National Pollutant Discharge Elimination System Permitting and Pretreatment for Shale Gas Extraction Wastewater Frequently Asked Questions

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Office of Wastewater Management

USEPA Office of Water

General Note

These FAQs provide advice on how to establish technology based and water quality based limits and pretreatment requirements in National Pollutant Discharge Elimination System permits for discharges from oil and natural gas extraction. The statutes and regulations cited in this document contain the requirements applicable to NPDES permitting. The document does not impose legally binding requirements on EPA, states, tribes, other regulatory authorities, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA, state, tribal and other decision makers retain the discretion to adopt approaches on a case-by-case basis that differ from those provided in this guidance where appropriate and consistent with statutory and regulatory requirements. EPA may update this document in the future as new information becomes available.

Introduction

The EPA regulates wastewater from oil and gas wells under the Clean Water Act (CWA) when it is discharged to surface waters or into Publicly Owned Treatment Works (POTWs). Previously, on March 17, 2011, the EPA issued a document entitled, *Natural Gas Drilling in the Marcellus Shale--NPDES Program Frequently Asked Questions*, to provide state and federal permitting authorities in the Marcellus Shale region with guidance on issues associated with treatment and disposal of wastewater from shale gas extraction (SGE)[1]. During the time since those Frequently Asked Questions (FAQs) were issued, the need for additional, more detailed, information to address water quality permitting and pretreatment became evident. This document supplements the March 17, 2011, FAQs and provides more detailed information to assist National Pollutant Discharge Elimination System (NPDES) permitting authorities and pretreatment control authorities in addressing issues related to SGE.

The March 17, 2011 FAQs were intended to provide information regarding SGE in the Marcellus shale deposit. While part of the information in those FAQs is specific to the geology and pollutant concentrations for the Marcellus shale, that information is likely to be relevant to extraction of gas from other shale deposits. The general issues and types of pollutants present are expected to be similar for SGE throughout the country; however, different shale deposits are likely to produce flowback from hydraulic fracturing and produced water that contain different pollutant concentrations. Thus, site specific data should be considered by regulatory authorities in their actions addressing flowback and produced water disposal.

These FAQs are likely to contain information that is useful in developing permit conditions for other types of onshore oil and gas extraction. Although this document is more directly focused on permit development relative to SGE, many of these issues and pollutants of concern are pertinent to other types of onshore oil and gas extraction, such as oil shale extraction. Hydraulic fracturing, which is the main source of water use and often the main source of wastewater in unconventional oil

[1] SGE wastewater can include hydraulic fracturing flowback water (HFFW), produced water, spent drilling fluids, and spent well completion and treatment fluids that result from shale gas extraction activities. HFFW and produced water are the main subject of this paper and appear more likely to be indirectly or directly discharged; however, all of these waste streams could potentially be discharged and would need to be addressed in the NPDES permit development process or through pretreatment programs.

and gas extraction, is commonly used in all types of oil and gas extraction.[2] Over 1 million wells have been hydraulically fractured in the United States.[3,4]

The technology based Effluent Limitations Guidelines (ELG) applicable to onshore oil and gas extraction do not treat gas or oil extracted from shale differently than extraction from other types of deposits covered by the ELG.[5] The regulatory requirements governing protection of water quality and pretreatment of wastewater disposed of in POTWs also do not differ for the various types of extraction or sources. Therefore, permitting authorities may wish to consider the information in this document during development of permits for any type of onshore oil and gas extraction.

Why is this information needed?

As the number of shale gas wells in the U.S. increases, so too does the volume of SGE wastewater that requires disposal and could potentially be discharged. Approximately 1 to 3 million gallons of wastewater is expected to be produced from a single well within the first 30 days following fracturing.[6] Wastewater associated with SGE can contain high levels of total dissolved solids (TDS), chlorides, fracturing fluid additives, metals, organics, naturally occurring radioactive materials (NORM) and other pollutants which likely would not be effectively treated in most wastewater treatment plants.

In some areas of the country, disposal of large volumes of produced water from oil and gas production has been occurring for decades. Typically, well operators transport this wastewater to injection wells permitted under the Safe Drinking Water Act Underground Injection Control (UIC) program. As a result, the wastewater is permanently emplaced underground. This practice has been commonly used by the oil and gas industry to dispose of wastewater. For example, this practice is widely used in extraction from the Barnett Shale formation where over 120 active disposal wells have been permitted by the UIC program. However, in some areas of the country where SGE activities have expanded, wastewater disposal wells are less

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[2] Beckwith, Robin, Hydraulic Fracturing, The Fuss, The Facts, The Future, Journal of Petroleum Technology, December, 2010, found online at: http://www.spe.org/jpt/print/archives/2010/12/10Hydraulic.pdf

[3] American Petroleum Institute, Oil and Natural Gas Overview, Hydraulic Fracturing Q & As, found online at: http://www.api.org/oil-and-natural-gas-overview/exploration-and-production/hydraulic-fracturing/hydraulic-fracturing-qa.aspx

[4] Montgomery, Carl T., and Michael Smith, Hydraulic Fracturing, History of an Enduring Technology, Journal of Petroleum Technology, December, 2010, found online at: http://www.spe.org/jpt/print/archives/2010/12/10Hydraulic.pdf

[5] Due to differences ion the amount of water and lifecycle of operations when the greatest volume of wastewater are produced Coal Bed Methane extraction in not regulated under the Oil and Gas Extraction ELG.

[6] Ground Water Protection Council and ALL Consulting. 2009. Modern Shale Gas Development in the US: A Primer. Ground Water Protection Council and ALL Consulting for US Department of Energy. Available at http://www.netl.doe.gov/technologies/oilgas/publications/epreports/shale_gas_primer_2009.pdf

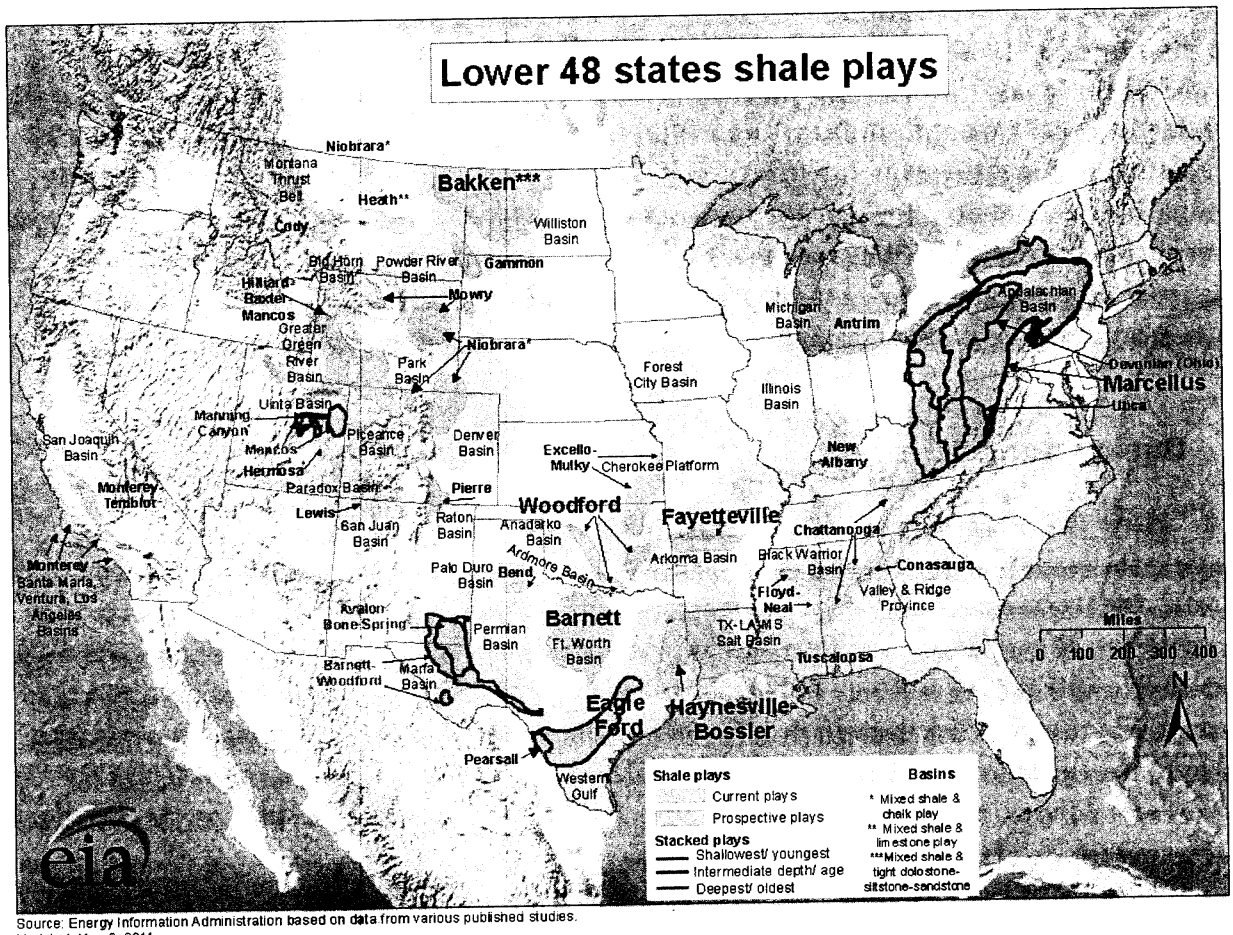
common. The lack of underground injection wells means that operators must use alternative disposal methods, creating new environmental challenges in some regions of the country. It is anticipated that over time, as the demand for wastewater disposal increases, more injection wells will be drilled where suitable geology exists. While disposal through underground injection is currently common, the practice of recycling SGE wastewater for use in hydraulic fracturing of new wells has recently grown in prevalence. The practice decreases the need for disposal in underground injection wells or at discharging CWTs or POTWs, and the potential environmental issues associated with those practices. Recycling also reduced the demand on local water sources (including groundwater, as applicable) and in areas where water is in short supply aids the industry's ability to extract oil and gas.

1 Background

1.1 How do different shale gas deposits compare?

Major shale deposits currently being developed in the United States include the Antrim, Barnett, Fayetteville, Haynesville, Marcellus, and Woodford shales. Those shale deposits all have the common characteristic of low porosity and permeability. Extraction almost universally requires horizontal drilling combined with extensive hydraulic fracturing. There are some differences in depth, aerial extent, gas content, and thickness that distinguish between the different shale deposits. A comparison follows in Table 1. Gas extraction activities at all of those shale deposits will present the same challenges for wastewater disposal; however, the degree of difficulty is likely to vary based on site specific conditions such as availability of underground injection wells.

Figure 3: Shale Gas Plays in the United States



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

Table 1: Comparison of Data for a range of Gas Shales in the United States[7]

Gas Shale Basin	Estimated Basin Area (mi^2)	Depth (ft)	Net Thickness (ft)	Gas Content (scf/ton)
Antrim	12,000	600-2,200	70-12	40-100
Barnett	5,000	6,500-8,500	100-600	300-350
Fayetteville	9,000	1,000-7,000	20-200	60-220
Haynesville	9,000	10,500-13,500	200-300	100-330
Marcellus	95,000	4,000-8,500	50-200	60-100
Woodford	11,000	6,000-11,000	120-220	200-300

2 Applicability of the Clean Water Act and Its Implementing Regulations

2.1 Does the CWA apply to wastewater from SGE to surface waters?

Yes. Natural gas drilling may result in wastewater that is discharged directly or indirectly to waters of the United States. The discharge of this water is subject to requirements under the CWA. The CWA prohibits the discharge of pollutants by point sources into waters of the United States, except in compliance with certain provisions of the CWA, including section 402. 33 U.S.C. 1311(a). Section 402 of the CWA establishes the NPDES program, under which the EPA, or an authorized state agency or tribe, may issue a permit allowing the discharge of pollutants into waters of the U.S. 33 U.S.C. 1342(a). NPDES permits must include technology-based effluent limits (based on the appropriate level of technology available to control the pollutants[8]) as well as any more stringent limits necessary to meet water quality standards applicable to the receiving water (i.e., water quality-based effluent limits). CWA Section 301(b), 33 U.S.C. § 1311(b).

In addition, the discharge or introduction of SGE wastewater to publicly owned treatment works (POTWs) is also subject to CWA regulation under section 307(b)(1) and EPA's implementing regulations. Section 307(b) of the CWA requires EPA to promulgate pretreatment standards for pollutants that may interfere with, pass through or are insusceptible to treatment at the POTW or are otherwise incompatible with POTW operations.

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[7] Arthur, J., et.al., 2008, An Overview of Modern Shale Gas Development in the United States, ALL Consulting, 21 p., posted at: http://www.all-llc.com/publicdownloads/ALLShaleOverviewFINAL.pdf

[8] Best available technology economically achievable (BAT) applies to toxic and non-conventional pollutants; best conventional technology (BCT) applies to conventional pollutants. CWA section 301(b)(2)(A)(BAT); 301(b)(2)(E)(BCT); "best practicable technology" (BPT) (the first stage of control) applies to all pollutants. .

2.2 What CWA regulations apply to discharges associated with SGE wastewater?

The technology-based requirements for direct discharges from oil and gas extraction facilities into waters of the U.S. are found in the Effluent Limitations Guidelines (ELG) for the Oil and Gas Extraction Category in 40 Code of Federal Regulations (CFR) Part 435.

SGE wastewater may also be transported to centralized waste treatment facilities (CWTs) which may be authorized to discharge treated effluent under the NPDES program. The technology-based ELGs for CWTs can be found at 40 CFR Part 437.

SGE wastewaters may also be indirectly discharged to POTWs that then discharge directly to waters of the U.S. Those types of discharges, made through POTWs, are commonly called indirect discharges, industrial users, or non-domestic discharges. For consistency in this document the term industrial users is used hereafter in this document. There are three types of applicable requirements that apply to all indirect dischargers to POTWs: general pretreatment regulations found at (40 CFR Part 403); any applicable categorical pretreatment regulations, analogous to ELGs and standards (which, for this point source category, are found at 40 CFR Part 435); and any local pollutant limits established by POTWs in accordance with EPA's regulations (40 CFR Parts 403.3(j) and 403.5(d)). Although the EPA has generally promulgated pretreatment standards that apply to industrial users along with the effluent guidelines for direct dischargers in these industrial categories, the current ELGs for onshore oil and gas extraction do not include pretreatment standards that address the disposal of SGE wastewater to POTWs. However, although there are no national categorical pretreatment standards that prohibit or restrict the disposal of SGE wastewater from Onshore Subcategory wells to POTWs, process wastewater from such operations may be introduced to POTWs only to the extent that such wastewater discharges are in compliance with all Federal, State, and local requirements.

For example, the EPA's general pretreatment regulations prohibit the introduction of wastewater into a POTW in certain defined circumstances, including introduction of pollutants that interfere with, pass through or are otherwise incompatible with POTW operations. 33 U.S.C. § 1317(b)(1). The general regulations that address pretreatment can be found at 40 CFR Part 403.

More detailed information concerning acceptance of wastewater at CWTs and POTWs and permit development issues is provided below in responses to questions 2.8-2.12 and in Section 5.

Oil and Gas Effluent Limitations Guidelines 40 CFR Part 435

2.3 Do the Oil and Gas Extraction ELGs for onshore operations, found at 40 CFR Part 435, Subpart C, apply to SGE?

Yes. Except as described in question 2.7 regarding the Agriculture and Wildlife Use Subcategory, the technology-based regulations (40 CFR Part 435, Subpart C) apply to onshore SGE facilities "engaged in the production, field exploration, drilling, well completion and well treatment in the oil and gas extraction industry." SGE fits squarely within this applicability statement. Although, as discussed in

Question 1.3 above, SGE is considered "unconventional" gas extraction, the waste streams generated by the processes that are utilized, such as hydraulic fracturing, were considered and covered by the ELG. *See,* 41 Fed. Reg. 44946 (Oct. 13, 1976); Technical Development Document at 22-23, 96, 137. Accordingly, the discharge prohibitions in 40 CFR Part 435, Subpart C, apply.

For all wells subject to Subpart C of the ELG, the direct discharge of wastewater is prohibited. This requirement is based on best practicable control technology currently available (BPT) for onshore facilities: "there shall be no discharge of waste water pollutants into navigable waters from any source associated with production, field exploration, drilling, well completion or well treatment (i.e., produced water, drilling muds, drill cuttings, and produced sand)." During the development process for the guidelines, EPA identified different technologies that operators can use to meet this zero discharge requirement (e.g., underground injection and use of pits/ponds for evaporation); although the effluent guidelines specify only the limits and not the particular technology that must be used to meet them.

2.4 May an NPDES permit authorize onsite discharge of SGE wastewater to a water of the U.S.?

Section 402(a) of the CWA and implementing regulations at 40 CFR § 125.3 require that all applicable technology based requirements must be applied in NPDES permits. An NPDES permit issued for a drilling activity must be consistent with the applicable technology-based requirements at 40 CFR Part 435, Subpart C, which state that "there shall be no discharge of wastewater pollutants into navigable waters from any source associated with production, field exploration, drilling, well completion, or well treatment (i.e., produced water, drilling muds, drill cuttings, and produced sand)."

2.5 Are facilities subject to 40 CFR Part 435, Subpart C required to obtain an NPDES permit that imposes the "no discharge" requirement for the activities identified in Subpart C?

If facilities do not discharge, they are not required to apply for NPDES permits under EPA's regulations. States may use their own authority under CWA section 510 (33 U.S.C. 1370) to ensure that the no discharge requirement in the effluent guideline is properly applied and to ensure that operator compliance is demonstrated.

Facilities subject to a zero discharge requirement may apply for permit coverage because permits afford some protection for discharges under certain circumstances. The NPDES regulations allow for upset and bypass in the event of an unanticipated discharge resulting from an exceptional incident that otherwise would be a CWA Section 301 violation for discharging without a permit. *See* 40 CFR § 122.41(m) and (n).

2.6 Can any SGE activity fall under the Stripper Subcategory (40 CFR 435 Subpart F)?

Under the regulations, the Stripper Subcategory only applies to onshore facilities that produce 10 barrels or less of crude oil per well per calendar day. It does not apply to gas extraction.

2.7 Do the ELGs allow for the direct discharge of produced waters from wells located onshore in some cases?

The Oil and Gas ELG does allow direct discharge of produced water in the Agricultural and Wildlife Use Subcategory. This subcategory applies to discharges in the western United States where certain conditions are met.

In some cases, gas extraction from shale deposits located in the western United States may fall under the Agriculture and Wildlife Use Subcategory (Subpart E). Subpart E, also known as the beneficial use subcategory, was issued to accommodate beneficial use practices in semiarid and arid parts of the country located west of the 98th meridian.[9] Historically this has been applied to some formations that have produced water with relatively low salinity. Under Subpart E, wells can be authorized to discharge produced water if it is of "good enough quality to be used for wildlife or livestock watering or other agricultural uses and is actually put to that use during periods of discharge."

In theory discharges of wastewater from SGE wells located west of the 98th meridian could be authorized under Subpart E; however, available data from ongoing SGE activities suggest that the produced water is likely to contain high concentrations of TDS that may require advanced treatment to meet the requirement to be of "good enough quality" to be used for wildlife or livestock watering or for irrigation. In addition to the technology-based requirements, any NPDES permit would also have to include water quality-based effluent limits that are as stringent as necessary to meet applicable water quality standards. See Section 3.3 for more discussion.

Centralized Waste Treatment Effluent Limitation Guideline

2.8 May SGE wastewater be transferred to a CWT facility for treatment and discharge?

Although the direct discharge of wastewater from Onshore Subcategory oil and gas extraction is not authorized, the wastewater may be transported to a CWT for treatment and subsequent discharge to surface waters. Direct and indirect discharges from a CWT are subject to the effluent limitations guidelines and pretreatment standards established at 40 CFR Part 437. Direct discharges may also be subject to any more stringent limits necessary to meet applicable water quality standards.

In the case of direct discharging CWTs, under section 402 of the CWA, additional technology-based limits may be required if the wastewater contains pollutants that were not considered in developing the CWT effluent guideline.[10] For such pollutants, section 402 of the CWA and EPA's NPDES regulations require that permit writers include technology-based limits developed on a case-by-case, "best professional judgment" (BPJ) basis. *See* 40 CFR §125.3(c)(3) ("Where promulgated effluent limitations guidelines only apply to certain aspects of the discharger's operation, or to *certain pollutants*, other aspects or activities are subject to regulation on a case by case basis..."). In developing technology-based BPJ limits, the

[9] The 98th meridian (or longitude) is located approximately 30 miles west of Oklahoma City, Oklahoma.
[10] See the Centralized Waste Treatment Development Document at :
http://water.epa.gov/scitech/wastetech/guide/cwt/develop_index.cfm

permit writer must consider the factors specified in 40 CFR § 125.3(d), the same factors that EPA considers in establishing categorical effluent guidelines.

In the case of CWTs that discharge to POTWs, any discharge must comply with the applicable CWT pretreatment standards. In addition, in specified circumstances, the receiving POTW must develop specific local limits applicable to the CWT discharging to the POTW in order to prevent violation of any of the general prohibitions of 40 C.F.R. § 403.5 on pass through and interference as well as any of the specific prohibitions at section 403.5(b). See Section 5.4 For further discussion of this issue.

In developing the CWT effluent guidelines, EPA did not evaluate certain pollutants that are likely to be present in SGE wastewater, such as radionuclides. Consequently, the permitting authority for the CWT will need to consider, based on the statutory factors for technology-based effluent limits, whether to require effluent limits to address those pollutants identified in the effluent but not considered by the CWT Effluent Guidelines in the CWT's NPDES permit. Further, given the absence of CWT pretreatment standards for certain pollutants present in SGE wastewater, POTWs that receive CTW discharges resulting from the treatment of SGE wastewater should explore whether additional local limits may be required for certain pollutants to prevent violation of the general and specific prohibitions of 40 C.F.R. § 403.5(d).

For some pollutants, such as TDS, EPA considered, but did not establish, pollutant limitations or pretreatment standards in the effluent guidelines and standards. Therefore, direct discharging CWTs are not subject to technology-based limits – either under the ELG or BPJ-based limits – for TDS. However, CWTs may be subject to more stringent water quality-based limits for TDS where necessary to meet applicable water quality standards. See CWA section 301(b)(1)(C); 40 CFR § 122.44(d)(1). Moreover, a POTW receiving CWT wastewater that may include a TDS contribution from SGE wastewater may still be need to establish local limits if TDS or other pollutants are present in the CWT wastewater that would violate the prohibitions of 40 CFR Part 403.5. TDS levels in Marcellus Shale wastewaters have been measured to be present in concentrations up to 345,000 mg/l.[11] Advanced technologies, such as distillation, are typically required to treat wastewater that contains high concentrations of TDS; however, the process may cause scaling and frequent cleaning of equipment may be required.[12] Additional detail on water quality permitting is discussed below in sections 3 and 4.

2.9 Does Part 435 Subpart G apply to the treatment and discharge of SGE wastewaters that are sent off-site for treatment and discharge at a Centralized Waste Treatment (CWT) facility?

Subpart G 40 CFR Part 435 does not apply to SGE wastewaters sent to CWTs. EPA promulgated Subpart G, in part, to eliminate the practice of sending wastewaters from one Part 435 subcategory to another to take advantage of less stringent discharge requirements applicable to certain subcategories. For example, a facility subject to the Coastal subcategory zero discharge limitations, that is located near a facility subject to the less stringent Offshore subcategory limitations, might have otherwise sent its

[11] Haynes, Thomas, 2009, Sampling and Analysis of Water Streams Associated with the Development of Marcellus Shale Gas, Gas Technology Institute, Des Plaines, IL.
[12] See footnote 15 on page 5

wastewater for treatment and discharge at the Offshore facility as a method of gaining relief from the more stringent Coastal subcategory requirements. Under Subpart G, even if the Coastal subcategory facility transports its wastewater for treatment and/or disposal at the Offshore subcategory facility, the discharge would still be subject to the more stringent zero discharge limitations.

If, however, a Part 435 Onshore subcategory facility transports its wastewaters to an off-site Centralized Waste Treatment facility, Subpart G would not apply. In this case, the wastewater discharge would be regulated by Part 437. *See* 40 CFR §437.1 (providing that Part 437 applies to "[t]reatment and recovery of ... industrial metal-bearing waters, oily wastes and organic-bearing wastes received from off-site"). In this scenario, transferring wastewaters off-site for authorized disposal meets the zero discharge requirement of Part 435 Subpart C ("no discharge of waste water pollutants into navigable waters").

2.10 What is the definition of "off-site" in regard to SGE wastewater treated at CWTs?

Part 437 establishes the requirements that apply to discharges from a CWT facility that result from, among other things, the treatment and recovery of certain "wastes received from off-site" of the CWT facility._ See 40 CFR § 437.1. "Site" is defined at 40 CFR § 122.2 to mean the land or water area where any "facility or activity" is physically located or conducted, including adjacent land used in connection with the facility or activity. 40 CFR § 437.2(n) defines "off-site" to mean "outside the boundaries of a facility."

For gas drilling activities, the land identified in the drilling permit, including the locations of wells, access roads, lease areas, and any lands where the facility is conducting its exploratory, development or production activities, or adjacent lands used in connection with the facility or activity, would constitute the "site." Land that is outside the boundaries of that area would be considered to be "off-site."

2.11 SGE wastewater is subject to what Subpart of 40 CFR Part 437?

40 CFR Part 437 establishes pretreatment standards and effluent limitations guidelines for three different subcategories of wastewater that may be accepted at a CWT for treatment and recovery operations: Metals Treatment and Recovery, Oils Treatment and Recovery, and Organics Treatment and Recovery. When the ELGs were promulgated, EPA understood that industrial wastes would not always fit neatly under one of the subcategories. EPA therefore developed guidance to help permit writers determine which subpart of the 40 CFR Part 437 ELGs best applies to particular wastes accepted by a CWT.[13] Chapter 5 of the Small Entity Compliance Guide[13] lists different waste sources that were examined during development of the ELG and were determined to best be addressed under each subpart. For waste sources not listed, the guidance contains additional criteria based on oil and grease content and metals concentrations that can be used for this determination. Available data for SGE wastewater show that the waste does not fit under the Oils or Metals Subcategories based on the recommended oil and grease content and metals concentrations provided in the guidance. CWTs are expected to receive waste containing different pollutant types and concentrations originating from a

[13] USEPA, Small Entity Compliance Guide, Centralized Waste Treatment Effluent Limitations Guidelines and Pretreatment Standards (40 CFR Part 437), EPA-821-B-01-003, June, 2001, posted online at: http://www.epa.gov/waterscience/guide/cwt/CWTcompliance_guide.pdf

variety of sources.[14] The permit writer should reexamine this determination based on site specific information when drafting a permit.

2.12 How is transportation of waste by pipeline addressed by the CWT regulations?

Under the regulations, CWTs may accept wastewater transported to the CWT via pipeline. Many industries, like SGE, find transporting wastewater via pipeline is a cost effective alternative to trucking. The CWT would be subject to applicable limitations imposed on its discharge through its NPDES permit or pretreatment program control mechanism. The CWT ELGs are only applicable to CWT discharges of treated piped wastewater if the treated piped wastewater is commingled with other wastewater covered by the CWT ELG. The CWT regulations at 40 CFR § 437.1(b)(3) address waste received via pipeline from offsite as follows:

> "(b) This part does not apply to the following discharges of wastewater from a CWT facility:
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> .
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> .
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> .
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> (3) Wastewater from the treatment of wastes received from off-site via conduit (e.g., pipelines, channels, ditches, trenches, etc.) from the facility that generates the wastes unless the resulting wastewaters are commingled with other wastewaters subject to this provision. A facility that acts as a waste collection or consolidation center is not a facility that generates wastes."

The requirement was included in the regulations to address wastes that are not as variable as those that were typically found to be treated at the CWT facilities studied during development of the ELGs. Unlike traditional CWT facilities, pipeline customers and wastewater sources do not change significantly and are limited by the physical and monetary constraints associated with pipelines. In addressing this issue, the preamble to the proposed regulation states:

> "EPA has concluded that the effluent limitations and pretreatment standards for centralized waste treatment facilities should not apply to such pipeline treatment facilities because their wastes differ fundamentally from those received at centralized waste treatment facilities. In large part, the waste streams received at centralized waste treatment facilities are more concentrated and variable, including sludges, tank bottoms, off-spec products, and process residuals. The limitations and standards developed for centralized waste treatment facilities, in turn, reflect the types of waste streams being treated and are necessarily different from those promulgated for discharges resulting from the treatment of process wastewater for categorical industries."[15]

EPA also addressed this issue in the final rule by stating that waste delivered via pipeline would have a more uniform flow rate and with a relatively consistent pollutant concentration. Wastes delivered solely by pipeline would be more consistent with a traditional manufacturing facility that did not accept waste from a variety of different sources.[16]

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[14] 64 FR 2286, January 13, 1999
[15] 60 FR 5463 - 5506, January 27, 1995
[16] 65 FR 81241 - 81313, December 22, 2000

3 Determining Pollutants Likely to be Present and the Need for Water Quality Based Effluent Limits.

3.1 What are the main potential pollutants of concern for permitting discharges to surface waters from POTWs or CWTs that accept SGE wastewaters?

SGE wastewater has the potential to contain a wide variety of pollutants that may include total dissolved solids (TDS), chlorides, radionuclides, bromide, metals, and organics. To better understand the pollutants likely to be present and their respective concentrations in SGE wastewater prior to treatment, EPA reviewed a sample of the publicly available data obtained from the Pennsylvania Department of Environmental Protection's Southwest Regional Office. Those data were submitted by the generator of the SGE wastewater to the State of Pennsylvania on the State's Form 26-R waste reports. These reports generally contained an analysis of over 50 pollutant parameters of wastewater produced from drilling, completion, and production from a Marcellus Shale or other shale gas well.[17]

Due to a relatively limited use of underground injection wells in the Marcellus shale play generally, and the historical use of discharge of SGE wastewater to surface waters in Pennsylvania, the information collected in the Pennsylvania Form 26-R reports represent a potential characterization of Marcellus shale SGE wastewaters that may be sent to CWTs and POTWs for treatment and then discharged to surface waters. The results of that review of SGE wastewater data are shown in Appendix A, Table 1 along with CWA 304(a) recommended criteria.

A comparison of those data with 304(a) recommended water quality criteria suggests that, for the limited Marcellus shale data analyzed by EPA, 20 pollutant parameters may have the potential to exceed EPA's recommended CWA 304(a) water quality criteria in the untreated SGE wastewater. This comparison is not indicative of a specific discharge, but rather, the potential for pollutant concentrations in SGE wastewater to be higher than ambient water quality criteria. Site-specific factors, such as available in-stream dilution are generally factored into a determination of whether a specific discharge has the reasonable potential to cause or contribute to an excursion above ambient water quality criteria. Additional data were obtained from literature in an effort to determine characteristics of wastewater from additional SGE deposits and are shown in Appendix A, Table 2. Although there are some general differences, data suggest that SGE wastewater from different deposits tend to contain concentrations of TDS and radionuclides that potentially could present an issue.

Note that the data analyzed for this document are not intended to be a complete list of pollutants that may be present in SGE wastewater.

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[17] The parameters typically analyzed include Acidity, Alkalinity (Total as CaCO3), Aluminum, Ammonia Nitrogen, Arsenic, Barium, Benzene,Beryllium, Biochemical Oxygen Demand, Boron, Bromide, Cadmium, Calcium, Chemical Oxygen Demand, Chlorides, Chromium, Cobalt, Copper, Ethylene Glycol, Gross Alpha, Gross Beta, Hardness (Total as CaCO3), Iron – Dissolved, Iron – Total, Lead, Lithium, Magnesium, Manganese, MBAS (Surfactants), Mercury, Molybdenum, Nickel, Nitrite-Nitrate Nitrogen, Oil & Grease, pH, Phenolics (Total) Radium 226, Radium 228, Selenium, Silver, Sodium, Specific Conductance, Strontium, Sulfates, Thorium Toluene, Total Dissolved Solids, Total Kjeldahl Nitrogen, Total Suspended Solids, Uranium, Zinc

Pollutants found in SGE wastewater may be of concern both for POTWs that accept wastewater from the industry and for POTWs that accept wastewater from CWTs that accept SGE wastewaters. Many CWTs may not effectively treat SGE wastewater. Although in development of the CWT Effluent Limitations Guidelines and pretreatment standards the EPA did consider some pollutants such as TDS, the Agency did not address and the regulation does not prescribe effluent limits or pretreatment standards for some pollutants that are likely to be present in SGE wastewater, such as radionuclides. Therefore, if pollutants are found to be an issue that are not adequately controlled or considered by ELG and pretreatment standards, additional appropriate technology and water quality based limits and pretreatment requirements must be considered and may need to be developed by the permitting authority and/or the pretreatment control authority. In the case of a POTW with an approved pretreatment program, the control authority is the POTW. For those POTWs without an approved program, the control authority is the NPDES State program director in a State with an approved NPDES program or an EPA Regional Administrator in States without an approved program. 40 C.F.R. § 403.3(f).

3.2 What options are available for regulatory agencies to gather effluent and receiving water data for use in making permitting decisions?

Section 308 of the CWA provides broad authority to require information from point sources in order to characterize the nature of their discharges and to develop effluent limitations. Pursuant to CWA Sections 308 and 402, NPDES regulations at 40 CFR § 122.21 provide specific requirements for the submission of information for owners or operators seeking an individual NPDES permit. Under that regulation, it is the responsibility of the applicant to characterize the wastewater to be discharged from the permitted facility and to provide the information necessary for the permitting authority to make informed decisions as it develops effluent limitations. In order to submit a complete NPDES permit application for an individual permit, the applicant must present data to properly characterize its discharge to enable a reasonable potential analysis to be completed by the permit writer at the time of permit issuance. 40 CFR §§ 122.44(g)(7), 122.21(g)(13) and 122.21(j). In addition to data specifically required by permit applications, 40 CFR § 122.21(g)(13) allows permitting authorities to reasonably require any additional data as necessary, for example, to support an assessment of potential water quality impacts. Based on available data, applications for CWTs and POTWs accepting oil and gas wastewater should generally include discharge data for the main pollutants of concern used in oil and gas operations or expected to be present in oil and gas extraction waste streams. For CWTs or POTWs that are considering accepting oil and gas extraction wastewater, data used to characterize the respective CWT or POTW effluent should include influent data characterizing that new wastewater. This information will allow all pollutants to be adequately addressed during permit development. Numerous chemical additives are used in SGE activities, such as hydraulic fracturing, that should be taken into account when collecting data for permit development. Permitting authorities should seek to obtain such data independently if not submitted by the applicant. Permitting authorities may reject an application as incomplete if insufficient influent and effluent data are included. 40 CFR § 122.21(e).

Existing Discharges: To characterize the effluent, existing dischargers applying for a reissued individual NPDES permit must provide the permitting authority with screening information for a suite of pollutants and pollutant parameters listed in the applicable application form, as required 40 CFR §§ 122.21(g) and 122.21(j). Data for pollutants that may be present but are not listed on the application form, such as

chloride and total dissolved solids, should also be required to be submitted. The data submitted should provide the permitting authority an adequate picture of the wastewater that the facility plans to accept.

New Discharges: For new (proposed) discharges, the application form for an individual permit requires an estimate of the effluent characteristics. The applicant must also report the existence of any technical evaluation concerning its wastewater treatment, along with the name and location of similar plants of which he has knowledge. 40 CFR § 122.21(k)(6). In addition, the applicant must characterize the anticipated pollutant concentrations and loads using data from similar discharges and/or based on characteristics, in accordance with the requirements of 40 CFR § 122.21(k)(5). Additional information on using representative data when actual effluent data are not available can be found in Section 3.2 of EPA's Technical Support Document for Water Quality Based Toxics Control (TSD).[18]

Existing Discharges where the CWT or POTW operator Plans to Begin Accepting SGE Wastewater: Permit conditions must require the permittee to notify the permitting authority of certain planned changes to the facility, including those that could significantly change the nature or increase the quantity of the pollutants discharged. 40 CFR§122.41(l)(1). Related permit requirements can also be found at 40 CFR § 122.42(a) (existing manufacturing, commercial, mining, and silv cultural dischargers) and 40 CFR § 122.42(b) (POTWs). For example, under 40 CFR § 122.42(b), treatment plant operators must provide adequate notice of any new introduction of pollutants from an industrial user, and any substantial change in the volume or character of pollutants being introduced into that POTW. Adequate notice includes information characterizing the new or increased waste and its impact to the facility or discharge. 122.42(b)(3)] Accordingly, SGE wastewater that may substantially change the volume or character of the pollutants introduced to a POTW would trigger this notification requirement, even if the facility already accepts other oil and gas wastewater.

Regulations allow the permitting authority to determine that an NPDES permit application is incomplete when it lacks effluent data that properly characterizes the discharge.[19] Regions and states should determine whether the permit application is complete when reviewing a draft or proposed permit and the associated application. Additionally, the regulations require permitting authorities to ask new dischargers to follow-up with actual effluent data within 24 months of commencement of discharge. 40 CFR § 122.21(k)(5)(vi).

Ambient Data: To develop effluent limits that protect the receiving water, when available, ambient water quality and biological data should be included in the NPDES permit development process and, where appropriate, should be incorporated as "background" conditions for receiving water characterization in reasonable potential analyses and limit development. Permits that are developed without the use of background data do not take into account the likely pollutant concentration in the receiving water and are not likely to effectively prevent a discharge from causing or contributing to an excursion of Water Quality Standards.

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[18] *Technical Support Document for Water Quality-based Toxics Control* (EPA/505/2-90-001 PB91-127415). 1991. Available at http://www.epa.gov/npdes/pubs/owm0264.pdf.

[19] See 40 C.F.R. § 122.21(e) (a permit application is determined to be complete at the discretion of the permitting authority) and 40 C.F.R. § 122.21(g)(13) (the applicant shall provide to the Director, upon request, such other information as the Director may reasonably require to assess the discharge).

3.3 What water quality-based requirements may apply in NPDES permits for discharges of SGE Wastewater from POTWs, CWTs and Agriculture and Wildlife Use Subcategory wells to waters of the U.S.?

The Clean Water Act and the EPA's NPDES regulations require limits to control all pollutants that have the reasonable potential to cause or contribute to exceedances of water quality standards. CWA section 301(b)(1)(C) and 40 CFR § 122.44(d)(1)(i). After application of technology-based effluent limits, if a discharge of SGE wastewater has a reasonable potential to cause or contribute to exceedances of water quality standards, the permit writer will need to develop water quality based effluent limits (WQBELs) to protect water quality. 40 CFR § 122.44(d)(1)(i). In some cases other additional requirements may be needed to comply with State regulations. The comparison of a snapshot of Marcellus shale wastewater pollutant data and recommended water quality criteria shown in Appendix A suggests that, 20 parameters appear to have the potential to be present in untreated wastewater at concentrations that exceed recommended water quality criteria. Further examination based on type of criteria showed that: drinking water maximum contaminant levels (MCLs) were exceeded for 8 parameters; water quality criteria for human health protection were exceeded for 9 parameters; and criteria for aquatic life protection were exceeded for 16 parameters. In addition to the commonly mentioned pollutants, such as total dissolved solids, SGE wastewater may contain metals and organic pollutants in concentrations that exceed water quality criteria and should be examined as part of the reasonable potential evaluation. Although this is a fairly simplistic comparison that does not represent site specific conditions that should be examined when developing water quality based permit limits, the comparison does show that limits may potentially be necessary to protect in-stream water quality and human health and aquatic life uses as well as the quality of downstream drinking water sources.

3.4 How should permit writers determine whether water quality-based limits are needed?

The procedure for determining the need for WQBELs is called a "reasonable potential" determination. Under EPA's regulations at 40 CFR § 122.44(d)(1)(i), WQBELs are required for all pollutants that the permitting authority determines "are or may be discharged at a level [that] will cause, have the reasonable potential to cause, or contribute to an excursion above any [applicable] water quality standard, including State narrative criteria for water quality." Thus, if a pollutant discharge has the reasonable potential to cause or contribute to an excursion above any applicable water quality standard – including narrative criteria – the discharger's NPDES permit must contain a WQBEL for that pollutant. 40 CFR § 122.44(d)(1)(iii)-(vi).

As described above, in response to question 3.2, all valid representative qualitative and quantitative information regarding the effluent and receiving water should be used in conducting a reasonable potential analysis. The reasonable potential analysis is used to determine whether an effluent limitation more stringent than the technology-based limitation is necessary to meet water quality standards, consistent with CWA section 301(b)(1)(C) and 40 CFR § 122.44(d)(1). The reasonable potential analysis is best made before the permit is issued rather than waiting to gather additional data during the permit's term so that the permitting authority can reasonably demonstrate that the permit is appropriately protective of water quality standards. For proposed discharges where effluent data are not available

Section 3.2 of the TSD[20] provides guidance for conducting a reasonable potential analysis using other similar data sources. An NPDES permit administrative record that fails to show evidence of a parameter-specific reasonable potential analysis would generally not show whether the permit contains limits as stringent as necessary, and thus the permit may not be consistent with the requirements of the CWA and implementing regulations. CWA § 301(b)(1)(C); 40 CFR § 122.44(d)(1).

Guidance for how to conduct a reasonable potential analysis where a State has adopted a numeric and narrative water quality criteria can be found in the TSD.[20] Permitting authorities are familiar with these analyses and have been implementing these procedures for developing water quality based effluent for over two decades.

Numeric Criteria

States have adopted numeric water quality criteria for protection of human health as well as acute and chronic numeric criteria for the protection of aquatic life. Should a reasonable potential analysis indicate that the discharge of any pollutant has the potential to cause or contribute to an in-stream excursion above the applicable State numeric criteria, the permit must include a limit as stringent as necessary to meet the criterion to be consistent with the CWA. 40 CFR § 122.44(d)(1)(iii).

Narrative Criteria

In addition to those parameters for which there are numeric water quality criteria, all States have adopted narrative water quality standards. "Narrative water quality criteria have the same force of law as other water quality criteria, and NPDES permits must contain effluent limits necessary to attain and maintain all applicable water quality criteria, including narrative criteria." 54 Fed. Reg. 23868, 23875 (June 2, 1989). *See also American Paper Inst. v. EPA*, 996 F.2d 346, 351 (DC Cir. 1993) (upholding EPA's regulation requiring translation of state narrative criteria into chemical-specific effluent limitations in permits as "an eminently reasonable means of effectuating the intent of the previously adopted narrative criteria as well as Congress' own intent... that *all* state water quality standards be enforced." (emphasis in original). There are numerous tools that the permitting authority may use to determine whether a discharge will cause or has a reasonable potential to cause or contribute to an in-stream excursion above an applicable narrative water quality criterion, consistent with 40 CFR § 122.44(d)(1)(ii) and as recommended in the EPA's Technical Support Document. These include State bioassessment methodologies; whole effluent toxicity testing; consideration of the effect on in-stream conditions from nearby, similar discharges; and consideration of best-available science related to the effects of similar discharges.

Where a State implements narrative criteria to protect designated uses, the State should provide information identifying the method by which the State intends to assess reasonable potential and regulate point source discharges, consistent with the narrative criteria. Such information may be included as part of the standards or as part of State implementation policies and procedures and should be documented in the permit fact sheet or statement of basis. In establishing a numeric interpretation

[20] USEPA, 1991, See footnote 18 of page 17.

of the narrative, States should establish numeric values based on EPA's 304(a) guidance, EPA's 304(a) guidance modified to reflect site-specific conditions, or other scientifically defensible methods. See 40 CFR § 122.44(d)(1)(vi).

4 Developing Water Quality Based Effluent limits.

4.1 What issues should permit writers take into account when developing water quality-based effluent limits and other conditions ?

When developing WQBELs, the permitting authority must ensure that the limits are as stringent as "necessary to ... achieve water quality standards," and that the level of water quality achieved by such limits is "derived from and complies with all applicable water quality standards." 40 CFR § 122.44(d)(1); CWA § 301(b)(1)(C).

Where there is reasonable potential for a pollutant to exceed a narrative criterion, and the state has not adopted chemical-specific criteria for such pollutant, then the permitting authority must establish a WQBEL based on one of the methods specified in the regulation. 40 CFR § 122.44(d)(1)(vi). WQBELs are generally expressed as chemical-specific numeric limitations on the quantity or concentration of the pollutant or pollutant parameter that may be discharged. Additionally, WQBELs may be numerically expressed in terms of Whole Effluent Toxicity (WET). Any such WQBEL must be set at a level that is as stringent as necessary to meet water quality standards. CWA § 301(b)(1)(C); 40 C.F.R § 122.44(d)(1).

Where there is no applicable TMDL, the determination of a limit that is as stringent as necessary is made on a case-by-case basis. In practice, such limits have been set based on the available in-stream dilution and either the numeric water quality criteria or a quantification of narrative water quality criteria. Where there is an applicable TMDL for the waterbody, the WQBEL must be consistent with the assumptions and requirements of any available wasteload allocation in the TMDL. 40 CFR § 122.44(d)(1)(vii)(B).

Chemical- or Parameter-Specific Numeric Effluent Limits

In many cases, states have adopted numeric criteria for parameters that are likely to be present in SGE wastewater, such as aluminum, barium, ammonia, and manganese. Where an SGE associated discharge is found to have reasonable potential to cause or contribute to an excursion above such numeric criteria within a State's water quality standards, EPA's regulations require that NPDES permits include WQBELs based on the approved numeric water quality criteria (40 CFR § 122.44(d)(1)(iii), as described in Chapter 5 of the TSD.

Since most SGE wastewaters contain high concentrations of TDS, WQBELs may be needed, where discharges of the pollutant from CWTs or POTWs have the reasonable potential to exceed state numeric or narrative water quality criteria. In the SGE wastewater, chloride typically constitutes a large portion of the total makeup of TDS in a sample. Elevated chloride levels can interfere with an aquatic organism's ability to maintain osmotic balance/control with its environment, as well as cause other effects. Some states have an applicable numeric water quality criterion for chloride. Where a state has

a numeric criterion, NPDES permit regulations require that permitting authorities assess reasonable potential and established permit limits where necessary to protect water quality based on the applicable numeric criterion. See 40 CFR § 122.44(d)(1)(iii). Where a state has not developed a numeric criterion for chloride, regulations at 40 CFR § 122.44(d)(1)(vi) require use of a numeric translation of the applicable narrative criterion. One option for development of such a numeric translation, is to use EPA's current 304(a) national recommended criteria for chloride for protection of aquatic life. These criteria were published by EPA in 1988. The current national criteria for Chloride are: acute aquatic life criteria of 860 mg/l, and chronic aquatic life criteria of 230 mg/L. EPA is currently in the process of updating these recommended criteria to reflect the latest science. That update is expected to be proposed during 2014. States have the option of developing other numeric translations of their narrative criterion; however, any translation should be scientifically defensible.

In addition to considering limits for TDS and chloride, states may choose to use other indicator parameters, such as numeric limits for other ions expected to be present as numeric interpretations of narrative criterion. For example, a State may also choose to employ numeric limitations for a suite of ions that are dominant in the high concentrations of TDS found in SGE wastewater. A number of different tools for developing permits that ensure compliance with narrative criteria are listed at CFR § 122.44(d)(1)(vi). One of those options is to use 304(a) recommended criteria as a numeric interpretation to determine reasonable potential to exceed narrative criteria and establish appropriate limits in accordance with 40 CFR § 122.44(d)(1)(vi).

The method used to derive numeric interpretations of narrative water quality criterion should be clearly described in the administrative record for the permit so that the regulated community and interested citizens are able to understand how and why certain limits are included in permits.

While the permitting authority may find it to be appropriate to include the State's narrative criteria in permits as enforceable limits, additional limits, such as numeric translations of the narrative criterion, may be more easily enforceable.

Numeric Whole Effluent Toxicity Limits

If there is a reasonable potential that a discharge will cause or contribute to an in-stream excursion above a numeric criterion for whole effluent toxicity (WET) the regulation at 40 CFR § 122.44(d)(1)(iv) requires that a permit must include limits for WET.

If there is a reasonable potential to cause or contribute to an excursion above a narrative water quality criterion, even where the permit includes a chemical-specific limit to meet a narrative criterion, the permit must include a limit for WET if toxicity testing data or other information indicates a reasonable potential for toxicity of the discharge to exceed a narrative criterion, unless the permitting authority demonstrates that chemical-specific limits for the effluent are sufficient" to meet standards. 40 CFR § 122.44(d)(1)(v); 54 Fed. Reg. 23868, 23879 (June 2, 1989). One method for making this demonstration would be to use toxicity testing to show that, after application of chemical-specific limits, the effluent has no acute or chronic toxic effects on aquatic life in the receiving water. 54 Fed. Reg. 36868, 36874 (June 2, 1989).

Consistent with these requirements, even if a Section 402 permit for a CWT or POTW that treats and discharges SGE wastewater includes numeric limits for TDS, Chlorides, and/or other parameters, there may be other pollutants in the effluent that, alone or through an additive or synergistic effect, could result in a reasonable potential to exceed the narrative criterion. Based on available information, EPA generally expects that permitting authorities would find that discharges of SGE wastewater will have the reasonable potential to exceed State narrative water quality criteria, as described in earlier responses; therefore, EPA generally expects that NPDES permits for these discharges will include WET limits, unless it can be demonstrated that the permit includes chemical-specific limits for all pollutants necessary to meet the narrative criteria.

4.2 What parameters are expected to be present in SGE wastewater that may need to be limited to protect drinking water resources downstream?

Water supply systems obtain water from a variety of sources, including groundwater, surface water, recycled wastewater and seawater. The water is then, in most cases, treated, disinfected through chlorination, chloramination, ozonation or ultra violet rays and then may also be fluoridated. Although the specific treatment process used by each facility varies, it typically involves several steps including screening, aeration, coagulation and flocculation, sedimentation, filtration, and disinfection. Chlorine reduces bacteria levels, but it can also react with other organic impurities present in water, such as bromine, producing various disinfection by-products (DBPs) that are listed as probable or possible human carcinogens. Ozone treatment acts as a powerful oxidizing and disinfecting agent and may reduce the formation of many halogenated DBPs, but has the potential to form bromate as a result of excess bromine in the source waters[21].

EPA has developed the National Primary Drinking Water Regulations (NPDWRs or primary standards) which are legally enforceable standards that apply to public water systems. The primary standards protect public health by limiting the levels of contaminants in drinking water. EPA has also developed National Secondary Drinking Water Regulations (NSDWRs or secondary standards) which are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. TDS and sulfates are examples of secondary drinking water contaminants that are contained in SGE wastewater. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards. The primary and secondary standards cover categories of compounds that are grouped as microorganisms (Cryptosporidium, Giardia), disinfectants (chlorine), disinfection byproducts (bromate, total trihalomethanes, haloacetic acids, and chlorite), inorganic chemicals (metals, etc), organic chemicals and radionuclides. The current maximum contaminant levels (MCLs) for bromate and total trihalomethanes are 0.010 mg/L and 0.080 mg/L respectively. In order to meet these numbers and protect the finished drinking water, public water systems need to determine if the drinking water source contains compounds that could react during the treatment process to cause an exceedance of the MCLs. A comparison of the potential concentration of other pollutants in SGE wastewater and MCLs can be found in Appendix A.

[21] Bonacquisti, T., 2006. A drinking water utility's perspective on bromide, bromate and ozonation. In Toxicology. Volume 221, Issues 2-3, pgs 145-148.

SGE wastewater discharged to CWTs or POTWs may contain TDS, chloride, bromide, and other contaminants. When these facilities discharge to surface waters upstream of a drinking water source, they may affect the drinking water quality or the drinking water treatment process. Total trihalomethane (TTHM) formation in drinking water plants is a potential impact to water supply that can be associated with the discharge of SGE wastewater. Bromide, which is often found in SGE wastewater, facilitates formation of brominated THMs when it is exposed to chlorine and other THM precursors during the disinfection process and bromate when treated with ozonation in drinking water treatment plants. The presence of bromine in source waters, even at levels as low as 100 ug/L can cause the formation of bromate in the discharge from a drinking water plant utilizing ozone[22]. Contaminants such as TDS and bromide are not readily removed from drinking water by conventional treatment and will require more costly treatment such as enhanced coagulation, activated carbon or other similar filtration of organic compounds, or reverse osmosis before chlorination for effective removal of DBP precursors. One, potentially less costly, method to reduce the formation of these compounds in finished water is to control the concentration of bromide in the source water.

Wastewater from SGE activities that is discharged through a CWT or POTW point source upstream or in an area that could have a potential impact on a drinking water source must be thoroughly evaluated to ensure that the downstream source is protected. This may require additional permit limits or other controls that may not be common in traditional NPDES permits.

Permitting authorities need to determine the best approach for controlling pollutants that may reach source waters. In order to evaluate the sources of contaminants throughout a watershed, permitting authorities should conduct a thorough evaluation of the upstream point sources. This evaluation may include a determination of the assimilative capacity of the watershed to help calculate discharge criteria. Modeling of the watershed or stream and upstream point sources for the parameters of concern should also be conducted. The models should take into consideration the drinking water treatment process to determine if any of the parameters of concern are causing problems at the drinking water intake. After the evaluation of the discharges is complete the permitting authority may want to consider if additional controls should be placed on upstream point sources based on the information. The controls might include additional discharge standards for point sources, more conservative standards for pollutants most likely to affect drinking water facility source waters or additional monitoring requirements for parameters of concern. During development of the permit the NPDES permitting authorities should provide notification in accordance with the requirements at 124.10 to any downstream drinking water treatment plants of the discharge of SGE wastewaters and any potential impacts.

In order for permits to be protective of human health, states will need to address any applicable water quality criterion for drinking water, fish tissue consumption, and contact recreation. Section 1.7 of the TSD[23] contains additional information on methods to protect human health. Drinking water uses are protected through criteria that are applicable at either the intake point or in the treated drinking water. Stream modeling will generally need to be done when developing permit limits based on criteria that

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[22] Gillogly, T., Najm, I., et al., 2001. Bromate formation and control during ozonation of low bromide waters. In: AWWARF, Denver, CO.

[23] USEPA, 1991, See footnote 18 on page 17.

apply at the drinking water intake so that processes such as in-stream dilution, interaction with other chemicals in the stream, and other in-stream processes that affect the pollutant are adequately taken into account. Protection of criteria for treated drinking water will generally require the additional step of determining how much removal occurs in the treatment process and how the pollutant reacts with chemicals used to treat or disinfect the water supply.

In addition to addressing the impacts of SGE wastewater in permit development, permitting authorities should consider their public participation process and how information is made available to potentially affected communities, including downstream utilities and Environmental Justice communities. Dissemination of water quality information will assist downstream drinking water plant operators in their efforts to address pollutants that may potentially be present in intake water. In most cases it may be more cost effective to treat CWT or POTW effluents to remove pollutants before discharge rather than at downstream drinking water plants.

4.3 Some shale deposits, such as the Marcellus Shale, are referred to as radioactive black shale in literature[24]. Are radionuclides an issue of concern with natural gas extraction and wastewater disposal?

Radionuclides associated with oil and gas extraction, also referred to as NORM, are a long standing waste management issue. A number of states with significant oil and gas extraction activity have established regulatory programs to address the issues associated with NORM in oil and gas extraction.[25,26,27] The issues commonly related to radionuclides in oil and gas extraction waste are decontamination of equipment and human health risk for workers.[25,28] Although low level radioactivity is inherent to all sedimentary rocks, organic-rich shales, such as the Marcellus and other black shales, tend to exhibit higher concentrations of radionuclides. That characteristic results from the tendency for uranium and thorium ions to concentrate in organic matter rather than scatter throughout the sedimentary strata.[29,30] Radium 226 and radium 228 are respectively byproducts of uranium and thorium decay that may be found in SGE wastewater[31,32]. In addition to the tendency for radionuclides

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[24] Milici, R.C. and C.S. Sweeney, 2006, Assessment of Appalachian Basin Oil and Gas Resources: Devonian Shale – Middle and Upper Paleozoic Total Petroleum System, Open File Report Series 2006-1237, U.S. Department of Interior, USGS.

[25] Railroad Commission of Texas, NORM – Naturally Occurring Radioactive Material, posted at: http://www.rrc.state.tx.us/environmental/publications/norm.php

[26] http://norm.iogcc.state.ok.us/reg/dsp_statereg.cfm

[27] See footnote 6 on page 3

[28] USGS, 1999, Naturally Occurring Radioactive Materials (NORM) in Produced Water and Oil Field Equipment – an Issue for the Energy Industry, USGS Fact Sheet FS-142-99, September

[29]Harper, J.A., 2008, The Marcellus Shale – An Old "New" Gas Reservoir in Bureau of Topographic and Geologic Survey Pennsylvania, Pennsylvania Geology, Pennsylvania Department of Conservation and Natural Resources, vol. 38, no. 1, Spring 2008

[30] Swanson, V.E., 1960, Oil Yield and Uranium Content of Black Shales, Uranium in Carbonaceous Rocks, pp. 1-44

[31] USGS, 1999, Naturally Occurring Radioactive Materials (NORM) in Produced Water and Oil Field Equipment – an Issue for the Energy Industry, USGS Fact Sheet FS-142-99, September

[32] Rowan, E.L., Engle, M.A., Jirby, C.S., and Kraemer, T.F., 2011, Radium Content of Oil- and Gas-Filed Produced Waters in the Northern Appalachian Basin (USA): Summary and Discussion of Data, U.S. Geological Survey Scientific Investigations Report 2011-5135, 31 p. (Available online at: http://pubs.usgs.gov/sir/2011/5135/)

to be present in higher concentrations in some types of deposits, such as black shales, radioactive elements such as radium may tend to be more abundant in produced water that contains high concentrations of chloride[33].

As an example, the Marcellus Shale can contain NORM that can be in fairly high concentrations in gas extraction wastewater. Radium 226 has been found to be present in concentrations up to 16,030 pCi/l in Marcellus Shale produced water.[34] HFFW from the Marcellus Shale has not been monitored extensively for radionuclides; however, Alpha particles have been found to be present at concentrations up to 18,950 pCi/l.[35] Those radionuclide concentrations exceed the drinking water Maximum Contaminant Levels of 5 pCi/L for Radium 266 and 15 pCi/l for Alpha particles.

Based on existing information on NORM associated with oil and gas extraction and the potential associated issues, care should be taken to address impacts to treatment facilities, such as scale buildup in equipment and contamination of sludge [biosolids]. Many CWTs discharge, as noted, to POTWs rather than directly discharging to waters of the United States; therefore, the same issues may also apply to POTWs that accept wastewater from CWTs accepting SGE wastewater[36].[37]. For example, contamination of biosolids at POTWs that requires a change of disposal practice (e.g., radioactivity, etc.) is considered to be interference under the pretreatment program. See 40 CFR §§ 403.3(k)(2) and 403.5(a)(1. See the discussion below at section 5 concerning circumstances in which a POTW must develop local limits to prevent violations of the general pretreatment requirements such as interference or violations of the specific prohibition of 40 C.F.R. § 403.5.

4.4 What tools are available to assist permitting authorities in developing appropriate permit conditions to address radionuclides?

Since oil and gas extraction waste is not discharged in many states, water quality and human health issues associated with discharges under NPDES permits have not been extensively examined for radionuclides. Permit issuance authorities will need to determine whether NORM that is present in oil and gas wastewater is effectively treated in the plant, settles as sludge, builds up in pipe scale, or affects downstream water quality and drinking water uses. Solubility models such as PHREEQE and SOLMINEQ are available tools that can be used to predict whether radionuclides are likely to be in insoluble compounds and settle or if they will remain in solution. Radium, an alkaline earth element with a tendency to combine with barium in produced water and HFFW, varies in solubility depending on the

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[33] http://norm.iogcc.state.ok.us/reg/dsp_statereg.cfm

[34] NYSDEC, 2009, Supplemental Generic Environmental Statement on the Oil, Gas, and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs, Appendix 13, available at: http://www.dec.ny.gov/energy/58440.html

[35] http://www.rrc.state.tx.us/environmental/publications/norm.php

[36] *Development Document for the CWT Point Source Category,* Final Rule: Development Document, USEPA, Washington, DC, 2000, available online at: http://water.epa.gov/scitech/wastetech/guide/treatment/develop_index.cfm

[37] *Development Document for the CWT Point Source Category,* Final Rule: Development Document, USEPA, Washington, DC, 2000, available online at: http://water.epa.gov/scitech/wastetech/guide/treatment/develop_index.cfm

concentration of other parameters present, such as sulfate and chloride.[38,39] If radium is part of an insoluble compound, such as barite, it tends to accumulate as pipe scale or sludge.[40] Pretreatment and permitting authorities should take into account the potential for radionuclides to affect operation and maintenance due to pipe scaling or to contaminate sludge and affect disposal practices. Plant operators should also be aware of the need to worker safety programs for NORM exposure and the need to decontaminate equipment if radionuclides build up in scale.

In considering the reasonable potential for the discharge to impact water quality and establish appropriate limits in accordance with 40 CFR § 122.44(d)(1), permit authorities should consider whether there is the potential for NORM to stay in solution and be present in the effluent. Most states have not established numeric radionuclide criteria for the protection of aquatic life uses or for human exposure through contact recreation or fish tissue consumption. In the absence of numeric criteria, permitting authorities are required to include appropriate limits in permits to protect a narrative water quality criterion when reasonable potential exists to cause or contribute to an excursion above the narrative water quality criterion. 40 CFR § 122.44(d)(1)(vi). The numeric criteria that are available in most states are the maximum contaminant levels (MCLs) that apply to treated drinking water. Relevant factors permitting authorities should consider when permitting these waste streams are: the appropriateness of mixing zones to allow in-stream dilution for calculation of reasonable potential and permit limits; the receiving stream water chemistry and in-stream interaction of NORM, such as precipitation; the potential for drinking water treatment plants to remove radionuclides; and the impact to drinking water treatment facilities including sludge contamination. BAT based limits were not established for radionuclides as part of the CWT ELGs and they were not considered as part of that rulemaking. To meet the Clean Water Act Section 301 requirements for BAT based limits, permitting authorities should examine whether radionuclides are present in CWT effluent in treatable concentration and, if so, they are required to consider, using best professional judgement, whether under the factors specified in 40 CFR § 125.3, BAT limits are appropriate.

5 Issues Related to Waste Acceptance at POTWs and Pretreatment.

5.1 What requirements do POTWs need to meet in order to accept shale gas wastewater?

POTWs must comply with their NPDES permit terms and conditions. As mentioned above in Section 3.2[41], permits for POTWs must include conditions that require that- - -"all POTWs ... provide adequate notice to the Director [EPA and/or the state NPDES permitting/pretreatment authority[42]] of the following:

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[38] Zielinski, R.A., and Budahn, J.R., 2007, Mode of Occurrence and Environmental Mobility of Oil Filed Radioactive Material at US Geologic Survey Research Site B, Osage-Skiatook Project, Northeastern Oklahoma, Applied Geochemistry 22, 2007, 2125-2137.

[39] FISHER, R. S. (1998), Geologic and Geochemical Controls on Naturally Occurring Radioactive Materials (NORM) in Produced Water from Oil, Gas, and Geothermal Operations. Environmental Geosciences, 5: 139–150.

[40] USGS, 1999, See footnote 31 on page 24.

[41] Applicable to State NPDES programs, see 40 CFR 123.25.

[42] Under 40 CFR 122.2, "*Director* means the Regional Administrator or the State Director, as the context requires, or an authorized representative. When there is no "approved State program" and there is an EPA administered program, "Director" means the Regional Administrator." Where a State does not have an approved State pretreatment program, the Regional Administrator is the Director of the pretreatment program under this provision.

(1) Any new introduction of pollutants into the POTW from an industrial user which would be subject to section 301 or 306 of the CWA if it were directly discharging those pollutants; and
(2) Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the [POTW's] permit.
(3) For the purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW."

Additionally, POTWs must comply with any of the applicable pretreatment requirements at 40 C.F.R Part 403 as discussed more fully in the sections that follow. In order to comply with these provisions and protect public health and the environment, and evaluate the need to establish local limits to ensure compliance with the general pretreatment standards and specific prohibitions of EPA's pretreatment regulations at 40 C.F.R. § 403.5, a POTW, when considering the acceptance of such wastewater, should collect information from the industry on the quality and quantity of the SGE wastewater proposed to be introduced to the POTW and assess the potential impact to the POTW if the POTW were to accept the wastewater. For SGE wastewater or in the case of discharges from a CWT that receives SGE wastewater, that discharge characterization should include information on the concentrations of total dissolved solids, specific ions, such as chlorides and sulfate, specific radionuclides, metals, and other pollutants that could reasonably be expected to be present in wastewater from a well. In addition to the ions, radionuclides, and metals that can be expected to be present in SGE wastewater, the characterization should include chemicals used in well drilling, completions, treatment, workover, or production that could reasonably be expected to be present in wastewater. Pursuant to the regulation at 40 CFR § 122.2, this information must generally be reported to EPA and/or the State program before the POTW may accept the wastewater. "Adequate notice" is meant to provide the EPA (or the state NPDES permitting authority) with enough time to determine if the POTW NPDES permit needs to be modified in order to address potential effects due to the potential new industrial user. In cases such as Pennsylvania, where the state is the permitting authority and EPA is the approval authority for pretreatment, the POTW must submit the required information to both agencies[43]. In addition to this notification, all industrial user discharges to a POTW, including discharges from CTWs, must comply with the specific prohibitions of 40 CFR § 403.5(b), in addition to any applicable categorical standards and any state and local limits.

EPA Regional offices, in their oversight role, should work with authorized States to ensure that NPDES permits for POTWs include the pretreatment notification requirements and definitions of 40 CFR §§ 122.2, 122.42(b), and 403.5(b). Inclusion of those requirements in permits, may help to highlight the need to report changes and help to prevent inadvertent oversight of the notification requirements.

5.2 What are the potential impacts of these pollutants to POTWs and CWTs?

Constituents in SGE wastewater such as TDS have been found to be present at concentrations ranging from 280 mg/l to 345,000 mg/l.[44] Chloride has been reported in concentrations up to 196,000 mg/l.[45]

[43] A list of states where EPA is the approval authority can be found at: http://cfpub2.epa.gov/npdes/statestats.cfm
[44] Haynes, 2009 (see footnote 11 on page 12)

TDS is not significantly removed by most conventional POTWs; therefore, pretreatment of the wastewater may be required prior to discharge to the POTW to prevent violations of the general and specific pretreatment requirements. Common constituents of TDS include calcium and magnesium (also a measure of "hardness"), sodium, sulfates, and chloride. When discharged to POTWs, individual constituents of TDS may result in POTW process inhibition in activated sludge, nitrification, and anaerobic digestion processes.[46,47] POTWs may exhibit these process inhibitions from these individual constituents at concentrations that are several orders of magnitude lower than the composite TDS found in SGE wastewater (example: sulfate at 400-1000 mg/l disrupting anaerobic digestion processes; chloride at 180 mg/l disrupting nitrification processes[48]). Biological treatment processes can be disrupted by high concentrations of chlorides, such as that found in SGE wastewater[49,50]. Some POTWs that had previously accepted oil and gas extraction waste through their pretreatment programs experienced operational problems due to high concentrations and spikes in concentrations of TDS.[51] In addition, some of the constituents in oil and gas extraction waste, such as metals, can precipitate during the treatment process and contaminate biosolids. Biosolid contamination may require expensive decontamination of biosolids drying beds or change the chosen method of use or disposal. Bromide, which can be present in SGE wastewater in significant concentrations, has the potential to be present in POTW effluent as a precursor for disinfection byproducts and may cause an increase in whole effluent toxicity[48].

Radionuclides are likely to be present in SGE wastewater and could pose a challenge for POTWs or CWTs. Radionuclides are discussed previously in the responses to questions 4.3 and 4.4.

A POTW may need to consider these same issues when it receives discharges from a CTW that itself treats SGE wastewater.

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[45] NYSDEC, 2009, Supplemental Generic Environmental Statement on the Oil, Gas, and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs, Appendix 13, available at: http://www.dec.ny.gov/energy/58440.html

[46] Hockenbury, Melvin Richard, D. Burnstein, and E.S. Jamro, *Total Dissolved Solids Effects on Biological Treatment*, Proceedings of the 32nd Industrial Waste Conference, Purdue University Libraries, pp. 56-62, Repository Number: ETRIWC1977008, 1977

[47] Tokuz, R. Yucel and W.W. Eckenfelder, Jr., *The Effect of Inorganic Salts on the Activated Sludge Process Performance,* Water Research, Vol. 13, pp. 99-104, 1979.

[48] USEPA, Local Limits Development Guidance Appendices, EPA 833-R-04-002B, July, 2004, Available at: http://cfpub.epa.gov/npdes/home.cfm?program_id=3

[49] Eckenfelder, W. Wesley, V.J. Boero, and T.H. Flippin, *The Effects of High TDS on the Activated Sludge Process*, Proceeding of WEFTEC Latin America, 2001

[50] Munirathinam, Kar, *Effects of High Level of Total Dissolved Solids on the Treatment of a High Strength Organic Chemical Wastewater*, Proceedings of WEFTEC, 2000.

[51] Record of communications between Scott Wilson (EPA, OWM), Morgan City, LA pretreatment program, and Ted Palit (EPA Region 6)

5.3 What are the considerations that should be made for acceptance of new wastes or changes to wastes being accepted by POTWs?

When considering the acceptance of such wastewater directly (or indirectly through a CWT), a POTW should collect information from the industrial user on the quality and quantity of the SGE wastewater proposed to be introduced to the POTW and assess the potential impact to the POTW. For SGE wastewater, EPA recommends that the characterization include the concentrations of the pollutant parameters identified in Appendix A, Table 1 and 2, and other pollutants that could reasonably be expected to be present based on site specific information on the geology and the gas extraction activity.

After obtaining specific information on the wastewater proposed to be accepted, plant operators should consider potential impacts to the facility as part of the decision to accept the waste or to limit the wastewater accepted. Acceptance of waste may present these potential concerns: corrosion, caused by high salinity; contamination of biosolids, due to radionuclides or other pollutants; and interference or disruption of the treatment process. In addition to the notification requirements discussed above, POTW operators will need to ensure that acceptance of wastewater would not cause the facility to violate the general pretreatment provisions found at 40 CFR Part 403.

POTWs may not accept SGE wastewater if acceptance of the wastewater would result in violations of the POTW's permit or contamination that interferes with POTW operations or disrupts biosolids processes, uses, or disposal. NPDES permits for discharges from POTWs to waters of the U.S. must also include water quality-based effluent limitations as necessary to meet applicable water quality standards. CWA section 301(b)(1)(C).. Information regarding water quality based limitations development is discussed in more detail earlier in this document.

As previously explained, meeting the requirements described above may be of concern to POTWs that accept wastewater from CWTs that accept SGE wastewaters because many CWTs may not be designed to treat SGE wastewater effectively. The CWT ELG (see 40 CFR Part 437) does not address or establish pretreatment standards for many pollutants that are likely to be present in high concentrations in SGE wastewater. Therefore, in certain circumstances appropriate local pretreatment limits on CWT discharges may need to be developed by the POTW. Water quality based limits may also need to be included.

5.4 What factors should be considered in determining the need for POTWs to develop local limits?

EPA recognizes that POTW operations vary due to site-specific factors. All POTWs with approved pretreatment programs, and all other POTWs found by EPA or the state as having experienced or having the potential to experience pass through or interference, must develop local limits where necessary to comply with the general pretreatment standards. See 40 CFR §§ 403.5(c) & 403.8(a). To assist in this evaluation, EPA has issued guidance on establishing local limits.[52,53]

All industrial user discharges to a POTW must comply with the general and specific prohibitions of 40 CFR § 403.5(b), any applicable categorical standards, and any state and local limits. Local limits are

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[52] See Footnote 48 on page 27

[53] Guidance Manual for the Control of Wastes Hauled to Publicly owned treatment works" EPA 833-B-98-003, September 1999.

developed by POTWs to enforce the specific and general prohibitions. The prohibitions and categorical standards are designed to provide a minimum acceptable level of control industrial user discharges, but do not take into account site-specific factors at POTWs that may necessitate additional controls. For example, the permit for a POTW that discharges into a river designated a "scenic river" under the Wild and Scenic Rivers Act may have more stringent limits than permits for facilities discharging to other waters. Similarly, a POTW that discharges above a drinking water supply intake may need to develop limits and take precautions to ensure that the downstream drinking water supply designated use is protected. To comply with either such case, the POTW may need to exert greater control over industrial user discharges. This additional control can be obtained by establishing local limits.

In addition to the general prohibitions of EPA's national pretreatment standards that prohibit the introduction of pollutants to the POTW, which cause Pass Through or Interference of the POTW, *specific prohibitions* also apply to all industrial user discharges to the POTW. 40 CFR § 403.3(b). Because of the possible presence of the pollutants identified in Appendix A in SGE waste streams, EPA recommends that a POTW, in considering whether to accept SGE waste streams, should assess the waste stream for its potential to violate the following specific prohibitions:

- Pollutants which will cause corrosive structural damage to the POTW, but in no case Discharges with pH lower than 5.0, unless the works is specifically designed to accommodate such Discharges. 40 CFR § 403.5(b)(2);
- Any pollutant, including oxygen demanding pollutants (BOD, etc.) released in a Discharge at a flow rate and/or pollutant concentration which will cause Interference with the POTW. 40 CFR 403.5(b)(4);
- Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems. 40 CFR 403.5(b)(7);
- Any trucked or hauled pollutants, except at discharge points designated by the POTW. 40 CFR 403.5(b)(8)

For example, corrosion of the POTW's pipes may be accelerated due to oxidation and reduction due to the presences of sulfates, chlorides, and iron. The presence of bromide in the wastewater may generate trihalomethanes during the disinfection process at the POTW[54,55,56,57]. Exposure to generated vapors is regulated through the pretreatment program, implementing health standards enforced by the Occupational Safety and Health Administration standards at 29 CFR 1910.[58] When developing local

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[54] Bober, Phillip S., Control of Trihalomethanes (THM's) In Wastewater, Philip S. Bober, Operations Superintendent, Wayne Township (NJ) (Available online at: http://www.state.nj.us/dep/dwq/pdf/thm_control.pdf)

[55] Hua, Guanghui, and Yeats, Steven, 2010, **Control of Trihalomethanes in Wastewater Treatment,** Florida Water Resources Journal, pages 6-12, APRIL (Available online at: http://www.fwrj.com/techarticles/0410%20FWRJ_tech1.pdf)

[56] Wei, Yuan-yuan;,Liu, Yan; Zhang, Yun; Dia, Rui-hua; Liu, Xiang; Wu, Jin-jian; and Zhang, Qiang , 2011, Influence of soluble microbial products (SMP) on wastewater disinfection byproducts: trihalomethanes and haloacetic acid species from the chlorination of SMP, Environ Sci Pollut Res Int, vol. 18, No. 1, pp. 46-50, January. (Avaiolable online at: http://environment.fudan.edu.cn/keyan/SCI-ESPR.pdf)

[57] Graczyk, T.K., Chalew, T.E., Maschinski, Y. and Lucy, F.E., Wastewater Treatment (not infectious hazards), APPLIED MICROBIOLOGY: INDUSTRIAL, Elsevier, Inc., 2009 (Available online at: http://www.jhsph.edu/bin/m/j/WastewaterTreatment_notinfectioushazards.pdf)

[58] http://www.gpo.gov/fdsys/pkg/CFR-2010-title29-vol6/pdf/CFR-2010-title29-vol6.pdf

limits to prevent the formation of toxic gases and vapors, the POTW may also refer to Guidance to Protect POTW Workers From Toxic and Reactive Gases and Vapors.[59]

The introduction of trucked and hauled waste present issues not only due to the pollutants themselves, but also on the rate of discharge of the pollutants, potentially causing a "slug discharge" to the POTW if released at a rate to not mix within the POTW treatment plant. The POTW may refer to Guidance Manual for the Control of Wastes Hauled to the Publicly Owned Treatment Works for additional guidance.[60] In addition to the 10 national pollutants of concern which EPA identified in its Local Limits Development Guidance, EPA recommends that a POTW considering the acceptance of SGE wastewater for treatment include the pollutants of Appendix A, Table 1 in its list of local limits of concern. Several of the pollutant parameters may already be discharged by other industrial users of the POTW but not previously evaluated. Consequently, the sampling and analysis for previously unanalyzed pollutant parameters should to be conducted in order to have a complete evaluation for local limits development.

5.5 How should EPA or state pretreatment approval authorities determine the need for POTW pretreatment program development?

Any POTW (or combination of POTWs operated by the same authority) with a total design flow greater than 5 million gallons per day (mgd) and receiving pollutants from Industrial Users that pass through or interfere with the operation of the POTW or are otherwise subject to Pretreatment Standards is required to establish a pretreatment program. 40 C.F.R. § 403.8(a) implementing CWA section 402 (b)(8). The EPA or State Pretreatment Approval Authority may require smaller POTWs to develop a pretreatment program if the nature or volume of the industrial influent, causes an occurrence of a pass through or interference event, violations of POTW effluent limitations, results in a reasonable potential to cause or contribute to an excursion of water quality criteria, or the contamination of municipal sludge. 40 C.F.R. § 403.8(f). In addition, the EPA or State Pretreatment Approval Authority may determine a program and its controls are needed to prevent the addition of pollutants into a POTW by an Industrial User or combination of Industrial Users that may cause a substantial hazard to the functioning of the treatment works, quality of the receiving waters, human health, or the environment. 40 C.F.R. § 403.8(a)In such cases, the Approval Authority may under the authority of section 402(b)(1)(C) of the Act and 40 CFR § 403.8(e), modify, or alternatively, revoke and reissue a POTW's NPDES Permit to:

(1) Put the POTW on a compliance schedule for the development of a POTW Pretreatment Program;
(2) Coordinate the issuance of a section 201 construction grant with the incorporation into a permit of a compliance schedule for POTW Pretreatment Program.
(3) Incorporate a modification of the POTW NPDES permit approved under section 301(h) or 301(i) of the act;
(4) Incorporate an approved POTW Pretreatment Program in the POTW permit; or
(5) Incorporate a compliance schedule for the development of a POTW pretreatment program in the POTW permit.

Based on analyses conducted by POTWs accepting SGE wastewater for treatment, several of the pollutants of concern in Appendix A could potentially exit the POTW untreated in the effluent.

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[59] EPA 812-B-92-001, June 1992, http://www.epa.gov/npdes/pubs/owm0256.pdf
[60] EPA 833-B-98-003, 1999, http://www.epa.gov/npdes/pubs/hwfinal.pdf

Consequently, EPA recommends that POTWs considering accepting SGE wastewater directly or indirectly from a CWT consider whether it needs to develop local limits or other pretreatment measures prior to the acceptance of such wastewaters. Controls on SGE wastewater received directly or indirectly may be necessary, in order to prevent any discharger to the POTW from causing a violation of the general pretreatment requirements or specific prohibitions or any categorical pretreatment requirements, and prevent the POTW from violating any of its effluent limitations

6 Other Related Issues.

6.1 What potential hazardous waste issues apply to the acceptance of oil & gas extraction wastewater at a POTW or CWT delivered via truck, train, or dedicated pipe?

In general, POTWs that receive hazardous wastes (as listed or identified by EPA RCRA Subtitle C regulations at 40 CFR Part 261) by truck, train, or dedicated pipe need to comply with RCRA hazardous waste requirements, including the permit-by-rule requirements of 40 CFR 270.60(c). However, wastes generated by activities associated with the exploration, development, and production of crude oil or natural gas, at primary field operations, are exempt from regulation as hazardous waste under RCRA Subtitle C. See 40 CFR § 261.4(b)(5). See also the July 1988 Regulatory Determination (53 FR 25466) and the March 1993 clarification of the Regulatory Determination (58 FR 15284).[61] These wastes include drilling fluids, produced water, and other wastes associated with the exploration, development, or production of crude oil or natural gas. According to the legislative history, the term "other wastes associated" specifically includes waste materials intrinsically derived from primary field operations associated with the exploration, development, or production of crude oil and natural gas (e.g., spent hydraulic fracturing fluids). The exemption does not apply to excess supplies, such as unused drilling fluids or treatment chemicals. POTWs or CWTs receiving exempt oil and gas extraction wastewaters would not be receiving hazardous wastes and thus would not need to meet RCRA hazardous waste requirements, including RCRA permit or permit-by-rule requirements. The guidance explains the following:

- "A mixture of an exempt waste with another exempt waste remains exempt.
- Mixing a non-hazardous waste (exempt or non-exempt) with an exempt waste results in a mixture that is also exempt.
- If, after mixing a non-exempt characteristic hazardous waste with an exempt waste, the resulting mixture exhibits any of the same hazardous characteristics as the hazardous waste (ignitability, corrosivity, reactivity, or toxicity), the mixture is a non-exempt hazardous waste.
- Generally, if a listed hazardous waste is mixed with an exempt waste, regardless of the proportions, the mixture is a non-exempt hazardous waste.

For additional information on this issue regarding the status of oil and gas exploration and production wastes that are exempt from RCRA subtitle C regulations, see:
http://www.epa.gov/epawaste/nonhaz/industrial/special/oil/oil-gas.pdf.

[61] http://www.epa.gov/epawaste/nonhaz/industrial/special/oil/index.htm

6.2 Does EPA's storm water definition at 40 CFR 122.26(b)(14)(iii) include discharges from a natural gas drilling operation?

40 CFR § 122.26(b)(14)(iii) does include natural gas activities, but only to the extent that they require permit coverage as described in 122.26(a)(2)(ii) and 122.26(c)(1)(iii).

In general and except as specified below for discharges of a reportable quantity or that contribute to a violation of a water quality standard, the Director may not require a permit for discharges of storm water from any field activities or operations associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities, including activities necessary to prepare a site for drilling and for the movement and placement of drilling equipment, whether or not such field activities or operations may be considered to be construction activities.[62]

Exceptions to the above general exemption may be found at 122.26(c)(1)(iii), which states: *"The operator of an existing or new discharge composed entirely of storm water from an oil or gas exploration, production, processing, or treatment operation, or transmission facility is not required to submit a permit application in accordance with paragraph (c)(1)(i) of this section, unless the facility:*

(A) Has had a discharge of storm water resulting in the discharge of a reportable quantity for which notification is or was required pursuant to 40 CFR § 117.21 or 40 CFR § 302.6 at anytime since November 16, 1987; or

(B) Has had a discharge of storm water resulting in the discharge of a reportable quantity for which notification is or was required pursuant to 40 CFR § 110.6 at any time since November 16, 1987; or

(C) Contributes to a violation of a water quality standard."

While stormwater discharges from oil and gas-related construction are generally subject to the conditional exemption, operators should still implement best management practices when undertaking earth disturbing activities to prevent discharging pollutants, including sediment, that would cause or contribute to a water quality standard violation, which under the above-cited regulation, would trigger storm water permitting requirements. See http://cfpub.epa.gov/npdes/stormwater/oilgas.cfm

6.3 What activities is EPA currently working on to address wastewater discharges associated with SGE?

As part of its effluent guidelines planning process under CWA section 304(m), EPA initiated a rulemaking to develop categorical standards for pretreatment. That proposed rule is expected in 2014. As part of the Effluent Limitations Guidelines development process the Agency is collecting data to better understand available treatment technologies and SGE wastewater disposal practices.

EPA is also updating the chloride water quality criteria for the protection of aquatic life under CWA Section 304(a)(1) in response to a State request for technical assistance. EPA's recommended Water Quality Criteria are used by states when setting or updating state water quality standards. Such standards provide a basis for establishing acceptable discharge limits. Because flowback and produced

[62] See CWA Section 402(l)(2) and CWA Section 502(24) as amended by the Energy Policy Act of 2005, Section 323

water from fracturing operations have very high-levels of total dissolved solids, and chlorides are the major component of the TDS, updating the water quality criteria for chloride will provide an updated scientific basis on which to issue discharge permits.

Appendix A

Table 1: Comparison of Pennsylvania Form 26R Data and Clean Water Act Section 304(a) Recommended Water Quality Criteria

		PADEP Form 26-R DATA		Chemical Data Variability (Number within data)			Aquatic Life Criteria (Freshwater)[6]		Human Health Criteria[6]		Drinking Water[7]
Parameter	**CAS NUMBER**	**Min. (mg/L)**	**Max. (mg/L)**	**No. of Datum**	**No. of Datum <PQL[1]**	**Non-detect[1]**	**Acute (mg/L)**	**Chronic (mg/L)**	**Water + Organism (mg/L)**	**Organism (mg/L)**	**MCL (mg/L)**
Benzene	71-43-2	0.0001	2.0	38	8	16	--------	--------	0.0022	0.051	0.005
Toluene	108-88-3	0.0007	1.6	38	6	19	--------	--------	1.3	150	1
Phenol	108-95-2	0.016	0.4	32	10	12	--------	--------	10.0	860	----------
Arsenic	7440-38-2	0.0011	0.0968	56	11	26	0.34	0.150	0.000018	0.00014	0.01
Aluminum	7429-90-5	0.150	2,600	51	8	13	0.75	0.087[4]	----------	----------	----------
Barium	7440-39-3	0.061	4,900	56	0	0	--------	--------	1.0	----------	2
Beryllium	7440-41-7	0.040	0.040	49	14	34	--------	--------	----------	----------	0.004
Hexavalent Chromium[1]	18540-29-9	0.0007[2]	2.2[2]	53	8	21	0.016	0.0011	----------	----------	100[8]
Trivalent Chromium[1]	16065-83-1	0.0007[2]	2.2[2]	53	8	21	0.570	0.0074	----------	----------	100[8]
Cadmium	7440-43-9	0.0013	0.018	49	9	28	0.002	0.00025	----------	----------	0.005
Copper	7440-50-8	0.0065	170,000	55	8	30	calc	calc	1.3	----------	Action Level = 1.3
Cyanide[4]	57-12-5	0.075[4]	0.11[4]	10	2	6	0.022	0.0052	0.140	0.140	Free cyanide=0.2
Iron	7439-89-6	1180	29,000	47	0	0	--------	1.0	0.300	----------	----------
Lead	12036-76-9	0.003	2.6	45	12	22	0.065	0.0025	----------	----------	0.015
Manganese	7439-96-5	0.593	48.5	29	0	0	--------	--------	0.050	0.100	----------
Mercury	7439-97-6	0.000025	0.065	47	14	19	0.0014	0.00077	----------	0.3 mg/Kg	0.002
Nickel	7440-02-0	0.0062	26,000	47	12	21	0.470	0.074	0.610	4.6	----------
Silver	7440-22-4	0.093	0.093	45	12	32	0.0032	--------	----------	----------	----------
Zinc	7440-66-6	0.0321	2.93	21	0	0	0.120	0.12	7.4	26	----------

		PADEP Form 26-R DATA		Chemical Data Variability (Number within data)			Aquatic Life Criteria (Freshwater)[6]		Human Health Criteria[6]		Drinking Water[7]
Parameter	**CAS* NUMBER**	**Min. (mg/L)**	**Max. (mg/L)**	**No. of Datum**	**No. of Datum <PQL[1]**	**Non-detect[1]**	**Acute (mg/L)**	**Chronic (mg/L)**	**Water + Organism (mg/L)**	**Organism (mg/L)**	**MCL (mg/L)**
Selenium	7782-49-2	0.004.3	0.0499	46	14	28	----------	0.0050	0.170	4.2	0.05
Ammonia Nitrogen	----------	38	25,000	15	0	0	calc	calc	----------	----------	----------
Chloride	2647-14-5	20	170,000	22	0	0	860	230	----------	----------	----------
pH(SU)	----------	5.21	9.75	39	0	0	--------	6.5-9	5-9	----------	----------
Radium 226 (pCi/L)	13982-63-3	0.0323	3.854	26	0	0	--------	--------	----------	----------	5 pCi/L
Radium 228 (pCi/L)	13982-63-3	0.0014	3.089	25	1	0	--------	--------	----------	----------	5 pCi/L
Total Dissolved Solids	----------	110	360,000	44	0	0	--------	--------	250	----------	----------
Bromide	----------	0.2	9,100	47	0	0	--------	--------	--------	--------	--------[3]

Note: Data were obtained from a sample of Pennsylvania's 26R report forms for hydraulic fracturing Flowback water or produced water. This data is an example of pollutant concentrations that have been reported and are shown here as an example of pollutants that could potentially exceed water quality criteria in certain circumstances. This information should not be viewed as a replacement for site specific data for permit decision making.

(1) The number of datum listed as less than the practical quantification limit (PQL) or non-detect are based on the listing on Form 26R. Non-detect means that the parameter was listed as not detected in the sample. Values stated as less than the PQL were found to be present but in concentrations too low to be reliably measured.

(2) Chromium data were reported as Total Chromium

(3) No MCL exists; however, bromide may have a potential to contribute to disinfection byproduct formation.

(4) Cyanide data were reported as reactive cyanide.

(5) The chronic aquatic life criterion is pH and hardness dependant and can vary significantly.

(6) Human health criteria for water and organism are based on consumption of both water and fish. Organism criteria are based on consumption of fish only. National Recommended Water Quality Criteria and background information can be found at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

(7) The Maximum Contaminant Levels for drinking water and background information can be found at: http://water.epa.gov/drink/contaminants/index.cfm

(8) The MCL for Chromium applies to Total Chromium

Table 2. Range of Chemical Constituents in Gas Extraction Wastewater

Chemical Constituents	Eastern U.S. [b] (Shale: Marcellus)	Western U.S. (Shale and Tight Sands: Piceance)		Southern U.S. (Shale: Barnett, Haynesville, Fayetteville, Woodford; Tight Sands)		EPA MCL or SMCL[c]
	Shale (mg/L)	Shale (mg/L)	Tight Sands (mg/L)	Shale (mg/L)	Tight Sands (mg/L)	
TDS	1,530 – 337,000	33,100 – 140,000	426-166,800	13,000 – 147,000	130,500-171,000	500 (SMCL)
Chlorides	287 – 228,000	6,880 – 65,800	12-95,000	10,000 – 80,500	84,000-92,500	250 (SMCL)
Metals						
Iron	0 – 810	--	1-100	22 – 62	--	0.3 (SMCL)
Calcium	30 – 123,000	148	3-31,300	8,000 – 14,100	8,800-10,000	--
Magnesium	9 – 3,190	0	1-2,100	500 – 1,450	--	--
Barium	0.4 – 15,700	--	1-311	<60	--	2 (SMCL)
Strontium	0.5 – 5,840	--	--	60 – 475	--	--
Sulfates	0 – 75,000	8.47 – 1600	1-9,000	0 – 140	--	250 (SMCL)
Manganese	0.15 – 98	--	--	8 – 14	--	0.5 (SMCL)
Organic Constituents						
Benzene (µg/L)	0.48 – 1,950	4.15 – 11	--	--	--	5 (MCL)
Trimethyl-benzene (µg/L)	<1,000	0.22 – 17,000	--	--	--	--
Propylene Glycol	17,100 – 29,700	100 – <10,000	--	--	--	--
Toluene (µg/L)	0.8 – 3,190	1.01 – 100	--	--	--	1 (MCL)
TOC[a]	1 – 1,080	--	--	10 – 460	--	--
Other						
Sodium	83 – 96,700	7,260 – 38,100	57-65,200	49,600	--	--
Ammonia	15 – 242	110 – 352	--	--	--	--
Oil and Grease	<0.5 – 1470	--	440	<4.8 – 1,720	--	--
Total Hardness	203 – 98,000	--	200	5,000 – 14,000	--	--
pH	0 – 8.6	8.06	5.2-9.3	5.5 – 8.0	5.6	6.5—8.5
TSS	11 – 3,220	--	--	0 – 850	--	--

Table 2. Range of Chemical Constituents in Gas Extraction Wastewater

Chemical Constituents	Eastern U.S. [b] (Shale: Marcellus)	Western U.S. (Shale and Tight Sands: Piceance)		Southern U.S. (Shale: Barnett, Haynesville, Fayetteville, Woodford; Tight Sands)		EPA MCL or SMCL[c]
	Shale (mg/L)	Shale (mg/L)	Tight Sands (mg/L)	Shale (mg/L)	Tight Sands (mg/L)	
Alkalinity	26 – 330	--	500 – 20,300	240 – 13,000	--	--
BOD	3 – 4,450	--	--	93 – 1,480	--	--
Radioactive Elements [d]						
Gross Alpha (pCi/L)	22.4 – 19,000	620 – 4,000	--	--	--	15 (MCL)
Gross Beta (pCi/L)	ND – 2,400	250 – 1,200	--	--	--	8 (MCL)
Radium 226 (pCi/L)	46 – 1,050	167 – 904	--	--	--	5 (MCL)
Radium 228 (pCi/L)	17 – 620	101 – 459	--	--	--	5 (MCL)

a – Total organic carbon (TOC) is an indicator of dissolved and undisolved organics.
b – Concentrations for tight sands wastewater in the Eastern U.S. are not readily available.
c – Source: U.S. EPA, 2011a.
d – Uranium is not typically one of the pollutants that gas extraction wastewater is sampled for because the decay products (i.e., radium) is more likely to be detected.

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