The secondary containment pit has prevented the fluids from flowing all over the well site, but the waste fluids have seeped into the surrounding soil. Thus, it is possible that groundwater contamination has occurred. These wastes, which may contain toxic chemicals, are now accessible to wildlife.

Benefits of closed containment systems

- Tanks require little or no maintenance.
- Tanks may be reused (moved to a new site) when the well stops producing.
- Tanks isolate waste products from the environment; if enclosed tanks are installed, there is no need to install fences or netting to keep out wildlife and livestock.

These systems greatly reduce or eliminate soil contamination, thereby reducing remediation costs.

Examples of closed containment systems:

- In 2003, the Farmington, New Mexico City Council approved five gas wells on the condition that the company agreed to store condensate wastes in buried tanks; and install double walled condensate tanks as a means of leak protection.(Source: Laura Banish. February 12, 2003. "Farmington council approves five new gas wells," *Farmington Daily Times*).
- Many well sites in New Mexico use tanks to hold production wastes, but most lack leak detection devices and adequate secondary containment systems.

In the photo to the right, the tank has a solid top to prevent wildlife access. But there is no secondary containment system to prevent any fluids that overflow from seeping into the soil, and there is no way to easily detect if the bottom of the tank is leaking."

## Closed-loop or "pitless" drilling systems

http://www.earthworksaction.org/index.php/issues/detail/alternatives_to_pits#CLOSEDLOOP

"During drilling operations, "closed-loop" drilling fluid systems (sometimes referred to as "closed mud" or "pitless" systems) can greatly reduce or eliminate the discharge of toxic drilling wastes on site. These systems negate the need for drilling reserve pits. Not only is it possible to have pitless drilling operations, it can also be an economic advantage to companies to used closed-loop drilling systems.

Many companies are using closed loop drilling systems in Texas, Louisiana, Oklahoma, Alaska and other states. Examples of companies who are using closed-loop technologies include: Shell, El Paso, Chevron-Texaco, Exxon, and many others.

Differences between conventional drilling and closed-loop drilling systems

At a typical oil or gas drilling site, drilling fluids (mud, water, additives) are circulated through the wellbore, then the fluids and drill cuttings (rock fragments created by the drilling process) are deposited in a reserve pit dug near well. This pit is used to hold used drilling fluids and wastes.

A reserve pit can be the source of considerable costs at a drilling site.

- The pit itself must be constructed at the beginning of drilling, which requires the use of heavy earthmoving equipment.
- The pit may have to be lined.
- When the drilling project is over, the pit, including all of the waste fluids and solids, must be properly remediated. Remediation could include activities such as: the removal and offsite disposal of the waste materials and liner; the burial of the wastes and liner; backfilling of the pit with soil; and revegetation of the disturbed pit area.

Also, there are health, environmental, and financial risks associated with pits, which can contaminate soils with hydrocarbons, metals and salts, and leak potentially toxic liquids into surface or groundwater. [2]

In a closed-loop drilling fluid system, the reserve pit is replaced with a series of storage tanks that separate liquids and solids. Equipment to separate out solids (e.g., screen shakers, hydrocyclones, centrifuges) and collection equipment (e.g., vacuum trucks, shale barges) minimize the amount of drilling waste muds and cuttings that require disposal, and maximize the amount of drilling fluid recycled and reused in the drilling process. The wastes created are typically transferred off-site for disposal at injection wells or oilfield waste disposal facilities.

The tanks represent an additional cost, but overall, pitless drilling can save an operator money because there is no need to construct a pit, there is a reduction in the amount of environmental releases, and the closed-loop system results in more efficient use of drilling fluid."

"Benefits of Pitless Drilling**:**[3]

- it eliminates unsightly and hazardous pits
- it reduces the time, energy and expense of building, fencing and reclaiming reserve pits
- it decreases the need for cuts in sensitive and hilly areas
- total surface disturbance associated with a well pad is reduced
- it eliminates risk of waterfowl and wildlife mortality related to pits
- it eliminates risk of damaging underground pipelines and utilities
- it allows drilling in areas with a high ground water table
- it virtually eliminates drilling waste
- rigs use less water per well - it can reduce water consumption by as much as 80%
- the US Environmental Protection Agency (EPA) has estimated that "closed loop systems" can reduce the volume of drilling fluids by as much as 90% [4]
- it eliminates soil segregation, which reduces wind erosion problems
- it reduces truck traffic associated with transporting drilling wastes by as much as 75%
- it may improve relationship with surface owners
- it greatly reduced waste tracking and need for land farming operations
- drill cuttings may be put to beneficial use, e.g., if not contaminated they may provide a source of finely-ground clay for berm construction around tank batteries or other uses
- the tanks can be re-used"

Closed-loop systems reduce company liability

“Pits may or may not be lined (depending on the oil and gas regulations); and pits are open to the atmosphere. Because of this, the pit may leak liquids into surface or groundwater and release high levels of volatile organic compounds, which in turn create health, environmental, and financial risks. If improperly fenced, livestock may enter the pit area. If the livestock is poisoned by the pit materials, companies may be liable for the deaths, and be required to compensate the livestock owner.

According to the Railroad Commission of Texas, even though closed-loop drilling is not always the least expensive option, some companies in Texas have elected to use only closed-loop drilling fluids systems in their operations. Why? Because whenever a closed-loop system is used, the operator reduces the potential future liability associated with a conventional earthen pit, and reduces the waste management and site closure costs. It's also good for the company image and public relations.”

Increased Utilization of Closed-Loop Drilling

“According to a paper entitled "Bulk Transportation of Drilling Wastes," delivered at an American Association of Drilling Engineers Conference in 2002:

> *. . .environmental concerns and regulatory authorities are forcing the offshore drilling industry to modify or eliminate dumping of drilling wastes overboard. On land rigs, the practice of constructing earthen reserve pits is also declining in favor of 'zero-discharge' closed-loop systems. Therefore the effective containment and transportation of drilling wastes is becoming ever more important. The environmental benefits of a well designed waste collection and transportation system can be observed directly in many cases.*[5]

The New Mexico Oil Conservation Division identifies closed-loop drilling as a "best management practice" in their *Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry*. (See footnote 1) New Mexico OCD is not alone in identifying closed-loop drilling systems as a best practice. In almost any pollution prevention or "Best Management Practices" document for the oil and gas industry, closed-loop drilling systems are mentioned as the most environmentally safe method for reducing the potential impact that drilling operations can have on the environment. For example, the practice is mentioned in the following documents:

- The Illinois Environmental Protection Agency's *Best Management Practices for Oil Exploration and Extraction*
- Railroad Commission of Texas' *Waste Minimization in Drilling Operations*

Increasingly, closed loop systems are being used all over the United States, Canada, and the world. In personal conversations with closed-loop drilling system companies, OGAP has heard that one company has performed approximately 900 closed-loop drilling operations in the past eight years (in CO, WY, ND, NM and other western states). A representative from another company operating out of Texas, Louisiana and Oklahoma remarked that most of the major companies in the region are using closed-loop drilling systems at the majority of their operations, because they understand the potential future liabilities that may follow them if they use conventional drilling systems that use reserve pits.

This information was corroborated by the Texas Railroad Commission, which stated that, "Even though it is not always cost effective, some companies have elected to use only closed loop drilling fluid systems in their operations. . .whenever a closed-loop system is used, the operator reduced his potential liability associated with a conventional earthen pit and waste management and site closure costs." [6]

According to the U.S. Congress, Office of Technology Assessment, these systems are increasingly being used (e.g., in California) because of the reduction in overall drilling costs and in the volume of wastes needing disposal. (See footnote 4)”

## Comparison of closed-loop systems versus pits

“CASE 1: Prima Energy's Cost-Benefit Analysis [7]

Prima Energy Corp. has drilled more than 68 wells in Colorado using a highly automated closed-loop system, which the company started developing along with Nabors Drilling USA, Inc. in 1993. The company found that the economics of drilling these wells in Colorado were best if drilling required less than 12 days.

The table below provides a summary of the economics of using conventional reserve pits versus closed-loop drilling systems.

| | Conventional rotary drilling with reserve pit | | Closed-loop drilling with mud motors and diamond bits (50 wells) | |
|---|---|---|---|---|
| | Amount | Cost | Amount | Cost |
| Water | 6,400 barrels | $ 4,720 | 1,200 barrels | $ 1,350 |
| Location | 300 x 300 feet | $ 3,000 | 200 x 150 feet | $ 900 |
| Mud | | $ 2,000 | | $ 1,700 |
| Surface Damages | | $ 3,500 | | $ 2,500 |
| 6,400Berm | | $ 1,000 | | 0 |
| Mud Haul | | $ 2,800 | | $ 900 |
| Dewatering Unit * | | 0 | | $ 8,250 |
| Total | | $17,020 | | $15,600 |

* Dewatering cost includes rental of unit, labor, extra fuel, polymer and acid, linear motion shaker, centrifuge, trucking, end loader and miscellaneous costs.

Prima Energy's calculated benefits of closed-loop drilling:

- cost savings of $1,320 per well
- water savings of 5,200 barrels (closed-loop drilling used 80% less water)

CASE 2: MiSWACO - Closed-loop vs. Conventional Systems: A tale of two wells [8]

Closed-loop systems employ a suite of solids control equipment to minimize drilling fluid dilution and provide the economic handling of the drilling wastes. For one company, a typical closed-loop system includes a series of linear-motion shakers, mud cleaners and centrifuges followed by a dewatering system. The combination of equipment typically results in a "dry" location where a reserve pit is not required, used fluids are recycled, and solid wastes can be landfarmed, hauled off or injected downhole.

Two wells, drilled only 200 ft apart in Matagorda County, TX, provided a unique opportunity to compare the cost savings difference between conventional solids-control equipment and the company's closed-loop system. Both wells drilled through the same formations, using the same rig crew, mud company and bit program.

The closed-loop system with improved solids control resulted in some significant savings:

- 43% savings in drilling fluid costs
- 23% fewer rotating hours
- 33% fewer days to drill to a comparable depth
- 37% reduction in the number of bits used
- up to 39% improvement in the rate of penetration

CASE 3: Reducing Waste Volume and Costs Using Closed-loop Systems [9]

Challenges: 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. 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.

| | Conventional reserve pit | Closed-loop drilling fluid system |
|---|---|---|
| **Surface disturbance** | reserve pit (235' x 77' x 5')<br>cuttings pit (20' x 10' x 5')<br>water pit (40' x 10' x 5') | No reserve pit necessary. |
| **Total drilling mud and wastes in pits** | 16,625 barrels | 1,100 barrels |
| **Total reduction in drilling mud and wastes in pits using closed-loop drilling** | | **15,625 barrels** |

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 surface disturbance by 18,000 square feet (0.4 acres).
- Reduced drilling mud and wastes in pits by 15,625 barrels.
- Reduced potential for environmental impact to surface and groundwater.

CASE 4: Closed Loop Drilling Fluid System [10]

Problem: A small independent operator was concerned about the volume of drilling waste in conventional reserve pits at his drilling locations. Waste management costs were a concern, as well as the costs associated with impact on adjacent land due to pit failures. The operator was concerned about the potential for surface water or ground water contamination and the associated potential liabilities.

Solution: The operator was drilling relatively shallow wells in normally pressured strata. Because the drilling plan was relatively simple, the operator investigated the feasibility of using a closed-loop drilling fluid system for these wells. The use of a closed-loop system eliminated the need for a conventional reserve pit. The operator negotiated with drilling contractors to obtain a turn-key contract that required the drilling company to use a closed-loop system and take responsibility for recycling the waste drilling fluid.

Benefits: The turn-key contract was incrementally more expensive. Yet, because of reduced drill site construction and closure costs; reduced waste management costs; and reduced surface damage payments, the operator realized a savings of about $10,000 per well. Also, the operator reduced the potential for environmental impact and associated potential liability concerns.

CASE 5: Closed-loop System Helps Reduce Drilling Waste [11]

A large oil and gas production company used a number of pollution prevention techniques, including closed loop drilling, to drill an exploratory well adjacent to the Tishomingo Wildlife Refuge in Johnston County, OK. The well was drilled on land owned by the U.S. Army Corps of Engineers. Some of the measures taken in drilling the well included:

- Using a closed-loop mud system that allowed for reuse of drilling fluids and use of smaller quantities of water for dilution of the mud to control viscosity and density
- Use of compressed air as the drilling fluid where possible, which allowed for the use of smaller quantities of water and drilling fluid
- Using a smaller casing, which allowed for the use of a 25% smaller hole. This generated a smaller volume of drill cuttings and required less drilling fluid

Savings and Benefits**:** The hole-size reduction, use of air drilling and closed-loop system reduced wastes by close to 1.5 million pounds. A material and disposal cost savings of $12,700 was achieved.

For more information:

Sources:


1. New Mexico Oil Conservation Division (OCD). *Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry.* Volume I, Section 6, pp. 49, 50. Available for download from the OCD web site.
2. U.S. Environmental Protection Agency (U.S. EPA). October, 2000. *Profile of the Oil and Gas Extraction Industry*. EPA Office of Compliance Sector Notebook Project. EPA/310-R-99-006. p.69.
3. Longwell, John. Prima Energy Corp; and Glenn Hertzler, Nabors Drilling USA, Inc. "Closedloop system as a cost effective alternative to reserve pits." Presentation to the Consortium for Emerging Gas Resources in the Greater Green River Basin, *Advances in Drilling Technologies for the North American Rockies* (Denver, Colorado, April 28, 1997).
4. U.S. Congress, Office of Technology Assessment. March, 1992. *Managing Industrial Solid Wastes from Manufacturing, Mining, Oil and Gas Production, and Utility Coal Combustion*. Background Paper, OTA-BPO-82. (Washington, DC: U.S. Gov. Printing Office). p. 75
5. Richards, M.J. and Love, W.W. 2002. "Bulk Transportation of Drilling Waste," a paper presented at the American *Association of Drilling Engineers 2002 Technology Conference*, April 2002, in Houston, TX. Paper AADE-O2-DFWM-HO-18.
6. Railroad Commission of Texas. Oil and Gas Division. *Waste Minimization in Drilling Operations.*
7. Longwell, John and Hertzler, Glenn. (Prima Energy Corp. and Nabors Drilling USA, Inc., respectively). 1997. "Closed-loop system as a cost effective alternative to reserve pits," presented at the *Advances in Drilling Technologies for the North American Rockies Conference* (April 28, 1997, Denver, CO); and Interstate Oil and Gas Conservation Commission. *1999 Chairman's Stewardship Award Report*.
8. M-I SWACO. "Swaco closed loop systems: A tale of two wells." *This is Swaco*. p. 3
9. New Mexico Oil Conservation Division (OCD). *Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry*. Available for download from the OCD web site.
10. Railroad Commission of Texas. Waste Minimization - Case Histories - Drilling Operations.
11. Oklahoma Department of Environmental Quality. Pollution Prevention Case Studies.


Other Sources

- Earthworks: General information on oil and gas industry pit pollution
- New Mexico groundwater contamination from oil and gas facilities and pits"

## Flareless "Green" Completions

http://www.earthworksaction.org/index.php/issues/detail/flareless_completions

**"**Flareless or "green" completions reduce flaring and venting of natural ga**s.** Before natural gas and coalbed methane wells begin producing gas for sale, the well bore and surrounding reservoir must be "cleaned up" (i.e., any fluids, sand, coal particles, or drill cuttings within the well bore must be removed). The conventional method for doing this is to pump air down the well bore, which lifts the waste fluids and solids out. The solid and liquid waste materials are then dumped into a pit or tank, and any gas that is removed is flared or vented to the atmosphere. In some flareless or green completions, natural gas, rather than air, is pumped down the well bore to clean it out.[1]

In flareless or green completions the gas that comes to the surface is separated from fluids and solids using a series of heavy-duty separators (sometimes referred to as "flowback units"). The water is discharged to tanks to be reused, the sand is sent to a reserve pit, and the gas is either cycled back through the well bore, or sent to a pipeline to be sold rather than vented or flared. According to the U.S. Environmental Protection Agency (EPA), benefits of this system include: the elimination or reduction in venting or flaring of natural gas; sale of the gas and condensate provides the operator with an immediate revenue stream; there is a reduction in solid waste and water pollution; and the system enables safer operating practices.

Emissions Reductions**:** One company, which drilled 63 wells using flareless completions, reported a reduction in natural gas emissions of 7,410 thousand cubic feet per year, which is 70% of the gas that would formerly have been vented to the atmosphere. [2] Another company has been able to reduce flaring by 85-90%.[3]

Costs and Pay-Back**:** The capital costs for companies include the use of separators, sand traps and tanks. One company reported these costs as being $180,000. The equipment, however, can be moved from site to site, so if a company were to complete 60 wells per year the annual capital charges would be less than $10,000. Operating costs are less than $1,000 per year. EPA has estimated that "green completions" can pay back their costs in about 1 year.

An alternative to sending the gas to the pipeline is to send it to a flare tank. Flare tanks capture and more fully combust the waste gases. The tanks can be carried from site to site. This practice avoids the costs associated with excavating and reclaiming flare pits, and avoids the potential liability associated with cleaning up soils contaminated by flaring.

For more information:

Sources:

[1]D'Ambrosio, D. July 14, 2004. "BP experiments with flareless wells in county," Durango Herald.

[2] U.S. Environmental Protection Agency. 2004. "Green Completions." EPA Partner Reported Opportunities for Reducing Methane Emissions, PRO Fact Sheet No. 703.

[3]Williams Production RMT Company - Parachute office (a subsidiary of Williams Energy Services)."

## Minimizing Surface Disturbance

http://www.earthworksaction.org/index.php/issues/detail/minimizing_surface_disturbance

"Well pads are often much larger than they need to be - sometimes exceeding several acres in size. At Ted Turner's Vermejo Park Ranch, however, the well pads are only 0.6 acres. (See Vermejo Park Ranch Coal Bed Methane Project Mineral Extraction Agreement Summary, in *Oil and Gas at Your Door - a Landowner's Guide to Oil and Gas Development*, Chapter III).

After the drilling phase if over, the portion of the drilling pad not needed for oil or gas production can be reclaimed. This is known as interim reclamation, and it is required by law in many states. Unfortunately, lack of enforcement by state agencies means that interim reclamation does not occur in many jurisdictions.

During the drilling phase, pad size can be reduced by drilling multiple wells from one site. For example, at the Vermejo Park Ranch two or more wells have been drilled from the same pad (see directional drilling).

Redesigning pits can decrease the amount of surface disturbance.

If a pitless drilling system is not used for drilling fluids, another approach may be to use a V-shaped pit instead of the traditional rectangular pit. This type of pit reduces water requirements, as well as the amount of surface disturbance.

The design is as follows: the open end of the "V" faces the drilling rig and the cross-sectional view resembles a squared-off funnel (about 10 feet deep with the upper 5 feet having slanted walls to a width of about 20 feet). Because the fluid must travel the full length of the pit, this design prevents mud from channeling between the discharge point and the suction point, and reduces the amount of water that must be added to maintain the desired fluid characteristics. In addition, because the V-shaped pit is long and narrow, it is easier to construct and leaves a smaller "footprint" at the site.[1]

A company installed a V-shaped reserve pit and compared the costs with those incurred at similar-sized wells using a traditional pit. The company determined that pit construction time was reduced by about 40 percent, water costs for the well were reduced by about 38 percent, and pit liner costs were reduced by about 43 percent. The total cost savings were about $10,800 per well.

It should be noted that whenever earthen pits are used to store wastes, they should be lined with multiple layers of synthetic fabric with leak detection devices between the layers.

For more information:

Sources:

1. Railroad Commission of Texas, Oil and Gas Division. *Waste Minimization in the Oil Field*. Chapter 5. Page 5-3."

## 9. Houston Advanced Research Center - Environmentally Friendly Drilling Systems Program (EFD) - *Hydraulic Fracturing BMPs*

**Website:** http://efdsystems.org/index.php/best-management-practices

**General Description:**

This national website directory contains EFD research information and publications on voluntary management practices. The program is operated by Houston Advanced Research Center and Texas A&M University, with the support of industry, environmental organizations, academia, and government agencies. The stated goal of the program is to "integrate advanced technologies into systems that significantly reduce the impact of petroleum drilling and production in environmentally sensitive areas." A presentation on the EFD program was given to the SEAB Shale Gas Production Subcommittee.[10]

**Specific Sections that Concern Pits, Tanks, and/or Land Application:**

- Search directory for information on voluntary management practices.

[10] Dr. Richard Haut, Houston Advanced Research Center, *Environmentally Friendly Drilling Systems Program*, Presentation to the Secretary of Energy Advisory Board Shale Gas Production Subcommittee, June 28, 2011, http://www.shalegas.energy.gov/resources/062811_efd_presentation.pdf

## 10. <u>Oklahoma Corporation Commission - *Pollution Prevention at Exploration and Production Sites in Oklahoma: BMPs for Prevention and Control of Erosion and Pollution*, Water Quality Series E-940, April 2002</u>

**Website:** http://www.occeweb.com/og/E-940.pdf

**General Description:**

This document presents voluntary management practices for use at typical exploration and production sites in Oklahoma.

**Specific Sections that Concern Pits and/or Tanks:**

<u>Drilling and Production Sites (p. 33)</u>

"Erosion control and prevention of water contamination should be considered when planning, constructing, and operating oil and gas facilities. Roads, pads, pits, and tank batteries should be constructed, maintained, and closed according to OCC rules."

<u>Containment for Tank Batteries and Pits (pp. 33-34)</u>

"Dikes should be constructed around storage tanks for spill containment (Figure 9)."

"The diked area should be large enough to contain at least the volume of the largest tank in the facility. A splash pad/apron should be constructed at the unloading area of any disposal well pit. Follow all applicable regulations concerning site facilities and containment for tank batteries and pits."

<u>Drillsite Pits and Disposal of Drilling Mud (p. 35)</u>

"Reserve mud pits and completion/fracture/workover pits must be constructed and lined according to OCC rules. At least 24 inches of freeboard must be maintained at all times to prevent overflow and the release of drilling mud or other fluids."

<u>Closure of Pits (p. 36)</u>

"Pits must be properly closed to prevent pollution of surface water or ground water, and/or danger to wildlife. This means taking extreme care to assure that pit contents don't escape."

"If the pit contents are to be consolidated in place, the pit must be completely dewatered before trenching, stirring, or otherwise disturbing the bottom of the pit. Trenching or stirring is prohibited for certain categories of pits."

“A minimum of three feet of soil cover must be applied over any remaining pit contents. Stockpiled topsoil should be applied last. The soil should be mounded and shaped to ensure runoff without erosion. Vegetation should be planted and diversion terraces constructed, if necessary (Figure 10).”

“Figure 10. The soil cover on a pit should be mounded and vegetated to shed water.”

## Response to Salt Water Spills (pp. 37-38)

“Contain the spill and prevent further discharge. Minimize the area affected by diking or containing the spill in emergency pits, leak-proof tanks, or other suitable methods.”
“Salt water spills to surface water must also be corrected immediately. Confine the spill to the smallest area possible by using temporary dikes and emergency pits.”

## 11. New Mexico Energy, Minerals, and Natural Resources Department - *Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry*, 2000

**Website:** http://www.emnrd.state.nm.us/ocd/documents/2000PollutionPreventionBMPs.pdf

**General Description:**

This document provides tools for developing an environmental management system for the oil and gas industry in New Mexico. It includes a pocket guide that can be used in the field quickly.

**Specific Sections that Concern Pits and/or Tanks:**

Volume 1
3.0. Systems Approach to Pollution Prevention and Energy Efficiency (pp. 12-13)

"Figure 3-3. Activity-Based Costing Analysis of Produced Water Management"

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

Case History 1 - Drilling Operations
Use of "Closed Drilling Pit System" to Reduce Drilling Waste (pp. 23-24)

"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…"

"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.*)"

Case History 2 – Reserve Pit Management Systems (pp. 25-26)

"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.”

“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.”

## 6.0. Traditional and Discrete Recommended Best Management Practices (pp. 49-50)

“These best management practices should be used as guidance in considering alternatives in the company’s comprehensive pollution prevention environmental management system…”

“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…”

“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.”

## 7.0. Oil and Gas Exploration and Production

## Table 7-2. Drilling Rig Operations Alternatives (p. 57)

“Mud and Additives”

- “Use a closed-loop mud system. (See Section 4.0, Case History 1).”
- “Use the reserve pit management system. (See Section 4.0, Case History 2.)”

“Produced Water”

- “Use a closed-loop drilling fluid system. (See Section 4.0, Case History 1)”
- “Hydrotest pipelines, equipment, and tanks with produced water.”

## Table 7-5. Storage and Transportation Alternatives (p. 62)

"Produced Water"

- "Use a closed-loop drilling fluid system. (See Section 4.0, Case History 1)"

"Oil-contaminates 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."
- "Use summary or secondary containment under tanks."

## 10.0. Oil Field Services

### Table 10-1. Well Servicing and Workover Alternatives (p. 76)

"Produced Water"

- "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."

## Volume 2

### 3.0. Waste Management Table: Alternatives for Wastes Generated in Oil & Gas Operations

Waste: "Chemicals, surplus or unusable" (p. 29)
Alternatives: "Do not dispose of chemicals in mud or workover pits."

Waste: "Drilling fluids and additives, used" (p. 33)
Alternatives - Source Reduction: "Use solids control technology (e.g., chemically enhanced centrifuge) to recover water from drilling mud and reserve pit."

Waste: "NORM," "NORM-containing materials" (p. 40)
Alternatives – Source Reduction: "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."

Waste: "Pit wastes. Includes: waste in reserve pits and emergency pits" (p. 44)
Alternatives:
"S: Use rig wash judiciously. Install high-pressure, low-volume spray nozzles with automatic cutoffs.
S: Segregate fresh water, salt water, and oil-based fluids and solids. Use the "reserve pit management system."
S: Remove oil as soon as possible to minimize contamination of pit.
S: Locate and eliminate all sources of water leaks.
S: Grade site and use diversion structures to prevent or minimize stormwater run-on volume.
S: Use a closed-loop drilling fluid system if feasible.

S: Design pit and pit system to minimize waste. For example, use the "V" shaped pit or the "reserve pit management system."
S: Size and construct pits to accommodate only the necessary volumes anticipated plus an adequate freeboard.
S: Use tanks/vacuum trucks rather than earthen pits for workovers.
R: Stabilized, uncontaminated solids may be suitable for use as daily cover at landfills.
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.
R: Contract a drilling mud recycler to take waste drilling mud.
D: Hazardous: send to an approved, state-permitted RCRA hazardous waste disposal facility.
D: Nonhazardous: send to a state-permitted municipal solid waste landfill."
(S = source reduction; R = recycling; D =disposal)

Waste: "Rigwash" (p. 46)
Alternatives – Source Reduction: "Collect rigwash in tanks rather than earthen pits."

Waste: "Soils, crude oil contaminated (in primary field operations)" (p. 48)
Alternatives – Source Reduction:

- "Develop operational procedures that prevent contamination of soils. For example, preventative maintenance on flowlines and containment under tank battery load-line connections."
- "Use impervious secondary containment. Use pit liner material around and under production facilities."

Waste: "Soils, lube oil contaminated" (p. 48)
Alternatives – Source Reduction: "Use impervious secondary containment. Use pit liner material around and under lubricating oil systems."

Waste: "Tank bottoms (basic sediment and water)" (p. 50)
Alternatives:
"S: Recycle back through treatment system, with no additional requirements.
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.
S: Add appropriate chemical agents to reduce tank bottom accumulation.
S: Treat light oil tank bottoms with high temperature in heavy oil dehydration facilities.
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.
S: Use cone bottom stock tanks and run bottoms through heater-treater more frequently than normal.
S: Reduce the number of tanks by consolidating produced fluid storage facilities.
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…"

## 12. Railroad Commission of Texas - *Surface Waste Management Manual*, December 15, 2010

**Website:** http://www.rrc.state.tx.us/forms/publications/SurfaceWasteManagementManual/

**General Description:**

This web-based document provides technical guidelines for management of nonhazardous oil and gas wastes in Texas.

**Specific Sections that Concern Pits:**

http://www.rrc.state.tx.us/forms/publications/SurfaceWasteManagementManual/chapter4.php

"Chapter IV- Pits

Disposal or storage of oil and gas wastes in a pit should be allowed only if the activity does not result in the waste of oil, gas and geothermal resources or the pollution of surface and subsurface water. The pollution potential for any pit depends on the geology, hydrology and soils in the area, the type and volume of waste, and current waste handling and disposal practices. It is recognized that pits associated with oil field activities necessarily must be located near the well sites whether the locations are favorable or unfavorable in regard to potential pollution. Pit locations that present the least potential for contamination are in areas of low relief to minimize erosion and dike failure. Sites on impervious formations (such as thick, massive clay beds) are preferred over permeable formations (such as limestone and sand aquifer recharge zones, terrace deposits and flood plain alluvium). In areas where clay beds do not occur at the land surface, importing off-site soils with a high clay and silt content could be considered. In most circumstances, artificial liners are the best alternative.

GEOLOGY AND GROUND WATER

The geology and hydrology across the state is extremely variable. Even across much smaller areas such as a county, large differences occur. Figure 1(pdf) shows the major and minor aquifers in Texas. The minor aquifers, while yielding water in smaller quantities or in smaller areas than the major aquifers, are in some areas the only source of water supply. While it is impossible to delineate in this manual all the geologic, hydrologic or soil conditions that exist across the State, these factors will be evaluated on a case by case basis as an application to maintain and use a particular pit is received by the Railroad Commission in Austin. The applicant will be required to determine the distance to the nearest water well within one mile of the pit, the depth of that well, and the depth to the shallowest fresh water. Depending on the type of pit construction, a description of the soil material may also be required.

As previously stated, a detailed description of all geologic and hydrologic conditions across the State is not intended. Figures 2 through 4 (pdf) and Figure 5 (pdf) show surface pits located in geologic and hydrologic environments with the least potential for ground water contamination.

In Figure 2 (pdf), the pit shown extends below the water table and will cause local contamination. The extremely slow movement of the ground water would prevent any significant contamination. Typical ground water flow rates through the clayey sediments under low hydraulic gradients are 0.1 to 0.5 foot per year. The Texas Coastal Plain is composed of clays, silts and sands, and the water table is generally within 10 feet of the surface in areas other than near cities, industrialized areas or heavily irrigated areas. The sands and silts are found in old stream and river channels. On-site investigation is necessary to avoid sand and silt zones in the clays. The primary concern is contamination of surface water from rainfall traversing the pit and washing the pit contents into surface water drainageways.

The bottom of the pit shown in Figure 3 (pdf) will also intersect the water table during wet seasons. Water movement, however, is very slow, and the dissolved mineral concentrations may be altered by ion exchange. The depth of the water table in the clay belts is difficult to measure. Formations appear to be saturated because of capillary action above the actual water table. In dry seasons, the water table will be below the bottom of the pit and the relatively impervious clays will retard any significant seepage of pit waste to the water table. Properly located pits away from surface drainage on broad upland flats and on divides are preferred.

Figure 4 (pdf) shows a locality where alternating beds of clays, mudstones, marls and shales comprise most of the sediments. These are generally good sites for placement of pits. Some of the central and north-central Texas area, however, is covered by alluvial sands and gravels or stream alluvium and terraces. Exposures of bedrock generally occur on the sides of broad valleys, between terraces and in upland areas. Locations with sandstones in the sediments, the sandy surficial deposits, stream alluvium and terrace deposits should be avoided, if possible, when selecting a pit site. Placement of unlined pits in these materials could result in contamination of surface and ground water. Much of north-central Texas uses surface water sources, although some ground water is produced from sandstones, and stream deposits. The water table is generally less the 100 feet below the surface. The excavation of thin surficial deposits, which in many areas is less than three feet thick, is easily performed and may be necessary to expose suitable material for pit placement.

The major and minor aquifers shown in Figure 1 (pdf) outcrop in most of the State. A more critical review of applications for pits placed in these areas will be required. Each major and minor aquifer should have significant amounts of clay, shales, mudstones or other impervious materials as part of its makeup. For example, the Carrizo-Wilcox is a major aquifer in southeast Texas, but contains predominately clay and shale formations alternating with sand, clayey sands, and sandy clays. The outcrops of the impervious strata are the desirable locations for pit placement. Pits located on sands, silt and gravel outcrops will require an artificial liner (i.e., PVC, HDPE, CSPE).

SOILS

The characteristics of the soil at the pit site are a factor in pit construction. Soil characteristics are classified by several methods which fall into two general categories, agriculture and engineering. The behavior of a soil as an engineering construction material is the concern in pit construction. The primary engineering properties of soils are their texture and their ability to be molded and compacted, called plasticity. For most pits, soils from the excavation will be used to build the dikes. Therefore, the native soil must be compactible to prevent seepage and erosion. The soils exposed to the bottom and sides of the pit must also be reworked either to form a suitable base for a liner or to retain the fluids in the pit if it is unlined. Often a pit may be deeper than the surface soil layer, which generally is no greater than three or four feet thick, and penetrate the subsoil or the unweathered sediments. The subsoil material may be much coarser and more permeable than the soil and be unsuitable for pit construction.

Generally, information on the occurrence of soils from an agricultural standpoint are available from the Natural Resources Conservation Service (NRCS) and the NRCS county-based office. While data from these sources contain much useful information on the thickness, composition, and permeability of undisturbed soils, site-specific data is often necessary to make good engineering judgments.

Field identification of soil samples is the best, and sometimes the only way to gain sufficient information. Again, it is important to know the type of material that will compose the pit bottom and dikes. Any on-site sample should be representative of these materials. Explanations of field techniques for determining the texture and plasticity of soils are available. When necessary, the services of a soils engineering firm may be utilized.

## PIT DESIGN AND CONSTRUCTION

The pit design and construction techniques described below more frequently apply to pits proposed for long-term, continuous use that must be authorized by permit. Pits that are authorized by rule such as basic sediment pits and completion/workover pits generally are less sophisticated in design. Nevertheless, good judgment is necessary to avoid seasonal problems of flooding or high water table. If such problems are prevalent, then fabricated tanks should be utilized

All earthen dikes surrounding pits should be constructed of soil material which is capable of achieving a permeability of 1 x 10-7 cm/sec or less when compacted. During construction, successive lifts should not exceed nine inches in thickness, and the surface between lifts should be scarified to achieve a good seal. The dike height and width should be consistent with the volume of wastewater to be retained. Where wastewater is retained in above ground pits, which will be discussed later, it is recommended that the top width of the dike be at least four feet and the side slopes not be steeper than 3 to 1 (three feet horizontal to one foot vertical). Dikes for all pits are "keyed" into the underlying soil to achieve a good seal between the ground and the bottom of the dike to prevent lateral seepage of wastewater through the base of the dike. (see Figures 5, 6, 7, and 8)(pdf)

Two of the most common construction methods for pits are "above ground" and "below ground". The above ground pit should be used in areas where the water table is high. The above ground method consists of constructing dikes around the area without excavating below the surface (see Figure 5) (pdf). The dike material can be obtained entirely from a borrow pit as in the case of Pit A, or the area intended for the pit can be excavated slightly and leveled to obtain material for the dikes (Pit B). Pits A and B are not lined because the underlying soil is relatively impermeable (K< or = 1.0 x 10-7 cm/sec) and of sufficient thickness (>2 feet) to inhibit seepage into the ground water. Because the wastewater level in this type of pit will be above ground level a breach in the dike might result in contamination of surface waters. Therefore, it is very important that the dikes around the above ground pit be properly engineered and constructed. Pits C and D in Figure 6 (pdf) are constructed in the same manner as those shown in Figure 5 (pdf) except that they are lined. The underlying sediments are relatively permeable (K> 1.0 x 10-7 cm/sec) and clays in the soil are not of sufficient thickness to prevent seepage of wastewater into the ground water.

The "below ground" method of constructing a pit consists of excavating an area and building dikes around the excavation (see Figure 7(pdf). The below ground pit should be used in areas where the water table is well below the surface. The pits in Figure 7 (pdf) are not lined because the underlying material is relatively impermeable and of sufficient thickness to inhibit seepage to the water table. Pit E is the preferred method of construction. The wastewater level in this pit will under normal conditions be at ground level or below. Therefore, the probability is low of wastewater flowing into area drainage if the dike is breached. The wastewater level in Pit F normally will be above ground level, requiring greater care in the engineering and construction of the dikes. The pits shown in Figure 8 (pdf) are lined because of the permeable underlying soils.

## LINERS

A liner is a continuous layer of materials that serves to restrict the release or migration of oilfield fluids, oil and gas wastes, or waste constituents. A liner may be constructed of synthetic or natural materials.

A liner must:

- Have a permeability low enough to contain the material.
- Be chemically compatible with the material with which it is expected to come into contact.
- Be mechanically compatible with the operation.

· Be capable of maintaining its integrity over time.

GEOMEMBRANE LINERS

Flexible membrane liners, or *geomembranes* are impervious thin sheets of synthetic polymer material. The most widely used geomembranes are high density polyethylene (HDPE), polyvinyl chloride (PVC), very low density polyethylene (VLDPE), and chlorosulfonated polyethylene (CSPE); of these, HDPE is used the most

Commercially available geomembrane liners should all have sufficiently low permeability (typical permeability values are 0.5 x 10-10 cm/sec or less); therefore, the concern is that the liners be chemically compatible with the material to be stored and possess physical and mechanical properties which enable them to survive installation and operation. Other important considerations are resistance to ultraviolet degradation and thermal degradation. The American Society for Testing and Materials (ASTM) has adopted a number of standards for geomembrane liners. Other ASTM standards for plastics and rubber may be applicable, as well as EPA developed test methods. In general, the operator will need to rely upon testing which has been performed by the manufacturer. The manufacturer should be able to provide results of verification testing which has been performed by an independent laboratory. The verification testing should have been performed on the actual batch of liner material to be used

Chemical Compatibility

Chemical compatibility is of prime concern when selecting a liner. Manufacturers and vendors have evaluated the resistance of their liners to many chemicals. These are available in the form of chemical resistance charts. If the fluid to be contained is not on the chart, or consists of a mixture of chemicals, compatibility testing of the specific fluid/liner combination may be warranted.

Mechanical Compatibility

The geomembrane must first survive transportation and installation, avoiding tear, puncture, and impact. Deformations caused by settlement of subgrade soils and backfilled zones beneath the liner are the prime mechanical consideration in the selection of a liner. Pit liners may also be subjected to weather, inflow and outflow of fluids, abrasion, hydrostatic pressure, thermal stress, cleaning and maintenance stress, and exposure to animals. Geomembrane manufacturers should provide results of testing for mechanical properties such as tensile properties, tear resistance, impact resistance, and puncture resistance. Mechanical properties are proportional to liner thickness, therefore, thicker liners are correspondingly more resistant to mechanical damage.

Maintain Integrity over Time

In addition to chemical and mechanical degradation as noted above, liners are also subject to thermal and ultraviolet degradation. Ultraviolet degradation occurs due to natural sunlight; thermal degradation occurs at both high and low temperatures. ASTM test methods are available to evaluate these properties and manufacturers should be able to provide test results. Exposed liners must contain carbon black or other pigments to minimize ultraviolet degradation. Liner degradation can be limited by initial selection of the proper liner and the use of appropriate operating procedures during the life of the pit. Earth covers may be used to protect liners from sunlight and mechanical damage, however, this does not allow for visual inspection of the liner.>

Installation

Compaction of the subgrade soil is required to provide a firm and unyielding base for the lining materials. Generally, a fill subgrade is built-up in a series of compacted layers, while an excavated subgrade is compacted only at its surface. The regularity and texture of the surface of the uppermost layer of compacted material is critical prior to liner installation. After compaction has been completed, the surface should be finished. This is best accomplished by looking for and removing rocks, debris or irregularities with sharp edges. Drags, vibrating rollers and smooth steel rollers are common tools for fine finishing the bottom and sidewalls of the pits. The fine finishing process is dependent on care and control of water. Liner placement should be halted when rainfall is imminent, and the placement of liner materials on the fine finished slopes should take place as soon after the completion of "finishing" as possible to ensure that no surfaces are lost to the erosive effects of surface runoff (see Figure 9(pdf).

The most likely place for a leak to occur is at the seams. The number of seams should be minimized. Seams should be oriented up and down, not across a slope. Factory seams should be used where possible. All field seaming should be performed by qualified personnel.

COMPACTED SOIL LINERS

Compacted soil liners are constructed of soils containing clay, which are spread and compacted in layers or lifts. These liners are not generally appropriate for the primary liner in pits containing produced water, brine, or other mineralized waters, but may be appropriate for certain applications. Soils classified as CL, CH, or SC in the Unified Soil Classification System are typically used to construct liners. To be adequate, a compacted soil liner should have a thickness of two feet or more and a hydraulic conductivity of 1 x 10-7 cm/sec or less. Compaction to 95% standard Proctor at a soil moisture content of 2 to 3% wet of optimum is appropriate. A primary advantage of compacted soil liners is their ability to self-seal when the liner is penetrated.

OTHER

Other liners may be suitable in some circumstances. These lining materials may include concrete and asphalt concrete, as well as blended or admixed liners of soil and cement, soil and asphalt, and soil and bentonite. The acceptability of any liner depends on the climate and hydrogeology of the pit location, and the intended pit use.

LEAK DETECTION SYSTEMS

Leak detection systems for synthetic liners will be required for brine and brine mining pits. Detection systems will not normally be required for liners of any type of other pit unless the pit is located in a very hydrologically sensitive area. Some common underdrain systems consist of a gravity flow drainfield and collection points installed either under the pit liner and above a secondary liner or outside of the pit.

Figure 10 (pdf) illustrates a sloping drainfield of coarse porous material that allows wastewater that has passed through the pit liner to accumulate at the low end of the pit above a secondary liner. A riser pipe perforated or slotted in the drain material interval extends from the collection point to the ground surface or along the sloping pit wall and berm. By extending a tape or long, small diameter, cylindrical rod into the riser pipe, the presence of wastewater in the pipe can be determined. This type of underdrain system can be used for relatively deep pits.

Figure 11 (pdf) also illustrates a sloping drainfield of coarse, porous material that allows wastewater that has passed through the pit liner to accumulate at the end of the pit above a secondary liner. A drain pipe connects the collection point to a sump or trench constructed outside of the pit. The presence of wastewater in the sump or trench indicates a leaking liner. This type of underdrain system can be used for above ground or slightly excavated pits. Manufacturers of the various artificial liners also may have information on leak detection systems.

Geonets are highly efficient at transmitting fluids in the plane of the net and can be used to replace granular drainage layers in leak detection systems. Geonets are geosynthetic drainage materials composed of layers of parallel ribs or strands overlying similar layers at various angles. Virtually all commercially available geonets are made of HDPE. Geonets are available from manufacturers and vendors of geomembrane liner systems. Manufacturers should be able to provide test results and information on mechanical and hydraulic properties. When installed, geonets *must* have both surfaces covered with a geomembrane, geotextile, or other suitable material to prevent intrusion of soil into its openings. Geonets occupy less vertical space in the excavation and are typically easier to install than granular drainage layers.

Regular inspections should be made of the embankment and the berms. In particular, attention should be given to possible ground movement, cracks and erosion of the earth because failure of the earthwork can result in failure of the liner. Damage to the liner can also result if weed growth begins under the liner, or if a soil cover is present, on top of the liner. The berm area around the pit should be treated with a weed killer initially and maintained in a weed-free condition.

Operational procedures which may endanger the integrity of a lined pit are:
1. discharge of high-temperature waste liquids onto exposed or unprotected liners;
2. operation of a vehicle over any portion of an exposed liner;
3. discharge of a waste to the pit that is incompatible with the liner; and/or
4. direct discharge of liquid waste under high pressure."

## Clarification for Filing Application to Maintain and Use a Pit (Form H-11)

http://www.rrc.state.tx.us/forms/publications/SurfaceWasteManagementManual/2010-FracPicNotice.pdf

"Due to new technology much larger pits are now needed for the storage and mixing of fresh water and fracture flow-back water. Many of these pits are constructed to store wastewater above ground level. The design of these large pits where waste is stored above ground level is considered the practice of engineering and must be prepared under seal of a registered engineer as required by the Occupations Code Chapter 1001.

Many pits used for the storage of fresh water are converted for the use of mixing fresh water and fracture flow-back water. While the use of a pit to store fresh water does not require a permit, an application for a permit to maintain and use a pit (Form H-11) must be submitted for the converted use. A proposal to store waste above ground level within dikes must be prepared under seal of an engineer registered in Texas.

It is recommended that if it is known that a fresh water pit will be eventually converted for use as a fracture flow-back pit, an engineer be involved in the design and construction of the pit."

**Specific Sections that Concern Land Application:**

http://www.rrc.state.tx.us/forms/publications/SurfaceWasteManagementManual/chapter5.php

## Chapter V- Discharges and Land Disposal

LANDFARMING

“Landfarming of the following oil and gas wastes is acceptable without a permit provided the wastes are disposed of on the same lease where they are generated, and provided written consent of the surface owner of the tract where the landfarming will occur is obtained: water base drilling fluids with a chloride concentration of 3000 mg/l or less; drill cuttings, sands and silts obtained while using water base drilling fluids with a chloride concentration of 3000 mg/l or less; and wash water used for cleaning drill pipe and other equipment at the well site. Other landfarming operations require a permit.

Landfarming is a method of treatment and disposal of low toxicity wastes in which the wastes are spread and mixed into the soils to promote reduction of organic constituents and dilution and attenuation of metals. A permit application to landspread water base drilling fluid and associated cuttings, a permit application to landtreat oil and gas wastes, and a permit application to land apply produced water are each by letter of request. Landfarming utilizes the physical, chemical and biological capabilities of the soil-plant system to control waste migration and to provide a safe means of disposal without impairing the potential of the land for future use. Landfarms should be located on fine or medium grained soil with a thickness of at least 20 inches and a slope of less than five percent. Stormwater runoff must be controlled by either natural drainage features or by diversion structures. Landfarms should not be located in any area prone to flooding.

The application of fluid waste should be designed so that direct runoff of waste does not occur and so that the soil-plant system is not subject to prolonged saturation. Overloading can damage vegetation, produce odors, and limit oxygenation of the soil. Landfarming operations are limited by severe weather conditions. Wastes should not be applied during rainy weather to reduce the possibility of contaminated runoff and the excessive compaction of the soil by machinery.

Waste liquids and slurries can be applied to the land surface or injected beneath the surface. Sprinkler irrigation, flood irrigation, ridge and furrow irrigation, and surface spreading from hauling vehicles are methods of surface application. Subsurface application can be accomplished by injection plowing or by following a surface application with a disc or plow. This method is more effective in minimizing runoff contamination, controlling odors, and degradation of oil and grease or other organic waste.”

## 13. U.S. Fish and Wildlife Service (Arkansas Field Office) - *Best Management Practices for Fayetteville Shale Natural Gas Activities*, April 2007

**Website:** http://www.fws.gov/arkansas-es/docs/AR_Natural_Gas_Pipeline_BMPs_v2_April_2007.pdf

**General Description:**

This document was developed by a multi-agency workgroup. It provides guidance for natural gas exploration, drilling, and production operations in the Fayetteville Shale area in Arkansas.

**Specific Sections that Concern Pits and/or Tanks:**

2.0. Wetlands (p. 10)

"2.2. Drilling sites subject to inundation due to over bank flooding should use a closed loop system to prevent drilling fluids from entering the system during floods."

4.0. Construction Activities (pp. 12-13)

"4.4. Well sites should be located to avoid sensitive resources (contact FWS, AGFC, and ANHC to identify sensitive resources). A closed mud system or steel tanks should be utilized to drill the well in sensitive habitats, wetlands, state-owned natural areas, wildlife management areas, and national wildlife refuges. In sensitive habitats, all fluids and cuttings should be hauled off site for disposal in accordance with AOGC and ADEQ requirements. Non-sensitive areas also should follow APCEC and AOGC regulations for disposal. Surface tanks must have berms sufficient to contain 1.5 times the total volume of all tanks. The berm area must be lined sufficient to prevent any leakage, and rip-stop padding must be used to prevent tears or punctures in liners. AOGC General Rule B-1 requires that a permit be issued before drilling can commence therefore a control point of knowing when and where this activity will occur before it occurs."

"4.5. The area used for mud tanks, generators, mud storage, and fuel tanks should be sloped slightly, where possible, or a suitable alternative should be used to provide surface drainage from the work area to a secondary pit (not the reserve pit – ADEQ regulations). AOGC General Rule B-26 establishes requirements for secondary containment. Reference BMP 4.4 for additional guidelines."

"4.6. Well pads should be capable of supporting the drill rig, tanks, heater-treater, and other production equipment. All equipment should be located on compacted fill material. Slope the well pad to the well cellar or other low point to collect spills and contaminated storm water that collects within the lined area (e.g., a separate pit should be used for collection of storm water [hydraulic fluids, honey oil, pipe dope, and other mechanical fluids that may spill onto the well pad and are prohibited by APCEC regulations from entering the reserve pit and being land applied])."

"4.14. A berm and fence with locked gate should be constructed around storage tanks to contain spills and protect wildlife, visitors, and guard against vandalism. A sign with site name, operator name, and emergency contact information should be posted at the gate. AOGC General Rules prescribe containment and identification requirements."

"4.15. Berms should be designed and constructed with sufficient perimeter and height to hold 1.5 times the volume of the largest tank. Containment systems with corrugated galvanized steel are available as an alternative to earthen dikes. Another option is to place a synthetic liner beneath the tanks, fold the liner into the berm, which then can be reinforced with a cement mixture. AOGC General Rule B-26 establishes requirements for secondary containment."

"4.16. Interim reclamation of the drill site should be completed within six months of well completion. Interim reclamation plans including production equipment or facility site diagrams should be provided to the appropriate agency prior to drilling. Additional consultation may be required to determine final drill site dimensions. Reserve pit closure should occur within 30 days in sensitive habitats and adhere to APCEC regulations in other areas."

"4.19. Reserve Pits

a. Closed loop systems (refer to definition below) are strongly recommended on publicly-owned properties and recommended on private lands located near sensitive areas, including flood plains. Closed loop systems require smaller pad sizes and are the safest protocol for avoiding environmental contamination.

*Closed Loop System:* a typical closed-loop system includes a series of linear motion shakers, mud cleaners and Centrifuges followed by a dewatering system. The combination of equipment typically results in a "dry" location where a reserve pit is not required.

b. Reserve pits should be located entirely in cut material. Avoid areas with shallow groundwater and waterbodies.

c. The reserve pit should be designed to contain all anticipated drilling muds, cuttings, and precipitation while maintaining a minimum two feet of freeboard.

d. ADEQ pit liner requirements include an impermeable liner (clay, synthetic, or combination) to prevent ground water and soil contamination and conserve water.

e. Oil based mud should not be used or stored in reserve pits during waterfowl migration periods (November to March). In some situations, netting may be required in order to prevent mortality of migratory birds (refer to BMP 1.8). Reserve pits with oil-based mud must use a synthetic liner per ADEQ regulations however, closed systems are encouraged. If site conditions warrant (i.e., floodplain, near waterbody, wellhead protection area, or other significant site issues), ADEQ or Arkansas Department of Health (ADHS) could require additional construction requirements.

f. Reserve pits should be fenced to prevent access by persons, wildlife, or livestock. The fence should remain in place until pit reclamation begins.

g. The operator must properly dispose of drilling fluids and muds from the reserve pit to a permitted facility and reclaim the pit area as soon as practicable following completion of drilling activities.

h. When closing reserve pits, follow the Arkansas Department of Environmental Quality Reserve Pit requirements (Refer to Appendix C for more information)."

## 6.0. Disposal of Produced Water, Drilling Fluids, Fracturing Fluids, Biocides, or Other Specialty Chemicals (p. 15)

6.3. Secondary containment of produced water tanks is strongly encouraged.

## 8.0. Well Servicing and Workover Operations (p. 15)

"8.1. Strategies for clean well servicing and work over operations include:…"

"b. Use a synthetic liner and board matting under rig components and construct berms/trenches to direct liquids to cellar when location conditions require it."
"c. Use steel tanks to hold work over fluids and all liquids and solids returned from the well until they can be removed from the site…"

## 14. <u>Natural Resources Law Center - *Intermountain Oil and Gas BMP Project*</u>

**Website:** http://www.oilandgasbmps.org/index.php

**General Description:**

This is a free-access website of voluntary management practices for oil and gas development in the Rocky Mountain Region. The database includes mandatory and voluntary management practices currently used or recommended for responsible resource management in the states of Colorado, Montana, New Mexico, Utah, and Wyoming. It is not intended to represent a consensus on the management practices for specific applications. The database describes each management practice, documents the source, provides a link to the source, and provides supplemental information.

**Specific Sections that Concern Pits, Tanks, and/or Land Application:**

- Search directory for information on voluntary management practices.

# 6. Findings

EPA agrees with the recommendation of the Shale Gas Subcommittee of the Secretary of Energy's Advisory Board (SEAB) that the federal government should encourage the development of additional and improved "best practices." Based on the review of existing voluntary management practices documents, ORCR determined that there is much existing guidance developed and being used by industry, federal, state, and non-governmental organizations. The scope ranges from local to state, regional, national, and international. The guidance documents compiled in this review are readily available to the public. In addition, there are ongoing efforts by the various stakeholder groups to continuously develop additional guidanceses and improve existing ones.

The voluntary management practices examined in ORCR's review are intentionally general rather than prescriptive due to the site-specific nature of E&P. Many of the documents recommend that users select the appropriate management practices for their specific needs. The general approach allows users the flexibility to select the management practices and adapt them to meet the site-specific requirements of the individual projects and the local conditions.

Many, but not all, of the documents examined in this review include recommended general technical criteria for E&P pits and tanks covering some or all of the following areas: general, permitting, construction, operational (including maintenance, inspection, monitoring, data collection, testing, remediation), and closure. However, as previously noted, EPA did not evaluate the adequacy or protectiveness of any of the voluntary management practices summarized in this document.

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