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Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources

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List of Acronyms/Abbreviations

Acronym	Definition
2BE	2-butoxyethanol
ACToR	Aggregated Computational Toxicology Resource database
AMEC	AMEC Environment & Infrastructure, Inc.
ANRC	Arkansas Natural Resources Commission
AO	administrative order
AOGC	Arkansas Oil and Gas Commission
API	American Petroleum Institute
ATSDR	Agency for Toxic Substance and Disease Registry
AWWA	American Water Works Association
BLM	Bureau of Land Management
BTEX	benzene, toluene, ethylbenzene, and xylenes
CARES	Casella Altela Regional Environmental Services
CASRN	chemical abstract services registration number
CBI	confidential business information
CBM	coalbed methane
CCST	California Council on Science and Technology
CDWR	Colorado Division of Water Resources
CFR	Code of Federal Regulations
CICAD	Concise International Chemical Assessment Document
CM	chemical mixing
COGCC	Colorado Oil and Gas Conservation Commission
CWCB	Colorado Water Conservation Board
CWT	centralized waste treatment
CWTF	centralized water treatment facility
DBNM	dibromochloronitromethane
DBP	disinfection by-products
DecaBDE	decabromodipheyl ether
DfE	Design for the Environment
DI	Drilling Info, Inc.
DMR	Discharge Monitoring Report
DNR	Department of Natural Resources
DO	dissolved oxygen
DOC	dissolved organic carbon
DOE	U.S. Department of Energy
DOGGR	California Department of Conservation's Division of Oil, Gas & Geothermal Resources
DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
DRO	diesel range organics
EERC	Energy and Environmental Research Center, University of North Dakota
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency

Acronym	Definition
EPA OW	U.S. Environmental Protection Agency's Office of Water
EPI	estimation programs interface
ERCB	Energy Resource Conservation Board
ERG	Eastern Research Group
ESN	Environmental Services Network
FRS	fluids recovery services
GES	Groundwater & Environmental Services, Inc.
GNB	Government of New Brunswick
GRO	gasoline range organics
GTI	Gas Technology Institute
GWPC	Ground Water Protection Council
HBCD	hexabromocyclododecane
HDPE	high-density polyethylene
HF	hydraulic fracturing
HHBP	Human Health Benchmarks for Pesticides
HISA	Highly Influential Scientific Assessment
HUC	hydrological unit code
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer
IOGCC	Interstate Oil and Gas Compact Commission
IPCC	Intergovernmental Panel on Climate Change
IPCS	International Programme on Chemical Safety
IRIS	Integrated Risk Information System
IUPAC	International Union of Pure and Applied Chemistry
KWO	Kansas Water Office
LOAEL	lowest observed adverse effect level
MCDA	multicriteria decision analysis
MCL	maximum contaminant level
MCLG	maximum containment level goal
MCOR	Marcellus Center for Outreach and Research
MIT	mechanical integrity test
MRL	minimum risk level
MSC	Marcellus shale coalition
MT GWIC	Montana Ground Water Information Center
MTBE	methyl tert-butyl ether
MVR	mechanical vapor recompression
NAS	National Academy of Sciences
NDDMR	North Dakota Department of Mineral Resources
NDDOH	North Dakota Department of Health
NDSWC	North Dakota State Water Commission
NETL	National Energy Technology Laboratory
NGO	non-governmental organization
NM OCD	New Mexico Oil Conservation Division

Acronym	Definition
NM OSE	New Mexico Office of the State Engineer
NOAEL	no observed adverse effect level
NORM	naturally occurring radioactive material
NPC	National Petroleum Council
NPDES	National Pollution Discharge Elimination System
NRC	National Resource Council
NTP	U.S. National Toxicology Program
NYSDEC	New York State Department of Environmental Conservation
O&G	oil and gas
ODNR	Ohio Department of Natural Resources
ODNR, DMRM	Ohio Department of Natural Resources, Division of Mineral Resources Management
OEPA	Ohio Environmental Protection Agency
ORD	Office of Research and Development
OSF	oral slope factor
OSHA	Occupational Safety & Health Administration
OSWER	Office of Solid Water and Emergency Response
OWRB	Oklahoma Water Resources Board
PA DCNR	Pennsylvania Department of Conservation and Natural Resources
PA DEP	Pennsylvania Department of Environmental Protection

Acronym	Definition
PAH	polycyclic aromatic hydrocarbon
PFBC	Pennsylvania Fish and Boat Commission
PDL	positive determination letter
PMF	Positive Matrix Factorization
POD	point-of-departure
POTW	publicly owned treatment work
PPRTV	provisional peer-reviewed toxicity value
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
QSAR	Quantitative Structure Activity Relationship
RfD	reference dose
RfV	reference value
RO	reverse osmosis
SAB	Science Advisory Board
SAIC	Science Applications International Corporation
SDWA	Safe Drinking Water Act
SDWIS	safe drinking water information system
SEECO	Southern Electrical Equipment Company
SGEIS	supplemented generic environmental impact statement
SHS MSC	statewide health standards for medium-specific concentrations
SMCL	secondary maximum contaminant level

Acronym	Definition
SPE	Society of Petroleum Engineers
SRB	Susquehanna River basin
SRBC	Susquehanna River Basin Commission
STO	Statoil
STRONGER	State review of oil and natural gas environmental regulations
SVOC	semi-volatile organic compounds
SWE	Southwestern Energy
TARM	TerrAqua Resource Management
TBA	tert-butyl alcohol
TDS	total dissolved solids
TENORM	technologically enhanced naturally occurring radioactive material
THM	trihalomethane
TIPRO	Texas Independent Producers and Royalty Owners Association
TMDL	total maximum daily load
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TSS	total suspended solids
TTHM	total trihalomethane
TWDB	Texas Water Development Board
TXRRC	Texas Railroad Commission
UCRB	Upper Colorado River basin
UIC	underground injection control
UOG	unconventional oil and gas
USGAO	U.S. Government Accountability Office
USGS	U.S. Geological Survey
UWS	Universal Well Services
VOC	volatile organic compounds
WAWSA	Western Area Water Supply Authority
WFR	Well File Review
WHO	World Health Organization
WRF	Water Research Foundation
WVDEP	West Virginia Department of Environmental Protection
WWTP	wastewater treatment plant
WYOGCC	Wyoming Oil and Gas Conservation Commission

Preface

The U.S. Environmental Protection Agency (EPA) is conducting a study of the potential impacts of hydraulic fracturing for oil and gas on drinking water resources. This study was initiated in Fiscal Year 2010 when Congress urged the EPA to examine the relationship between hydraulic fracturing and drinking water resources in the United States. In response, EPA developed a research plan (*Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources*) that was reviewed by the Agency's Science Advisory Board (SAB) and issued in 2011. A progress report on the study (*Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources: Progress Report)*, detailing the EPA's research approaches and next steps, was released in late 2012 and was followed by a consultation with individual experts convened under the auspices of the SAB.

The EPA's study includes the development of several research projects, extensive review of the literature and technical input from state, industry, and non-governmental organizations as well as the public and other stakeholders. A series of technical roundtables and in-depth technical workshops were held to help address specific research questions and to inform the work of the study. The study is designed to address research questions posed for each stage of the hydraulic fracturing water cycle:

- Water Acquisition: What are the possible impacts of large volume water withdrawals from ground and surface waters on drinking water resources?
- Chemical Mixing: What are the possible impacts of surface spills of hydraulic fracturing fluid on or near well pads on drinking water resources?
- Well Injection: What are the possible impacts of the injection and fracturing process on drinking water resources?
- Flowback and Produced Water: What are the possible impacts of surface spills of flowback and produced water on or near well pads on drinking water resources?
- Wastewater Treatment and Waste Disposal: What are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?

This report, *Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources*, includes both the literature review and results from the research projects conducted as part of the EPA's study. It will undergo independent, external peer review in accordance with Agency policy and all of the peer review comments received will be considered in the development of the final report.

The EPA's study will contribute to the understanding of the potential impacts of hydraulic fracturing activities for oil and gas on drinking water resources and the factors that may influence those impacts. The study will help facilitate and inform dialogue among interested stakeholders, including Congress, other Federal agencies, states, tribal government, the international community, industry, non-governmental organizations, academia, and the general public.

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