EPA Contract EP-C-10-023

Quality Assurance Project Plan v1 for WA 3-4

HYDRAULIC FRACTURING

Prepared for:

U.S. Environmental Protection Agency
Office of Research and Development
Office of Science Policy
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July 25, 2013

Quality Assurance Project Plan for Hydraulic Fracturing

APPROVAL SHEET

Signatures indicate approval of this Quality Assurance Project Plan and commitment to follow the applicable procedures noted:

/s/ February 21, 2013
David Marker – Westat Work Assignment Manager Date

/s/ March 11, 2013
David Morganstein – Westat QA Officer Date

/s/ 8/13.2013
Beverly Randolph – EPA Technical Project Officer Date

/s/ August 6, 2013
Jill Dean – EPA Work Assignment Manager Date

/s/ 8/13.2013
Stephen Watkins – EPA/Quality Assurance Officer, Office of Science Policy Date

Disclaimer

EPA does not consider this internal planning document an official Agency dissemination of information under the Agency's Information Quality Guidelines, because it is not being used to formulate or support a regulation or guidance; or to represent a final Agency decision or position. This planning document describes the overall quality assurance approach that will be used during the research study. Mention of trade names or commercial products in this planning document does not constitute endorsement or recommendation for use.

The EPA Quality System and the Hydraulic Fracturing Research Study

EPA requires that all data collected for the characterization of environmental processes and conditions are of the appropriate type and quality for their intended use. This is accomplished through an Agency-wide quality system for environmental data. Components of the EPA quality system can be found at http://www.epa.gov/quality/. EPA policy is based on the national consensus standard ANSI/ASQ E4-2004 *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*. This standard recommends a tiered approach that includes the development and use of Quality Management Plans (QMPs). The organizational units in EPA that generate and/or use environmental data are required to have Agency-approved QMPs. Programmatic QMPs are also written when program managers and their QA staff decide a program is of sufficient complexity to benefit from a QMP, as was done for the study of the potential impacts of hydraulic fracturing (HF) on drinking water resources. The HF QMP describes the program's organizational structure, defines and assigns quality assurance (QA) and quality control (QC) responsibilities, and describes the processes and procedures used to plan, implement and assess the effectiveness of the quality system. The HF QMP is then supported by project-specific QA project plans (QAPPs). The QAPPs provide the technical details and associated QA/QC procedures for the research projects that address questions posed by EPA about the HF water cycle and as described in the *Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources* (EPA/600/R-11/122/November 2011/www.epa.gov/hydraulic fracturing). The results of the research projects will provide the foundation for EPA's 2014 study report.

This QAPP provides information concerning the water acquisition, chemical mixing, well injection, flowback and produced water, and wastewater treatment and waste disposal stage projects of the HF water cycle as found in Figure 1 of the HF QMP and as described in the HF Study Plan. Appendix A of the HF QMP includes the links between the HF Study Plan questions and those QAPPs available at the time the HF QMP was published.

Distribution
(Element A.3)

This Quality Assurance Project Plan (QAPP) will be distributed to staff of the U.S. Environmental Protection Agency and Westat (Table 1). A copy of the document will be provided to all Westat staff involved in the project, including those who join the project after publication of the QAPP.

Table 1. QAPP distribution

Name Title	Contact Information	Mailing Address
U.S. Environmental Protection Agency		
Beverly Randolph Technical Project Officer	202-566-1013 Randolph.beverly@epa.gov	U.S. Environmental Protection Agency Office of Water 1200 Pennsylvania Ave. NW, (4303T) Washington, DC 20460
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1. Introduction

EPA is studying the potential impacts of hydraulic fracturing on drinking water resources at the request of the U.S. Congress, specifically the Appropriations Conference Committee of the House of Representatives. Stakeholders may use the information from this study to inform their decision making regarding hydraulic fracturing.

ERG assisted EPA in developing a technical questionnaire that was sent to nine hydraulic fracturing service companies on September 9, 2010. EPA received questionnaire responses from all nine companies. Westat assisted EPA in analyzing the nine questionnaire responses to determine how representative these companies were of hydraulic fracturing companies throughout the nation and for major fracturing areas. We then developed a sampling plan and selected nine oil and gas well owner/operators for whom these service companies hydraulically fractured wells. Westat also used a statistical approach to select a set of the wells hydraulically fractured by the service companies for which the well owner/operators were asked to provide information. The EPA then sent an information request on August 11, 2011, to the selected nine oil and gas well owner/operators regarding well construction, design, and well operation practices for the selected 350 oil and gas wells that were hydraulically fractured from 2009-2010.

As directed by EPA, Westat has prepared this detailed Quality Assurance Project Plan (QAPP). It is responsive to all applicable elements specified in EPA Requirements for Quality Assurance Project Plans (1). This QAPP is a project-specific supplement to Westat's Quality Management Plan (QMP) approved April 17, 1998 and revised December 1, 2009, which was prepared in accordance with EPA Requirements for Quality Management Plans. Westat's QMP details the responsibilities of the Westat's Quality Assurance Officer (QAO) and Project Management Team and describes procedures used to plan, implement, and assess project quality. These procedures, tailored to the needs of the tasked activities, will be used on Westat's work assignment associated with this program. This plan addresses the secondary data sources, as Westat will not be involved in any of the primary data collection.

References are presented in Section 6. Throughout this document, each time a reference is cited, a number corresponding to the Section 6 listing is shown in parentheses.

Section 7 contains a list of acronyms used throughout this document.

2. Project Management Elements

This section addresses project management, including project history and objectives, roles and responsibilities, and project goals. In addition, this section presents the mechanisms EPA and ERG will use to ensure that all participants understand the goals and the approach to be used for this project. In its Requirements of Quality Assurance Project Plans (1), EPA identifies the following nine project management elements:

- A.1: Title and Approval Sheet;
- A.2: Table of Contents;
- A.3: Distribution List;
- A.4: Project Organization;
- A.5: Problem Definition/Background;
- A.6: Project/Task Description;
- A.7: Quality Objectives;
- A.8: Special Training/Certification; and
- A.9: Project Documents and Records.

Elements A.1 through A.3 have been provided earlier in this document. The remaining elements are presented below.

2.1 Element A.4: Project Organization

Project organization for Westat's support of this project is depicted in Figure 2-1. The Westat Project Director and Work Assignment Manager (WAM) will be responsible for management and administrative aspects of the work performed. He will also be responsible for ensuring that the quality of work, schedule, and budget meet the requirements of the EPA hydraulic fracturing study. He will provide technical direction and oversight to Westat staff. He will be the principal contact for

the EPA WAM on project issues, deliverables, and schedule. The Westat WAM will also keep the Project QA Officer advised of any quality problems that arise.

The Project QA Officer will be responsible for the development and execution of QA activities throughout the course of the project, including those related to the questionnaire task. The Project QA Officer will also ensure that the Westat WAM is obtaining appropriate technical review of all deliverables.

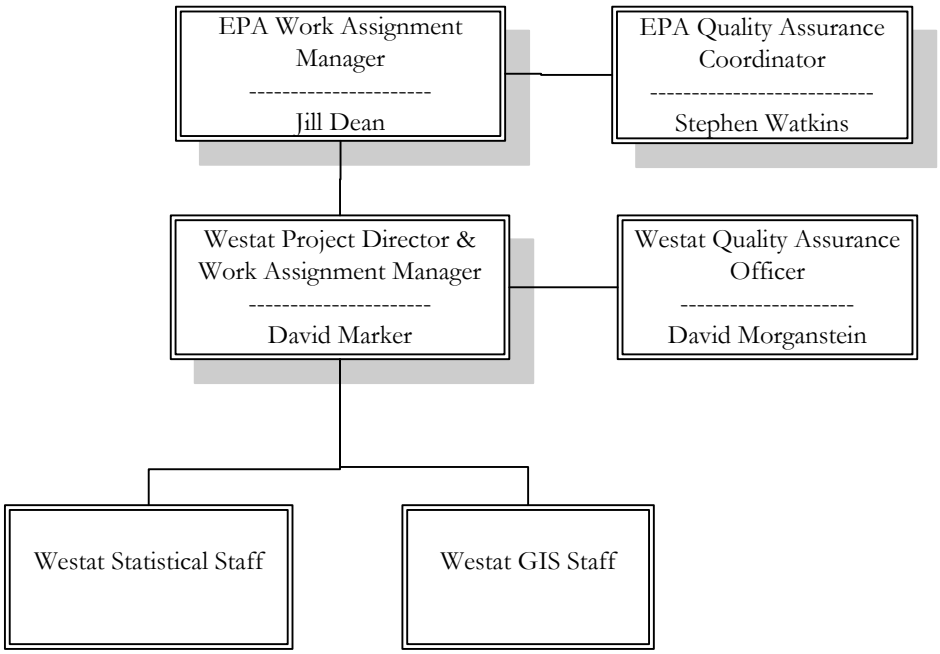

Figure 2-1. Project level QA organization for Westat's support for the evaluation of information on hydraulic fracturing

2.2 Element A.5: Problem Definition/Background

This section explains the purpose of the hydraulic fracturing study. It also presents a brief background of hydraulic fracturing.

2.2.1 Background

Over the past few years, the use of hydraulic fracturing for oil and gas extraction has increased and has expanded over a wider diversity of geographic regions and geologic formations. Public concerns have focused recently on the potential drinking water impacts of the hydraulic fracturing process used during natural gas production from unconventional resources such as shale and coalbed methane formations. Given this expansion and increasing concerns, EPA announced in March 2010 that it would study the potential adverse impact that hydraulic fracturing may have on drinking water. During the summer of 2010, EPA conducted a series of meetings to receive broad, balanced input on research topics from stakeholders in key regions affected by hydraulic fracturing. EPA developed a draft study plan in February 2011 using input from stakeholders and EPA's Science Advisory Board, which focused on drinking water resources (quality and quantity). The study plan was finalized in November 2011.

In September 2010, EPA requested data from nine well service companies that perform hydraulic fracturing. The objectives of the information request were:

- Identify key industry well owner/operators;
- Obtain contact information for persons within each company most familiar with hydraulic fracturing operations and for companies that have been contracted to perform hydraulic fracturing;
- Gain information on the location and services performed for past and future hydraulic fracturing operations;
- Obtain the names and formulations/mixtures of hydraulic fracturing fluids;
- Obtain chemical and proppant constituent information for each formulation/mixture of hydraulic fracturing fluid;
- Define policies, practices, and standard operating procedures for common operations; and
- Identify water specifications for each formulation/mixture.

2.2.2 Statement of key questions and project objectives

Westat is supporting EPA in its study of the use and potential impacts of hydraulic fracturing on drinking water and public health.

Westat will support EPA in answering the following key questions:

1. How representative are the hydraulic fracturing service companies that responded to its 2010 information request?
2. How many wells should be included in the 2011 information request of oil and gas well owner/operators?
3. How should the oil and gas well owner/operators be selected?
4. How does hydraulic fracturing affect drinking water quality, especially drinking water aquifers and surface water bodies?
5. How does hydraulic fracturing and the associated dewatering affect hydrogeology, such as structural stability and subsidence?
6. What practices are established to control drinking water impacts?
7. What methods are being used for chemical analyses of the hydraulic fracturing fluid?
8. How does hydraulic fracturing differ across the country?

Westat will summarize findings in a series of memoranda.

2.3 Element A.6: Project/Task Description

This section provides a management level overview of the work Westat will perform in support of this project. Westat will perform this work at the direction of EPA.

2.3.1 Assessment of representativeness

Westat evaluated data collected by EPA from nine hydraulic fracturing service companies regarding their practices, and information regarding the hydraulic fracturing and oil and gas industries in order to assess the extent to which the nine respondents were representative of their industry as a whole. Westat examined third-party sources (e.g. websites and industry representatives) to gather independent information on the number of wells recently drilled and their approximate locations. We then compared the distribution of wells from these sampled companies with estimates of the universe of all wells.

2.3.2 Statistical sample designs

Westat will provide statistical support to meet EPA's objective to evaluate the potential impacts of hydraulic fracturing on drinking water resources. In August 2011, EPA requested information from oil and gas well owner/operators who were the customers of the hydraulic fracturing service companies that responded to EPA's 2010 request. EPA requested well files for a sample of wells that were reported by the hydraulic fracturing companies. EPA desired that this new request go to no more than nine oil and gas well owner/operators, and that the request provide information as representative as possible of the wells hydraulically fractured by the nine service companies. Westat identified, evaluated, and recommended options for choosing the nine oil and gas well owner/operators from which EPA could request information. In addition to selecting the nine oil and gas well owner/operators, Westat proposed a sample size, sampling plan, and study design for selecting a representative sample of wells for which the nine well owner/operators were asked to provide information to EPA. EPA desired that the study design be as simple as possible, and Westat evaluated the extent to which including stratification to gain representativeness provided improved results.

2.3.3 Revised survey weights and guidance

Westat will provide survey weights and statistical documentation on applying the survey weights. When respondents identify particular circumstances that might affect the survey weights (e.g., eligibility) and statistical analyses, Westat will provide recommendations to EPA in handling the response. After the response deadline and EPA classifies the sample draw into appropriate categories (i.e., respondents, out-of-scope, non-respondent, etc.), Westat will provide draft and revised survey weights that are adjusted for nonresponse and other factors.

2.3.4 Population estimates

Westat will provide statistical estimates of population and subpopulation sizes, characteristics, and variability in response to technical direction that identifies the specific population estimates and types of adjustments such as non-response, undercounts, over-counts, and post-stratification. In addition, Westat will adjust analysis results for missing data resulting from item and survey non-response. With each set of population estimates, Westat will provide documentation about the

population definitions, statistical, methodology and the results. Westat will incorporate EPA comments and updated databases into revisions.

2.3.5 Statistics appendix

Westat will provide an outline, draft appendix, and final version of the appendix that describe the design of the information request, outcomes, quality assurance, and methodology for population estimation. Westat will incorporate the EPA WAM comments into revised versions. The final version shall be delivered in a format that can be easily incorporated into one of the main technical documents for the study.

2.3.6 Respond to statistical issues

Upon receipt of written technical direction, Westat will provide statistical review and comments on documents specific to hydraulic fracturing. These documents will be provided to Westat by the EPA WAM. EPA may obtain these studies from sources such as OW, other EPA Offices, EPA Regions, states, other government agencies including OMB, industry reports, and professional journals.

Westat will provide up to three additional statistical analyses, statistical review, and research relevant to hydraulic fracturing as specified in written technical directives.

2.4 Element A.7: Quality Objectives and Acceptance Criteria

This QAPP is intended to ensure that data collected for the evaluation of hydraulic fracturing information are of the quality necessary to support EPA in determining the potential impact of hydraulic fracturing on drinking water resources. The main sources of data for this task are data collected in the questionnaires, existing EPA studies, web sites, and third-party databases.

All project deliverables will include documentation supporting the work that identifies the sources of data, assumptions made, and calculations used in their development with sufficient detail so that the work can be reproduced by qualified third parties.

2.4.1 Assessment of representativeness

Westat evaluated data collected in 2010 by EPA from nine hydraulic fracturing service companies regarding their practices, and information regarding the hydraulic fracturing and oil and gas industries in order to assess the extent to which the nine respondents are representative of their industry as a whole. Westat examined third-party sources (e.g. websites and industry representatives) to gather independent information on the number of wells recently drilled and their approximate locations. We used geographic information systems (GIS) as well as analytic methods to compare the sampled wells with these estimates of the universe of all wells.

Westat compared the data from the nine service companies with third-party data that were available on the web and through industry contacts, as described in Table 2. The third-party information was not useful for assessing representativeness. The available information is generally a compilation of information obtained from many state-level data systems. These state-level sources collect different information making it difficult to develop a national comparison for a fixed period of time. Missing data from the third-party source limited Westat's ability to quantitatively assess the representativeness of the data but it did not prevent all data analyses.

Table 2. Representativeness data acceptance criteria

Acceptance Criterion: Questionnaire Data	Description/Definition	Specification
Timeliness	Are data within the time period of interest?	What time period is covered by the data?
Internal consistency	For an individual data source, do national numbers equal the sum of all subnational areas?	Does it appear that parts of the data are inconsistent?
Completeness	For a given data source, do data contain information on drilling date and locational information?	Does it appear that parts of the data are missing?
Representativeness	Do the questionnaire data represent the plays with the most activity during the period under review?	Compare compiled questionnaire data to available websites or industry sources.

2.4.2 Statistical sample designs

In August 2011, EPA requested information from nine oil and gas well owner/operators who were the customers of the hydraulic fracturing service companies that responded to EPA's 2010 request.

EPA's request included a request for a set of files for a sample of wells that were representative of the wells hydraulic fractured by the nine hydraulic fracturing service companies. Westat identified, evaluated, and recommended options for choosing the nine oil and gas well owner/operators from which EPA requested information in order that the companies were representative of the wells fractured by the nine hydraulic fracturing service companies that provided information in 2010. To the extent possible, the data were also representative of hydraulic fracturing conducted by the nine service companies in the major shale plays, coal bed methane, and tight sands production areas of the continental United States. Westat proposed a sample size, sampling plan, and study design to achieve this representativeness.

Westat identified and assessed data sources and databases regarding the make-up and structure of the oil and gas production industry as well as the database provided by EPA based on responses from the nine hydraulic fracturing service companies. These were used to develop the sample frame for selecting a sample of oil and gas well owner/operators. Westat recommended a sample design and, based on comments from EPA, it developed a finalized design. We then selected the sample of oil and gas well owner/operators.

Table 3. Sample design data acceptance criteria

Acceptance Criterion: Questionnaire Data	Description/Definition	Specification
Timeliness	Are data current?	Do the data all cover the same time period?
Representativeness	Will the sample design yield a representative sample of companies?	Are the sampled companies likely to include wells across the plays with the most activity during the time period under review?
Completeness	For a given data source, does it cover some or all of the plays with the most activity during the period under review?	There should be documentation of whether or not the reported data cover all the active plays or are restricted to specific locations.
Comparability	Are the data from the different data sources consistent?	Compare counts of companies and/or wells in different locations.

2.4.3 Revised survey weights and guidance

Westat will provide survey weights and statistical documentation on applying the survey weights. When respondents identify particular circumstances that might affect the survey weights (e.g., eligibility) and statistical analyses, Westat will provide recommendations to EPA in handling the

response. Westat will provide draft and revised (based on EPA comments) survey weights that are adjusted for nonresponse and other factors.

Table 4. Survey weights data acceptance criteria

Acceptance Criterion: Questionnaire Data	Description/Definition	Specification
Precision	Can the weights be improved to increase precision?	Examine weight outliers for possible trimming.
Bias	Do the weights yield unbiased estimates?	Are there collapsing or other factors that could lead to biased estimates?
Completeness	What response rate was achieved? Is that likely to introduce any bias?	Document the response rate both at the company and well level.

2.4.4 Population estimates

Westat will use databases from EPA containing information from the 350 well files requested from well owner/operators in 2011 to produce population estimates. To the extent possible, Westat will process these databases using the same variable names and labels as are on the files we receive. It is possible that limitations on naming conventions in SAS will require Westat to modify these names. If that occurs, Westat will provide a mapping of the existing variables to Westat's modified variables.

Westat will provide statistical estimates of population and subpopulation sizes, characteristics, and variability for specific population estimates and types of adjustments such as non-response, undercounts, overcounts, and post-stratification. In addition, Westat will adjust analysis results for missing data resulting from item and survey non-response. With each set of population estimates, Westat will provide documentation about the population definitions, statistical, methodology and the results. Westat will incorporate EPA comments and updated databases into revisions. Copies of computer programs and databases will be provided for final versions, along with corresponding documentation.

Table 5. Population estimates data acceptance criteria

Acceptance Criterion: Questionnaire Data	Description/Definition	Specification
Precision	Can the weights be improved to increase precision?	Examine weight outliers for possible trimming.
Bias	Do the weights yield unbiased estimates?	Is there collapsing or other factors that could lead to biased estimates?
Completeness	What response rate was achieved? Is that likely to introduce any bias?	Document the response rate both at the company and well level.
Comparability	Are the data consistent with other available data?	Compare counts of companies and/or wells with other available data sources.

2.4.5 Statistics appendix

Westat will provide an outline, draft appendix, and final version of the appendix that describe the survey design, outcomes, quality assurance, and methodology for population estimation. Westat will incorporate the EPA WAM comments into revised versions. The final version shall be delivered in a format that can be easily incorporated into one of the main technical documents for the study.

Table 6. Statistical appendix data acceptance criteria

Acceptance Criterion: Questionnaire Data	Description/Definition	Specification
Completeness	Does the appendix cover all activities conducted by Westat?	Review all previous deliverables for inclusion.
Usability	Is the appendix in the appropriate format(s)?	Discuss with EPA any formatting requirements.

2.4.6 Respond to statistical issues

Westat will provide statistical review and comments on documents specific to hydraulic fracturing. These documents will be provided to Westat by the EPA WAM. EPA may obtain these studies from sources such as OW, other EPA Offices, EPA Regions, states, other government agencies including OMB, industry reports, and professional journals. Westat will provide a preliminary assessment to EPA to assure we are interpreting the issues consistent with EPA's needs. In-depth review will then be reported in detailed memoranda or reports.

Table 7. Statistical issues data acceptance criteria

Acceptance Criterion: Public Comments	Description/Definition	Specification
Accuracy	Are the data in document an accurate reflection of the best information available?	Compare data sources with those used by EPA.
Representativeness	Are the data representative of what they claim to be?	Identify data sources and compare to other available information.
Comparability	Are the data consistent with the goal of EPA's analysis?	Do these data address the same questions as EPA is addressing. Even if not a perfect match, do they provide useful insights?

2.5 Element A.8: Special Training/Certification

During the course of this work assignment, Westat will be accessing and evaluating Toxic Substance Control Act (TSCA) confidential business information (CBI) data. Westat will, at all times, adhere to CBI procedures when handling confidential information. Westat will manage all reports, documents, and other materials and all draft documents developed under this work assignment in accordance with the procedures set forth in EPA's TSCA CBI Protection Manual dated October 20, 2003 (3). Westat staff requiring access to TSCA CBI for this project will maintain active TSCA CBI clearance. The Westat office in Rockville, Maryland, has an approved TSCA CBI storage area, which allows Westat staff to work on TSCA CBI at that location. All work involving TSCA CBI will be completed at Westat's Rockville, Maryland, office.

2.6 Element A.9: Documents and Records

Westat has developed and instituted document control mechanisms for the review, revision, and distribution of QAPPs. Each QAPP has a signed approval form, title page, table of contents, and EPA-approved document control format (shown below) that appears in the upper right-hand corner of each page:

Section No.
Revision No.
Date

During the course of the project, any revision to the QAPP will be circulated to all Westat and EPA project staff. Westat will document the circulation of the revised QAPP to project staff with a signature page for the revision.

Westat will follow its Current Best Method (CBM) for Documentation to track major communications between staff and between Westat and EPA (see Appendix A for a summary of the CBM). All memoranda will be tracked in a Memo Log. Modifications or replacements to earlier memos are given revision numbers so it is clear what is being replaced. At the beginning of any revised memo there is a short description of what has changed and what has not.

Because many industries identified their questionnaire data as TSCA CBI, Westat's hydraulic fracturing record database will also be treated as TSCA CBI. The record database will be stored in Westat's TSCA CBI room, on a TSCA CBI computer. Access to the locked TSCA CBI room is limited to those Westat employees with CBI clearance.

Management of project data is specifically described in Element B.10, Data Management, of this QAPP.

3. Data Generation and Acquisition

This section describes data generation and acquisition; however, Westat will not be responsible for generating any data. We will be developing sampling plans and managing data that are returned to EPA. Therefore, this section discusses the following two elements:

- B.1: Sampling Process Design; and,
- B.10: Data Management.

The following elements are not relevant to Westat's support of EPA's hydraulic fracturing study, because Westat will not be supporting field work.

- B.2: Sampling Methods;
- B.3: Sample Handling and Custody;
- B.4: Analytical Methods;
- B.5: Quality Control;
- B.6: Instrument/Equipment Testing, Inspection and Maintenance;
- B.7: Instrument/Equipment Calibration and Frequency; and
- B.8: Inspection/Acceptance of Supplies and Consumables.
- B.9: Nondirect Measurements; and

3.1 Element B.1: Sampling Process Design

Westat designed a sample for selecting nine oil and gas well owners/operators from the customers reported to EPA by the nine hydraulic fracturing service companies in 2010. We also selected a sample of wells for those oil and gas well owner/operators to include in their responses.

In both cases a probability-based design was used. In selecting nine oil and gas operating companies to represent activities across the country, some were required to be selected with certainty. The

design reflected oil and gas well owner/operators that operate in all of the major production areas in the country. Our goal was to include companies of different size since it is possible that well characteristics could be related to company size. For example, larger companies may have more complete records and may use different types of chemicals.

Westat used standard software (e.g. Microsoft Excel, SAS) to create the universe of companies (and wells) and produce tabulations describing this universe. Based on this characterization of the universe, a sampling plan was developed. Selection of the sample of companies (and wells) used Westat's proprietary software for sample selection, WESSAMP. A summary of this is included in the appendix. WESSAMP has been used for hundreds of U.S. government studies.

3.2 Element B.10: Questionnaire Data Management

Most of the data used under this task will be maintained in SAS data files to allow for ease of analysis. Smaller databases will be maintained in Microsoft Excel. Variables will be given English labels and values to assure that data are used correctly. Westat senior staff will review documents prepared by junior staff to assure proper documentation and use of data.

All memoranda will be tracked and numbered as called for in Westat's CBM for documentation. This will assure version control and clarify what is replaced when/if it is needed. A summary of the documentation CBM is in Appendix A to this QAPP.

Whenever possible we will use either commercial off the shelf (COTS) or well-documented Westat proprietary software that has been used on hundreds of government databases. An example is software developed by Westat to weight survey responses (WESWGT) that produces standard output to check for outliers, collapsing for nonresponse, and other key factors that must be reviewed to improve the final weights. By using such software Westat minimizes the opportunities for errors and simultaneously expedites the processing time required to produce final data sets.

Some of the data used by Westat under this task will be TSCA CBI, for example some of the responses from the questionnaires. All such data will be managed following the procedures set forth in EPA's TSCA CBI Protection Manual dated October 20, 2003 (3). Westat staff requiring access to TSCA CBI for this project will maintain active TSCA CBI clearance. The Westat Rockville,

Maryland, office has an approved TSCA CBI storage area and multiple TSCA-compliant stand-alone computers, which allows Westat staff to work on TSCA CBI at that location.

4. Assessment and Oversight Elements

This section describes technical review, audits, and corrective actions that will be performed on the hydraulic fracturing information evaluation to ensure the QAPP is implemented as approved.

4.1 Element C.1: Assessments and Response Actions

All work conducted for the hydraulic fracturing project will be subject to technical review by Westat senior staff. Senior staff will approve planned work of more junior staff in advance so that there will be few surprises at the review stage. All deliverables will be reviewed by the Westat WAM before delivery to EPA.

As part of Westat's QA/QC procedures on this project, the Westat QA Officer will review this QAPP for completeness and applicability. He will be available to assist staff with QA issues as they arise and will periodically review compliance with the QAPP. He will discuss the findings of such reviews with the Westat Project Director.

Westat will cooperate with EPA on all assessments performed by EPA on the hydraulic fracturing project. EPA plans to conduct technical system assessments (TSAs), audits of data quality (ADQs), and QA review of final products.

4.2 Element C.2: Reports to Management

Westat will describe QA activities conducted for major deliverables, such as summary memoranda, when such documents are delivered to EPA. These descriptions may be included in the document or in the transmittal email, as directed by EPA. Additionally, Westat will provide the EPA WAM with monthly reports on the status of QA activities. These reports will be incorporated into Westat's monthly technical progress reports, and will include descriptions of any problems encountered and identification of problem resolution and/or corrective actions taken during the reporting period.

5. Data Validation and Usability Element

This section describes data review, verification, and validation. It also discusses how validated data will be evaluated to determine if they adequately answer the questions posed in Section 2.2.2 and meet the quality objectives stated in Section 2.4.

5.1 Elements D.1 and D.2: Data Review, Verification, and Validation; and Validation Methods

Westat reviewed all of the data that could be used for completeness and representativeness. We examined whether the data covered the entire country and specifically if it included all of the major shale plays. While there is no known total number of wells drilled, we compared estimates from the multiple data sources to determine if there were obvious gaps in some of these sources.

Westat will review all data sets for apparent outlier values. We will attempt to determine whether these are indeed true values, the result of data entry errors, or have some other explanation. We will discuss these outliers with EPA and those who provided the data in an attempt to determine how best to utilize these special cases. The changes made to data based on these reviews will be documented in our final report.

5.2 Element D.3: Reconciliation with User Requirements

In Section 2.4 we described the checks Westat will use to determine the accuracy, timeliness, completeness, representativeness, and comparability of the data. Westat will report these measures of quality to the EPA WAM in the monthly report.

In addition, Westat will describe data quality and limitations in its reports so later data users may determine if the data are of sufficient quality for their use. Westat will work with EPA to determine to what extent data that do not meet the specified data acceptance criteria may be used to support EPA's Study on Hydraulic Fracturing and how this determination will be documented. All data use determinations will be made by EPA and data determined by EPA to be unacceptable will not be used to support this study.

Westat will include an evaluation of data quality in all project deliverables. Westat will also identify the sources of data, assumptions made, changes or modifications to data based on follow up conversations with industry representatives, and calculations used in their development in all project deliverables including databases. These identifications will be sufficiently detailed and transparent to ensure the reproducibility of the work by qualified third parties.

6. References

1. U.S. Environmental Protection Agency. EPA Requirements for Quality Assurance Project Plans QA/R-5. EPA/240/B-01/003. Office of Environmental Information, March 2001.

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7. List of Acronyms

Acronym	Description
ADQs	Audits of Data Quality
CBM	Current Best Methods
CBI	Confidential Business Information
COTS	Commercial Off The Shelf
DP	Data Processing
GIS	Geographic Information System
HF	Hydraulic Fracturing
MOS	Measure of Size
NAEP	National Assessment of Education Progress
PPS	Probability Proportional to Size
PSU	Primary Sampling Unit
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
SSUs	Second Stage Units
TSAs	Technical System Assessments
TSCA	Toxic Substance Control Act
WAM	Work Assignment Manager
WESSAMP	Proprietary software for sample selection
WESWGT	Proprietary software for weighting survey responses