REPORT

Groundwater Corrective Action Monitoring Program Plan

Northern Indiana Public Service Company LLC
R.M. Schahfer Generating Station
Wheatfield, IN

Submitted to:

Northern Indiana Public Service Company LLC

801 East 86th Avenue
Merillville, IN 46410

Submitted by:

WSP USA Inc.
10 AL PAUL LANE, SUITE 103
MERRIMACK, NEW HAMPSHIRE 03054

+1 603 668 0880

GL21508844

March 2023

Revision 0

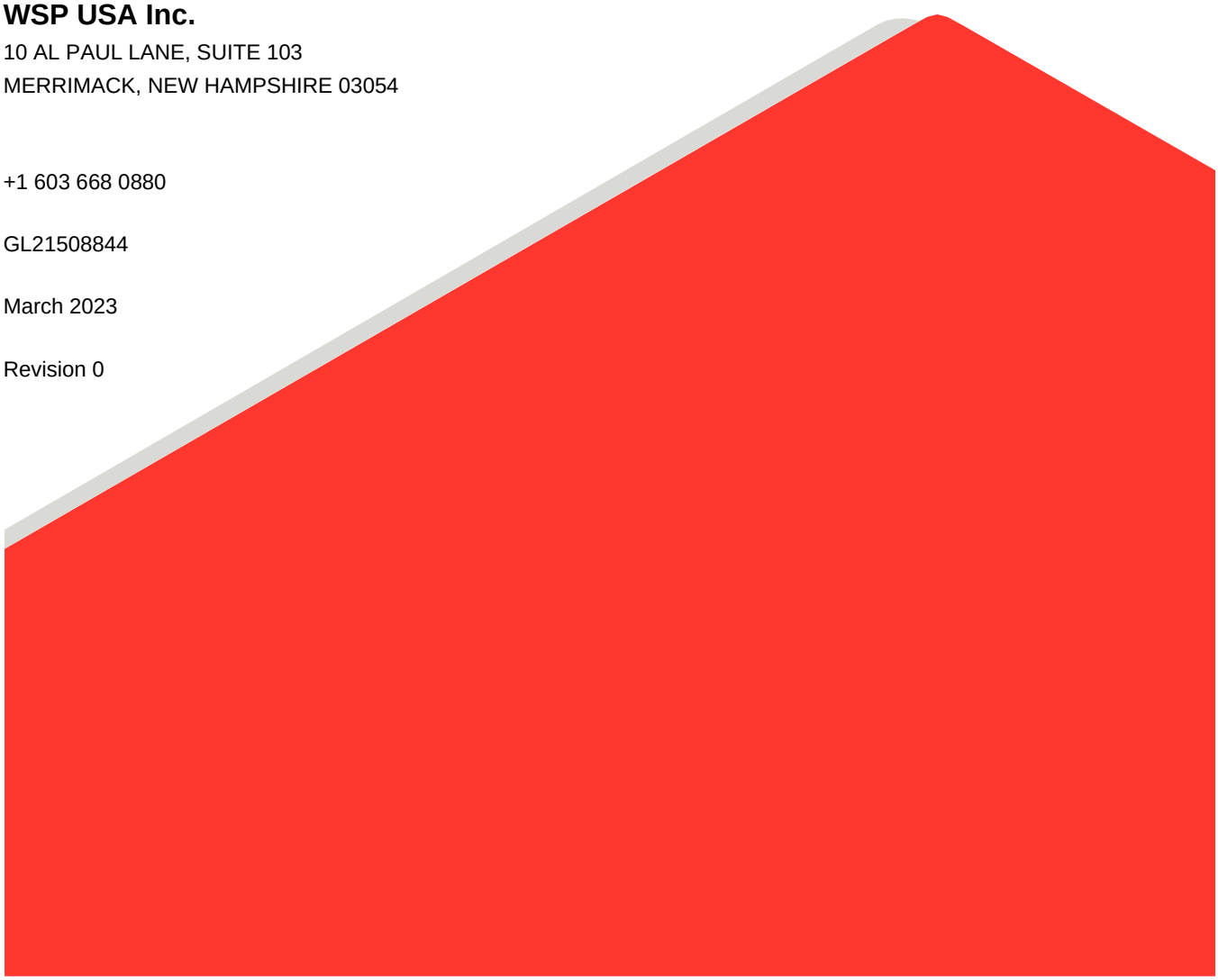


Table of Contents

TABLES

FIGURES

APPENDICES

ACRONYMS

ASD	Alternative Source Demonstration
CAM	Corrective Action Monitoring
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
CSM	Conceptual Site Model
DO	Dissolved Oxygen
FPR	False Positive Rate
Golder	Golder Associates USA Inc.
GWPS	Groundwater Protection Standards
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
LCL	Lower Confidence Limit
LOD	Limit of Detection
MCL	Maximum Contaminant Level
MCU	Multi-Cell Unit
MCWB	Metal Cleaning Waste Basin
MNA	Monitored Natural Attenuation
MSRB	Material Storage Runoff Basin
ND	Not Detected
NIPSCO	Northern Indiana Public Service Company LLC
ORP	Oxidation-Reduction Potential
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSD	Statistically Significant Decrease
SSI	Statistically Significant Increase
TDS	Total Dissolved Solids
UCL	Upper Confidence Limit
UPL	Upper Prediction Limit
UTL	Upper Tolerance Limit
WSP	WSP USA Inc.

1.0 INTRODUCTION

On behalf of Northern Indiana Public Service Company LLC (NIPSCO), WSP USA Inc. (WSP), formerly Golder Associates USA Inc. (Golder), prepared this Groundwater Corrective Action Monitoring (CAM) Program for the coal combustion residuals (CCR) management units at NIPSCO's Rollin M. Schahfer Generating Station (RMSGS or Site).

WSP prepared the CAM Program in accordance with both federal and state requirements. Specifically, the United States Environmental Protection Agency (USEPA) requires groundwater monitoring at subject CCR management units under 40 Code of Federal Regulations (CFR) Parts 257 and 261, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule" (CCR Rule), as amended. In addition, the Indiana Department of Environmental Management (IDEM) has adopted by reference part of the CCR Rule, in 329 Indiana Administrative Code (IAC) 10-9-1. In conformance with 40 CFR §257.98, this CAM Program establishes a ground water monitoring program that meets the requirements of an Assessment Monitoring program, documents the effectiveness of the corrective action remedy, and demonstrates compliance with the groundwater protection standard.

RMSGS is located at 2723 E 1500 N Road, Wheatfield, Jasper County, Indiana (Latitude 41° 12' 36" and Longitude 87° 01' 48", see Figure 1) and occupies an area of approximately four-square miles. The CCR units addressed by this Groundwater Corrective Action Monitoring Program Plan will be closed by removal of CCR material and capping in accordance with the IDEM-approved Closure Application, dated March 17, 2023. The CCR units include the areas described below and shown on Figure 2:

- Drying Area – approximate 5.5-acre unlined impoundment surrounded by an earth-fill dike with one-foot slurry trench core and located north-northeast of the Waste Disposal Area (WDA)
- Material Storage Runoff Basin (MSRB) – approximate 15-acre rectangular unlined impoundment surrounded by an earth-fill dike with one-foot slurry trench core and located north of the Drying Area and adjacent to and west of the Metal Cleaning Waste Basin
- Metal Cleaning Waste Basin (MCWB) – approximate 15-acre rectangular unlined impoundment surrounded by an earth-fill dike with one-foot slurry trench core and located north of the Drying Area and adjacent to and east of the MSRB

Due to the locations and proximity of the Drying Area, MSRB, MCWB, and unregulated former CCR waste management areas to one another, and because there is no practical means of monitoring between the adjacent units, NIPSCO's approach for these CCR surface impoundments is monitoring the three separate CCR Units as one individual unit herein referred to as the Multi-Cell Unit (MCU).

2.0 GROUNDWATER MONITORING SYSTEM

Pursuant to 40 CFR §257.91(a), (b), and (c), WSP designed and installed the groundwater monitoring system for the MCU based upon the Conceptual Site Model (CSM), supporting hydrogeologic information, and CCR Rule groundwater monitoring regulatory requirements. Supporting details including the hydrogeologic data considered are included in the Groundwater Monitoring System Design Manual Revision 4.0 (GMSDM, Golder 2022). The monitoring well network includes background wells and multiple monitoring wells located around the perimeter of and downgradient of the MCU, satisfying the requirements of §257.91(a), and approved by IDEM in the MCU Closure Application.

The monitoring well network is shown on Figure 2 and contains the following monitoring wells and piezometers:

Table 1 – Monitoring Well Network

Well Purpose	Monitoring Well ID
Background Monitoring Wells	PC-GAMW03, PC-GAMW03B, PC-GAMW68, and PC-GAMW68B
Downgradient Monitoring Wells	PC-GAMW08, PC-GAMW08B, PC-GAMW09, PC-GAMW09B, PC-GAMW16R, PC-GAMW16BR, PC-GAMW17, PC-GAMW17B, PC-GAMW17B, PC-GAMW18, and PC-GAMW18B
Assessment Monitoring Wells	PC-GAMW46, PC-GAMW46B, PC-GAMW52, PC- GAMW52B, PC-GAMW53, PC-GAMW53B, PC-GAMW54, PC-GAMW54B, PC-GAMW55R, PC-GAMW55B, PC-GAMW56, and PC-GAMW56B
Piezometers (non-CCR Rule Monitoring Wells)	GAMW04, GAMW06, GAMW07, GAMW07B, GAMW15, GAMW15B, GAMW63B, and GAMW64B

A summary of the well construction information is provided in Table 2. The boring and well construction logs are provided in Appendix A. The monitoring well locations are shown in Figure 2.

3.0 GROUNDWATER CORRECTIVE ACTION MONITORING PROGRAM

The overall groundwater CAM Program for RMSGS consists of both a background monitoring program to determine baseline conditions at the Site and a post-closure monitoring program that addresses monitoring of the MCU after implementation of groundwater corrective actions pursuant to the requirements of 40 CFR §257.98 and 257.95. The groundwater Sampling Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) are provided in Appendix B and Appendix C, respectively, and the background and post-closure monitoring programs are described in the sections below.

3.1 Background Monitoring Program

WSP designed the background monitoring program to provide a representative baseline of water quality data for each well in the monitoring well network. Pursuant to 40 CFR §257.90(b)(iii), the program consists of a minimum of eight independent unfiltered samples collected from each upgradient (i.e., background) and downgradient compliance well at an existing CCR unit. WSP will use the background monitoring program results during its statistical analysis of the subsequent post-closure monitoring program results. Development of appropriate, statistically valid background values for each constituent/monitoring well is discussed in Section 6.0.

WSP began the background monitoring program in July 2016 and will continue the program until the completion of MCU closure construction activities (currently scheduled to be completed in 2024). Background samples are analyzed by a contract laboratory for the constituents listed in 40 CFR §257 Appendices III and IV. A list of the background groundwater quality monitoring parameters analyzed is provided in Section 3.1.1 below.

3.1.1 Constituents

As part of the background monitoring program, samples from all upgradient and downgradient wells are analyzed for the 40 CFR §257 Appendix III and Appendix IV parameters shown in Table 3 below:

Table 3 - Appendix III and Appendix IV Monitoring Parameters

Appendix III Parameters	Appendix IV Parameters	
■ boron ■ calcium ■ chloride ■ fluoride ■ pH (field measurement)] ■ sulfate ■ total dissolved solids (TDS)	■ antimony ■ arsenic ■ barium ■ beryllium ■ cadmium ■ chromium ■ cobalt	■ fluoride ■ lead ■ lithium ■ mercury ■ molybdenum ■ selenium ■ thallium ■ radium 226 and 228 (combined

3.2 Post-Closure Monitoring Program

WSP designed the post-closure monitoring program to meet the requirements of an Assessment Monitoring program listed in 40 CFR §257.95, document the effectiveness of the corrective action remedy, and provide the appropriate data needed by NIPSCO to demonstrate compliance with the groundwater protection standards. Because NIPSCO's selected groundwater remedy includes CCR source removal, capping, and monitored natural attenuation (MNA) (Selection of Remedy Report; Golder, 2022), this post-closure monitoring program also includes MNA Monitoring.

NIPSCO will implement the post-closure monitoring program at the first semi-annual sampling event following the completion of closure construction activities (currently scheduled to be completed in 2024).

3.2.1 Assessment Monitoring

The purpose of Assessment Monitoring program is to monitor and compare concentrations of the 40 CFR §257 Appendix IV parameters to the Groundwater Protection Standards (GWPS). Components of the Assessment Monitoring program, including analytical requirements, sampling frequency, groundwater protection standards, and data evaluation/response, are discussed in the following sections.

3.2.1.1 Analytical Requirements and Sampling Frequency

For at least three years following the implementation of corrective actions, NIPSCO will sample and analyze groundwater from all wells in the monitoring well network for all 40 CFR §257 Appendix III and Appendix IV parameters (see Table 3 above) on at least a semi-annual basis.

3.2.1.2 Groundwater Protection Standards

Pursuant to 40 CFR §257.95, WSP developed proposed GWPS for all CCR Rule Appendix IV constituents based on the following:

- For constituents with an established maximum contaminant level (MCL) under 40 CFR §141.62 (MCLs for Inorganic Contaminants) or 40 CFR §141.66 (MCLs for Radionuclides), the GWPS is the applicable MCL.
- For cobalt, lead, lithium, and molybdenum, constituents that do not have MCLs, the GWPS is the health-based standard included in the amended CCR Rule (i.e., Phase 1 Part 1 amendment).

- For constituents for which the background level is higher than the MCL or health-based standard, the GWPS is the background concentration established from the upgradient wells.

The applicable GWPS for each constituent will be included in the Annual Groundwater Monitoring and Corrective Action Reports required by 40 CFR §257.90(e). The MCL-based and health-based GWPS will be updated upon USEPA's promulgation of new and/or revised standards. The background-based GWPS may be updated every two years by incorporating the monitoring results from the two most recent years into the existing background as described in Section 4.3.

3.2.1.3 Evaluation and Response

After each monitoring event, NIPSCO will determine if any constituents are detected above the GWPS at a statistically significant level. If no constituents are detected above the GWPS, NIPSCO will continue sampling until compliance with the GWPS has been achieved for three consecutive years.

If one or more constituents are detected above the GWPS, NIPSCO may perform one or both of the following activities:

- Confirm the detection with an immediate resample
- Complete an Alternative Source Demonstration (ASD), within 90 days of the GWPS exceedance. The ASD would be certified by a qualified professional engineer and placed on the publicly available website.

If following an immediate resample, one or more constituents are confirmed to be above the GWPS, NIPSCO will prepare a GWPS exceedance notification, within 30 days of the GWPS exceedance, and place the notification in the Facility's operating record and on the publicly available website.

3.2.2 MNA Monitoring Program

The purpose of MNA monitoring program is to evaluate the effectiveness of the groundwater corrective action remedy. Components of the MNA monitoring program, including analytical requirements, sampling frequency, and data evaluation/response, are discussed in the following sections.

3.2.2.1 Analytical Requirements and Sampling Frequency

Following the implementation of groundwater corrective actions, NIPSCO will sample and analyze groundwater samples from all wells in the monitoring well network on at least a semi-annual basis. In addition to the parameters collected as part of the assessment monitoring program, samples from all wells will be analyzed for the general geochemical parameters listed below:

- Metals: iron, manganese, magnesium, potassium, and sodium
- Nitrate
- Phosphate/Phosphorus
- Total Alkalinity

3.2.2.2 Evaluation and Response

The MNA monitoring program will assess the effectiveness of the remedy by doing the following:

- Evaluating long-term trends in cobalt concentrations in the CCR wells where SSLs have been identified to demonstrate that the groundwater plume is stable or decreasing and not expanding; and

- Evaluating geochemical parameters measured in the field (e.g., pH, dissolved oxygen [DO], and oxidation-reduction potential [ORP]) during each sampling event and collecting periodic general geochemistry sample data to assess changes to the general geochemical conditions of the aquifer that may indicate the effectiveness of the remedy.

During the MNA Evaluation for the Site (Golder, 2020), WSP used geochemical models to evaluate the reversibility or desorption of metals of interest from the perspective of changes in groundwater pH, redox, and TDS at Site wells. As part of this evaluation, WSP established a threshold range of pH, redox, and TDS for wells where SSLs exist.

Deviations from these threshold values, or a historical trend in pH, redox, or TDS could indicate a trigger has been established that would precede an actual GWPS exceedance. However, a trigger outside of a threshold can also be an indicator of long-term changes to a Site's geochemistry or an indicator that MNA is progressing and the Site is returning to a pre-CCR condition. Thus any triggers must be thoroughly evaluated.

The only SSL currently identified for the MCU is cobalt at well GAMW08. The acceptable ranges for pH, redox, and TDS in this well are summarized in Table 4 below.

Table 4 – Acceptable Ranges for Field Parameters in GAMW08

Parameter	Acceptable Range
pH	6.5 to 11.0 S.U.
Eh (millivolts)	-200 to +600 mV
TDS (milligrams per liter)	<3,000 mg/L

3.3 Annual Groundwater Monitoring and Corrective Action Report

As required by 40 CFR §257.90(e), NIPSCO will complete an Annual Groundwater Monitoring and Corrective Action Report by January 31 of each year. In accordance with 40 CFR §257.90(e), the Annual Groundwater Monitoring and Corrective Action Report will include the following information at a minimum:

1) A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit;

2) Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;

3) In addition to all the monitoring data obtained under §§ 257.90 through 257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs;

4) A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels); and

5) Other information required to be included in the annual report as specified in §§ 257.90 through 257.98.

6) A section at the beginning of the annual report that provides an overview of the current status of groundwater monitoring and corrective action programs for the CCR unit.

In addition, NIPSCO will comply with the recordkeeping requirements specified in 40 CFR §257.105(h)(1), the notification requirements specified in 40 CFR §257.106(h)(1), and the internet requirements specified in 40 CFR §257.107(h)(1).

4.0 STATISTICAL EVALUATION OF DATA

Following completion of data validation, NIPSCO will perform a statistical evaluation of the data, which meets the applicable requirements of 40 CFR §257.98, to determine compliance with the GWPS. The following sections describe the overall statistical approach and methods that will used in the evaluation.

4.1 Overall Statistical Approach for Corrective Action

Previous statistical analyses for the MCU used methodologies that were appropriate for Detection and Assessment monitoring, specifically identifying statistically significant increases (SSI) relative to background concentrations and the GWPS. However, after the completion of closure and initiation of corrective measures, the MCU has entered the Corrective Action phase (40 CFR §257.98), therefore, other statistical analyses are more appropriate.

As described in USEPA's March 2009 *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance;* USEPA, 2009), the goal of the statistical monitoring program during the Detection and Assessment monitoring phases is to identify SSIs relative to background or an established criteria, thereby allowing the owner/operator to determine if a release(s) has occurred and to respond by implementing a Corrective Action (i.e., a groundwater remedy), if necessary.

Conversely, the goal of the post-remedy Corrective Action monitoring program is to demonstrate compliance with the GWPS (described below in Section 6.3.1). Thus, the goal of the statistical analysis procedures being employed pursuant to this CAM Program is to analyze the data to determine when groundwater concentrations are consistently below the established criteria, which the *Unified Guidance* refers to as "statistically significant decreases" (SSDs). According to the Federal rule under Corrective Action monitoring, groundwater compliance is demonstrated when concentrations are below the established GWPS for a period of three consecutive years, at which point groundwater monitoring is no longer required.

For this CAM Program, NIPSCO intends to fulfill the requirements of 40 CFR §257.98 using a confidence interval approach relative to a fixed GWPS. This methodology is the recommended approach for Corrective Action programs in the *Unified Guidance*. As stated therein, "confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them."

4.2 General Statistical Methods

Although NIPSCO has selected confidence intervals as the overall statistical approach for data evaluation during the CAM program, it will continue to be necessary for NIPSCO to examine the data for outliers, anomalies, and trends during the CAM period. Outliers and anomalies are generally defined as inconsistently large or small values that can occur as a result of sampling, laboratory, transportation, or transcription errors, or even by chance alone. Statistically significant trends indicate a source of systematic error or may be indicative of actual contamination.

If outliers or trends are not identified and addressed appropriately, false positives (i.e., an indication of a release when none exists) and/or false negatives (i.e., falsely concluding there is no release in the presence of an actual release) could result. Therefore, NIPSCO will evaluate outliers/anomalies and trends and correct them (if appropriate) before continuing with the statistical evaluation of the groundwater monitoring data.

4.2.1 Outlier Testing

To prevent the inclusion of anomalous/outlier data in the statistical analyses, NIPSCO will test the monitoring data for outliers. An outlier is a value that is statistically different from most other values in a data set for a given groundwater parameter. Reasons for outliers may include the following:

- Sampling errors or field contamination
- Analytical errors or laboratory contamination
- Recording or transcription errors
- Faulty sample preparation or preservation, or shelf-life exceedance
- Extreme, but accurately detected, environmental conditions (e.g., spills, migration from the Facility).

Following data validation, NIPSCO will perform formal testing on each data set for the presence of outliers using the methods described in the *Unified Guidance*. The outlier test assumes the background data are normally distributed. Thus, if the background data are log-normally distributed, the outlier test will be applied to the log-normally transformed data and not the raw data.

If NIPSCO identifies a statistical outlier based on an outlier test, they will investigate the source of the abnormal measurement. Valid reasons for the outlier values may include contaminated sampling equipment, laboratory contamination of the sample, or errors in transcription of the data values. In addition, it possible that the value may be a true, but an extreme data point. Once a specific reason for the outlier is documented, NIPSCO will exclude the data point from further statistical analysis.

If a plausible reason cannot be identified, NIPSCO will treat the result as a true but extreme value and may include the result in further statistical analysis. In some cases, however, professional judgement may be necessary and would be used to remove extreme value from further statistical analysis, even when an underlying cause cannot be identified.

As described in Section 5.2.3 of the *Unified Guidance*, the removal of extreme outliers (even those for which a cause cannot be identified) has the effect of reducing the background mean and standard deviation, thus resulting in more conservative (i.e., protective) statistical calculations. However, if the most recent data point is identified as an outlier, it is generally inappropriate to remove the data point until additional data (e.g., verification sample or next sampling event) are available to support the data removal.

Consistent with standard groundwater monitoring procedures, NIPSCO may decide to collect additional independent samples to verify anomalous/outlier results. If the anomalous/outlier result is not verified, however, the outlier/anomaly result will be removed from further statistical analyses to maintain the accuracy of the evaluation method.

Following outlier testing, NIPSCO will keep the identified outliers in the groundwater monitoring database, but flag them as outliers. Over time, even extreme outliers may ultimately be identified as members of the actual sample population as additional groundwater monitoring data are added to the database.

It is important to remember that the true population can never be known, because it would take an infinite number of samples to perfectly identify a given population. Statistical analysis is a procedure for modeling the true population using a limited number of existing data points, and the true population can be more closely modeled as more data are gathered.

4.2.2 Trend Analysis

NIPSCO will perform a statistical trend analysis (e.g., Mann-Kendall/Sen's Slope Analysis) on the groundwater dataset. Along with data normality and sample independence, one of the important assumptions of statistical data analysis is the absence of trends in the background data set. It is generally inappropriate to calculate a confidence interval when a data series exhibits a trend. If the statistical trend analysis detects a trend in the background dataset, NIPSCO will evaluate additional information and records to determine an underlying cause.

Trends can result from a multitude of causes, including natural temporal variability, incomplete well development (particularly for new background wells), well damage or deterioration, systematic laboratory or field sampling errors, influence of an off-Site upgradient source, and leakage from a CCR unit. No matter the source, it is generally considered inappropriate to incorporate trending data in statistical calculations, since trends will typically result in an over-estimate of the background variability. However, trends in the data are expected following Corrective Action (i.e., closure by removal), and, in fact, may be considered a positive indicator.

NIPSCO will be performing closure by removal, therefore, decreasing trends are expected in those wells that have reported SSIs during the Detection and Assessment monitoring periods. If NIPSCO detects trends during the CAM period, the most appropriate course is to apply "confidence bands" around the trend line. Confidence bands are simply a confidence interval method that is applied to trending datasets. The Unified Guidance recommends the use of confidence bands for determining compliance of trending data during both the Assessment and CAM periods. For those constituent-well pairs that show statistically significant trends, NIPSCO will use the results of the confidence band approach to determine compliance with GWPS.

Additional discussion of confidence intervals and confidence bands is provided below in Section 4.3.5.

4.2.3 Normality Testing

Following the review of dataset for outliers and trends, NIPSCO will test initially the dataset for normality using the Shapiro-Wilk Test of Normality (either single group or multiple group version) for sample size up to 50, the Shapiro-Francia Test of Normality for sample size more than 50, or other acceptable test methods. If an alternative test method is proposed for evaluating the normality of data, NIPSCO will provide appropriate supporting information with the statistical analysis results demonstrating that the alternative method has a similar level of power to detect deviations from the normal distribution as the Shapiro-Wilk and Shapiro-Francia test methods.

Upon completion of initial testing, NIPSCO will use the following guidelines for decisions regarding additional testing:

1) If the raw data are not normally distributed, then the data should be natural log-transformed and re-tested for normality using the above methods.

7) If the raw or the natural log-transformed data are normally distributed, then a normal distribution test (also referred to as a Parametric test) can be applied.

8) If neither the raw nor the natural log-transformed data fit a normal distribution, then a distribution-free test will be applied.

4.2.4 Reporting of Low and Zero Values

Groundwater data sets generally contain low and/or not detected (ND) values that are difficult to manage during statistical data analysis. However, there are a variety of accepted methods for incorporating that data.

Laboratories generally report constituents that are not present above the Limit of Detection (LOD) for the analytical method as not detected (ND) or less than the LOD (e.g., < 5 µg/l) rather than as zero or not present. If concentrations are above the LOD but below the laboratory Practical Quantitation Limit (PQL), laboratories will report that value as a J-flagged concentration (J-value). In their analytical reports, the laboratories include the LOD and the PQL for each analytical method.

For statistical analyses during the CAM Program, NIPSCO will use one-half of the LOD for all ND values and the reported J-values when calculating intrawell confidence intervals.

4.2.5 False Positive Rate

As discussed above, one of the primary goals of the selection of a proper statistical evaluation method is to limit the potential for results to indicate false positives or false negatives. During Corrective Action, the primary concern is a false negative (i.e., compliance has been achieved when concentrations are actually still exceeding the GWPS). As stated in the *Unified Guidance*, during Corrective Action, "the most important consideration is to ensure that the true population parameter is actually below the clean-up standard before declaring remediation a success". Thus, the *Unified Guidance* recommends the use of a "reasonably low, fixed, test-wise false positive rate" (FPR).

For CAM of the MCU, NIPSCO will use a test-wise FPR (α) of 0.05. As a result, there will only be a 5 percent chance of NIPSCO incorrectly declaring that a well-constituent pair is "in compliance" when its concentrations are actually above the GWPS. The FPR is used in the calculation of confidence interval as described below in Section 4.3.2.

4.2.6 Verification Sampling

As part of the CAM program, NIPSCO will perform verification sampling if an initial statistical exceedance is reported to confirm the initial exceedance, as a "1 of 2 pass strategy". Verification sampling is an important aspect of any statistical analysis program, as it decreases the potential for false positives and false negatives. Therefore, NIPSCO will collect verification samples on a schedule that allows for physical independence of the samples.

Following the "1 of 2 pass strategy", if the concentration of the verification sample does not confirm the original sample result, then NIPSCO will flag the original result as an outlier in the database. If the verification result confirms the original result, NIPSCO will retain both values in the database.

4.3 Corrective Action Statistical Analysis Method

This section discusses the procedures, methods, and processes that will be implemented as part of the Corrective Action statistical evaluation. As described above, the general statistical procedures described in Section 4.2

(outliers, trends, normality, etc.) will be performed prior to the Corrective Action statistical evaluation described below.

4.3.1 Establishing a Ground Water Protection Standard

Following the removal of outliers and the performance of general statistics described in Section 4.2, the GWPSs will be established. The GWPSs are key elements of the CAM Program, as they are used to determine when groundwater concentrations are “in compliance” and the MCU can exit Corrective Action.

In accordance with 40 CFR §257.95, GWPS must be established for all Appendix IV constituents and they must equal to one of the following:

1) the MCL

2) the health-based standard included in the Phase 1 Part 1 amendment for constituents that do not have MCLs, or

3) the background concentration established from upgradient wells for those constituents whose background concentration is greater than the MCL or health-based standard.

NIPSCO has already established GWPS based on MCLs and the health-based standards. For background-based GWPS, NIPSCO will use one of two acceptable methods identified in the *Unified Guidance* to establish a GWPS and described below. In the unlikely event that all values are ND, the background-based GWPS will be set equal to the LOD.

The two methods identified in the *Unified Guidance* include the tolerance interval method and the prediction interval method. If the background dataset is normally or transformed normally distributed, the *Unified Guidance* recommends Tolerance Intervals over the Prediction Intervals for establishing a GWPS. If the background data are non-normal (even after transformation), then a large number of background observations are required to calculate a non-parametric tolerance interval. If there is an insufficient number of background observations to calculate a non-parametric tolerance interval, typically a minimum of 60 background observations, then a non-parametric Prediction Interval approach should be used. The interval methods are described below.

4.3.1.1 Tolerance Interval Based GWPS

For Tolerance Interval Based GWPSs, NIPSCO will calculate the Upper Tolerance Limit (UTL) for each detected Appendix IV constituent. Tolerance Limits, as outlined in the *Unified Guidance* (Section 17.2), are a concentration limit that is designed to contain a pre-specified percentage of the dataset population. Two coefficients associated with tolerance intervals are (1) the coverage coefficient (γ), which is used to contain the population portion, and 2) the tolerance coefficient (or confidence level (1-α)), which is used to set the confidence of the test. Typically, the UTL is calculated to have both coverage and confidence of 95%.

Tolerance limits can be completed using both parametric (Section 17.2.1 of *Unified Guidance*) and non-parametric methods (Section 17.2.2 of *Unified Guidance*). However, as described above, the non-parametric method requires at least 60 background (or historical) measurements in order to achieve 95% confidence with 95% coverage. Tolerance limits can be calculated using most groundwater statistical software packages. The tolerance limit, that is calculated as a product of this method then becomes the GWPS, and is compared against the confidence interval for the compliance data, as described below.

4.3.1.2 Prediction Interval Based GWPS

If the minimum requirements for using the Tolerance Interval method cannot be met, then NIPSCO will use the Prediction Interval method. For the establishment of a GWPS, a one-sided prediction interval is calculated using background (or historical) datasets based on a specified number of future comparisons - four future comparisons is typical. The *Unified Guidance* suggests using either 1) a prediction interval about a future mean for normally/transformed-normally distributed datasets or 2) a prediction interval about a future median for datasets with a high percent of ND or non-normally distributed data. The Upper Prediction Limit (UPL), that is calculated as a product of this method then becomes the GWPS, and is compared against the confidence interval for the compliance data, as described below.

4.3.2 Confidence Intervals for Corrective Action

Once the GWPS is established for each constituent, the *Unified Guidance* recommends the confidence interval method to evaluate the groundwater data from the Corrective Action monitoring network. Using confidence intervals, compliance is identified by comparing the calculated confidence interval for each well- constituent pair against the established GWPS.

A confidence interval statistically defines the upper and lower bounds of a specified population within a stipulated level of significance. As described above under Section 4.2.5, confidence intervals for the MCU will be calculated using a FPR of 0.05, which is also referred to as the 95% Confidence Interval. Confidence interval calculations require a minimum of four independent observations, however, more representative confidence intervals are achieved with a growing data set. Thus, confidence intervals will be recalculated following the receipt and incorporation of new data from each Corrective Action monitoring event.

NIPSCO will calculate confidence intervals for each constituent identified in 40 CFR Part 257 Appendix IV and 35 IAC §845.600 on a well-constituent pair basis. Because closure by removal of the MCU is projected for 2024 and a minimum of four values are required to calculate a confidence interval, NIPSCO will perform the first Corrective Action statistical analysis following the second semi-annual CAM event in 2026, which will be the fourth overall CAM event following closure.

It should be noted that it would be inappropriate to calculate the confidence interval using data from the period prior to closure, because those data represent conditions prior to the Corrective Action. Therefore, any results from the statistical analysis of those data would produce inappropriate conclusions.

NIPSCO will select an appropriate confidence interval calculation method for each well-constituent pair based on the attributes of the data being analyzed, including: (1) the data distribution, (2) the detection frequency, and (3) potential trends in the data. The guidelines for selecting an appropriate confidence interval calculation method are summarized in Table 5 below.

Table 5 – Guidelines for Selecting an Appropriate Confidence Interval Calculation Method

Data Distribution	Non-detect Frequency	Data Trend	Unified Guidance Confidence Interval Method
Normal	Low	Stable	Confidence Interval Around Normal Mean (Section 21.1.1)
Transformed Normal (Log-Normal)	Low	Stable	Confidence Interval Around Lognormal Arithmetic Mean (Section 21.1.3)

Data Distribution	Non-detect Frequency	Data Trend	Unified Guidance Confidence Interval Method
Non-normal	N/A	Stable	Nonparametric Confidence Interval Around Median (Section 21.2)
Statistically Significant Trend Noted	Low	Trend	Confidence Band Around Theil-Sen Line (Section 21.3.2)

For a CAM Program, the UCL is the attribute of prime interest for determining compliance. If the UCL is below the GWPS, the well-constituent pair is considered to be in compliance. If the UCL (or both the UCL and LCL) is greater than the GWPS, the test is considered to be a statistical exceedance, the well-constituent pair is considered to be out of compliance, and additional CAM is required.

During the CAM Program, NIPSCO will use a per test FPR (α) of 0.05 will be used as an initial error level for calculating the two-tailed confidence intervals for the groundwater monitoring network (which means 2.5% FPR per tail). In some cases, it is appropriate to adjust the FPR of the confidence interval based on the number of data points available as well as the distribution of the data being evaluated. If deemed necessary, NIPSCO will use an approach provided in Section 22 of the *Unified Guidance* for determining an appropriate per test FPR based on the data characteristics.

4.3.3 Confidence Intervals for Trending Data

As described above in Section 4.2.2, trends are expected during the CAM Program because the Corrective Action is expected to improve groundwater conditions. This could include increasing trends for naturally occurring constituents whose concentrations were diminished by CCR impacts, and decreasing trends for other constituents that increased due to influence from the CCR Unit.

If a trend is not managed when constructing a confidence interval, the confidence interval will inadvertently incorporate both natural variability in the underlying population and variation due to the trend. Thus, the confidence interval will be wider than it should be, making it more difficult to demonstrate compliance with the GWPS. In addition, the confidence interval will have less statistical power to judge the success of remedial efforts.

As stated in the *Unified Guidance*, “when a linear trend is present, it is possible to construct an appropriate confidence interval built around the estimated trend. A continuous series of confidence intervals is estimated at each point along the trend”, which is “termed a simultaneous confidence band. An upper or lower confidence band will tend to follow the estimated trend line whether the trend is increasing or decreasing. It is computed once the trend line has been estimated.”

For this CAM Program, if a statistically significant trend is noted in the monitoring data, a confidence band will be constructed around the trend. The trend analysis method for the MCU will be the Mann-Kendall/Sens Slope Analysis. The Theil-Sen trend line that results from a Sens Slope Analysis is a non-parametric alternative to linear regression, meaning the Theil-Sen method can be applied to data with less regard for the data normality assumptions required to construct a linear regression line. As indicated in the table above, the non-parametric confidence band method is further described in Section 21.3.2 of the *Unified Guidance*.

In some situations, anticipated or existing trends may temporarily reverse during the monitoring program, especially in early stages of post-closure monitoring. As described above, due to the removal of the source materials, it is anticipated that trends will decrease with time; however, an initial increase may occur prior to the

onset of decreasing concentrations. Ground-disturbing activity related to the removal can sometimes result in short-term increases in concentrations, as the stable groundwater regime is destabilized by the removal. Typically, however, the groundwater regime eventually returns to stabilized conditions and trends return to normal.

In the event trend reversals are noted during CAM Program, it may be necessary to adjust the data set to correct for these trend reversals. Adjustments may include the exclusion of data prior to the trend reversal and/or the institution of moving windows. If a moving window approach is selected, a minimum of eight values will be contained in the moving window, starting with the most recent observation, and including at least the seven previous observations. The same confidence band approach will be applied to the adjusted data set, regardless of whether the data set is adjusted to exclude data prior to a trend reversal or whether a moving window approach is used.

4.4 Updating Background Values in Corrective Action

The *Unified Guidance* suggests that updating statistical limits should only be completed after a minimum of 4 to 8 new measurements are available (i.e., every 2 to 4 years of semiannual monitoring, assuming no verification sampling). The periodic update of background datasets, during which additional data are incorporated into the background, improves statistical power and accuracy by providing a more conservative estimate of the true background population. For the CAM Program, updating of background values will only apply to those GWPS that are based on background data.

Prior to incorporating additional data into the background dataset, a test should be performed to demonstrate that the "new data" are from the same statistical population as the existing background results. Below are three methods that can be used in determining if the new data should be included in the background:

- Time Series Graphs can be used as a qualitative test to assist with the determination whether a new group of data match the historical data or if there is a concentration trend that could be indicative of a release or evolving groundwater conditions.
- Box-Whisker plots can also be used to determine whether or not the datasets are similar.
- Mann-Whitney (or Wilcoxon Rank) Test is a quantitative test used to evaluate the ranked medians of both the historical and "new dataset" populations. An α of 0.05 should be used for this evaluation. After calculation, if the Mann-Whitney statistic does not exceed the calculated critical value, the test assumes that the two data populations have equal medians, and therefore are likely from the same statistical population.

Ultimately, the Mann-Whitney (Wilcoxon Rank Sum) Test is the statistical test that will be used to determine whether new observations should be included in the background dataset. It is important to note that a failure of the Mann-Whitney Test does not automatically preclude the incorporation of new data into the background; however, if differences are noted, a review of the new data will be conducted to determine if the noted difference is a result of a change in the natural conditions of the groundwater or if it is the result of a potential release from the MCU. If the new data are included in the background dataset, the GWPS will be recalculated, as described in Section 4.3.1 above.

4.5 Response to Statistical Exceedances during Corrective Action

If the UCL exceeds the GWPS during future CAM events, no additional actions other than confirmatory monitoring are required. As described in the Selection of Remedy Report (Golder, 2022), because the selected remedy

includes removal of CCR source material, capping, and MNA, if statistical exceedances are noted during future CAM events, MNA is the ongoing process that will be used to remediate groundwater. Complementing the removal of the CCR source materials from the MCU, MNA functions as a finishing or polishing step in the timely return of groundwater to applicable standards.

5.0 EXITING CORRECTIVE ACTION GROUNDWATER MONITORING

As specified in 40 CFR §257.98(c) and 35 IAC §845.680(c), in order to exit Corrective Action and consider the remedy complete, it must be demonstrated that:

- The owner or operator of the CCR surface impoundment demonstrates compliance with the GWPS established by IAC 35 §845.600 has been achieved at all points within the plume of contamination that lies beyond the waste boundary;
- The GWPS has not been exceeded for each well-constituent pair for a period of three consecutive years, based on the results of the confidence interval/confidence band approach described above; and,
- All actions required to complete the remedy have been satisfied.

6.0 FUTURE REVISIONS

In conformance with the applicable requirements of the CCR Rule, this CAM Program addresses the sampling of, and the management and evaluation of field and analytical information from, the groundwater monitoring well network for the MCU. Should future amendments to the regulations create additional or different requirements, and/or Site changes occur that require modifications to the existing program, NIPSCO will modify the CAM Program and/or prepare an Addendum and implement appropriate procedural modifications to the existing program.

7.0 REFERENCES

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. USEPA Office of Resource Conservation and Recovery – Program Implementation and Information Division, March 2009.

USEPA, 2015. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. USEPA Office of Solid Waste and Emergency Response, 40 CFR Parts 257 and 261, April 17, 2015.

Golder, 2017. CCR Groundwater Monitoring Program Implementation Manual – Northern Indiana Public Service Company Rollin M Schahfer Generating Station. Golder Associates Inc., October 2017.

Golder, 2020. Monitored Natural Attenuation Evaluation – Northern Indiana Public Service Company LLC Rollin M. Schahfer Generating Station. Golder Associates Inc., November 2020.

Golder, 2022. CCR Groundwater Monitoring System Design Manual – Northern Indiana Public Service Company LLC Rollin M. Schahfer Generating Station. Golder Associates Inc., May 2022.

Golder, 2022. Selection of Remedy Report – Multi-Cell Unit (MCU) Northern Indiana Public Service Company LLC Rollin M. Schahfer Generating Station. Golder Associates Inc., December 2022.

IDEM, 2023. Approval of Closure/Post-Closure Plan – NIPSCO R. M. Schahfer Generating Station. Indiana Department of Environmental Management, March 17, 2023.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. USEPA Office of Resource Conservation and Recovery – Program Implementation and Information Division, March 2009.

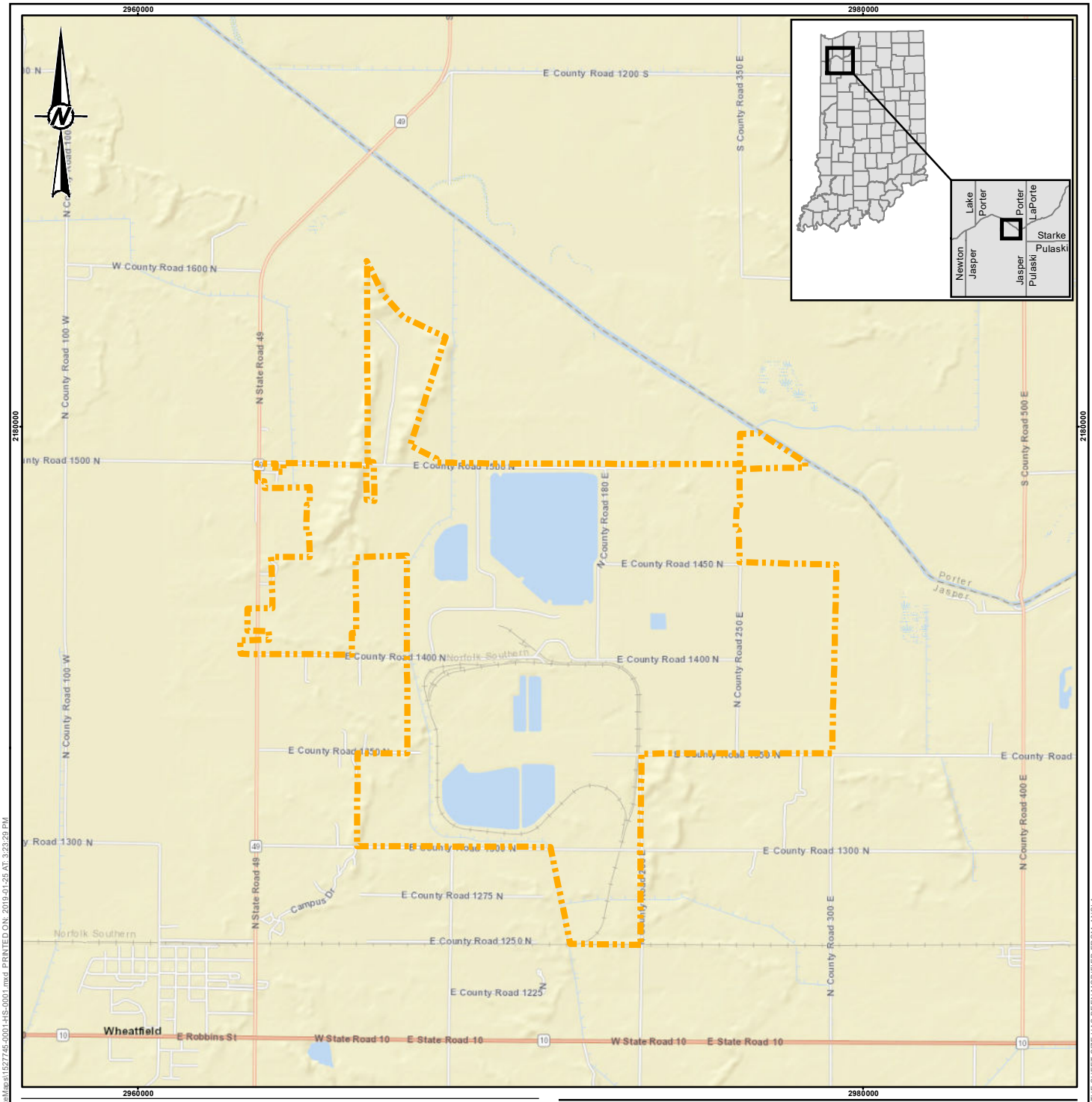
USEPA, 2015. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. USEPA Office of Solid Waste and Emergency Response, 40 CFR Parts 257 and 261, April 17, 2015.

Table 1 Monitoring Well Construction Details
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

CCR Unit	Monitoring Well ID	Ground Surface Elevation (ft-NAVD88)	Total Borehole Depth (ft)	Top of Casing Elevation (ft-NAVD88)	Sounded Well Depth (ft-btoc)	Well Material	Screen Length (ft)	Screen Depth		Screen Elevation		
								Top (ft-bgs)	Bottom (ft-bgs)	Top (ft-NAVD88)	Middle (ft-NAVD88)	Bottom (ft-NAVD88)
MSRB, MCWB, and Drying Area	PC-GAMW03	665.14	15.0	668.77	18.30	2" Sch 40 PVC	10.0	5.0	15.0	660.14	655.14	650.14
	PC-GAMW03B	665.29	35.0	668.16	37.79	2" Sch 40 PVC	10.0	25.0	35.0	640.29	635.29	630.29
	GAMW04	665.81	15.0	669.21	17.86	2" Sch 40 PVC	10.0	5.0	15.0	660.81	655.81	650.81
	GAMW06	667.50	15.0	670.81	18.82	2" Sch 40 PVC	10.0	5.0	15.0	662.50	657.50	652.50
	GAMW07	666.55	15.0	669.89	18.89	2" Sch 40 PVC	10.0	5.0	15.0	661.55	656.55	651.55
	GAMW07B	666.83	40.0	669.39	42.40	2" Sch 40 PVC	10.0	30.0	40.0	636.83	631.83	626.83
	PC-GAMW08	665.95	15.0	669.66	18.78	2" Sch 40 PVC	10.0	5.0	15.0	660.95	655.95	650.95
	PC-GAMW08B	665.92	36.0	668.47	38.79	2" Sch 40 PVC	10.0	26.0	36.0	639.92	634.92	629.92
	PC-GAMW09	665.10	15.0	668.99	18.48	2" Sch 40 PVC	10.0	5.0	15.0	660.10	655.10	650.10
	PC-GAMW09B	665.35	35.0	668.29	37.42	2" Sch 40 PVC	10.0	25.0	35.0	640.35	635.35	630.35
	GAMW15	665.01	15.0	668.25	18.71	2" Sch 40 PVC	10.0	5.0	15.0	660.01	655.01	650.01
	GAMW15B	665.14	35.0	668.05	38.86	2" Sch 40 PVC	10.0	25.0	35.0	640.14	635.14	630.14
	GAMW16*	665.20	15.0	668.37	18.20	2" Sch 40 PVC	10.0	5.0	15.0	660.20	655.20	650.20
	PC-GAMW16R	664.35	20.0	667.17	21.75	2" Sch 40 PVC	10.0	10.0	20.0	654.35	649.35	644.35
	GAMW16B*	665.16	35.0	667.76	40.13	2" Sch 40 PVC	10.0	25.0	35.0	640.16	635.16	630.16
	PC-GAMW16BR	664.39	40.0	667.32	42.45	2" Sch 40 PVC	10.0	30.0	40.0	634.39	629.39	624.39
	PC-GAMW17	668.81	15.0	671.93	18.00	2" Sch 40 PVC	10.0	5.0	15.0	663.81	658.81	653.81
	PC-GAMW17B	668.86	35.0	670.60	40.34	2" Sch 40 PVC	10.0	25.0	35.0	643.86	638.86	633.86
	PC-GAMW18	666.04	15.0	669.07	18.51	2" Sch 40 PVC	10.0	5.0	15.0	661.04	656.04	651.04
	PC-GAMW18B	665.94	35.0	668.47	35.89	2" Sch 40 PVC	10.0	25.0	35.0	640.94	635.94	630.94
	PC-GAMW46	661.99	15.0	664.80	17.50	2" Sch 40 PVC	10.0	5.0	15.0	656.99	651.99	646.99
	PC-GAMW46B	661.98	32.0	664.79	33.00	2" Sch 40 PVC	10.0	22.0	32.0	639.98	634.98	629.98
	PC-GAMW52	664.07	15.0	666.79	18.50	2" Sch 40 PVC	10.0	5.0	15.0	659.07	654.07	649.07
	PC-GAMW52B	664.50	37.0	666.90	39.34	2" Sch 40 PVC	10.0	27.0	37.0	637.50	632.50	627.50
	PC-GAMW53	664.68	15.0	667.24	17.49	2" Sch 40 PVC	10.0	5.0	15.0	659.68	654.68	649.68
	PC-GAMW53B	664.62	36.0	667.29	40.10	2" Sch 40 PVC	10.0	26.0	36.0	638.62	633.62	628.62
	PC-GAMW54	663.87	15.0	666.37	15.46	2" Sch 40 PVC	10.0	5.0	15.0	658.87	653.87	648.87
	PC-GAMW54B	663.98	32.0	666.47	36.41	2" Sch 40 PVC	10.0	22.0	32.0	641.98	636.98	631.98
	GAMW55*	665.06	15.0	667.64	18.68	2" Sch 40 PVC	10.0	5.0	15.0	660.06	655.06	650.06
	PC-GAMW55R	665.36	15.0	667.71	16.31	2" Sch 40 PVC	10.0	5.0	15.0	660.36	655.36	650.36
	PC-GAMW55B	665.18	35.0	667.53	37.60	2" Sch 40 PVC	10.0	25.0	35.0	640.18	635.18	630.18
	PC-GAMW56	665.43	15.0	667.91	15.56	2" Sch 40 PVC	10.0	5.0	15.0	660.43	655.43	650.43
	PC-GAMW56B	665.33	35.0	667.82	36.84	2" Sch 40 PVC	10.0	25.0	35.0	640.33	635.33	630.33
	GAMW63B	666.31	33.0	668.74	35.43	2" Sch 40 PVC	10.0	23.0	33.0	643.31	638.31	633.31
	GAMW64B	664.42	31.0	666.83	33.26	2" Sch 40 PVC	10.0	21.0	31.0	643.42	638.42	633.42
	PC-GAMW68	665.93	17.0	665.53	17.03	2" Sch 40 PVC	10.0	7.0	17.0	658.93	653.93	648.93
	PC-GAMW68B	666.00	34.5	665.72	34.78	2" Sch 40 PVC	10.0	24.5	34.5	641.50	636.50	631.50

Notes
ft-bgs = Feet below ground surface
ft-NAD88 = feet relative to the North American Vertical Datum of 1988
ft-btoc = Feet below top of casing
MSRB = Material Storage Runoff Basin
MCWB = Metal Cleaning Waste Basin
No highlight indicates well is not part of the CCR monitoring program, however, water levels are measured in these wells to supplement groundwater contour maps.
Yellow highlight indicates a CCR background well
Green highlight indicates a CCR downgradient well
2" Sch 40 PVC = Two-inch diameter well, constructed of schedule 40 polyvinyl chloride materials
Survey elevations for new wells obtained from Marbach, Brady, and Weaver survey, June 2016, August 2018, June 2019, June 2020, and October 2020
*Decommissioned monitoring well.

Prepared by: TG
Checked by: DFSC
Reviewed by: HAL



LEGEND

Approximate Property Line

0 0.75 1.5

1 " = 0.75 miles Miles

NOTE(S)

REFERENCE(S)

SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

PROJECT

R.M. SCHAHFER GENERATING STATION
WHEATFIELD, INDIANA

TITLE

SITE LOCATION MAP

CONSULTANT

wsp

YYYY-MM-DD	2023-03-28
DESIGNED	DFSC
PREPARED	SHL
REVIEWED	DFSC
APPROVED	MAH

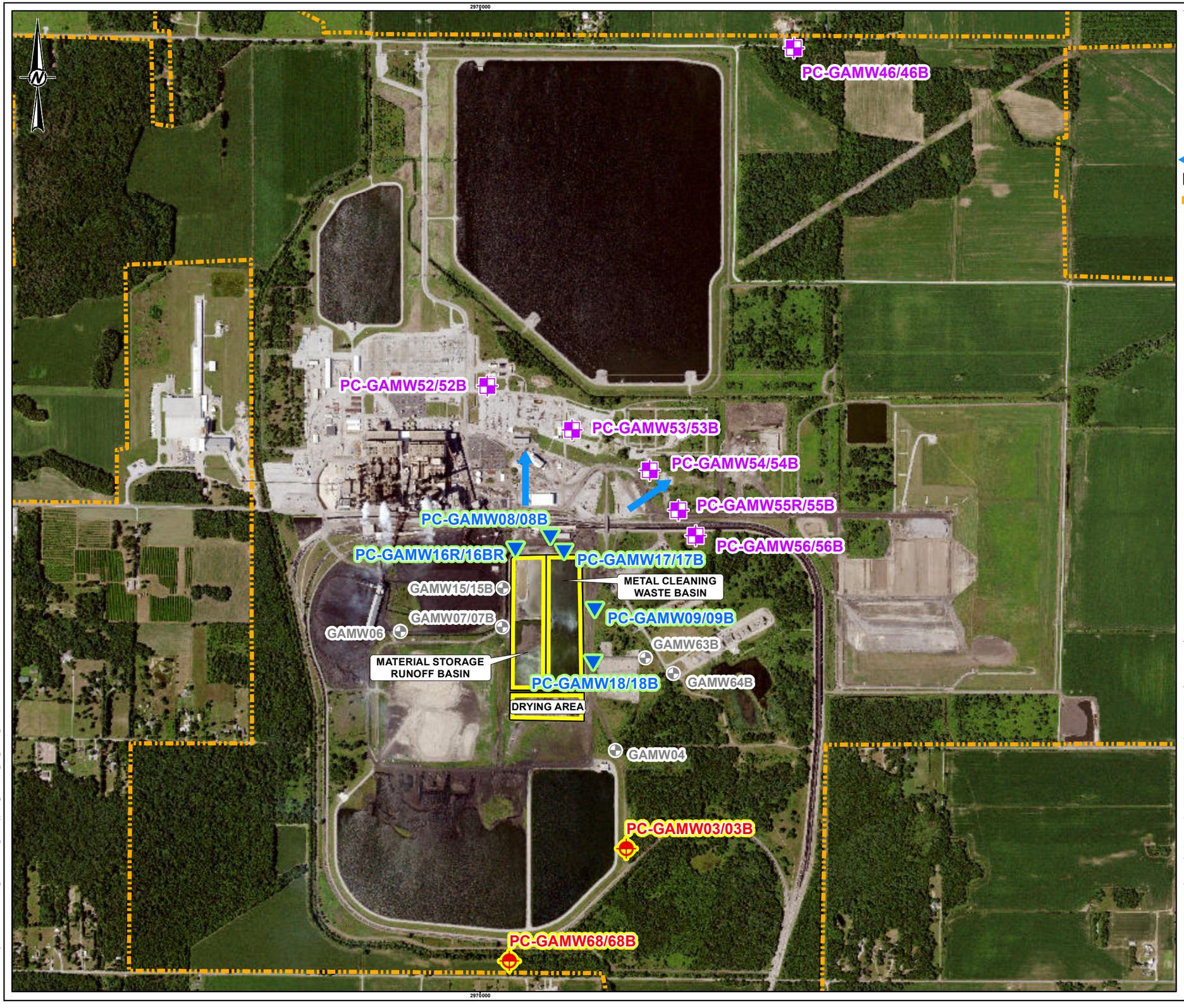
PROJECT NO.	CONTROL	REV.	FIGURE
19121567	A	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

1 in

0

PATH: V:\001\GIS Projects\NIPSCO\Schahfer\09_PROJ\19127745_ProjectSupport\40_PROD\001_RMSGSSiteMaps\19127745-0001-HS-0001.mxd PRINTED ON: 2019-01-25 AT: 3:23:29 PM



LEGEND

- Non-CCR
- Background Monitoring Well
- Assessment Monitoring Well
- Downgradient Monitoring Well
- Generalized Groundwater Flow Direction
- CCR Units
- Approximate Property Line

0 1,000 2,000

1 " = 1,079 feet Feet

NOTE(S)

REFERENCE(S)

1. SERVICE LAYER CREDITS: NATIONAL AGRICULTURE IMAGERY PROGRAM (NAIP), FARM SERVICES AGENCY (FSA), U. S. DEPARTMENT OF AGRICULTURE (USDA), UITS, INDIANA SPATIAL DATA PORTAL

CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY LLC

PROJECT

R.M. SCHAHFER GENERATING STATION
WHEATFIELD, INDIANA

TITLE

WELL LOCATION MAP
MATERIAL STORAGE RUNOFF BASIN, METAL CLEANING WASTE BASIN, AND DRYING AREA

CONSULTANT

wsp

YYYY-MM-DD	3/9/2023
DESIGNED	DFSC
PREPARED	EMM
REVIEWED	DFSC
APPROVED	MAH

PROJECT NO.	CONTROL	REV.	FIGURE
GL21508844	A	0	2

APPENDIX A

Boring and Well Construction Logs

BOREHOLE LOG: GAMW-03

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK:

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2169821.527 E: 2971646.342
GROUND SURFACE ELEV.: 665.11
TOP OF CASING ELEV.: 668.77
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 6/27/2015
END DATE/TIME: 6/27/2015

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	dark brown fine SILTY SAND		1	SS		1.83 / 2	0-2': SILTY SAND, fine, poorly-graded, dark brown, plant roots, trace gravel, trace silt, moist, loose. (SM) SPTs (2-2-2-3)		Cement and bentonite grout mix 0-1.5 ft-bgs Bentonite chips 1.5-3.5 ft-bgs Filter Pack #7 Sand 3.5-4 ft-bgs Filter Pack #5 Sand 4-15 ft-bgs 2" PVC Screen slot 0.010" 5-15 ft-bgs
660.0	gray to brown fine SAND, trace silt		2	SS		2 / 2	5-5.83': SILTY SAND, fine, poorly-graded, trace gravel, dark brown, plant roots, non-cohesive, moist, loose. (SM) 5.83-7': SAND, fine, poorly-graded, light brown, orange stained ribbons, trace silt, wet, compact. (SP) SPTs (5-5-5-5)		
655.0			3	SS		2 / 2	10-12': SAND, fine, poorly-graded, gray to brown, trace silt, wet, loose. (SP) SPTs (3-3-4-3)		
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: John
DRILL RIG: CME 75

LOGGED BY: AP
CHECKED BY: CEM
DATE: 7/27/15

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-03B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 37
DEPTH TO BEDROCK: 36.8

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2169813.708 E: 2971647.06
GROUND SURFACE ELEV.: 665.29
TOP OF CASING ELEV.: 668.20
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/24/2016 8:05:00 AM
END DATE/TIME: 5/24/2016 10:42:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	FILL- light brown fine to medium SAND, occasional organics, fly ash/ boiler slag, trace silt		1	SS		1.6 / 2	0-1.7': SAND, organics, light brown medium sand lenses; dark brown; trace fly ash/ boiler slag, trace silt, loose. (FILL) 1.7-2': SAND, oxidized, fine, poorly-graded; trace silt, loose (FILL). SPTs (3-2-5-5)		Bentonite grout mix 0-23 ft-bgs
660.0			2	SS		1.7 / 2	5-5.75': SAND, fine, poorly-graded; light brown to brown; trace organics, trace silt, loose. (FILL) 5.75-7': SAND, medium, poorly-graded; brown; trace silt, wet, loose. (FILL) SPTs (3-4-4-5)		
655.0			3	SS		2 / 2	10-12': SAND, fine, poorly-graded; brown; trace oxides, trace silt, wet, very loose. (FILL) SPTs (2-2-2-2)		
650.0	brown, fine to medium SAND, trace gravel and oxides, trace silt		4	SS		0.9 / 2	15-17': SAND, fine, well-graded; brown; trace gravel, trace silt, moist, very loose. (SW) SPTs (1-2-2-3)		
645.0			5	SS		1 / 2	21-22': SAND, medium, well-graded; brown; trace gravel, trace silt, moist, loose. (SP) SPTs (2-2-4-4)		Bentonite chips 23-25 ft-bgs Filter Pack #5 Sand 25-37 ft-bgs

LITHOLOGY LEGEND

Fill (made ground) | USCS Well-graded Sand (SW) | Shale

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 55

LOGGED BY: HV
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

BOREHOLE LOG: GAMW-03B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 37
DEPTH TO BEDROCK: 36.8

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2169813.708 E: 2971647.06
GROUND SURFACE ELEV.: 665.29
TOP OF CASING ELEV.: 668.20
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/24/2016 8:05:00 AM
END DATE/TIME: 5/24/2016 10:42:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	brown, fine to medium SAND, trace gravel and oxides, trace silt		6	SS		1.5 / 2	25-27': SAND, medium, well-graded; brown; trace oxides, trace silt, moist, compact. (SW) SPTs (4-5-7-7)		2 PVC Screen slot 0.010 27-37 ft-bgs
635.0			7	SS		0.9 / 2	30-32': SAND, medium, well-graded; brown; trace gravel, trace silt, wet, loose.(SP) SPTs (3-5-4-5)		
630.0	dark grey to black SHALE		8	SS		2 / 2	35-35.7': SAND, fine, poorly-graded; trace silt, moist, loose.(SP) 35.7': auger refusal in SHALE; dark grey to black.		
625.0									
620.0									

LITHOLOGY LEGEND

Fill (made ground)

USCS Well-graded Sand (SW)

Shale

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 55

LOGGED BY: HV
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

BOREHOLE LOG: GAMW-04

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK:

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2170737.635 E: 2968871.614
GROUND SURFACE ELEV.: 665.73
TOP OF CASING ELEV.: 669.21
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 6/27/2015
END DATE/TIME: 6/27/2015

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	brown to black fine SILTY SAND, trace gravel		1	SS		2 / 2	0-0.92': SAND, fine, poorly-graded, some organic silt in top 4 inches, light reddish-brown, plant roots, non-cohesive, wet, loose. (SP) 0.92-2': SILTY SAND, fine, poorly-graded, brown to black, trace gravel, non-cohesive, moist, loose. (SM) SPTs (2-3-4-3)		Cement and bentonite grout mix 0-1 ft-bgs Bentonite chips 1-3 ft-bgs Filter Pack #7 Sand 3-3.5 ft-bgs Filter Pack #5 Sand 3.5-15 ft-bgs 2" PVC Screen slot 0.010" 5-15 ft-bgs
660.0	gray to reddish-brown fine to medium SILTY SAND		2	SS		1.83 / 2	5-5.67': SILTY SAND, fine, poorly-graded, trace gravel, brown to black, non-cohesive, moist, loose. (SM) 5.67-6.17': SAND, fine, poorly-graded, light reddish-brown, trace silt, wet, loose. (SP) 6.17-7': SILTY SAND, fine, poorly-graded, gray to brown, non-cohesive, moist, loose. (SM) SPTs (2-3-4-5)		
655.0	gray fine SAND, trace silt		3	SS		1.58 / 2	10-12': SAND, fine, poorly-graded, gray, trace silt, wet, loose. (SP) SPTs (3-3-4-3)		
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: John
DRILL RIG: CME 75

LOGGED BY: AP
CHECKED BY: CEM
DATE: 7/27/15

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-06

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK:

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172320.062 E: 2969128.6
GROUND SURFACE ELEV.: 667.50
TOP OF CASING ELEV.: 670.81
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 6/29/2015
END DATE/TIME: 6/29/2015

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	FILL- BOILER SLAG and FLY ASH, gray clayey SAND		1	SS		1.92 / 2	0-1.42': BOILER SLAG and ASH, black, loose, wet, non-cohesive. (FILL) 1.42-2': CLAYEY SAND, gray, cohesive, stiff, W>PL. (FILL) SPTs (3-5-5-6)		Cement and bentonite grout mix 0-1 ft-bgs
665.0			2	SS		2 / 2	5-5.83': BOILER SLAG and ASH, black, loose, moist, non-cohesive. (FILL) 5.83-6.67': CLAYEY SAND, gray, cohesive, stiff W>PL. (FILL) 6.67-7': SAND, medium, poorly-graded, dark brown to light brown, trace silt, moist, loose. (SP) SPTs (3-4-4-6)		Bentonite chips 1-3 ft-bgs Filter Pack #7 Sand 3-4 ft-bgs Filter Pack #5 Sand 4-15 ft-bgs 2" PVC Screen slot 0.010" 5-15 ft-bgs
660.0									
	light brown medium SAND, trace silt		3	SS		2 / 2	10-11': CLAYEY SAND, dark gray, cohesive, wet, W>PL. (SC) 11-12': SAND, medium, poorly-graded, light brown, trace silt, wet, loose. (SP) SPTs (2-3-3-4)		
655.0									
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

Fill (made ground)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 75

LOGGED BY: HMV
CHECKED BY: CEM
DATE: 7/27/15

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-07

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK:

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172327.533 E: 2970256.339
GROUND SURFACE ELEV.: 666.60
TOP OF CASING ELEV.: 669.89
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 6/29/2015
END DATE/TIME: 6/29/2015

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	FILL- BOILER SLAG and black FLY ASH, brown medium SAND, trace gravel, trace silt		1	SS		2 / 2	0-0.83': SAND, medium, poorly-graded, dark brown, organics, trace gravel, trace silt, moist, loose. (FILL) 0.83-1.5': FLY ASH, black, non-cohesive, moist, loose. (FILL) 1.5-2': SAND, medium, poorly-graded, brown, trace silt, moist, loose. (FILL) SPTs (4-4-5-7)		Cement and bentonite grout mix 0-1 ft-bgs Bentonite chips 1-3 ft-bgs Filter Pack #7 Sand 3-4 ft-bgs Filter Pack #5 Sand 4-15 ft-bgs 2" PVC Screen slot 0.010" 5-15 ft-bgs
660.0	light brown to black fine to medium SAND, trace gravel, trace silt		2	SS		1.66 / 2	5-6.25': FLY ASH, black, trace gravel, trace silt, moist, loose. (FILL) 6.25-7': SAND, poorly-graded medium, brown, trace gravel, trace silt, loose, wet. (SP) SPTs (7-5-3-3)		
655.0			3	SS		1.42 / 2	10-11.08': SAND, fine to medium, poorly-graded, black, trace gravel, trace organics, trace silt, wet, very loose. (SP) 11.08-12': SAND, medium, poorly-graded, light brown, trace silt, wet, very loose. (SP) SPTs (5-2-2-7)		
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

Fill (made ground)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 75

LOGGED BY: HMV
CHECKED BY: CEM
DATE: 7/27/15

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-07B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 41
DEPTH TO BEDROCK: 40

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172318.589 E: 2970251.363
GROUND SURFACE ELEV.: 666.83
TOP OF CASING ELEV.: 669.37
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/25/2018 11:40:00 AM
END DATE/TIME: 7/25/2018 12:10:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	FILL- black BOILER SLAG and light to dark brown SILTY SAND, trace gravel			RS			0-0.8': SILTY SAND, fine, poorly-graded, light to dark brown, trace rounded gravel <1 cm, trace organics, dry. (SM)		Bentonite Grout 0-26 ft bgs
				RS					
665.0				RS			0.8-1.4': SILTY SAND, fine, poorly-graded, dark brown, moist. (SM)		
	dark brown fine SILTY SAND			RS			1.4-1.8': BOILER SLAG, black, moist. (FILL)		
	light gray fine GRAVELLY SAND, trace clay			RS			1.8-2.7': SILTY SAND, fine, poorly-graded, dark brown, moist. (SM)		
	light gray to orange-brown fine to medium SAND			RS			2.7-3.2': GRAVELLY SAND, fine, poorly-graded, light gray, rounded gravel up to 2 inch, some clay, cohesive, wet. (SP)		
				RS			3.2-3.4': SAND, fine to medium, well-graded, orange-brown, wet. (SW)		
660.0				RS			5-5.5': SAND, fine to medium, well-graded, orange-brown, wet. (SW)		
							5.5-7.8': SAND, fine to medium, well-graded, light gray to light brown, wet. (SW)		
				RS			7.8-7.9': SAND, fine to medium, well-graded, orange, wet. (SW)		
							7.9-9': SAND, fine to medium, well-graded, light gray to light brown, wet. (SW)		
655.0	light brown to light gray fine to coarse SAND, trace to some gravel			RS			10-11.3': SAND, fine to medium, well-graded, light brown to light gray, wet. (SW)		
							11.3-13.3': SAND, fine to coarse, well-graded, light brown to light gray, trace rounded gravel <1 cm, wet. (SW)		
650.0				RS			16-18': SAND, fine to coarse, well-graded, light brown to light gray, trace rounded gravel <1 cm, wet. (SW)		
				RS			18-20': SAND, medium to coarse, well-graded, light brown, some rounded gravel <1 inch, trace fine sand, wet. (SW)		
				RS			20-22': SAND, medium to coarse, well-graded, light brown, some rounded gravel <1 inch, trace fine sand, wet. (SW)		
645.0				RS			22-25': SAND, fine to coarse, well-graded, light gray, some rounded gravel <1 inch, wet. (SW)		

LITHOLOGY LEGEND

- Fill (made ground)
- USCS Well-graded Sand (SW)
- USCS Silty Sand (SM)
- Shale
- USCS Poorly-graded Gravelly Sand (SPG)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/12/18

Golder Associates

BOREHOLE LOG: GAMW-07B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 41
DEPTH TO BEDROCK: 40

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172318.589 E: 2970251.363
GROUND SURFACE ELEV.: 666.83
TOP OF CASING ELEV.: 669.37
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/25/2018 11:40:00 AM
END DATE/TIME: 7/25/2018 12:10:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	light brown to light gray fine to coarse SAND, trace to some gravel			RS			25-29.2': SAND, fine to coarse, well-graded, light gray, some rounded gravel <1 inch, wet. (SW)		Bentonite Chips 26-28 ft bgs
									#5 Sand Filter Pack 28-40 ft bgs
				RS			30-32': SAND, fine to coarse, well-graded, light gray, some rounded gravel <1 inch, wet. (SW)		2" PVC Screen slot 0.010 30-40 ft bgs
635.0				RS			32-34': SAND, fine to coarse, well-graded, light gray, some rounded gravel 1 up to 3 inch, wet. (SW)		
			SB-07B-35'-37'	RS			35-36.3': SAND, fine to coarse, well-graded, light gray, some rounded gravel <1 inch, wet. (SW) 36.3-37': SAND, fine to coarse, well-graded, light gray, little rounded gravel 1 cm to 3 inch and <1 cm, wet. (SW)		
630.0				RS			37-37.5': SAND, fine to coarse, well-graded, light gray, little rounded gravel 1 cm to 3 inch and <1 cm, wet. (SW)		
	gray clayey SHALE			RS		1 / 1	40-41': CLAYEY SHALE, gray, weathered, wet. Less weathered from 40.5-41'.		#5 Sand 40-41 ft bgs
625.0									
620.0									

LITHOLOGY LEGEND

Fill (made ground)
USCS Well-graded Sand (SW)
USCS Silty Sand (SM)
Shale
USCS Poorly-graded Gravelly Sand (SPG)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/12/18

Golder Associates

BOREHOLE LOG: GAMW-08

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK:

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173335.204 E: 2970799.89
GROUND SURFACE ELEV.: 666.01
TOP OF CASING ELEV.: 669.66
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 6/28/2015
END DATE/TIME: 6/28/2015

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	FILL- SANDY GRAVEL, BOILER SLAG, trace silt		1	SS		1.33 / 2	0-2': SANDY GRAVEL, poorly-graded, angular, gray-brown, lenses of black BOILER SLAG, trace silt, dry, compact. (FILL) SPTs (6-12-14-19)		Cement and bentonite grout mix 0-1 ft-bgs Bentonite chips 1-3 ft-bgs Filter Pack #7 Sand 3-4 ft-bgs Filter Pack #5 Sand 4-15 ft-bgs 2" PVC Screen slot 0.010" 5-15 ft-bgs
660.0	brown medium SAND, trace silt		2	SS		1.5 / 2	5-7': SAND, medium, poorly-graded, brown, trace silt, wet, very loose. (SP) SPTs (1-1-1-1)		
655.0			3	SS		2 / 2	10-12': SAND, medium, poorly-graded, brown to light brown, trace silt, wet, loose. (SP) SPTs (2-2-5-9)		
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

Fill (made ground)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 75

LOGGED BY: HMV
CHECKED BY: CEM
DATE: 7/27/15

Golder Associates

BOREHOLE LOG: GAMW-08B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 37
DEPTH TO BEDROCK: 36

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173334.7 E: 2970790.588
GROUND SURFACE ELEV.: 665.92
TOP OF CASING ELEV.: 668.45
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/25/2018 2:35:00 PM
END DATE/TIME: 7/25/2018 3:10:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	light brown GRAVEL			RS			0-0.25': GRAVEL, rounded <2 inch, light brown, dry. (GW)		Bentonite Grout 0-22 ft bgs
	light gray fine to coarse GRAVELLY SAND			RS					
665.0				RS			0.25-0.8': GRAVELLY SAND, fine to coarse, well-graded, light gray, rounded gravel up to <2 inch, dry. (SW)		
	dark brown fine SILTY SAND, some gravel								
	brown fine to medium CLAYEY SAND, some gravel			RS			0.8-1.5': SILTY SAND, fine, poorly-graded, dark brown, some rounded gravel <1 inch, moist. (SM)		
	brown fine to medium SAND			RS			1.5-3': CLAYEY SAND, fine to medium, well-graded, brown, some rounded gravel <1 inch, cohesive, dry. (SC)		
							3-5': SAND, fine to medium, well-graded, brown, moist. (SW)		
	light gray fine to medium SAND, some silt						5-7': SAND, fine to medium, well-graded, light gray, some silt, somewhat cohesive, wet. (SW)		
660.0				RS					
	light gray to light brown fine to coarse SAND, trace to some gravel								
655.0									
650.0							16-17.5': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
				RS					
				RS			17.5-19': SAND, fine to coarse, well-graded, light gray to light brown, trace rounded gravel <1 cm, wet. (SW)		
							20-24': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
645.0									
				RS					Bentonite Chips 22-24 ft bgs
				RS			24-28': SAND, fine to coarse, well-graded, light gray, wet. (SW)		#5 Sand Filter Pack 24-36 ft bgs

LITHOLOGY LEGEND

USCS Well-graded Gravel (GW)
USCS Clayey Sand (SC)
USCS Well-graded Gravelly Sand (SWG)
USCS Well-graded Sand (SW)
USCS Silty Sand (SM)
USCS Poorly-graded Gravelly Sand (SPG)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/12/18

Golder Associates

BOREHOLE LOG: GAMW-08B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 37
DEPTH TO BEDROCK: 36

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173334.7 E: 2970790.588
GROUND SURFACE ELEV.: 665.92
TOP OF CASING ELEV.: 668.45
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/25/2018 2:35:00 PM
END DATE/TIME: 7/25/2018 3:10:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	light gray to light brown fine to coarse SAND, trace to some gravel			RS					2" PVC Screen slot 0.010 26-36 ft bgs
				RS			28-30': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
635.0			SB-08B-30-32	RS			30-31.25': SAND, fine to coarse, well-graded, light gray, wet. (SW) 31.25-32': SAND, medium to coarse, well-graded, light gray, some rounded gravel <1 inch, wet. (SW)		
	light gray coarse SAND and GRAVEL			RS			32-34': SAND and rounded GRAVEL <1 cm, coarse, poorly-graded, light gray, wet. (SP)		
630.0	gray clayey SHALE			RS		2 / 1	36-37': CLAYEY SHALE, gray, wet.		#5 Sand 36-37 ft bgs
625.0									
620.0									

LITHOLOGY LEGEND

USCS Well-graded Gravel (GW)
USCS Clayey Sand (SC)
USCS Well-graded Gravelly Sand (SWG)
USCS Well-graded Sand (SW)
USCS Silty Sand (SM)
USCS Poorly-graded Gravelly Sand (SPG)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/12/18

Golder Associates

BOREHOLE LOG: GAMW-09

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK:

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172509.361 E: 2971291.294
GROUND SURFACE ELEV.: 665.18
TOP OF CASING ELEV.: 668.99
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 6/28/2015
END DATE/TIME: 6/28/2015

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	light brown to black medium SAND, trace silt		1	SS		1.75 / 2	0-1': SAND, medium, poorly-graded, black, organics, trace silt, moist, very loose. (SP) 1-2': SAND, medium, poorly-graded, light brown, trace silt, moist, very loose. (SP) SPTs (2-1-1-2)		Cement and bentonite grout mix 0-1 ft-bgs Bentonite chips 1-3 ft-bgs Filter Pack #7 Sand 3-4 ft-bgs Filter Pack #5 Sand 4-15 ft-bgs 2" PVC Screen slot 0.010" 5-15 ft-bgs
660.0			2	SS		1.5 / 2	5-6': SAND, medium, poorly-graded, brown, trace silt, moist, compact. (SP) 6-7': SAND, medium, poorly-graded, light brown, trace silt, moist, compact. (SP) SPTs (4-5-5-6)		
655.0			3	SS		1.92 / 2	10-10.58': SAND, medium, poorly-graded, brown, trace silt, wet, compact. (SP) 10.58-12': SAND, fine, poorly-graded, light brown, trace silt, wet, compact. (SP) SPTs (1-2-2-5)		
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: John
DRILL RIG: CME 75

LOGGED BY: HMV
CHECKED BY: CEM
DATE: 7/27/15

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-09B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 34.5
DEPTH TO BEDROCK: 34.5

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172502.567 E: 2971291.67
GROUND SURFACE ELEV.: 665.35
TOP OF CASING ELEV.: 668.29
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/24/2016 1:10:00 PM
END DATE/TIME: 5/24/2016 3:09:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	FILL- fine sand, occasional organics, oxides, fine lenses and fly ash/ boiler slag, trace silt		1	SS		1.9 / 2	0-1': SAND, organics, fine, poorly-graded; dark brown; trace fly ash/ boiler slag, trace silt, loose. (FILL) 1-2': SAND, fine, poorly-graded; light brown; trace silt, dry, loose. (FILL) SPTs (2-2-3-4)		Bentonite grout mix 0-20.5 ft-bgs
660.0			2	SS		1.3 / 2	5-7': SAND, fine, poorly-graded; light brown; trace iron oxides, trace organics, trace silt, dry, compact. (FILL) SPTs (5-6-7-7)		
655.0			3	SS		1.2 / 2	10-12': SAND, 2 thick clayey lens, trace fly ash/ boiler slag, trace iron oxides, fine, poorly-graded; light brown; trace silt, dry, compact. (FILL) SPTs (6-8-8-7)		
650.0			4	SS		1.9 / 2	15-17': SAND, fine, poorly-graded; light brown; trace fly ash/ boiler slag, trace silt, wet, loose. (FILL) SPTs (2-4-3-5)		
645.0	red brown tan GRAVEL, trace silt		5	SS		1.5 / 2	20-20.9': GRAVEL, rounded, well-graded; red brown tan; trace silt, wet, loose. (GW) 20.9-22': SAND, fine, poorly-graded; light brown; trace silt, wet, loose. (SP) SPTs (3-5-4-6)		Bentonite chips 20.5-22.5 ft-bgs
	light brown fine SAND, trace gravel, trace silt								Filter Pack #5 Sand 22.5-34.5 ft-bgs 2 PVC Screen slot

LITHOLOGY LEGEND

Fill (made ground)
Shale
USCS Well-graded Gravel (GW)
USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 55

LOGGED BY: HV
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-09B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 34.5
DEPTH TO BEDROCK: 34.5

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172502.567 E: 2971291.67
GROUND SURFACE ELEV.: 665.35
TOP OF CASING ELEV.: 668.29
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/24/2016 1:10:00 PM
END DATE/TIME: 5/24/2016 3:09:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	light brown fine SAND, trace gravel, trace silt		6	SS		1.5 / 2	25-27': SAND, fine, poorly-graded; light brown; trace gravel, trace silt, wet, compact. (SP) SPTs (5-6-6-7)		0.010 24.5-34.5 ft-bgs
635.0			7	SS		1.1 / 2	30-32': SAND, fine, poorly-graded; light brown; trace gravel, trace silt, wet, loose. (SP) 34.5': auger refusal in SHALE; dark grey to black. SPTs (3-3-5-4)		
630.0	SHALE								
625.0									
620.0									

LITHOLOGY LEGEND

Fill (made ground)
Shale
USCS Well-graded Gravel (GW)
USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 55

LOGGED BY: HV
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

BOREHOLE LOG: GAMW-15

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK: 37

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172753.762 E: 2970258.353
GROUND SURFACE ELEV.: 665.01
TOP OF CASING ELEV.: 668.25
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 5/25/2016 8:37:00 AM
END DATE/TIME: 5/25/2016 9:20:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	FILL- black FLY ASH, grey SAND, some boiler slag, some fine to coarse gravel, trace silt		1	SS		1.8 / 2	0-1.4': FLY ASH, some boiler slag, poorly-graded; black; trace medium angular gravel, trace silt, moist, compact. (FILL) 1.4-2': FLY ASH, some fine to coarse angular gravel, poorly-graded; black; trace silt, moist, compact. (FILL) SPTs (3-9-12-13)		Bentonite grout mix 0-1 ft-bgs Bentonite chips 1-3 ft-bgs Filter Pack #5 Sand 3-15 ft-bgs 2 PVC Screen slot 0.010 5-15 ft-bgs
660.0			2	SS		2 / 2	5-5.8': FLY ASH, some slag, poorly-graded; black; trace fine rounded gravel, trace silt, moist, loose. (FILL) 5.8-7': SAND; fine, poorly-graded, light grey; trace silt, moist, loose. (FILL) SPTs (1-3-4-4)		
655.0			3	SS		1.8 / 2	10-10.2': FLY ASH; black; trace silt, wet, loose. (FILL) 10.2-10.8': SAND, little coarse rounded gravel, poorly-graded; grey; trace silt, wet, loose. (FILL) 10.8-12': SAND, little fine rounded gravel, poorly-graded; light grey; trace silt, wet, loose. (FILL) SPTs (1-1-4-4)		
650.0									
645.0									

LITHOLOGY LEGEND

Fill (made ground)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 75

LOGGED BY: DSD
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-15B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 37.7
DEPTH TO BEDROCK: 37

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172749.68 E: 2970258.917
GROUND SURFACE ELEV.: 665.14
TOP OF CASING ELEV.: 668.05
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 5/24/2016 11:15:00 AM
END DATE/TIME: 5/24/2016 4:00:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	FILL- black FLY ASH, grey SAND, some boiler slag, some fine to coarse gravel, trace silt		1	SS		1.8 / 2	0-1.4': FLY ASH, some boiler slag, poorly-graded; black; trace medium angular gravel, trace silt, moist, compact. (FILL) 1.4-2': FLY ASH, some fine to coarse angular gravel, poorly-graded; black; trace silt, moist, compact. (FILL) SPTs (3-9-12-13)		Bentonite grout mix 0-23.7 ft-bgs
660.0			2	SS		2 / 2	5-5.8': FLY ASH, some slag, poorly-graded; black; trace fine rounded gravel, trace silt, moist, loose. (FILL) 5.8-7': SAND; fine, poorly-graded, light grey; trace silt, moist, loose. (FILL) SPTs (1-3-4-4)		
655.0			3	SS		1.8 / 2	10-10.2': FLY ASH; black; trace silt, wet, loose. (FILL) 10.2-10.8': SAND, little coarse rounded gravel, poorly-graded; grey; trace silt, wet, loose. (FILL) 10.8-12': SAND, little fine rounded gravel, poorly-graded; light grey; trace silt, wet, loose. (FILL) SPTs (1-1-4-4)		
650.0			4	SS		1.6 / 2	15-16.2': SAND, some fine angular gravel, some boiler slag, poorly-graded; grey; trace silt, wet, loose. (FILL) 16.2-17': SAND, some fine subrounded gravel, poorly-graded; light tan; trace silt, wet, loose. (FILL) SPTs (1-3-6-8)		
645.0			5	SS		0.3 / 2	20-22': GRAVEL and BOILER SLAG, some sand, fine, subrounded and angular, poorly-graded; light grey; trace silt, wet, compact. (FILL) SPTs (1-6-12-15)		Bentonite chips 23.7-25.7 ft-bgs

LITHOLOGY LEGEND

Fill (made ground)

Shale

USCS Poorly-graded Sand (SP)

USCS Low Plasticity Clay (CL)

DRILLING COMPANY: Earth Exploration
DRILLER: Jeff Silcox
DRILL RIG: CME 75

LOGGED BY: DSD
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

BOREHOLE LOG: GAMW-15B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 37.7
DEPTH TO BEDROCK: 37

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2172749.68 E: 2970258.917
GROUND SURFACE ELEV.: 665.14
TOP OF CASING ELEV.: 668.05
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 75
START DATE/TIME: 5/24/2016 11:15:00 AM
END DATE/TIME: 5/24/2016 4:00:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	light grey fine to medium SAND, some gravel, trace silt		6	SS		1.1 / 2	25-26.5': SAND, fine, poorly-grade; light grey; trace silt, wet, loose. (SP) 26.5-27': SAND, some fine angular gravel, medium, poorly-graded; light grey; trace silt, wet, loose. (SP) SPTs (1-3-4-7)		Filter Pack #5 Sand 25.7-37.7 ft-bgs
635.0			7	SS		2 / 2	30-31.25': SAND, fine to medium, poorly-graded; light grey; trace silt, wet, loose. (SP) 31.25-31.4': SAND and GRAVEL, fine, subrounded, well-graded; light grey; trace silt, wet, dense. (SW) 31.4-32': SAND, some silt, fine, poorly-graded; light grey; non-cohesive, wet, dense. (SP) SPTs (4-12-23-27)		2 PVC Screen slot 0.010 27.7-37.7 ft-bgs
630.0			8	SS		1.3 / 2	35-36.6': SAND, fine to medium, poorly-graded; light grey; trace silt, wet, compact. (SP) 36.6-36.9': SAND, fine subrounded gravel, poorly-graded; light grey; trace silt, wet, compact. (SP)		
	light grey CLAY, some fine rounded gravel grey SHALE		9	SS		0.7 / 0.7	36.9-37': CLAY, some fine rounded gravel, poorly-graded; light grey; cohesive, wet, very stiff. (CL) SPTs (3-11-12-22)		
625.0							37-37.7': SHALE; grey; cohesive, moist, dense. SPTs (30-50/2)		
620.0									

LITHOLOGY LEGEND

Fill (made ground)

Shale

USCS Poorly-graded Sand (SP)

USCS Low Plasticity Clay (CL)

DRILLING COMPANY: Earth Exploration
DRILLER: Jeff Silcox
DRILL RIG: CME 75

LOGGED BY: DSD
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

BOREHOLE LOG: GAMW-16R

PROJECT: NIPSCO LLC Schahfer
PROJECT NO.: 19121567
HOLE DEPTH: 20
DEPTH TO BEDROCK: N/A

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173189.507 E: 2970396.681
GROUND SURFACE ELEV.: 664.35
TOP OF CASING ELEV.: 667.17
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD: N/A
DRILL RIG: Geoprobe 7822 DT
START DATE/TIME: 9/23/2020 7:35:00 AM
END DATE/TIME: 9/23/2020 8:58:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	FILL - sand backfill						0-10' Augered without sampling (sand backfill)		Cement-bentonite Grout 0-5 ft-bgs
660.0									1/4" Coated Bentonite Pellets 5-7 ft-bgs
									#5 Sand Filter Pack 7-20 ft-bgs
655.0	fine brown SAND, some medium, trace gravel, trace silt		1	SS		0.6 / 2	10-10.6': (SP) fine SAND, poorly graded, trace gravel, sub-angular to sub-rounded, trace silt, non cohesive, wet, very loose SPTs (WR-WR-WR-WR)		2 PVC Screen slot 0.010 10-20 ft-bgs
			2	SS		1.7 / 2	12-13.7': (SP) medium SAND, poorly graded, sub angular to sub rounded, non cohesive, wet, very loose SPTs (1-1-2-2)		
650.0			3	SS		1 / 2	14-15': (SP) fine to medium SAND, poorly graded, sub angular to sub rounded, trace gravel, trace silt, dark gray staining, non cohesive, wet, very loose SPTs (1-1-2-3)		
			4	SS		0.9 / 2	16-16.9': (SP) fine SAND, poorly graded, sub angular, trace gravel, trace silt, non cohesive, wet, very loose to loose SPTs (2-4-4-5)		
645.0			5	SS		1.2 / 2	18-19.2': (SP) fine to medium SAND, poorly graded, sub angular, trace silt, orange staining, non cohesive, wet, loose SPTs (4-5-5-6)		
640.0									

LITHOLOGY LEGEND

Fill (made ground)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Strata Earth Services, LLC
DRILLER: Scott Komen
DRILL RIG: Geoprobe 7822 DT

LOGGED BY: KB
CHECKED BY: KJ
DATE: 10/19/20

Golder Associates

BOREHOLE LOG: GAMW-16BR

PROJECT: NIPSCO LLC Schahfer
PROJECT NO.: 19121567
HOLE DEPTH: 40
DEPTH TO BEDROCK: 37

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173189.526 E: 2970399.45
GROUND SURFACE ELEV.: 664.39
TOP OF CASING ELEV.: 667.32
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD: N/A
DRILL RIG: Geoprobe 7822 DT
START DATE/TIME: 9/23/2020 11:40:00 AM
END DATE/TIME: 9/23/2020 4:10:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	FILL - sand backfill						0-10' Augered without sampling (sand backfill)		Cement-bentonite Grout 0-25 ft bgs
660.0				SS					
655.0	fine brown SAND, some medium, trace gravel, trace silt		1	SS		0.6 / 2	10-10.6': (SP) fine SAND, poorly graded, trace gravel, sub-angular to sub-rounded, trace silt, non cohesive, wet, very loose SPTs (WR-WR-WR-WR)		
			2	SS		1.7 / 2	12-13.7': (SP) medium SAND, poorly graded, sub angular to sub rounded, non cohesive, wet, very loose SPTs (1-1-2-2)		
650.0			3	SS		1 / 2	14-15': (SP) fine to medium SAND, poorly graded, sub angular to sub rounded, trace gravel, trace silt, dark gray staining, non cohesive, wet, very loose SPTs (1-1-2-3)		
			4	SS		0.9 / 2	16-16.9': (SP) fine SAND, poorly graded, sub angular, trace gravel, trace silt, non cohesive, wet, very loose to loose SPTs (2-4-4-5)		
645.0			5	SS		1.2 / 2	18-19.2': (SP) fine to medium SAND, poorly graded, sub angular, trace silt, orange staining, non cohesive, wet, loose SPTs (4-5-5-6)		
			5	SS		1.4 / 2	20-21.3': (SP) SAND, fine to medium, poorly-graded; brown; trace silt, wet, compact 21.3-22': (SW) SAND, some fine rounded gravel, fine to medium, well-graded; dark brown; trace silt, wet, compact SPTs (4-7-9-12)		
	brown fine to coarse SAND, some gravel, trace silt								
640.0									

LITHOLOGY LEGEND

Fill (made ground)
USCS Low Plasticity Clay (CL)
USCS Poorly-graded Sand (SP)
Shale
USCS Well-graded Sand (SW)

DRILLING COMPANY: Strata Earth Services, LLC
DRILLER: Scott Komen
DRILL RIG: Geoprobe 7822 DT

LOGGED BY: KB
CHECKED BY: KJ
DATE: 10/19/20

Golder Associates

BOREHOLE LOG: GAMW-16BR

PROJECT: NIPSCO LLC Schahfer
PROJECT NO.: 19121567
HOLE DEPTH: 40
DEPTH TO BEDROCK: 37

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173189.526 E: 2970399.45
GROUND SURFACE ELEV.: 664.39
TOP OF CASING ELEV.: 667.32
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD: N/A
DRILL RIG: Geoprobe 7822 DT
START DATE/TIME: 9/23/2020 11:40:00 AM
END DATE/TIME: 9/23/2020 4:10:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	brown fine to coarse SAND, some gravel, trace silt		6	SS		0 / 2	25-27': No recovery SPTs (4-7-10-14)		1/4" Coated Bentonite Pellets 25-28 ft-bgs
635.0			7	SS		1.3 / 2	30-31.6': (SW) SAND, fine to medium, well-graded; brown; trace silt, wet, compact 31.6-32': (SP) SAND, little small subrounded gravel, fine to medium, poorly-graded; grey; trace silt, wet, compact SPTs (1-3-10-12)		#5 Sand Filter Pack 28-40 ft-bgs 2 PVC Screen slot 0.010 30-40 ft-bgs
	grey to brown medium to coarse SAND, little gravel, trace silt								
630.0			8	SS		2 / 2	34-34.6': (SP) SAND, fine, poorly-graded; brown; trace silt, wet, dense 34.6-35': (SP) SAND, some fine rounded gravel, medium, poorly-graded; dark grey; trace silt, wet, dense		
	grey CLAY		9	SS		0.3 / 2	35-36': CLAY; grey; cohesive, dry, hard. (CL) SPTs (12-15-22-7)		
	weathered gray clayey SHALE						37-37.3': weathered gray clayey SHALE		
625.0									
620.0									
615.0									

LITHOLOGY LEGEND

Fill (made ground)
USCS Low Plasticity Clay (CL)
USCS Poorly-graded Sand (SP)
Shale
USCS Well-graded Sand (SW)

DRILLING COMPANY: Strata Earth Services, LLC
DRILLER: Scott Komen
DRILL RIG: Geoprobe 7822 DT

LOGGED BY: KB
CHECKED BY: KJ
DATE: 10/19/20

Golder Associates

BOREHOLE LOG: GAMW-17

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK: 38

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173164.442 E: 2970944.074
GROUND SURFACE ELEV.: 668.81
TOP OF CASING ELEV.: 671.93
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/25/2016
END DATE/TIME: 5/25/2016

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	FILL- SAND, GRAVEL, ORGANICS, trace fly ash/ boiler slag, trace silt		1	SS		1.6 / 2	0-1.1': SAND, organics, fine, poorly-graded; light brown; trace silt, dry, loose. (FILL) 1.1-2': SAND, fine, poorly-graded; light brown; trace fly ash, trace silt moist, loose. (FILL) SPTs (1-3-2-2)		Bentonite grout mix 0-1 ft-bgs Bentonite chips 1-3 ft-bgs
665.0			2	SS		0.9 / 2	5-6.6': SAND, fine, poorly-graded; light brown; trace silt, moist, loose. (FILL) 6.6-6.7': GRAVEL, fly ash/ boiler slag, angular, medium, well-graded; trace silt, loose. (FILL) 6.7-7': SAND, fine, poorly-graded; light brown; trace fly ash/ boiler slag, trace silt, moist, loose. (FILL) SPTs (3-7-3-5)		Filter Pack #5 Sand 3-15 ft-bgs 2 PVC Screen slot 0.010 5-15 ft-bgs
660.0	dark brown to grey fine SAND, trace iron oxides, trace organics, trace silt		3	SS		1.6 / 2	10-11.1': SAND, fine, well-graded; light brown to brown; trace organics, trace fly ash/boiler slag, trace silt, wet, loose. (FILL) 11.1-12': SAND, fine, poorly-graded; dark brown to grey; trace iron oxides, trace silt, wet, loose. (SP) SPTs (3-5-1-2)		
655.0									
650.0									
645.0									

LITHOLOGY LEGEND

Fill (made ground)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 55

LOGGED BY: HV
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-17B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 38
DEPTH TO BEDROCK: 38

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173164.838 E: 2970947.442
GROUND SURFACE ELEV.: 668.86
TOP OF CASING ELEV.: 670.60
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/25/2016 8:23:00 AM
END DATE/TIME: 5/25/2016 9:13:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	FILL- SAND, GRAVEL, ORGANICS, trace fly ash/ boiler slag, trace silt		1	SS		1.6 / 2	0-1.1': SAND, organics, fine, poorly-graded; light brown; trace silt, dry, loose. (FILL) 1.1-2': SAND, fine, poorly-graded; light brown; trace fly ash, trace silt moist, loose. (FILL) SPTs (1-3-2-2)		Bentonite grout mix 0-24 ft-bgs
665.0			2	SS		0.9 / 2	5-6.6': SAND, fine, poorly-graded; light brown; trace silt, moist, loose. (FILL) 6.6-6.7': GRAVEL, fly ash/ boiler slag, angular, medium, well-graded; trace silt, loose. (FILL) 6.7-7': SAND, fine, poorly-graded; light brown; trace fly ash/ boiler slag, trace silt, moist, loose. (FILL) SPTs (3-7-3-5)		
660.0	dark brown to grey fine SAND, trace iron oxides, trace organics, trace silt		3	SS		1.6 / 2	10-11.1': SAND, fine, well-graded; light brown to brown; trace organics, trace fly ash/boiler slag, trace silt, wet, loose. (FILL) 11.1-12': SAND, fine, poorly-graded; dark brown to grey; trace iron oxides, trace silt, wet, loose. (SP) SPTs (3-5-1-2)		
655.0			4	SS		1.8 / 2	15-17': SAND, fine, poorly-graded; dark brown to grey; trace organics, trace silt, wet, very loose. (SP) SPTs (1-2-2-3)		
650.0	dark brown fine to medium SAND, trace silt		5	SS		1 / 2	20-22': SAND, fine to medium, well-graded; dark brown; trace silt, wet, loose. (SW) SPTs (2-4-4-6)		
645.0									Bentonite chips 24-26 ft-bgs

LITHOLOGY LEGEND

Fill (made ground)

Shale

USCS Poorly-graded Sand (SP)

USCS Well-graded Sand (SW)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 55

LOGGED BY: HV
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

BOREHOLE LOG: GAMW-17B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 38
DEPTH TO BEDROCK: 38

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173164.838 E: 2970947.442
GROUND SURFACE ELEV.: 668.86
TOP OF CASING ELEV.: 670.60
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/25/2016 8:23:00 AM
END DATE/TIME: 5/25/2016 9:13:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	dark brown fine to medium SAND, trace silt		6	SS		1.6 / 2	25-27': SAND, fine to medium, well-graded; dark brown; trace silt, wet, very loose. (SW) SPTs (1-1-2-2)		Filter Pack #5 Sand 26-38 ft-bgs
640.0			7	SS		1.3 / 2	30-32': SAND, fine to medium, well-graded; dark brown; trace silt, wet, loose. (SW) 38': auger refusal in SHALE; dark grey to black. SPTs (3-4-4-5)		2 PVC Screen slot 0.010 28-38 ft-bgs
635.0									
	SHALE								
630.0									
625.0									
620.0									

LITHOLOGY LEGEND

Fill (made ground)
Shale
USCS Poorly-graded Sand (SP)
USCS Well-graded Sand (SW)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 55

LOGGED BY: HV
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

BOREHOLE LOG: GAMW-18

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK:

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2171919.782 E: 2971272.405
GROUND SURFACE ELEV.: 666.04
TOP OF CASING ELEV.: 669.07
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/24/2016 11:12:00 AM
END DATE/TIME: 5/24/2016 11:28:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	FILL- dark brown SAND, trace fly ash/ boiler slag, trace organics, trace silt		1	SS		2 / 2	0-2': SAND, fine to medium; poorly-graded; dark brown; trace fly ash/boiler slag, trace organics, trace silt, moist, loose. (FILL) SPTs (3-3-3-3)		Bentonite grout mix 0-1 ft-bgs Bentonite chips 1-3 ft-bgs Filter Pack #5 Sand 3-15 ft-bgs 2 PVC Screen slot 0.010 5-15 ft-bgs
660.0	brown fine SAND, trace silt		2	SS		2 / 2	5-6.1': SAND, fine to medium, poorly-graded; dark brown; trace fly ash/ boiler slag, trace organics, trace silt, moist, loose. (FILL) 6.1-7': SAND; fine, poorly-graded; brown; trace silt, moist, loose. (SP) SPTs (2-4-5-6)		
655.0			3	SS		1.3 / 2	10-12': SAND; fine, poorly-graded; brown; trace silt, wet, loose. (SP) SPTs (2-4-4-7)		
650.0									
645.0									

LITHOLOGY LEGEND

Fill (made ground)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Earth Exploration
DRILLER: Doug Carlson
DRILL RIG: CME 55

LOGGED BY: HV
CHECKED BY: JMR
DATE: 3/22/17

Golder Associates

BOREHOLE LOG: GAMW-18B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 36
DEPTH TO BEDROCK: 35

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2171910.003 E: 2971272.53
GROUND SURFACE ELEV.: 665.94
TOP OF CASING ELEV.: 668.45
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/26/2018 9:35:00 AM
END DATE/TIME: 7/26/2018 10:35:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	dark brown SILTY SAND, some organics			RS			0-1.7': SILTY SAND, well-graded, dark brown, some organics, dry. (SM)		Bentonite Grout 0-21 ft bgs
	orange to dark brown fine SAND, some silt			RS			1.7-2.3': SAND, fine, poorly-graded, orange to dark brown, some silt, moist. (SP)		
	light brown fine to medium SAND			RS			2.3-4.2': SAND, fine to medium, well-graded, light brown, moist. (SW)		
660.0				RS			5-7.4': SAND, fine to medium, well-graded, light brown, wet. (SW)		
	light brown fine CLAYEY SAND			RS			7.4-8.75': CLAYEY SAND, fine, poorly-graded, light brown, cohesive, wet. (SC)		
655.0				RS			10-13': CLAYEY SAND, fine, poorly-graded, light brown, cohesive, wet. (SC)		
	light brown to light gray fine to coarse SAND, trace to some gravel			RS			13-13.7': SAND, fine to coarse, well-graded, light brown, wet. (SW)		
				RS			13.7-14.8': SAND, medium to coarse, well-graded, light brown, some rounded gravel <1 inch, some fine sand, wet. (SW)		
650.0				RS			16-20': SAND, fine to coarse, well-graded, light brown, some rounded gravel <1 inch, wet. (SW)		
645.0				RS			20-23.7': SAND, medium to coarse, well-graded, light brown, some rounded gravel <1 inch, little fine sand, wet. (SW)		Bentonite Chips 21-23 ft bgs #5 Sand Filter Pack 23-35 ft bgs
				RS					

LITHOLOGY LEGEND

USCS Silty Sand (SM)
USCS Clayey Sand (SC)
USCS Poorly-graded Sand (SP)
Shale
USCS Well-graded Sand (SW)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/12/18

Golder Associates

BOREHOLE LOG: GAMW-18B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 36
DEPTH TO BEDROCK: 35

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2171910.003 E: 2971272.53
GROUND SURFACE ELEV.: 665.94
TOP OF CASING ELEV.: 668.45
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/26/2018 9:35:00 AM
END DATE/TIME: 7/26/2018 10:35:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	light brown to light gray fine to coarse SAND, trace to some gravel			RS			24-24.9': SAND, medium to coarse, well-graded, light brown, some rounded gravel <1 inch, some fine sand, wet. (SW)		2" PVC Screen slot 0.010 25-35 ft bgs
				RS			24.9-25.3': SAND, medium to coarse, well-graded, light gray, some rounded gravel <1 inch, trace fine sand, wet. (SW)		
							25.3-28': SAND, fine to coarse, well-graded, light gray, trace rounded gravel, wet. (SW)		
635.0				RS			28-32': SAND, fine to coarse, well-graded, light gray, trace rounded gravel, wet. (SW)		
			SB-18B-32'-34'	RS			32-33.75': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
	light gray SHALE			RS		2 / 1	35-35.5': SHALE, light gray, wet, little weathering.		#5 Sand 35-36 ft bgs
630.0	light gray clayey SHALE						35.5-36': CLAYEY SHALE, light gray, wet, little weathering.		
625.0									
620.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)
USCS Clayey Sand (SC)
USCS Poorly-graded Sand (SP)
Shale
USCS Well-graded Sand (SW)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/12/18

Golder Associates

BOREHOLE LOG: GAMW-46

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK: 31

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2178839.026 E: 2973531.388
GROUND SURFACE ELEV.: 661.99
TOP OF CASING ELEV.: 664.78
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/15/2018 4:00:00 PM
END DATE/TIME: 5/15/2018 4:20:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	dark brown fine SAND, some silt								
	light brown fine CLAYEY SAND		1	SS		1.7 / 2	0-0.3': SAND, fine, poorly-graded, dark brown, some silt, moist, loose. (SP) 0.3-1': CLAYEY SAND, fine, poorly-graded, light brown, moist, loose. (SC) 1-1.7': SAND, fine, poorly-graded, orange, moist, loose. (SP) SPTs (2-2-3-4)		Bentonite Chips 0-3 ft bgs
	light brown to orange fine to medium SAND								
660.0			2	SS		1.8 / 2	5-6.8': SAND, fine to medium, well-graded, light brown to orange, moist, loose. (SW) SPTs (2-2-3-4)		#5 Sand Filter Pack 3-15 ft bgs 2" PVC Screen slot 0.010 5-15 ft bgs
655.0									
	light brown to light gray fine to coarse SAND, trace rounded gravel		3	SS		1.4 / 2	10-11.4': SAND, fine to coarse, well-graded, light brown, wet, compact. (SW) SPTs (4-5-7-8)		
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

USCS Poorly-graded Sand (SP) | USCS Clayey Sand (SC) | USCS Well-graded Sand (SW)

DRILLING COMPANY: Earth Exploration
DRILLER: Jeff Silcox
DRILL RIG: CME 55

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/14/18

Golder Associates

BOREHOLE LOG: GAMW-46B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 32
DEPTH TO BEDROCK: 31

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2178838.974 E: 2973532.878
GROUND SURFACE ELEV.: 661.98
TOP OF CASING ELEV.: 664.77
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/15/2018 2:20:00 PM
END DATE/TIME: 5/15/2018 3:00:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	dark brown fine SAND, some silt								CETCO Grout 0-18 ft bgs
	light brown fine CLAYEY SAND		1	SS		1.7 / 2	0-0.3': SAND, fine, poorly-graded, dark brown, some silt, moist, loose. (SP) 0.3-1': CLAYEY SAND, fine, poorly-graded, light brown, moist, loose. (SC) 1-1.7': SAND, fine, poorly-graded, orange, moist, loose. (SP) SPTs (2-2-3-4)		
660.0	light brown to orange fine to medium SAND		2	SS		1.8 / 2	5-6.8': SAND, fine to medium, well-graded, light brown to orange, moist, loose. (SW) SPTs (2-2-3-4)		
655.0			3	SS		1.4 / 2	10-11.4': SAND, fine to coarse, well-graded, light brown, wet, compact. (SW) SPTs (4-5-7-8)		
650.0	light brown to light gray fine to coarse SAND, trace rounded gravel		4	SS		2 / 2	15-17': SAND, fine to coarse, well-graded, light brown, trace rounded gravel <1 inch, wet, compact. (SW) SPTs (2-4-7-6)		Bentonite Chips 18-20 ft bgs
645.0			5	SS		1.2 / 2	20-21.2': SAND, fine to coarse, well-graded, light gray, trace rounded gravel <1 inch, wet, compact. (SW) SPTs (8-10-9-10)		#5 Sand Filter Pack 20-32 ft bgs
640.0									2" PVC Screen slot 0.010 22-32 ft bgs

LITHOLOGY LEGEND

USCS Poorly-graded Sand (SP)
Shale
USCS Clayey Sand (SC)
USCS Well-graded Sand (SW)

DRILLING COMPANY: Earth Exploration
DRILLER: Jeff Silcox
DRILL RIG: CME 55

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/14/18

Golder Associates

BOREHOLE LOG: GAMW-46B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 32
DEPTH TO BEDROCK: 31

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2178838.974 E: 2973532.878
GROUND SURFACE ELEV.: 661.98
TOP OF CASING ELEV.: 664.77
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD:
DRILL RIG: CME 55
START DATE/TIME: 5/15/2018 2:20:00 PM
END DATE/TIME: 5/15/2018 3:00:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	light brown to light gray fine to coarse SAND, trace rounded gravel		6	SS		1 / 2	25-26': SAND, fine to coarse, well-graded, light gray, trace rounded gravel up to 2 inches, wet, compact. (SW) SPTs (7-7-8-10)		
635.0									
			7	SS		2 / 2	30-31': SAND, fine to coarse, well-graded, light gray, trace rounded gravel <1 inch, wet, loose. (SW) 31-32': CLAYEY SHALE, light gray, very soft from 31-31.5'. SPTs (3-3-3-4)		
	light gray clayey SHALE								
630.0									
625.0									
620.0									
615.0									

LITHOLOGY LEGEND

USCS Poorly-graded Sand (SP)
Shale
USCS Clayey Sand (SC)
USCS Well-graded Sand (SW)

DRILLING COMPANY: Earth Exploration
DRILLER: Jeff Silcox
DRILL RIG: CME 55

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/14/18

Golder Associates

BOREHOLE LOG: GAMW-52

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK: 39

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2175030.9 E: 2970079.13
GROUND SURFACE ELEV.: 664.07
TOP OF CASING ELEV.: 666.77
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/30/2018 2:00:00 PM
END DATE/TIME: 7/30/2018 2:20:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	brown to dark brown fine SILTY SAND			RS			0-1.5': SILTY SAND, fine, poorly-graded, brown to dark brown, dry. (SM)		Bentonite Chips 0-4 ft bgs
	light gray to light brown fine to coarse SAND			RS			1.5-4': SAND, fine to coarse, well-graded, light brown, moist. (SW)		
660.0				RS			4-8': SAND, medium to coarse, well-graded, light gray, wet. (SW)		#5 Sand Filter Pack 4-15 ft bgs 2" PVC Screen slot 0.010 5-15 ft bgs
655.0									
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)

USCS Well-graded Sand (SW)

DRILLING COMPANY: Layne
DRILLER: K. Fehrman
DRILL RIG: SDC500-28EA

LOGGED BY: TGB
CHECKED BY: KMC
DATE: 3/4/19

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 19/12/11

BOREHOLE LOG: GAMW-52B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 40
DEPTH TO BEDROCK: 39

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2175031.998 E: 2970073.234
GROUND SURFACE ELEV.: 664.5
TOP OF CASING ELEV.: 666.88
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/30/2018 11:30:00 AM
END DATE/TIME: 7/30/2018 12:20:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	brown to dark brown fine SILTY SAND			RS			0-1.5': SILTY SAND, fine, poorly-graded, brown to dark brown, dry. (SM)		Bentonite Grout 0-23 ft bgs
	light gray to light brown fine to coarse SAND			RS			1.5-4': SAND, fine to coarse, well-graded, light brown, moist. (SW)		
660.0				RS			4-8': SAND, medium to coarse, well-graded, light gray, wet. (SW)		
655.0									
650.0				RS			16-20': SAND, medium to coarse, well-graded, light gray, wet. (SW)		
645.0	light gray coarse SAND, some gravel			RS			20-22': SAND, coarse, poorly-graded, light gray, some rounded gravel <1 inch, wet. (SP)		
	gray fine to coarse SAND			RS			22-24': SAND, fine to coarse, well-graded, gray, wet. (SW)		Bentonite Chips 23-25 ft bgs
640.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)
Shale
USCS Well-graded Sand (SW)
USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: TGB
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

BOREHOLE LOG: GAMW-52B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 40
DEPTH TO BEDROCK: 39

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2175031.998 E: 2970073.234
GROUND SURFACE ELEV.: 664.5
TOP OF CASING ELEV.: 666.88
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/30/2018 11:30:00 AM
END DATE/TIME: 7/30/2018 12:20:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	gray fine to coarse SAND			RS			25-29': SAND, fine to coarse, well-graded, gray, wet. (SW)		#5 Sand Filter Pack 25-37 ft bgs
635.0				RS			30-34': SAND, fine to coarse, well-graded, gray, wet. (SW)		2" PVC Screen slot 0.010 27-37 ft bgs. Broke PVC in well; trouble with well floating so well is set 2 feet above top of shale.
630.0			SB-52B-35'-37'	RS			35-37': SAND, fine to coarse, well-graded, gray, wet. (SW)		
				RS			37-39': SAND, fine to coarse, well-graded, gray, wet. (SW)		#5 Sand 37-40 ft bgs
625.0	gray clayey SHALE			RS			CLAYEY SHALE, gray, wet.		
620.0									
615.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)
Shale
USCS Well-graded Sand (SW)
USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: TGB
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-53

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK: 36

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2174535.339 E: 2971036.469
GROUND SURFACE ELEV.: 664.68
TOP OF CASING ELEV.: 667.22
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/30/2018 10:30:00 AM
END DATE/TIME: 7/30/2018 10:40:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	FILL- dark brown SILTY SAND, some gravel			RS			0-1': SILTY SAND, well-graded, dark brown, some angular gravel <2 inch, dry. (FILL)		Bentonite Chips 0-4 ft bgs
	dark brown SILTY SAND			RS			1-2': SILTY SAND, well-graded, dark brown, dry. (SM)		
	light brown fine to medium SAND			RS			2-2.5': SAND, fine to medium, well-graded, light brown, dry. (SW)		
	dark brown fine SILTY SAND			RS			2.5-3': SILTY SAND, fine, poorly-graded, dark brown, dry. (SM)		
	light gray to gray fine to coarse SAND			RS			3-4': SAND, fine to medium, well-graded, light gray, moist. (SW)		
660.0				RS			4-5.75': SAND, fine to medium, well-graded, light gray, wet. (SW)		#5 Sand Filter Pack 4-15 ft bgs 2" PVC Screen slot 0.010 5-15 ft bgs
				RS			5.75-7': SAND, fine to coarse, well-graded, gray, wet. (SW)		
655.0									
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

Fill (made ground)

USCS Silty Sand (SM)

USCS Well-graded Sand (SW)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: TGB
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-53B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 37
DEPTH TO BEDROCK: 36

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2174536.542 E: 2971032.602
GROUND SURFACE ELEV.: 664.62
TOP OF CASING ELEV.: 667.27
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/30/2018 8:40:00 AM
END DATE/TIME: 7/30/2018 9:30:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	FILL- dark brown SILTY SAND, some gravel			RS			0-1': SILTY SAND, well-graded, dark brown, some angular gravel <2 inch, dry. (FILL)		Bentonite Grout 0-22 ft bgs
	dark brown SILTY SAND			RS			1-2': SILTY SAND, well-graded, dark brown, dry. (SM)		
	light brown fine to medium SAND			RS			2-2.5': SAND, fine to medium, well-graded, light brown, dry. (SW)		
	dark brown fine SILTY SAND			RS			2.5-3': SILTY SAND, fine, poorly-graded, dark brown, dry. (SM)		
	light gray to gray fine to coarse SAND			RS			3-4': SAND, fine to medium, well-graded, light gray, moist. (SW)		
660.0				RS			4-5.75': SAND, fine to medium, well-graded, light gray, wet. (SW)		
				RS			5.75-7': SAND, fine to coarse, well-graded, gray, wet. (SW)		
655.0									
650.0				RS			16-20': SAND, fine to coarse, well-graded, gray, wet. (SW)		
645.0				RS			20-22': SAND, fine to coarse, well-graded, gray, wet. (SW)		
	dark gray to black with black staining fine to coarse SAND			RS			22-24': SAND, fine to coarse, well-graded, dark gray to black with black staining, no odor, wet. (SW)		Bentonite Chips 22-24 ft bgs
640.0									#5 Sand Filter Pack 24-36 ft bgs

LITHOLOGY LEGEND

Fill (made ground)
Shale
USCS Silty Sand (SM)
USCS Well-graded Sand (SW)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: TGB
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

BOREHOLE LOG: GAMW-53B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 37
DEPTH TO BEDROCK: 36

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2174536.542 E: 2971032.602
GROUND SURFACE ELEV.: 664.62
TOP OF CASING ELEV.: 667.27
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/30/2018 8:40:00 AM
END DATE/TIME: 7/30/2018 9:30:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	dark gray to black with black staining fine to coarse SAND		SB-53B-25'-27'	RS			25-27': SAND, fine to coarse, well-graded, dark gray to black with black staining, no odor, wet. (SW)		2" PVC Screen slot 0.010 26-36 ft bgs
				RS			27-29': SAND, fine to coarse, well-graded, dark gray to black with black staining, no odor, wet. (SW)		
635.0	gray fine to coarse SAND, some gravel		SB-53B-30'-32'	RS			30-31': SAND, fine to coarse, well-graded, gray, some rounded gravel <2 inch, wet. (SW)		
630.0									
	gray SHALE			RS		3 / 1	36-37': SHALE, gray, weathered, wet.		#5 Sand 36-37 ft bgs
625.0									
620.0									
615.0									

LITHOLOGY LEGEND

Fill (made ground)
Shale
USCS Silty Sand (SM)
USCS Well-graded Sand (SW)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: TGB
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-54

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK: 32

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2174080.28 E: 2971911.363
GROUND SURFACE ELEV.: 663.87
TOP OF CASING ELEV.: 666.35
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/30/2018 7:40:00 AM
END DATE/TIME: 7/30/2018 8:00:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	dark brown fine SILTY SAND, some organics			RS			0-0.8': SILTY SAND, fine, well-graded, dark brown, some organics, moist. (SM)		Bentonite Chips 0-4 ft bgs
	light brown fine to medium SAND			RS			0.8-1.5': SAND, fine to medium, well-graded, light brown, moist. (SW)		
	dark brown fine SILTY SAND			RS			1.5-2.7': SILTY SAND, fine, well-graded, dark brown, cohesive, moist. (SM)		
	light gray fine to medium SAND			RS			2.7-3.3': SAND, fine to medium, well-graded, light gray, wet. (SW)		
660.0				RS			4-7.4': SAND, fine to medium, well-graded, light gray, wet. (SW)		#5 Sand Filter Pack 4-15 ft bgs 2" PVC Screen slot 0.010 5-15 ft bgs
655.0									
650.0									
645.0									
640.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)

USCS Well-graded Sand (SW)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-54B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 35
DEPTH TO BEDROCK: 32

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2174081.639 E: 2971906.899
GROUND SURFACE ELEV.: 663.98
TOP OF CASING ELEV.: 666.45
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/27/2018 10:10:00 AM
END DATE/TIME: 7/27/2018 10:40:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	dark brown fine SILTY SAND, some organics			RS			0-0.8': SILTY SAND, fine, poorly-graded, dark brown, some organics, moist. (SM)		Bentonite Grout 0-18 ft bgs
	light brown fine to medium SAND			RS			0.8-1.5': SAND, fine to medium, well-graded, light brown, moist. (SW)		
	dark brown fine SILTY SAND			RS			1.5-2.7': SILTY SAND, fine, poorly-graded, dark brown, cohesive, moist. (SM)		
	light gray fine to medium SAND			RS			2.7-3.3': SAND, fine to medium, well-graded, light gray, wet. (SW)		
660.0							4-7.4': SAND, fine to medium, well-graded, light gray, wet. (SW)		
				RS					
655.0									
650.0									
	light gray fine to coarse SAND, trace to some gravel						16-20': SAND, fine to coarse, well-graded, light gray, trace rounded gravel <1 inch, wet. (SW)		
				RS					Bentonite Chips 18-20 ft bgs
645.0									
							20-23.7': SAND, fine to coarse, well-graded, light gray, trace rounded gravel <1 inch, wet. (SW)		#5 Sand Filter Pack 20-32 ft bgs
				RS					2" PVC Screen slot 0.010 22-32 ft bgs
640.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM) | USCS Well-graded Sand (SW) | Shale

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-54B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 35
DEPTH TO BEDROCK: 32

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2174081.639 E: 2971906.899
GROUND SURFACE ELEV.: 663.98
TOP OF CASING ELEV.: 666.45
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/27/2018 10:10:00 AM
END DATE/TIME: 7/27/2018 10:40:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
635.0	light gray fine to coarse SAND, trace to some gravel		SB-54B-30'-32'	RS			30-31.8': SAND, medium to coarse, well-graded, light gray, some rounded gravel <2 inch, some fine sand, wet. (SW)		
630.0	light gray clayey SHALE			RS		7 / 3	32-34': CLAYEY SHALE, light gray, weathered. 34-35': CLAYEY SHALE, light gray, little weathering.		#5 Sand 32-35 ft bgs
625.0									
620.0									
615.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM) | USCS Well-graded Sand (SW) | Shale

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

BOREHOLE LOG: GAMW-55R

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK: 35

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173631.971 E: 2972230.541
GROUND SURFACE ELEV.: 665.36
TOP OF CASING ELEV.: 667.71
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 6/8/2019 11:45:00 AM
END DATE/TIME: 6/8/2019 12:30:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	dark brown fine SILTY SAND, some gravel			RS			0-0.8': SILTY SAND, fine, poorly-graded, dark brown, some rounded gravel up to 3 inch, trace organics, moist. (SM)		Bentonite Chips 0-4 ft bgs
				RS			0.8-2.2': SILTY SAND, fine, poorly-graded, dark brown, cohesive, moist. (SM)		
	light brown fine to medium SAND			RS			2.2-3.2': SAND, fine to medium, well-graded, light brown, moist. (SW)		
	light brown to light gray fine SAND, some silt			RS			3.2-3.75': SAND, fine, poorly-graded, light brown to light gray, some silt, cohesive, moist. (SP)		
	light brown fine to medium SAND			RS			4-4.9': SAND, fine to medium, well-graded, light brown, moist. (SW)		#5 Filter Pack Sand 4-15 ft bgs
660.0	light gray to light brown medium to coarse SAND, some fine sand, trace gravel			RS			4.9-6.8': SAND, medium to coarse, well-graded, light gray, some fine sand, trace rounded gravel <1 inch, wet. (SW) 6.8-6.9': SAND, medium, brown. (SP) 6.9-7.8': SAND, medium to coarse, well-graded, light gray, some fine sand, trace rounded gravel <1 inch, wet. (SW)		2" PVC Screen slot 0.010 5-15 ft bgs
655.0									
650.0									
645.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)

USCS Well-graded Sand (SW)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Layne
DRILLER: K. Fehrman
DRILL RIG: SDC500-28EA

LOGGED BY: ANB
CHECKED BY: KMC
DATE: 12/3/19

Golder Associates

BOREHOLE LOG: GAMW-55B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 36
DEPTH TO BEDROCK: 35

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173632.338 E: 2972222.718
GROUND SURFACE ELEV.: 665.18
TOP OF CASING ELEV.: 667.51
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/26/2018 1:00:00 PM
END DATE/TIME: 7/26/2018 1:35:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	dark brown fine SILTY SAND, some gravel			RS			0-0.8': SILTY SAND, fine, poorly-graded, dark brown, some rounded gravel up to 3 inch, trace organics, moist. (SM)		Bentonite Grout 0-21 ft bgs
				RS			0.8-2.2': SILTY SAND, fine, poorly-graded, dark brown, cohesive, moist. (SM)		
	light brown fine to medium SAND			RS			2.2-3.2': SAND, fine to medium, well-graded, light brown, moist. (SW)		
	light brown to light gray fine SAND, some silt			RS			3.2-3.75': SAND, fine, poorly-graded, light brown to light gray, some silt, cohesive, moist. (SP)		
	light brown fine to medium SAND			RS			4-4.9': SAND, fine to medium, well-graded, light brown, moist. (SW)		
660.0	light gray to light brown medium to coarse SAND, some fine sand, trace gravel			RS			4.9-6.8': SAND, medium to coarse, well-graded, light gray, some fine sand, trace rounded gravel <1 inch, wet. (SW) 6.8-6.9': SAND, medium, brown. (SP) 6.9-7.8': SAND, medium to coarse, well-graded, light gray, some fine sand, trace rounded gravel <1 inch, wet. (SW)		
655.0									
650.0				RS			16-18': SAND, medium to coarse, well-graded, light brown, some fine sand, trace rounded gravel <1 inch, wet. (SW)		
	light gray coarse SAND, some rounded gravel, some medium sand			RS			18-20.7': SAND, coarse, poorly-graded, light gray, some rounded gravel <1 inch, some medium sand, wet. (SP)		
645.0	light gray fine to coarse SAND			RS			20.7-21.5': SAND, fine to coarse, well-graded, light gray, wet. (SW)		Bentonite Chips 21-23 ft bgs #5 Sand Filter Pack 23-35 ft bgs

LITHOLOGY LEGEND

USCS Silty Sand (SM)
Shale
USCS Well-graded Sand (SW)
USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/16/19

BOREHOLE LOG: GAMW-55B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 36
DEPTH TO BEDROCK: 35

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173632.338 E: 2972222.718
GROUND SURFACE ELEV.: 665.18
TOP OF CASING ELEV.: 667.51
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/26/2018 1:00:00 PM
END DATE/TIME: 7/26/2018 1:35:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	light gray fine to coarse SAND			RS			25-29.2': SAND, fine to coarse, well-graded, light gray, wet. (SW)		2" PVC Screen slot 0.010 25-35 ft bgs
635.0	light gray fine to coarse SAND, some gravel		SB-55B-30'-32'	RS			30-32': SAND, fine to coarse, well-graded, light gray, some rounded gravel <2 inch, wet. (SW)		
				RS			32-33.2': SAND, fine to coarse, well-graded, light gray, some rounded gravel <2 inch, wet. (SW)		
630.0	light gray SHALE			RS			35-36': SHALE, light gray, dry, very weathered.		#5 Sand 35-36 ft bgs
625.0									
620.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)
Shale
USCS Well-graded Sand (SW)
USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

BOREHOLE LOG: GAMW-56

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 15
DEPTH TO BEDROCK: 35

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173343.43 E: 2972428.296
GROUND SURFACE ELEV.: 665.43
TOP OF CASING ELEV.: 667.89
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/27/2018 8:45:00 AM
END DATE/TIME: 7/27/2018 8:55:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	dark brown fine SILTY SAND, some gravel, some organics and debris			RS			0-0.7': SILTY SAND, fine, poorly-graded, dark brown, some rounded gravel up to 3 inch, some organics and debris, dry. (SM)		Bentonite Chips 0-4 ft bgs
				RS					
	light gray to brown fine to coarse SAND			RS			0.7-1.6': SILTY SAND, fine, poorly-graded, dark brown, cohesive, moist. (SM)		
				RS			1.6-2.4': SAND, fine to medium, well-graded, dark and light brown, moist. (SW)		
							2.4-3.1': SAND, fine to medium, well-graded, light gray, moist. (SW)		#5 Sand Filter Pack 4-15 ft bgs
				RS			5-5.4' SAND, fine to medium, well-graded, light gray, moist. (SW)		
660.0				RS			5.4-6.25': SAND, fine to medium, well-graded, light gray, wet. (SW)		2" PVC Screen slot 0.010 5-15 ft bgs
				RS			6.25-8.4': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
655.0				RS			10-13.8': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
650.0									
645.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)

USCS Well-graded Sand (SW)

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

NIPSCO RMSGS 1648171 - NIPSCO CCR RMSGS - WITH NON-CCR WELLS.GPJ GOLDER NH 2011.GDT 1/25/19

BOREHOLE LOG: GAMW-56B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 36
DEPTH TO BEDROCK: 35

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173343.227 E: 2972423.771
GROUND SURFACE ELEV.: 665.33
TOP OF CASING ELEV.: 667.80
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/27/2018 7:10:00 AM
END DATE/TIME: 7/27/2018 7:35:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	dark brown fine SILTY SAND, some gravel, some organics and debris			RS			0-0.7': SILTY SAND, fine, poorly-graded, dark brown, some rounded gravel up to 3 inch, some organics and debris, dry. (SM)		Bentonite Grout 0-21 ft bgs
				RS					
	light gray to brown fine to coarse SAND			RS			0.7-1.6': SILTY SAND, fine, poorly-graded, dark brown, cohesive, moist. (SM)		
				RS			1.6-2.4': SAND, fine to medium, well-graded, dark and light brown, moist. (SW)		
							2.4-3.1': SAND, fine to medium, well-graded, light gray, moist. (SW)		
660.0				RS			5-5.4' SAND, fine to medium, well-graded, light gray, moist. (SW)		
				RS			5.4-6.25': SAND, fine to medium, well-graded, light gray, wet. (SW)		
				RS			6.25-8.4': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
655.0				RS			10-13.8': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
650.0				RS			16-20': SAND, fine to coarse, well-graded, light gray, wet. (SW)		
645.0	light to dark gray fine to coarse SAND, trace to some gravel			RS			20-23.8': SAND, fine to medium, well-graded, light gray, some coarse sand, trace rounded gravel <1 inch, wet. (SW)		Bentonite Chips 21-23 ft bgs #5 Sand Filter Pack 23-35 ft bgs

LITHOLOGY LEGEND

USCS Silty Sand (SM) | USCS Well-graded Sand (SW) | Shale

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

BOREHOLE LOG: GAMW-56B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 36
DEPTH TO BEDROCK: 35

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2173343.227 E: 2972423.771
GROUND SURFACE ELEV.: 665.33
TOP OF CASING ELEV.: 667.80
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 7/27/2018 7:10:00 AM
END DATE/TIME: 7/27/2018 7:35:00 AM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	light to dark gray fine to coarse SAND, trace to some gravel			RS			25-28.25': SAND, fine to coarse, well-graded, light gray, trace rounded gravel <1 inch, wet. (SW)		2" PVC Screen slot 0.010 25-35 ft bgs
				RS			28.25-29': SAND, medium to coarse, well-graded, dark gray, some rounded gravel <1 inch, some fine sand. (SW)		
635.0			SB-56B-30'-32'	RS			30-31.75': SAND, fine to coarse, well-graded, light gray, trace rounded gravel <1 inch, wet. (SW) 31.75-32': SAND, medium to coarse, well-graded, dark gray, some rounded gravel <3 inch, trace fine sand, wet. (SW)		
				RS			32-33.2': SAND, medium to coarse, well-graded, dark gray, some rounded gravel <3 inch, trace fine sand, wet. (SW)		
630.0	light gray SHALE			RS		1.2 / 1	35-36': SHALE, light gray, moist, little weathering.		#5 Sand 35-36 ft bgs
625.0									
620.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM) | USCS Well-graded Sand (SW) | Shale

DRILLING COMPANY: Layne
DRILLER: K. Fahrman
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: KMC
DATE: 11/13/18

Golder Associates

BOREHOLE LOG: GAMW-63B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 33.5
DEPTH TO BEDROCK: 33.5

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2171969.161 E: 2971860.966
GROUND SURFACE ELEV.: 669.02
TOP OF CASING ELEV.: 668.74
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 6/7/2019 8:00:00 AM
END DATE/TIME: 6/7/2019 8:50:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	brown to gray fine to medium SILTY SAND			RS			0' to 1.75': SILTY SAND, fine, trace rounded gravel <1inch, brown, non-cohesive, moist, trace organics, poorly graded (SM).		Bentonite Grout 0-19 ft bgs
	gray fine to medium SAND			RS			3' to 4.75': SAND, fine to medium, some rounded gravel <1inch, light brown, trace coarse sand, well-graded (SW).		
665.0				RS			4.75' to 11': SAND, medium to coarse, light brown, some fine sand, wet, non-cohesive, well-graded (SW).		
660.0				RS			11' to 11.5': SAND, medium to coarse, trace rounded gravel <1cm, gray, wet, non-cohesive, well graded (SW)		
655.0				RS			15' to 21.3': SAND, fine to coarse, gray, wet, non-cohesive, well-graded (SW).		
650.0	gray fine to coarse SAND			RS			21.3' to 22.8': CLAYEY SAND, fine to coarse, trace rounded gravel <1", gray, wet, non-cohesive, well-graded (SW-SC).		Bentonite Chips 19-21 ft bgs #5 Sand Filter Pack 21-23 ft bgs
645.0				RS			22.8' to 23': SAND, fine to coarse, trace gravel rounded <1", gray, wet, non-cohesive, well-graded (SW).		2" PVC Screen slot 0.010 23-33 ft bgs

LITHOLOGY LEGEND

USCS Well-graded Sand with Silt (SW-SM)
Shale
USCS Well-graded Sand (SW)
USCS Well-graded Sand with Clay (SW-SC)

DRILLING COMPANY: Layne
DRILLER: M. Backhaus
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: AMH
DATE: 9/16/19

Golder Associates

BOREHOLE LOG: GAMW-63B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 33.5
DEPTH TO BEDROCK: 33.5

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2171969.161 E: 2971860.966
GROUND SURFACE ELEV.: 669.02
TOP OF CASING ELEV.: 668.74
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 6/7/2019 8:00:00 AM
END DATE/TIME: 6/7/2019 8:50:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	gray fine to coarse SAND			RS			25' to 31.75': SAND, fine to coarse, trace rounded gravel <1 inch, gray, wet, non-cohesive, well-graded (SW).		
640.0	gray CLAYEY SHALE			RS			33' to 33.5': CLAYEY SHALE, gray, weathered, soft		#5 Sand 33-33.5 ft bgs
635.0									
630.0									
625.0									
620.0									

LITHOLOGY LEGEND

USCS Well-graded Sand with Silt (SW-SM)
Shale
USCS Well-graded Sand (SW)
USCS Well-graded Sand with Clay (SW-SC)

DRILLING COMPANY: Layne
DRILLER: M. Backhaus
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: AMH
DATE: 9/16/19

Golder Associates

BOREHOLE LOG: GAMW-64B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 30.5
DEPTH TO BEDROCK: 31

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2171789.81 E: 2972174.664
GROUND SURFACE ELEV.: 664.42
TOP OF CASING ELEV.: 666.83
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 6/7/2019 11:30:00 AM
END DATE/TIME: 6/7/2019 12:10:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	dark brown fine SILTY SAND			RS			0' to 1': SILTY SAND, fine, dark brown, trace organics, moist, non-cohesive, poorly graded (SM).		Bentonite Grout 0-17 ft bgs
				RS			1' to 1.8': SILTY SAND, fine, trace rounded gravel <1", dark brown, moist, non-cohesive, poorly graded (SM).		
	light brown fine to medium SAND, some orange streaking			RS			1.8' to 2.8': SAND, fine to medium, light brown, some clay, some orange streaking, moist, cohesive, well-graded (SW-SC).		
				RS			2.8' to 3.75': SAND, fine to coarse, light brown, some orange streaking, wet, non-cohesive, well-graded (SW).		
660.0									
				RS			7' to 8.5': SAND, fine to medium, light brown, trace coarse sand, wet, non-cohesive, well-graded (SW).		
	gray fine CLAYEY SAND, some dark gray streaks			RS			8.5' to 9': CLAYEY SAND, fine, gray with dark gray streaks, wet, non-cohesive, poorly graded (SC).		
655.0				RS			9' to 10.25': CLAYEY SAND, fine, gray, with dark gray streaks, wet, non-cohesive, poorly graded (SC).		
	gray fine to coarse SAND						10.25' to 17.5': SAND, fine to coarse, gray, wet, non-cohesive, well-graded (SW).		
				RS					
650.0									Bentonite Chips 17-19 ft bgs
							17.5' to 23.75': SAND, medium to coarse, gray, some rounded gravel <1cm, trace fine sand, non-cohesive, wet, well-graded (SW).		
645.0									#5 Sand Filter Pack 19-31 ft bgs
				RS					2" PVC Screen slot 0.010 21-30.5 ft bgs
640.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)
Shale
USCS Well-graded Sand (SW)
USCS Poorly-graded Sand with Clay (SP-SC)

DRILLING COMPANY: Layne
DRILLER: M. Backhaus
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: AMH
DATE: 9/16/19

Golder Associates

BOREHOLE LOG: GAMW-64B

PROJECT: NIPSCO Schahfer
PROJECT NO.: 164-8171
HOLE DEPTH: 30.5
DEPTH TO BEDROCK: 31

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2171789.81 E: 2972174.664
GROUND SURFACE ELEV.: 664.42
TOP OF CASING ELEV.: 666.83
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: ROTOSONIC
CORING METHOD:
DRILL RIG: SDC500-28EA
START DATE/TIME: 6/7/2019 11:30:00 AM
END DATE/TIME: 6/7/2019 12:10:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	SAMPLE INFORMATION: Type	SAMPLE INFORMATION: PID (ppm)	SAMPLE INFORMATION: Soil Rec./Att. Or Core Rec. %	SAMPLE INFORMATION: Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
	gray fine to coarse SAND			RS			27' to 30.5': SAND, medium to coarse, gray, some rounded gravel <1cm, trace fine sand, non-cohesive, wet, well-graded (SW).		
635.0									
	gray CLAYEY SHALE			RS			30.5' to 31': CLAYEY SHALE, gray, slighty weathered, hard		#5 Sand 30.5-31 ft bgs
630.0									
625.0									
620.0									
615.0									

LITHOLOGY LEGEND

USCS Silty Sand (SM)
Shale
USCS Well-graded Sand (SW)
USCS Poorly-graded Sand with Clay (SP-SC)

DRILLING COMPANY: Layne
DRILLER: M. Backhaus
DRILL RIG: SDC500-28EA

LOGGED BY: DFS
CHECKED BY: AMH
DATE: 9/16/19

Golder Associates

BOREHOLE LOG: GAMW-68

PROJECT: NIPSCO LLC Schahfer
PROJECT NO.: 19121567
HOLE DEPTH: 18
DEPTH TO BEDROCK: N/A

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2168555.544 E: 2970328.36
GROUND SURFACE ELEV.: 665.95
TOP OF CASING ELEV.: 665.53
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD: N/A
DRILL RIG: Geoprobe 7822 DT
START DATE/TIME: 8/27/2020 3:25:00 PM
END DATE/TIME: 8/27/2020 6:00:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	brown fine SAND, some silt, trace organics light and dark brown fine SAND, trace organics		1	SS		1.8 / 2	0-0.5': (SP-SM) SAND, fine, some organics (roots), brown, non cohesive, dry, loose 0.5-1.5': (SP) SAND, fine, light dark, brown, non cohesive, moist, loose 1.5-1.8': (SP) SAND, fine, trace organics (roots), light and dark, brown, non cohesive, moist, loose SPTs (6-6-6-7)		Completed as flush mount Bentonite Chips 1-4 ft bgs
	orange and brown fine SAND light brown to brown fine to medium SAND		2	SS		1.4 / 2	2-2.5': (SP) SAND, fine, trace organics (roots), light and dark brown, non cohesive, moist, loose 2.5-2.8': (SP) SAND, fine, orange and brown, non cohesive, moist, loose 2.8-3.4': (SP) SAND, fine, light brown, non cohesive, moist, loose SPTs (3-3-4-3)		1/4" Coated Bentonite Pellets 4-6 ft bgs
660.0			3	SS		1.2 / 2			
			4	SS		1.2 / 2	4-5.2': (SP) SAND, fine to medium, light brown, non cohesive, moist, loose, wet at 4.4 ft-bgs SPTs (3-4-4-3)		#5 Sand Filter Pack 6-17 ft bgs 2" PVC Screen slot 0.010 7-17 ft bgs
			5	SS		1 / 2	6-7.2': (SP) SAND, fine to medium, light brown to brown, non cohesive, wet, compact SPTs (4-6-12-16)		
655.0			6	SS		1.6 / 2	8-9': (SP) SAND, fine to medium, trace coarse, brown, non cohesive, wet, compact SPTs (2-5-8-11) 10-11': (SP) SAND, fine to medium, some coarse sand and fine round gravel from 11 to 11.3 ft bgs; brown, non cohesive, wet, compact		
			7	SS		2 / 2	11.3-11.6': (SP) SAND, fine to medium, trace coarse, brown, non cohesive, wet, compact SPTs (4-7-8-11)		
			8	SS		0.7 / 2	12-14': (SP) SAND, medium, some fine and coarse sand, brown, non cohesive, wet, compact SPTs (3-7-10-12) 14-14.6': (SP) SAND, medium, some fine and coarse sand, trace fine-coarse subrounded gravel, brown, non cohesive, wet, compact		
650.0			9	SS		2 / 2	14.6-14.7': (SP) SAND, fine, brown, non cohesive, wet, compact SPTs (2-3-7-12)		Native sand collapsed to 17 ft bgs
							16-17.5': (SP) SAND, fine, some medium, brown, non cohesive, wet, loose 17.5-18': (SP) SAND, fine, brown, non cohesive, wet, compact SPTs (2-5-8-14)		
645.0									

LITHOLOGY LEGEND

USCS Poorly-graded Sand with Silt (SP-SM)

USCS Poorly-graded Sand (SP)

DRILLING COMPANY: Strata Earth Services, LLC
DRILLER: Scott Komen
DRILL RIG: Geoprobe 7822 DT

LOGGED BY: KMC
CHECKED BY: KJ
DATE: 10/19/20

Golder Associates

BOREHOLE LOG: GAMW-68B

PROJECT: NIPSCO LLC Schahfer
PROJECT NO.: 19121567
HOLE DEPTH: 34.7
DEPTH TO BEDROCK: 34.7

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2168557.418 E: 2970325.081
GROUND SURFACE ELEV.: 665.97
TOP OF CASING ELEV.: 665.72
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD: N/A
DRILL RIG: Geoprobe 7822 DT
START DATE/TIME: 8/26/2020 11:20:00 AM
END DATE/TIME: 8/27/2020 3:15:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
665.0	brown fine SAND, some silt, trace organics light and dark brown fine SAND, trace organics		1	SS		1.8 / 2	0-0.5': (SP-SM) SAND, fine, some organics (roots), brown, non cohesive, dry, loose 0.5-1.5': (SP) SAND, fine, light dark, brown, non cohesive, moist, loose 1.5-1.8': (SP) SAND, fine, trace organics (roots), light and dark, brown, non cohesive, moist, loose SPTs (6-6-6-7)		Completed as flush mount Bentonite chips 1-6 ft bgs
	orange and brown fine SAND light brown to brown fine to medium SAND		2	SS		1.4 / 2	2-2.5': (SP) SAND, fine, trace organics (roots), light and dark brown, non cohesive, moist, loose 2.5-2.8': (SP) SAND, fine, orange and brown, non cohesive, moist, loose 2.8-3.4': (SP) SAND, fine, light brown, non cohesive, moist, loose SPTs (3-3-4-3)		
660.0			3	SS		1.2 / 2			Cement Grout 6-20 ft bgs
			4	SS		1.2 / 2	4-5.2': (SP) SAND, fine to medium, light brown, non cohesive, moist, loose, wet at 4.4 ft-bgs SPTs (3-4-4-3)		
			5	SS		1 / 2	6-7.2': (SP) SAND, fine to medium, light brown to brown, non cohesive, wet, compact SPTs (4-6-12-16)		
655.0			6	SS		1.6 / 2	8-9': (SP) SAND, fine to medium, trace coarse, brown, non cohesive, wet, compact SPTs (2-5-8-11) 10-11': (SP) SAND, fine to medium, some coarse sand and fine round gravel from 11 to 11.3 ft bgs; brown, non cohesive, wet, compact		
			7	SS		2 / 2	11.3-11.6': (SP) SAND, fine to medium, trace coarse, brown, non cohesive, wet, compact SPTs (4-7-8-11)		
			8	SS		0.7 / 2	12-14': (SP) SAND, medium, some fine and coarse sand, brown, non cohesive, wet, compact SPTs (3-7-10-12)		
650.0			9	SS		2 / 2	14-14.6': (SP) SAND, medium, some fine and coarse sand, trace fine-coarse subrounded gravel, brown, non cohesive, wet, compact 14.6-14.7': (SP) SAND, fine, brown, non cohesive, wet, compact SPTs (2-3-7-12)		
			10	SS		2 / 2	16-17.5': (SP) SAND, fine, some medium, brown, non cohesive, wet, loose 17.5-18': (SP) SAND, fine, brown, non cohesive, wet, compact SPTs (2-5-8-14)		
	brown SILT and fine SAND brown to gray-brown fine to medium SAND, some coarse sand, trace fine gravel						18-19.4': (SP) SAND, fine to medium, brown, non cohesive, wet, loose 19.4-19.7': (ML/SP) SILT and SAND, fine, brown, non cohesive, wet, loose 19.7-20': (SP) SAND, fine to medium, brown-gray, non cohesive, wet, loose SPTs (2-4-4-7)		1/4" Coated Bentonite Pellets 20-22 ft bgs
645.0			11	SS		1.8 / 2			
			12	SS		2 / 2	20-21': (SP) SAND, fine to medium, brown-gray, non cohesive, wet, loose 21-21.8': (SW) SAND, fine to coarse, trace fine sub rounded gravel, gray-brown, non cohesive, wet, loose SPTs (2-1-2-7)		#5 Sand Filter Pack 22-34.5 ft bgs
			13	SS		2 / 2			2" PVC Screen slot

LITHOLOGY LEGEND

USCS Poorly-graded Sand with Silt (SP-SM)
Shale
USCS Poorly-graded Sand (SP)
USCS Silt (ML)

DRILLING COMPANY: Strata Earth Services, LLC
DRILLER: Scott Komen
DRILL RIG: Geoprobe 7822 DT

LOGGED BY: KMC
CHECKED BY: KJ
DATE: 10/19/20

Golder Associates

BOREHOLE LOG: GAMW-68B

PROJECT: NIPSCO LLC Schahfer
PROJECT NO.: 19121567
HOLE DEPTH: 34.7
DEPTH TO BEDROCK: 34.7

BOREHOLE LOCATION: Wheatfield, IN
COORDINATES: N: 2168557.418 E: 2970325.081
GROUND SURFACE ELEV.: 665.97
TOP OF CASING ELEV.: 665.72
DATUM: Indiana West Zone NAD 83

DRILLING METHOD: Hollow-stem auger
CORING METHOD: N/A
DRILL RIG: Geoprobe 7822 DT
START DATE/TIME: 8/26/2020 11:20:00 AM
END DATE/TIME: 8/27/2020 3:15:00 PM

Depth Elev.	LITHOLOGY DESCRIPTION	Graphical Log	SAMPLE INFORMATION: Sample No. Or Run No.	Type	PID (ppm)	Soil Rec./Att. Or Core Rec. %	Soil Sample Description Or Discontinuity Data (Depth, Dip, Angle From Core Axis, Type, and Surface Description)	Well Graphic	Well Construction Information
640.0	brown to gray-brown fine to medium SAND, some coarse sand, trace fine gravel		13	SS		2 / 2	22-22.8': (SW) SAND, fine to coarse, trace fine sub rounded gravel, gray-brown, non cohesive, wet, loose		0.010 24.5-34.5 ft bgs
			14	SS		2 / 2	22.8-23.4': (SP) SAND, fine to medium, some coarse sand, trace fine rounded gravel, brown, non cohesive, wet, compact		
			15	SS		2 / 2	23.4-24': (SP) SAND, fine to medium, trace coarse sand, trace fine rounded gravel, gray-brown, non cohesive, wet, compact SPTs (5-12-15-16)		
635.0			16	SS		1.5 / 2	24-26': (SP) SAND, fine to medium, trace coarse sand, trace fine sub rounded gravel, gray-brown, non cohesive, wet, compact SPTs (4-9-16-16)		
			17	SS		1.5 / 2	26-26.3': (SW) SAND, fine to coarse, gray-brown, non cohesive, wet, loose 26.3-28': (SP) SAND, fine to medium, some coarse sand, trace fine rounded gravel, non cohesive, wet, compact to dense SPTs (7-14-19-21)		
	slightly weathered, weak, friable light gray SHALE		18	SS		0.7 / 0.7	28-30': (SP) SAND, fine to medium, some coarse sand, trace fine rounded gravel, non cohesive, wet, compact to dense SPTs (9-14-22-19)		
630.0							30-31.5': (SW) SAND, fine to coarse, trace fine rounded gravel, gray-brown, non cohesive, wet, loose. Increasing grain size with depth SPTs (2-3-4-10)		
							32-33.5': (SP) SAND, medium, some fine, some coarse sand, non cohesive, wet, compact SPTs (6-8-13-23)		
625.0							34-34.5': (SP) SAND, medium, some fine, some coarse sand, non cohesive, wet, compact 34.5-34.7': Slightly weathered, weak, friable light gray shale		
620.0									

LITHOLOGY LEGEND

USCS Poorly-graded Sand with Silt (SP-SM)
Shale
USCS Poorly-graded Sand (SP)
USCS Silt (ML)

DRILLING COMPANY: Strata Earth Services, LLC
DRILLER: Scott Komen
DRILL RIG: Geoprobe 7822 DT

LOGGED BY: KMC
CHECKED BY: KJ
DATE: 10/19/20

Golder Associates

APPENDIX B

Sampling Analysis Plan

APPENDIX B

SAMPLING AND ANALYSIS PLAN

R. M. Schahfer Generating Station
Material Storage Runoff Basin, Metal Cleaning Waste Basin, and Drying Area

Submitted to:

Northern Indiana Public Service Company LLC
801 East 86th Avenue
Merrillville, IN 46410

Submitted by:

WSP USA Inc.
10 Al Paul Lane, Suite 103
Merrimack, New Hampshire 03054

+1 603 668 0880

GL21508844

March 2023

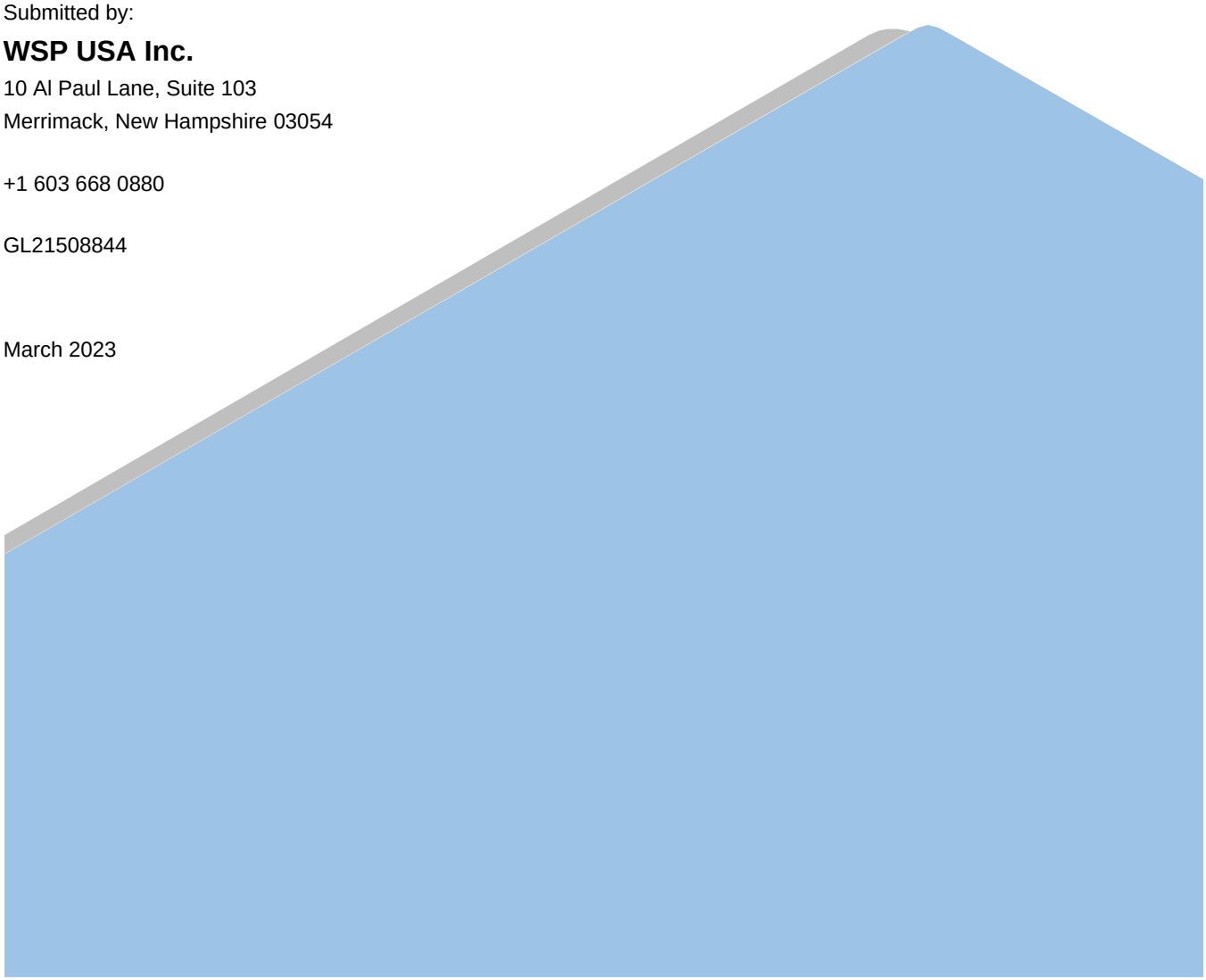


Table of Contents

TABLES

ATTACHMENTS

1.0 INTRODUCTION

1.1 Background

Northern Indiana Public Service Company LLC (NIPSCO) plans to close by removal three surface impoundments at the R. M Schahfer Generating Station (RMSGS) located in Wheatfield, Indiana including the Material Storage Runoff Basin (MSRB), Metal Cleaning Waste Basin (MCWB), and the Drying Area (herein referred to collectively as the CCR Unit). WSP USA Inc. (WSP), formerly Golder Associates USA Inc. (Golder), prepared this Sampling and Analysis Plan (SAP) on behalf of NIPSCO to address the monitoring requires as part of the Corrective Action Monitoring and associated quality assurance (QA) to assess post-closure groundwater quality. This document has been appended to the Corrective Action Groundwater Monitoring Program Plan dated March 2023 prepared by WSP. This SAP should be used in conjunction with the Quality Assurance Project Plan (QAPP) prepared by WSP for the Corrective Action Groundwater Monitoring Program Plan.

2.0 GROUNDWATER SAMPLING AND ANALYSIS

2.1 Sampling Goal, Personnel, Approach, and Controls

NIPSCO's overall goals of the groundwater monitoring program are a) the collection of representative samples that achieve data quality objectives, and b) when the analytical results are evaluated statistically, they allow for accurate and early detections of impacts, if any, to groundwater quality as a result of a verified release from the regulated unit or units being monitored. The collection of samples by qualified, consistent field staff familiar with both program requirements and the specifics of the monitoring network represent a key component and serve as a quality control function that allows the achievement of these program goals.

WSP's groundwater sampling team consists of experienced individuals that perform the work in accordance with generally accepted practices within the industry, applicable provisions of the IDEM Remediation Closure Guide (RCG – revised March 2020 edition), and the Standard Operating Procedures (SOPs) discussed herein. The following sections, which are consistent with USEPA low-flow sampling guidance and the requirements of the CCR Rule, outline the program sample collection procedures. Although this section provides reference to specific forms, the use of other equivalent forms to record the necessary data may be substituted so long as the same basic requirements are met.

2.2 Sampling Order

Each monitoring well is equipped with dedicated bladder pump; therefore, the use of dedicated pumps, combined with specific field techniques that address sample collection procedures, reduce the likelihood of cross-contamination and associated effects on samples. Accordingly, the routine sampling order typically follows a sequence based on consideration of field conditions (e.g., access, individual well recharge rates at the time of sampling, potential or actual weather impacts), not necessarily a simple default approach of sampling background locations prior to any downgradient locations.

2.3 Assessment of Monitoring Well and Piezometer Condition

The monitoring wells are being operated and maintained so they perform to their design specifications throughout the life of the monitoring program. Piezometers will be subject to the same requirements as monitoring wells. During each sampling event, all wells subject to monitoring, including those for which measurement of water levels is the only scheduled activity, are located and their identity confirmed. Prior to performing any water level measurements, purging, or sampling, each monitoring well is visually inspected to assess its integrity. The condition of each monitoring well, including protective bollards, protective steel casings or road boxes, operation

and security of locks, concrete pads, PVC casing, and inner cap is assessed for any physical damage or other breach that may indicate compromised integrity. The results of the well inspections are documented in the comments section of the field sampling forms and/or in field notebooks. In addition, any indications of significant damage, tampering, etc. are promptly reported to NIPSCO environmental compliance management personnel for appropriate follow-up action. Necessary repairs, other than replacement, will be completed within 10 days of discovery unless otherwise approved by IDEM.

2.4 Equipment Calibration

Equipment used to record field water quality parameters is calibrated each day prior to use. Calibrations are performed following manufacturers' recommendations and, at a minimum, re-checked at the end of each day. Calibration solutions for standardization materials are freshly prepared or taken from non-expired stock. In the absence of manufacturer specifications or regulatory guidance, field equipment is calibrated to within +/- 10 percent of the standard (or 0.1 standard units for pH meters), if possible. Equipment that fails calibration may not be used until repaired and calibrated or replaced. Calibration data are recorded in the field and records are maintained as part of the permanent project file. A sample field Instrument Calibration Form is included in Attachment A.

2.5 Water Level Gauging

Static water levels are measured in each monitoring well prior to purging using an electronic meter accurate to 0.01 foot. Measurements are obtained from the surveyed measuring point on each well. To the extent feasible, these measurements are taken within a 24-hour period Site-wide. Data are recorded on the Record of Water Level Readings form or Groundwater Sample Collection form, examples of which are included in Attachment A.

Prior to initial use and between wells, the portion of the water level indicator that contacts groundwater in the well is decontaminated to avoid cross-contamination between monitoring wells. In addition to decontaminating the downhole equipment, sampling personnel don new gloves between wells, and more frequently as needed, to reduce the potential for cross-contamination.

2.6 Pre-sample Well Purging

WSP follows USEPA low-flow sampling protocols to collect the groundwater samples. Low-flow sampling is advantageous because it can greatly reduce the volume of water that must be purged from a well before representative samples can be collected, and typically provides for the collection of more representative samples than do other purge methods, as well as consistency in analytical results between sampling events. Low-flow sampling is accomplished using dedicated low-flow bladder pumps.

Purging is targeted at a rate equal to the well yield to avoid drawing stagnant well column water into the pump (i.e., between 100 and 500 milliliters per minute). During the well purge activities, the flow rate and the depth to groundwater is typically monitored on regular intervals (every 3 to 5 minutes) to verify that the purge activities are not removing stagnant water from the water column in the monitoring well. Stabilization of the water column is considered achieved when three consecutive water level measurements vary by 0.3 foot or less at a pumping rate of no more than 500 ml/min.

Depth to water and field water quality parameter measurements are made during purging on approximate 3- to 5-minute intervals. If a field meter equipped with a flow cell is used, the volume of the flow cell is purged between field measurements. Stabilization is attained, and purging deemed complete when three consecutive measurements of each field parameter vary within the following ranges:

- Temperature: +/- 10% - Degrees Celsius
- pH: +/- 0.1 - Standard Units
- Conductivity: +/- 3% - milliSiemens
- ORP: +/- 10 mV - millivolt
- DO: +/- 10% (or +/- 0.1 mg/L if less than 1.0 mg/L) – milligrams per liter
- Turbidity: Less than 5 Nephelometric Turbidity Units (NTU)

All data gathered during monitoring well purging are recorded on a Groundwater Sample Collection form. Field personnel manage purge water generated during sampling activities in consultation with NIPSCO environmental compliance management personnel.

If dedicated equipment malfunctions during a sampling event, non-dedicated equipment may be used to collect a groundwater sample, provided the pump is decontaminated prior to use in each well. The pump and associated discharge hoses will be decontaminated using a non-phosphate-based detergent and water mixture followed by a deionized water rinse to avoid cross-contamination between monitoring wells as provided in the Section 2.10.

2.7 Sample Collection

Once the water quality field measurement data indicate that purging activities have been successfully completed, required samples are collected directly from the discharge line on the dedicated, low-flow pump into laboratory-provided, pre-preserved sample containers selected for the required parameters or compatible parameters (e.g., all metals samples are collected in one bottle). Sample collection is performed at the same rate (or lower) than was used during the well purging process. Sample containers are kept closed until the time each set of sample containers is to be filled. Groundwater samples collected as part of the monitoring program are not filtered prior to analysis. Groundwater samples are collected in the designated size and type of containers required for specific parameters. Sample containers are filled in such a manner as to prevent loss of preservatives due to spilling or overfilling. The parameters sampled for is provided in Table 1 and the analytical methods and practical quantitation limits (PQLs) associated with these parameters are provided in Table 2. Planned sample containers, minimum volumes, chemical preservatives, and holding times for each analyte are provided in Table 3. These may change depending on laboratory requirements and will be verified by the field team prior to each sampling event.

2.8 Sample Preservation and Handling

Upon obtaining the groundwater samples, they are packed into insulated, ice-filled coolers that are kept closed unless contents are being removed or added. Sample preservation methods including chemical addition, refrigeration, and protection from light are used to retard biological action, retard hydrolysis, and reduce sorption effects. Samples are kept at no more than 6°C from collection to laboratory delivery. Samples are delivered directly to the laboratory or sent via overnight courier following chain-of-custody (COC) procedures.

2.9 Chain-of-Custody Program

The COC program allows for tracing and documenting sample possession and handling from the time of field collection through laboratory analysis. The COC program includes sample labels, sample seals, field Groundwater Sample Collection forms, and the COC record. Each sample is assigned a unique sample identification number

to be recorded on the sample label. Each sample identification number and description are recorded on the field Groundwater Sample Collection form and on the COC document.

The intent of this SOP is to provide guidance to maintain sample integrity. The chain-of-custody form provides evidence and documentation of sample collection, shipment, laboratory receipt, and laboratory custody until disposal of the sample. The chain-of-custody form identifies each sample collected and the individuals responsible for sample collection, shipment, and receipt.

Once collected, samples are in one's custody if they are: (1) in the custodian's possession or view; (2) in a secured location (under lock) with restricted access; or (3) in a container that is secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s).

2.9.1 Responsibilities

Field personnel who collect the samples are responsible to initiate the chain-of-custody protocol. Upon sample collection, but prior to storage, shipment, or transportation, field personnel shall properly and completely fill out the chain-of-custody form with a waterproof ink pen. The Field Team Leader shall review the form prior to sample storage, shipment, or transportation. If an individual makes an error during the completion of the chain-of-custody form, a line shall be drawn through the error and the correction entered. Field personnel completing the form shall initial and date the error. Under no circumstances is white-out or erasing acceptable. Field sampling personnel are responsible for making a copy of the completed chain-of-custody form and giving the form to the WSP Project Manager. The WSP Quality Assurance Manager or designee shall review the form and place it in the project file with the field sampling forms. Upon receipt by the laboratory, the laboratory sample custodian shall assume responsibility for completing the chain-of-custody procedures. Upon completion of analysis, the laboratory shall submit a copy of the completed chain-of-custody form with the analytical data to the Project Manager who will place it in the project file.

Equipment Description

- Chain-of-custody forms
- A waterproof ink pen

2.9.2 Procedures

Field personnel shall use a waterproof ink pen to complete the chain-of-custody forms. Preparation of the chain-of-custody form includes:

- Complete the chain-of-custody form by entering the project name, client name, laboratory name and address, the person to whom the chemical analyses results shall be reported, and invoicing information at the top of the form. An example Chain-of-custody form is provided as Attachment A.
- COC(s) will be completed and sent with the samples for each shipment.
- Sample-specific information shall include the field identification number, the date and time the sample is collected, the depth at which the sample was taken, the type of sample (e.g., groundwater), the type of analyses requested, and preservatives used. Samples shall be grouped for shipment with other samples for similar analysis and use a common form. More than one chain-of-custody form shall be used if the number of samples placed in a cooler is greater than the number of entry spaces on the chain-of-custody form.

- The COC record will identify the contents of each shipment and maintain the custodial integrity of the samples. A locked seal will be placed across the front and back of each cooler containing samples when coolers are ready for shipment. All custody seals will be signed and dated. The chain-of-custody form will be cross-checked for errors and signed.
- Each person taking possession of the samples shall sign and date the chain-of-custody both as a recipient and as a relinquisher of the samples. When the samples are delivered to the laboratory, the laboratory sample custodian will sign the chain-of-custody as the last recipient of the samples.
- If the samples are directly transported to the laboratory, the chain-of-custody shall be kept in the possession of the person delivering the samples. Upon receipt by the laboratory, the sample receiver(s) shall open the shipping containers, compare the contents with the chain-of-custody form, and sign and date the form. Any discrepancies shall be noted on the chain-of-custody form and the Project Manager notified immediately.
- Prior to shipment by a commercial carrier, make a copy of the chain-of-custody form. If the samples are delivered directly to the laboratory by field personnel, a copy of the form shall be made after the laboratory representative signs and dates the chain-of-custody form.
- Chain-of-custody forms shall be maintained with the analytical data.

2.9.3 Sample Labels

Sample labels sufficiently durable to remain legible when wet contain the following information, written with indelible ink:

- Site and sample identification number
- Monitoring well number or other location
- Date and time of collection
- Name of collector
- Parameters to be analyzed
- Preservative, if applicable

Sample names are unique between sampling events. Sample names are in the format Well ID-MMDDYY such that MMDDYY is the sample date with two digits for the month, day, and year. No spaces or underscores are allowed in sample IDs. The date does not contain any dashes or underscores.

2.9.4 Sample Seal

The shipping container is sealed to prevent the samples from being disturbed during transport to the laboratory. A seal is placed across the front and back of each cooler containing samples when coolers are ready for shipment. All custody seals are signed and dated.

2.9.5 Field Forms

All field information is completely and accurately documented to become part of the final report for the groundwater monitoring event. Equipment calibration readings are included on field forms. Example field forms are included in Attachment A. The field forms document the following information:

- Identification of the monitoring well
- Sample identification number
- Field meter calibration information
- Static water level depth
- Purge volume
- Time monitoring well was purged
- Date and time of collection
- Parameters requested for analysis
- QA/QC samples, if collected
- Preservative used
- Field water quality parameter measurements
- Water levels recorded during low-flow purge
- Field observations on sampling event
- Name of collector(s)
- Weather conditions including air temperature and precipitation

The COC record is required for tracking sample possession from time of collection to time of receipt at the laboratory. The National Enforcement Investigations Center (NEIC) of USEPA considers a sample to be in custody under any of the following conditions:

- It is in the individual's possession
- It is in the individual's view after being in his possession
- It was in the individual's possession and he/she locked it up
- It is in a designated secure area

All environmental samples are handled under strict COC procedures beginning in the field. The Field Team Leader is the field sample custodian, responsible for ensuring that COC procedures are followed. A COC record accompanies each individual shipment. The record contains the following information:

- Sample destination and transporter
- Sample identification numbers
- Signature of collector
- Date and time of collection
- Sample type

- Identification of monitoring well
- Number of sample containers in shipping container
- Parameters requested for analysis
- Signature of person(s) involved in the chain of possession
- Inclusive dates of possession

A copy of the completed COC form is placed in a water-resistant bag, accompanies the shipment, and is returned to the shipper after the shipping container reaches its destination. The COC record is also used as the analysis request sheet. When shipping by courier, the courier does not sign the COC record: copies of shipping forms are retained to document custody.

2.10 Field Equipment Decontamination

Field personnel will use the procedures in this section to decontaminate all non-dedicated monitoring equipment (e.g., field water quality meter and water level meter) to collect field water quality measurements. The procedures include:

1) Clean with tap water and soap (e.g., Alconox) using a brush to remove obvious particulate matter and surface films;
2) Rinse thoroughly with tap water; and
3) Rinse thoroughly with deionized or distilled water.

3.0 ANALYTICAL AND QUALITY CONTROL PROCEDURES

3.1 Analytical Methods

NIPSCO proposes a monitoring parameter list appropriate to the site environmental and geological background conditions; Site investigation findings; surface impoundment waste management history; and current monitoring provisions of the CCR Rule and 329 IAC, Article 10, Rule 9. From the perspective of evaluating potential post-closure impacts to water quality, the results generated from this approach will be amenable to applying statistical-based (e.g., intra-well or inter-well) or standards-based comparisons. Consistent with the CCR Rule monitoring requirements and the Corrective Action Groundwater Monitoring Plan and subsequent supporting documents, the post-closure monitoring parameter list will include:

Field-based water quality parameters	pH, specific conductance, temperature, turbidity, oxidation-reduction potential
40 CFR, Part 257 Appendix III Detection Monitoring Parameters	Boron, calcium, chloride, fluoride, sulfate, total dissolved solids, pH
40 CFR, Part 257 Appendix IV Assessment Monitoring Parameters	Antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, radium 226 and 228 (combined)
Additional Monitored Natural Attenuation Parameters	Iron, manganese, magnesium, potassium, sodium, nitrate, phosphate, phosphorus, and total alkalinity

3.2 Data Quality Objectives

As part of the evaluation component of the Quality Assurance (QA) program, analytical results are evaluated for precision, accuracy, representativeness, completeness, and comparability (PARCC). These are defined as follows:

- Precision is the agreement or reproducibility among individual measurements of the same property, usually made under the same conditions
- Accuracy is the degree of agreement of a measurement with the true or accepted value
- Representativeness is the degree to which a measurement accurately and precisely represents a characteristic of a population, parameter, or variations at a sampling point, a process condition, or an environmental condition
- Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions
- Comparability is an expression of the confidence with which one data set can be compared with another data set regarding the same property

The accuracy, precision and representativeness of data will be functions of the sample origin, analytical procedures, and the specific sample matrices. Quality Control (QC) practices for the evaluation of these data quality indicators include the use of accepted analytical procedures, adherence to hold time, and analysis of QC samples (e.g., blanks, replicates, spikes, calibration standards, and reference standards).

Quantitative QA objectives for precision and accuracy, along with sensitivity (detection limits) are established in accordance with the specific analytical methodologies, historical data, laboratory method validation studies, and laboratory experience with similar samples. The representativeness of the analytical data is a function of the procedures used to process the samples (see the full QAPP in Appendix C).

Completeness is a qualitative characteristic which is defined as the fraction of valid data obtained from a measurement system (e.g., sampling and analysis) compared to that which was planned. Completeness can be less than 100 percent due to poor sample recovery, sample damage, or disqualification of results, which are outside of control limits due to laboratory error or matrix-specific interferences. Completeness is documented by including sufficient information in the laboratory reports to allow the data user to assess the quality of the results. The overall completeness goal for each task is difficult to determine prior to data acquisition. For this project, all reasonable attempts will be made to attain 90% completeness or better (laboratory).

Comparability is a qualitative characteristic, which allows for comparison of analytical results with those obtained by other laboratories. This may be accomplished using standard accepted methodologies, traceability of standards to the National Bureau of Standards (NBS) or USEPA sources, use of appropriate levels of quality control, reporting results in consistent, standard units of measure, and participation in inter-laboratory studies designed to evaluate laboratory performance.

Data quality and the standard commercial report package will be evaluated with respect to PARCC criteria using the laboratory's QA practices, use of standard analytical methods, certifications, participation in inter-laboratory studies, temperature control, adherence to hold times, and COC documentation following the data quality assessment procedures (also frequently referred to Data Validation) described herein. The laboratory QC control

limits in place at the time of sample analysis, which are routinely re-evaluated following the procedures in the laboratory quality assurance policies and the requirements of the analytical methods, will be used as the quantitative QC criteria.

3.3 Quality Assurance/Quality Control Samples

This section describes the various Quality Assurance/Quality Control (QA/QC) samples that are collected in the field and analyzed in the laboratory and the frequency at which they will be performed.

3.3.1 Field Equipment Rinsate Blanks

In situations where sampling equipment is not dedicated or disposable, an equipment rinsate blank is collected. The equipment rinsate blanks are prepared in the field using laboratory-supplied analyte-free water. The water is poured over and through each type of sampling equipment following decontamination and submitted to the laboratory for analysis of target constituents. One rinsate blank is collected for every 10 samples, if needed (e.g., equipment malfunction requires use of different, non-dedicated bladder pump).

3.3.2 Field Duplicates

Field duplicates are collected by sampling the same location twice, but the field duplicate is assigned a unique sample identification number. Samplers document which location is used for the duplicate sample. One field duplicate is collected for every 10 samples.

Field duplicate samples are given a unique sample ID in the form FDNN-MMDDYY where NN is a sequential number for the event and MMDDYY is the sample date with two digits for the month, day, and year. The field duplicate sample is submitted with a generic sampling time of 12:00 so that the sample time cannot be used to deduce the sampling location. The location where the field duplicate sample is collected is recorded on both the field form and in the field notebook.

3.3.3 Field Blank

Field blanks are also collected as part of the field sampling QA/QC program. The purpose of the field blank is to detect any contamination that might be introduced into the groundwater samples through the air or through sampling activities.

Field blanks are prepared in the field (at the sampling site) using laboratory-supplied bottles and deionized or laboratory reagent-quality water. Each field blank is prepared by pouring the deionized water into the sample bottles at the location of one of the wells in the sampling program. Preservatives are added to specific sample bottles as required. The well at which the field blank is prepared is identified on the Field Log along with any observations that may help explain anomalous results (e.g., prevailing wind direction, up-wind potential sources of contamination). Once a field blank is collected, it is handled and shipped in the same manner as the rest of the samples.

Field blank results are reported in the laboratory results as separate samples, using the designation FBNN-MMDDYY where NN is a sequential number for the event and MMDDYY is the sample date with two digits for the month, day, and year. One field blank is collected for every 10 samples.

3.3.4 Laboratory Quality Control Samples

NIPSCO selected Pace Analytical Services (Pace), a national laboratory, to analyze the groundwater samples. Pace's Indianapolis, Indiana and Pittsburgh, Pennsylvania laboratories analyze the metals/anions/total dissolved

solids, and radium 226/228, respectively. Pace has an established QC check program using procedural (method) blanks, laboratory control spikes, matrix spikes, and duplicates. Details of the internal QC checks used by Pace are found in the laboratory Quality Assurance Manual (QAM) and the published analytical methods. These QC samples are used to determine if results may have been affected by field activities or procedures used in sample transportation or if matrix interferences are an issue. One (1) Matrix Spike (MS)/ Matrix Spike Duplicate (MSD) set (i.e., one sample plus one MS, and one MSD sample at one location) is collected per 20 samples. MS/MSD samples have a naming convention as follows:

- Sample: GAMW-01-MMDDYY
- MS: GAMW-01-MS-MMDDYY
- MSD: GAMW-01-MSD-MMDDYY

3.4 Laboratory Quality Control Procedures

Pace adheres to a quality assurance program that complies with the National Environmental Laboratory Accreditation Conference (NELAC) program, which is documented in their QAM. This document describes mechanisms employed by Pace that yield reported that data meet or exceed applicable EPA and State requirements. The QAM describes the laboratory's experience, its organizational structure, and procedures in place to provide quality analytical data. The QAM outlines the sampling, analysis, and reporting procedures used by the laboratory. Pace is responsible for the implementation of and adherence to the QA/QC requirements outlined in the QAM. Copies of Pace's QAMs (Indianapolis, Indiana and Pittsburgh, Pennsylvania laboratories) are provided in the QAPP.

Audits are an important component of the quality assurance program at the laboratory. Internal system and performance audits are conducted periodically to ensure adherence by all laboratory departments to the QAM. External audits are conducted by accrediting agencies or states. These reports are transmitted to department managers for review and response. Pace will take corrective measures for any finding or deficiency found in an audit per their accreditation requirements.

Data Quality Reviews (DQRs), or equivalent, are requests submitted to the laboratory to formally review results that differ from historical results, or that exceed certain permit requirements or quality control criteria. The laboratory prepares a formal written response to DQRs explaining discrepancies. The DQR is the first line of investigation following any anomalous result.

3.4.1 Laboratory Documentation

Upon receipt of the samples at Pace, the following activities are recommended:

- The samples will be examined upon receipt to ensure collection in EPA-approved containers for the requested analysis. The sample collection data and time will also be reviewed to confirm the EPA-required sample holding time has not expired or will not expire before the analysis can be performed.
- The information concerning transportation mode and manner will be reported on the form. Samples will be transported on ice or under refrigeration, and the inside temperature of the cooler recorded upon opening.
- The pH of each sample as well as the sample appearance will be recorded if required by the analytical method. Also, preservative adjustments, filtration, and sample splitting will also occur as required prior to distribution. Sample adjustments will be fully documented.

During analysis of the samples, it is recommended that the laboratory agent maintain the integrity of the samples as follows:

- During the sample analysis period, the samples will be preserved in accordance with method guidelines.
- If at any point during the analysis process, the results are considered technically inaccurate, the analysis will be performed again if holding times have not been exceeded.
- Documentation activities should be completed with permanent ink in a legible manner with mistakes crossed out with a single line.

3.5 Laboratory Analyses

Analytical procedures will be performed in accordance with EPA *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846,* as updated and other EPA-approved methods. The constituents, along with proposed test methods and Practical Quantitation Limit (PQLs), are listed in Tables 2 and 3. The selected analytical methods provide PQLs that are below applicable groundwater standards.

Alternate methods may be used if they have the same or lower PQL. Methods with higher PQLs will be considered if the concentration of the parameter is such that an alternate test method with a higher PQL will provide the same result.

3.5.1 Practical Quantitation Limit

Laboratory-specific PQLs will be used as the reporting limits for quantified detections of required monitored constituents. Laboratory PQLs should be reported with the sample results.

3.5.2 Method Detection Limits

Laboratory-specific Method Detection Limits (MDLs) will be used as the reporting limits for estimated detections of required monitored constituents. Constituents detected at concentrations above the MDL but below the PQL will be reported as estimated with a qualifying “J” flag on the laboratory certificates of analysis. Laboratory MDLs should be reported with the sample results.

3.5.3 Method Blanks

Laboratory method blanks are used during the analytical process to detect any laboratory-introduced contamination that may occur during analysis. A minimum of one method blank should be analyzed by the laboratory per sample batch.

3.6 Data Review, Verification, and Validation

Data review, verification, and validation techniques include screening, accepting, rejecting, or qualifying data based on specific QC criteria to identify quality issues which could affect the use of the data for decision making purposes. Following receipt of the analytical data from the subcontract laboratory, WSP validates 100% of the groundwater data generated as part of the CCR monitoring in accordance with the National Functional Guidelines for Inorganic Data Review (EPA 540-R-2017-001, January 2017). Using the terminology from Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 540 R-10-006, January 2009), 100% of the data undergoes Stage 2A data validation which assesses both sample-related and instrument-related QC parameters. In particular, the data are reviewed for completeness and adherence to the requested analytical methods. Quantitative sample and instrument specific QC parameters, including field and method blank data, MS/MSD recovery and precision; laboratory control samples (LCS) and instrument calibrations presented in the

summaries provided in the laboratory data packages are reviewed for conformance with the laboratory QC criteria.

Should QC non-conformances be identified during the data validation, the following qualifiers will be appended to the data[1]:

U The analyte was analyzed for but was not detected above the level of the reported sample quantitation limit.

J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample. No direction of bias is indicated.

J+ The result is an estimated quantity, but the result may be biased high.

J- The result is an estimated quantity, but the result may be biased low.

UJ The analyte was analyzed for but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

R The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.

Qualified results are reported for validated samples on the analytical reporting forms provided in the data packages or as data summary tables accompanying the laboratory deliverable package. Qualified results, data packages, and analytical results are stored in the operating record.

The PARCC criteria and criteria specified in applicable guidelines may not always be achievable. The data validation guidelines provide directions for the determination of data usability. Qualified data can often provide useful information, although the degree of certainty associated with the result may not be as planned. Professional judgment, in conjunction with USEPA guidance documents, is used to determine data usability and where necessary, professional judgment is used to evaluate scenarios not specifically described in the referenced documents. Should the Stage 2A validation identify deficiencies that were not addressed, after consultation with NIPSCO, WSP would move to a more extensive validation for that data package.

3.7 Reconciliation with User Requirements

Throughout the project, NIPSCO and WSP will determine if project data quality objectives (DQO) are being met and assess whether the data being collected is sufficient and appropriate. Periodic evaluations of the monitoring program will be made to determine if a change in frequency or analytical parameters is appropriate. Individuals making measurements throughout the process will also assess whether the DQO are being met.

Individuals making field measurements will determine whether field quality control criteria were met. The field QA/QC will be overseen by the field team leader. Corrective actions will be initiated in the field, as necessary. This corrective action may include recalibration of instruments or use of a different type of instrument.

[1] Note that the U and J qualifiers may also be associated with the data by the laboratory to indicate non-detect and estimated values below the PQL respectively.

The analysts in the laboratory will determine if analytical QC criteria are achieved. Corrective action in the form of re-analysis or re-calibration may be warranted. Laboratory analytical data and field data will be assessed by a data validation specialist under the direction of the QA Manager to determine usability regarding the DQO.

As noted in the data validation guidelines, data may not always meet precision and accuracy requirements but may still be considered usable. The data will be assessed regarding the project DQO, and professional judgment used in conjunction with guidance documents will determine data usability.

Tables

Table 1: Groundwater Quality Monitoring Parameters
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

Monitoring Parameter	
Field Parameters	Temperature, pH, Conductivity, Dissolved Oxygen, and Turbidity
Appendix III[1]	Boron
	Calcium
	Chloride
	Fluoride
	Sulfate
	pH
	Total Dissolved Solids (TDS)
Appendix IV[1]	Antimony
	Arsenic
	Barium
	Beryllium
	Cadmium
	Chromium
	Cobalt
	Fluoride
	Lead
	Lithium
	Mercury
	Molybdenum
	Selenium
	Thallium
	Radium 226 & 228
Additional Monitored Natural Attentuation Parameters	Iron
	Magnesium
	Manganese
	Potassium
	Sodium
	Nitrate
	Phosphate and Phosphorus
	Total Alkalinity

Notes:

1.) Analyte lists match requirements for monitoring from USEPA Rule 40 CFR Part 257.94(b).

Prepared By: DFSC
Checked By: TDH
Reviewed By: MAH

Table 2: Analytical Methods and Practical Quantitation Limits
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

Analyte	Analytical Method[3,4]	Preservative	Hold Times	PQL (mg/L)	MCL (mg/L)
Appendix III - Detection Monitoring[1]					
Boron	SW-846 6010C	HNO_3	6 months	0.10	NA
Calcium	SW-846 6010C	HNO_3	6 months	1.0	NA
Chloride	SW-846 9056A	NA	28 days	0.250	NA
Fluoride	SW-846 9056A	NA	28 days	0.050	4.00
pH	SW-846 9040B	NA	NA	-	NA
Sulfate	SW-846 9056A	NA	28 days	0.25	NA
Total Dissolved Solids (TDS)	SM-2540C	NA	7 days	10	NA
Appendix IV - Assessment Monitoring[1]					
Antimony	SW-846 6020A[5]	HNO_3	6 months	0.0010	0.006
Arsenic	SW-846 6020A[5]	HNO_3	6 months	0.0010	0.010
Barium	SW-846 6020A[5]	HNO_3	6 months	0.0010	2.00
Beryllium	SW-846 6020A[5]	HNO_3	6 months	0.00020	0.004
Cadmium	SW-846 6020A[5]	HNO_3	6 months	0.00020	0.005
Chromium	SW-846 6020A[5]	HNO_3	6 months	0.0020	0.100
Cobalt[6]	SW-846 6020A[5]	HNO_3	6 months	0.0010	0.006
Fluoride	SW-846 9056A	NA	28 days	0.050	4.00
Lead[6]	SW-846 6020A[5]	HNO_3	6 months	0.0010	0.015
Lithium[6]	SW-846 6010C	HNO_3	6 months	0.0010	0.040
Mercury	SW-846 7470A	HNO_3	28 days	0.0010	0.002
Molybdenum[6]	SW-846 6020A[5]	HNO_3	6 months	0.0010	0.100
Selenium	SW-846 6020A[5]	HNO_3	6 months	0.0010	0.050
Thallium	SW-846 6020A[5]	HNO_3	6 months	0.0010	0.002
Radium 226 & 228	EPA 903.1 (Radium 226), EPA 904.0 (Radium	HNO_3	6 months	NA	5.00
Additional Monitored Natural Attenuation Parameters					
Iron	SW-846 6010C	HNO_3	6 months	0.10	NA
Magnesium	SW-846 6010C	HNO_3	6 months	1.0	NA
Manganese	SW-846 6010C	HNO_3	6 months	0.010	NA
Potassium	SW-846 6010C	HNO_3	6 months	1.0	NA
Sodium	SW-846 6010C	HNO_3	6 months	1.0	NA
Nitrate	EPA 353.2	NA	48 hours	0.10	NA
Phosphate	EPA 365.1	H_2SO_4	28 days	0.15	NA
Phosphorus	EPA 365.1	H_2SO_4	28 days	0.050	NA
Total Alkalinity	SM-2320B	NA	14 days	10	NA

Notes:

1.) Analyte list matches requirements for detection and assessment monitoring from United States Environmental Protection Agency (USEPA) Detection - USEPA Appendix III Constituents and Assessment Monitoring - USEPA Appendix IV Constituents - 40 CFR Part 257.Monitoring.

2.) SW-846 denotes Test Methods for Evaluating Solid Waste, Physical- Chemical Methods, EPA publication SW-846, 3rd edition, and subsequent updates.

3.) Other industry-used or agency-approved methods may be used provided that they produce the necessary level of precision and accuracy for data use and reporting.

4.) Updates to the methods listed here are approved for use.

5.) EPA Method 6020A with a collision cell

6.) These four constituents do not have MCLs. The value listed under the MCL column is the applicable health-based standard.

Dash (-) = no information available

HNO_3 = Nitric acid

MCL = Maximum Contaminant Level from USEPA 2016 Edition of the Drinking Water Standards and Health Advisories. (http://water.epa.gov/drink/contaminants/index.cfm.)

mg/L = Milligrams per liter

NA = Not applicable

NP = Not promulgated

pCi/L = Picocuries per liter

PQL = Practical Quantitation Limit

Prepared By: DFSC
Checked By: TDH
Reviewed By: MAH

Table 3: Sample Container Information and Hold Times
NIPSCO LLC R. M. Schahfer Generating Station
Wheatfield, Indiana

Parameter	Container & Volume	Preservative	Maximum Holding Time
pH, Specific Conductance, temperature, ORP, turbidity	Flow-through cell	None	15 minutes (field analysis)
Mercury (total)	Plastic, 250 mL	HNO_3 to pH<2	28 days
Metals (total) except mercury			6 months
Total Dissolved Solids (TDS)	Plastic, 500 mL	None	7 days
Fluoride, Chloride, Sulfate		None	28 days
Alkalinity, Nitrate	Plastic, 500 mL	None	14 days, 48 hours
Phosphate, Phosphorus	Plastic, 250 mL	H_2SO_4	28 days
Radium 226/228	Plastic, 2 x 1 Liter	HNO_3 to pH<2	6 months

Notes:
ORP = Oxidation Reduction Potential
mL = Milliliter
HNO_3 = Nitric acid

Prepared By: DFSC
Checked By: TDH
Reviewed By: MAH

ATTACHMENT A

Field Forms

CALIBRATION FORM

WSP Project Name: NIPSCO LLC/RMSGS/IN **Project Number:** GL21508844

WSP Personnel Present:

Date:

Meter Type: **YSI**

Model Number:

S/N

Specific Conductivity **Lot # :** **Expire Date:**

Standard	Unit		Meter reading		Time	
1.413	mS/cm					Initial
						Check
						Check

Acceptable Range 1.342-1.484

Dissolved Oxygen

Baro Pressure	Temp °C	% D.O.	mg / L D.O.	D.O. Charge	Time	
						Initial
						Check
						Check

pH

4.01 Buffer: Lot #: **Exp. Date:** **7.01 Buffer: Lot #:** **Exp. Date:**

Standard	Meter reading		Meter reading		Meter reading
	Initial		Check		Check
Time		Acceptable Range			
4.01		3.81-4.21			
7.01		6.75-7.36			
10.00		9.50-10.50			

10.00 Buffer: Lot #: **Exp. Date:**

ORP **Lot#:** **Expire Date:**

Standard	Meter reading		Meter reading		Meter reading
	Initial		Check		Check
Time		Acceptable Range			
240.0		228-252			

Turbidity

Meter Type: **LaMotte**

Model Number: **20/20**

S/N

Standard	Meter reading		Meter reading		Meter reading
	Initial		Check		Check
Time		Acceptable Range			
1.00		0.95-1.05			
10.00		9.50-10.5			

Comments:

Sampler Signature: Date:

GROUNDWATER SAMPLE COLLECTION FORM

SITE DESCRIPTION

Project Name: NIPSCO LLC/RMSGS/IN
Project Number: GL21508844
Location: Wheatfield, Indiana

WEATHER CONDITIONS

Temperature:
Wind:
Precipitation:

SAMPLE DESCRIPTION

Sample ID:
Date:
Time at Well Site:
Time of Sample Collection:
Sampled by:
Sampling Method: Bladder Pump
Type of Sampling Equipment: Pump tubing

FIELD BLANK NOTES

Field Blank Name:
Field Blank /Rinse Water type:
Lot Number:
Analyses:

VOLUME OF WATER TO BE PURGED

Casing Inside Diameter: inches
Casing Volume: liters/ft
Column of Water in Well: feet
Volume of Water in Well: liters
Well Volumes to Purge:
Min. Volume to be Purged: liters
Method of Purging:
Well Purged Dry?: Yes No

COLUMN OF WATER IN WELL BEFORE PURGE

Total Depth of Well: ft TOC
Depth to Water : ft TOC
Column of Water in Well: ft
Depth to Water after Purge: ft TOC

Appearance of Sample:

WELL PURGE CONTROL

	Purge 1	Purge 2	Purge 3	Purge 4	Purge 5	Purge 6	Purge 7
Time:							
Volume Removed (liters):							
pH:							
Specific Conductance (uS/cm):							
Temperature (Degrees C):							
Turbidity (NTU):							
ORP (millivolts):							
DO (mg/l) :							
Water Level (ft BTOC)							

Starting Purge Time:
Ending Purge Time:
Average Purge Rate: ml/min
Total Volume Purged: liters

SAMPLE CONTAINERS REQUIRED

Analysis	Container Number, Type and Size	Filter	Preservative and Source

Chain of Custody #:
Shuttle ID:
Trip Blank ID:
Lab Name:
Air Bill #:

REMARKS: 2" - 0.617 liters/ft 1" - 0.053 liters/ft
1.5" - 0.347 liters/ft

Field Team Leader:

Water Level Collection Summary Form - Schahfer Generating Station, Wheatfield, Indiana
Project No.: GL21508844

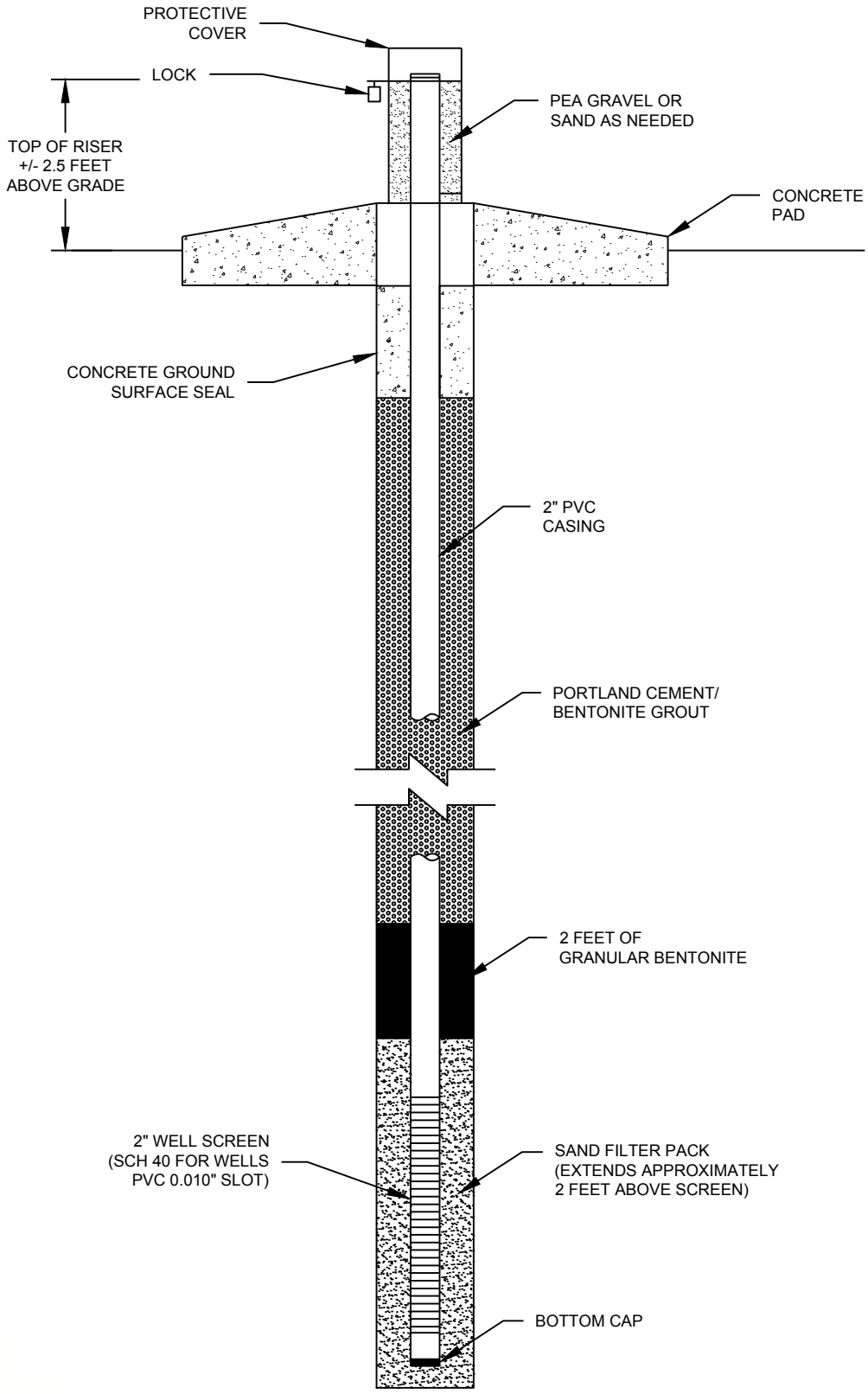
Date: Inspector:

Arrival Time: Signature:

Leaving Time: Weather Conditions:

Sample Point ID	WL Time	Ref Point	Depth to Water (ft btoc)	Sounded Well Depth	Locked?	Labeled?	PVC Cap?	Surface Seal OK?	Notes
PC-GAMW-04									
GAMW-06									
PC-GAMW-07									
PC-GAMW-07B									
PC-GAMW-08									
PC-GAMW-08B									
PC-GAMW-09									
PC-GAMW-09B									
PC-GAMW-15									
PC-GAMW-15B									
PC-GAMW-16R									
PC-GAMW-16BR									
PC-GAMW-17									
PC-GAMW-17B									
PC-GAMW-18									
PC-GAMW-18B									
PC-GAMW-52									
PC-GAMW-52B									
PC-GAMW-53									
PC-GAMW-53B									
PC-GAMW-54									
PC-GAMW-54B									
PC-GAMW-55R									
PC-GAMW-55B									
PC-GAMW-56									
PC-GAMW-56B									
PC-GAMW-61									
PC-GAMW-61B									
PC-GAMW-62B									
PC-GAMW-62B									
GAMW-69									
GAMW-70									
GAMW-71									

Notes:



CLIENT
NIPSCO LLC

PROJECT
GROUNDWATER MONITORING PROGRAM

CONSULTANT
GOLDER

YYYY-MM-DD	2016-07-08
DESIGNED	RWC
PREPARED	JSP
REVIEWED	
APPROVED	

TITLE
TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM

PROJECT NO.	SUBTITLE	REV.	FIGURE
19121567	A	0	1

CHAIN-OF-CUSTODY Analytical Request Document

Pace Analytical®

Chain-of-Custody is a LEGAL DOCUMENT - Complete all relevent fields

LAB USE ONLY- Affix Workorder/Login Label Here or List Pace Workorder Number or MTJL Log-in Number Here

ALL SHADED AREAS are for LAB USE ONLY

Company:	Billing Information:
Address:	
Report To:	Email To:
Copy To:	Site Collection Info/Address:
Customer Project Name/Number:	State: County/City: Time Zone Collected: [ ] PT [ ] MT [ ] CT [ ] ET
Phone: Email:	Site/Facility ID #:
Collected By (print):	Purchase Order #: Quote #:
Collected By (signature):	Turnaround Date Required:
Sample Disposal: [ ] Dispose as appropriate [ ] Return [ ] Archive: _____ [ ] Hold:_____	Rush: [ ] Same Day [ ] Next Day [ ] 2 Day [ ] 3 Day [ ] 4 Day [ ] 5 Day (Expedite Charges Apply)

Compliance Monitoring? [ ] Yes [ ] No

DW PWS ID #: DW Location Code:

Immediately Packed on Ice: [ ] Yes [ ] No

Field Filtered (if applicable): [ ] Yes [ ] No

Analysis: _____

* Matrix Codes (Insert in Matrix box below): Drinking Water (DW), Ground Water (GW), Wastewater (WW), Product (P), Soil/Solid (SL), Oil (OL), Wipe (WP), Air (AR), Tissue (TS), Bioassay (B), Vapor (V), Other (OT)

Container Preservative Type **

Lab Project Manager:

** Preservative Types: (1) nitric acid, (2) sulfuric acid, (3) hydrochloric acid, (4) sodium hydroxide, (5) zinc acetate, (6) methanol, (7) sodium bisulfate, (8) sodium thiosulfate, (9) hexane, (A) ascorbic acid, (B) ammonium sulfate, (C) ammonium hydroxide, (D) TSP, (U) Unpreserved, (O) Other _____

Analyses

Lab Profile/Line:

Customer Sample ID	Matrix *	Comp / Grab	Collected (or Composite Start) Date	Collected (or Composite Start) Time	Composite End Date	Composite End Time	Res Cl	# of Ctns

Lab Sample Receipt Checklist:

Custody Seals Present/Intact	Y N NA
Custody Signatures Present	Y N NA
Collector Signature Present	Y N NA
Bottles Intact	Y N NA
Correct Bottles	Y N NA
Sufficient Volume	Y N NA
Samples Received on Ice	Y N NA
VOA - Headspace Acceptable	Y N NA
USDA Regulated Soils	Y N NA
Samples in Holding Time	Y N NA
Residual Chlorine Present	Y N NA
Cl Strips: _____	
Sample pH Acceptable	Y N NA
pH Strips: _____	
Sulfide Present	Y N NA
Lead Acetate Strips: _____	

LAB USE ONLY:
Lab Sample # / Comments:

Customer Remarks / Special Conditions / Possible Hazards:

Type of Ice Used: Wet Blue Dry None

Packing Material Used:

Radchem sample(s) screened (<500 cpm): Y N NA

SHORT HOLDS PRESENT (<72 hours): Y N N/A

Lab Tracking #:

Samples received via: FEDEX UPS Client Courier Pace Courier

Lab Sample Temperature Info:
Temp Blank Received: Y N NA
Therm ID#: _____
Cooler 1 Temp Upon Receipt: _____oC
Cooler 1 Therm Corr. Factor: _____oC
Cooler 1 Corrected Temp: _____oC
Comments:

Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:

MTJL LAB USE ONLY

Table #:
Acctnum:
Template:
Prelogin:
PM:
PB:

Trip Blank Received: Y N NA
HCL MeOH TSP Other

Non Conformance(s): YES / NO

Page: _____
of: _____

APPENDIX C

Quality Assurance Project Plan

APPENDIX C

QUALITY ASSURANCE PROJECT PLAN CLOSURE APPLICATION

R. M. Schahfer Generating Station

Material Storage Runoff Basin, Metal Cleaning Waste Basin, and Drying Area

Submitted to:

Northern Indiana Public Service Company LLC
801 East 86th Avenue
Merrillville, IN 46410

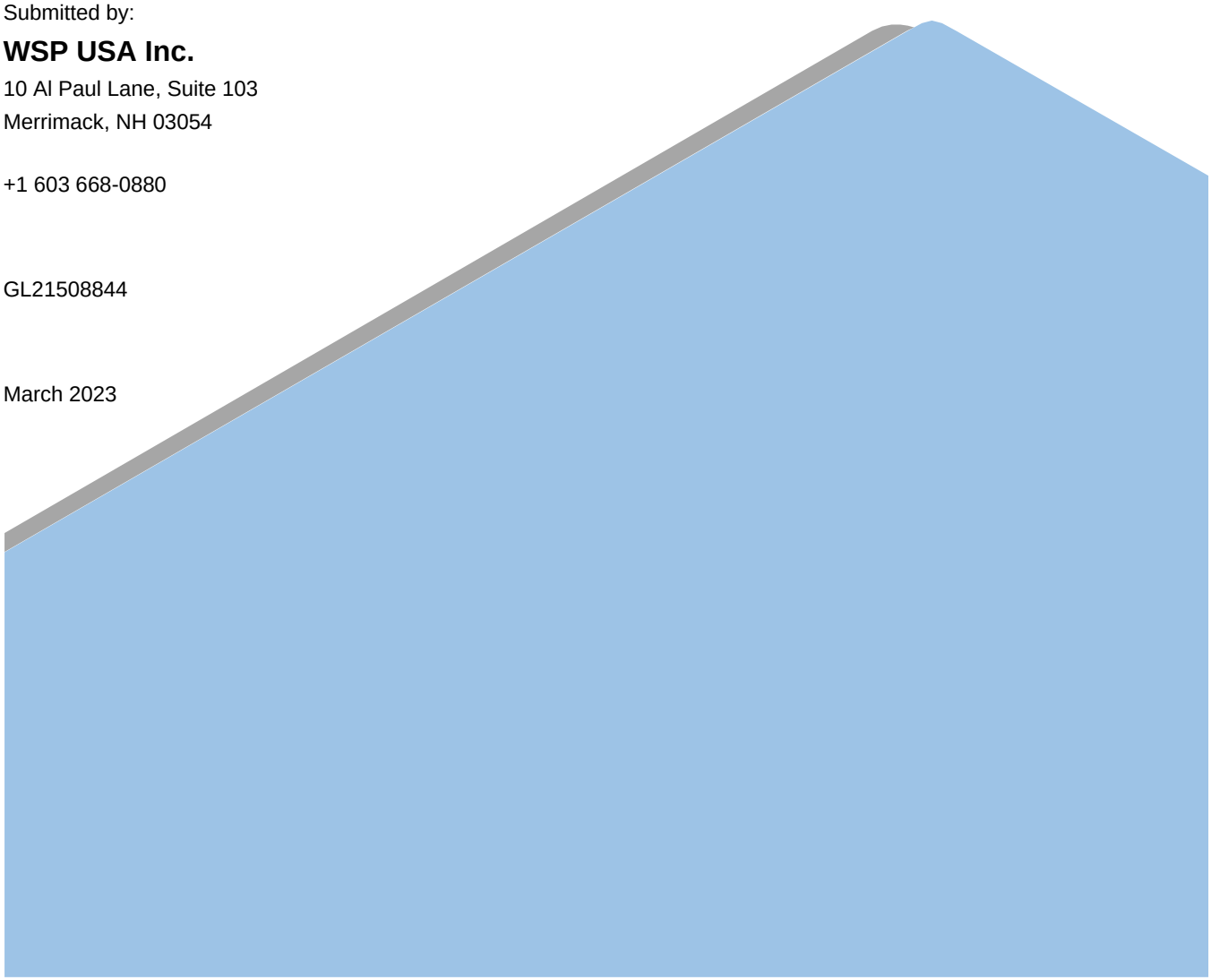
Submitted by:

WSP USA Inc.
10 Al Paul Lane, Suite 103
Merrimack, NH 03054

+1 603 668-0880

GL21508844

March 2023



LIST OF ACRONYMS

Acronym	Definition
AO	Agreed Order
AOC	Area of Concern
Golder	Golder Associates Inc.
ASTM	American Society for Testing and Materials
CCR	Coal Combustion Residuals
CO	Consent Order
COPC	Contaminants of Potential Concern
COPEC	Contaminants of Potential Ecological Concern
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
FTP	File Transfer Protocol
GC/ECD	Gas chromatography/electron capture detection
GC/MS	Gas chromatography/mass spectrometry
GIS	Geographical Information System
HASEP	Health, Safety, and Environmental Plan
HHRA	Human Health Risk Assessment
ICPES	Inductively Coupled Plasma Emission Spectroscopy
ICPMS	Inductively Coupled Plasma Mass Spectrometry
ID	Identification
IDEM	Indiana Department of Environmental Management
IDW	Investigation Derived Waste
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NCR	Nonconformance Report
NIPSCO	Northern Indiana Public Service Company LLC
OSHA	Occupational Safety and Health Administration
PC	Personal Computer
PE	Performed Evaluation
PID	Photoionization Detector
PM	Project Manager
QA/QC	Quality Assurance/Quality Control
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
RFI	RCRA Facility Investigation
RL	Reporting Limit
RMSGS	Rollin M. Schahfer Generating Station
RPD	Relative Percent Difference
RER	Relative Error Ratio
SOP	Standard Operating Procedure
SPLP	Synthetic Precipitation Leaching Procedure
SRM	Standard Reference Material
SWMU	Solid Waste Management Unit
SVOCs	Semi-volatile Organic Compounds
USGS	United States Geological Survey
WP	RFI Work Plan

Table of Contents

TABLES

FIGURES

ATTACHMENTS

1.0 PROJECT DESCRIPTION

In accordance with an Indiana Department of Environmental Management (IDEM)-approved closure application, Northern Indiana Public Service Company (NIPSCO) will close by removal three surface impoundments at the Rollin M. Schahfer Generating Station (RMSGS) including the Material Storage Runoff Basin (MSRB), Metal Cleaning Waste Basin (MCWB), and the Drying Area (collectively referred to hereafter as the CCR Unit). WSP USA Inc. (WSP), formerly Golder Associates USA Inc. (Golder), prepared this Quality Assurance Project Plan (QAPP) on behalf of NIPSCO to address the monitoring required as part of the groundwater Corrective Action Monitoring and associated quality assurance (QA) to assess post-closure groundwater quality. This document has been appended to the Corrective Action Groundwater Monitoring Program Plan dated March 2023 prepared by WSP. This QAPP should be used in conjunction with the Sampling Analysis Plan (SAP) prepared by WSP for the Corrective Action Groundwater Monitoring Program Plan.

This QAPP presents the organization, planned activities and specific quality assurance and quality control (QA/QC) procedures to support the post-closure groundwater monitoring program. Specific protocols for sampling, sample handling and storage, chain of custody and laboratory and field analyses will be described. All QA/QC procedures will be structured in accordance with applicable technical standards including U.S. Environmental Protection Agency's (EPA's) requirements, regulations, and IDEM guidance and technical standards.

This QAPP has been prepared in accordance with the U.S. EPA Region V RCRA QAPP Instructions, April 1998 and incorporates guidance of the USEPA Requirement for Quality Assurance Project Plans; USEPA QA/G5, EPA/240/R-02/009, dated December 2002; Guidance for the Data Quality Objectives Process; U.S. EPA QA/G4, August 2000, Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods, 3rd Edition (EPA SW-846, 1986), and Indiana State Solid Waste regulations (329 IAC Rule 10).

1.1 Overall Project Objectives and Decision Statements

The objectives of the Corrective Action Monitoring program are to assess the presence or absence, as well as the nature and extent, of groundwater impacts associated with the impoundments to determine changes in groundwater quality and flow direction. Overall objectives of the data collection effort will be to:

- Monitor groundwater quality during the post-closure period
- Verify groundwater gradients, flow direction, flow rates, and potential areas of discharge

Target parameter and reporting limit goals for the QAPP are summarized in Table 1.1. Associated specific objectives for field and laboratory data collection are tabulated in Section 1.4 of this QAPP.

1.2 QAPP Preparation Guidelines

This QAPP has been prepared in accordance with U.S. EPA Region 5 RCRA QAPP Instructions (April 1998), and IDEM's Office of Land Quality (OLQ) Quality Assurance Project Plan Guidance.

1.3 Project Objectives and Intended Data Usages

The project objective is to provide defensible results to assess groundwater conditions and to support additional project needs (e.g., remediation system design and monitoring). Data will be screened against developed and accepted environmental benchmarks determined to be appropriate for this Site.

1.3.1 Project Target Parameters

NIPSCO proposes a monitoring parameter list that is appropriate to the site environmental and geological background conditions; historical site investigation findings; impoundment waste management history; and current monitoring provisions of the CCR Rule. From the perspective of evaluating potential post-closure impacts to water quality, the results generated from this approach will be amenable to applying either statistical-based (e.g., intra-well or inter-well) or standards-based comparisons. The post-closure monitoring parameter list will include:

Field-based Water Quality Parameters	pH, specific conductivity (SC), temperature, turbidity, oxidation-reduction potential (ORP)
40 CFR, Part 257 Appendix III Detection Monitoring Parameters	Boron, calcium, chloride, fluoride, sulfate, total dissolved solids (TDS), pH
40 CFR, Part 257 Appendix IV Assessment Monitoring Parameters	Antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, radium 226 and 228 (combined)
Additional Monitored Natural Attenuation Parameters	Iron, magnesium, manganese, potassium, sodium, nitrate, phosphate, phosphorus, and total alkalinity

Analytes and their method detection limits (MDLs) and reporting limits (RLs) in milligrams per liter (mg/l) for this program are listed below in Table 1-1. The RL and MDL are not applicable for radium. Radium results will have a sample-specific minimum detectable concentration (MDC).

Table 1-1: Target Analyte Metals and Inorganics

Analyte Description	CAS Number	RL	MDL
Antimony	7440-36-0	0.00100	0.000160
Arsenic	7440-38-2	0.00100	0.000490
Barium	7440-39-3	0.00100	0.00110
Beryllium	7440-41-7	0.00020	0.0000530
Boron	7440-42-8	0.100	0.0110
Cadmium	7440-43-9	0.00020	0.0000610
Calcium	7440-70-2	1.00	0.240
Chromium	7440-47-3	0.00200	0.000600
Cobalt	7440-48-4	0.00100	0.0000210
Lead	7439-92-1	0.00100	0.000110
Lithium	7439-93-2	0.00800	0.000290
Mercury	7439-97-6	0.000200	0.0000900

Analyte Description	CAS Number	RL	MDL
Molybdenum	7439-98-7	0.00100	0.000230
Selenium	7782-49-2	0.00100	0.000250
Thallium	7440-28-0	0.00100	0.0000740
Total Dissolved Solids	STL00242	10.0	7.40
Chloride	16887-00-6	0.25	0.130
Fluoride	16984-48-8	0.0500	0.00900
Sulfate	14808-79-8	0.25	0.130
Combined Radium 226 + 228	STL02186	NA	NA
Iron	7439-89-6	0.10	0.049
Magnesium	7439-95-4	1.0	0.072
Manganese	7439-96-5	0.010	0.0025
Potassium	7440-09-7	1.0	0.28
Sodium	7440-23-5	1.0	0.21
Alkalinity	-	10.0	10.0
Nitrate	14797-55-8	0.10	0.011
Phosphate	7723-14-0	0.15	0.15
Phosphorus	139527-23-5	0.050	0.050

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

NIPSCO holds responsibility for all phases of the groundwater Corrective Action Monitoring program. NIPSCO has contracted WSP to perform the groundwater monitoring program, prepare the reports, and perform subsequent studies, if required. WSP will provide project management support to NIPSCO. The various quality assurance, field, laboratory, and management responsibilities of key project personnel are provided in the flowing sections.

2.1 Project Organization Chart

Figure 1 presents the lines of authority specific to this Corrective Action Monitoring program.

2.2 Management Responsibilities

2.2.1 NIPSCO Project Manager

The NIPSCO project manager (PM), Mr. Jeff Loewe, will be responsible for implementing the project and has the authority to commit the resources necessary to meet project objectives and requirements. His primary function is to ensure that technical, financial, and scheduling objectives are achieved successfully. Mr. Loewe will review the work performed on each task to verify its quality, responsiveness, and timeliness. Mr. Loewe is ultimately responsible for the preparation and quality of interim and final reports and he will approve all reports before submission to IDEM. He will represent the company and project team at agency meetings and public involvement activities.

2.2.2 IDEM Project Manager

The IDEM Project Manager, to be identified prior to closure and post-closure plan approval by IDEM, will be responsible for communicating with NIPSCO and providing direction and clarification of post-closure related activities, as necessary. The IDEM PM will be the point of contact for all communication with IDEM.

2.2.3 WSP Program Manager

The WSP Program Manager, Mr. Mark Haney will report to NIPSCO's PM. Mr. Haney will act as the direct line of communication between WSP and NIPSCO and is responsible for all WSP corrective action activities completed on behalf of NIPSCO. Project quality, accountability, and leadership responsibility throughout all phases of the project will be vested in the WSP Program Manager. He is the primary focal point for control of the project activities. Mr. Haney will be supported by QA personnel, who will provide reviews, guidance, and technical advice on project execution issues. The project team, consisting of supervisory, health and safety, and technical personnel, will support Mr. Haney so that the project meets professional standards, is safely executed, and complies with applicable laws, regulations, statutes, and industry codes. Individuals of the project team are responsible for fulfilling appropriate portions of the project QA program, in accordance with assignments made by Mr. Haney. Mr. Haney is responsible for satisfactory completion of the project QA program. He may assign specific responsibilities to other members of the project staff. Mr. Haney will notify NIPSCO of any long-term changes in core personnel. Mr. Haney is responsible to NIPSCO that the project meets the CCR Rule technical objectives and quality requirements.

2.2.4 WSP Technical Coordinator

The WSP Technical Coordinator, Mr. Thomas Haskins, will report directly to the WSP Project Manager and will assume the responsibilities of project management in his absence. Mr. Haskins will provide the overall day-to-day programmatic guidance to the field team, subcontract laboratory and driller, and support staff and will verify that monitoring-related documents, procedures, and project activities meet WSP standards for quality. He will assist Mr. Haney in developing detailed work schedules and will monitor field activities. In addition, he will fill a key role in the interpretation and reporting of findings.

2.2.5 Quality Assurance Coordinator

The WSP QA manager, Ms. Danielle Sylvia Cofelice, reports directly to Mr. Haney and is responsible for ensuring that WSP procedures for this project are being followed. Ms. Sylvia Cofelice has assisted Mr. Haney with the preparation of the QAPP. She will provide direction and oversight for the laboratory program and will be responsible for data validation and data quality assessment.

2.3 Laboratory Responsibilities

Pace Analytical Services (Pace), Indianapolis, IN and/or Greensburg, PA will be responsible for all analytical work. Ms. Tina Sayer is the Pace Program Manager for all NIPSCO work with Pace. Ms. Sayer coordinates NIPSCO work within the Pace laboratories and ensures that appropriate resources are committed and that project requirements are understood and met. Ms. Sayer will communicate as needed with WSP and will be responsible for providing bottles and supplies, monitoring progress in the laboratory, and overseeing production and final review of all reports. NIPSCO maintains contractual relationships with additional laboratories (i.e., ALS) and as necessary due to capacity, response time or other conditions, may replace Pace with ALS or another laboratory. If such change is made, WSP will provide this QAPP to the replacement lab with the caveat that the replacement lab must adhere to all other conditions of the QAPP.

2.4 Field Technical Staff

2.4.1 Field Team Leader and Health and Safety Officer

WSP will identify the field team leader prior to mobilizing to the field. This person will be the field lead geologist/engineer and field team leader for this project, as well as the Health and Safety Officer. The field team leader will coordinate field mobilization activities and be on-site during sampling activities. He/she will oversee all phases of work at the Site that generates data. Specific responsibilities include:

- Daily coordination with NIPSCO personnel regarding field activities and logistical issues
- Management and supervision of all field personnel, including subcontractors
- Implementing QC requirements for field measurements and documentation of field activities
- Adhering to work schedules as established by the Project Director
- Communicating with the laboratory for timely delivery of supplies
- Advising the laboratory of any changes to scheduled sample submittals
- Performing the sampling in accordance with approved procedures and methodologies, that QA/QC samples have been collected as required, and that sampling forms, labels, chain-of-custody forms, and custody seals have been prepared correctly
- Directing the packaging and delivering or shipping samples to the laboratory
- Identifying any problems at the field team level, resolving issues in consultation with Mr. Haskins and Mr. Haney
- Contributing to required reports
- The field team leader will provide as appropriate daily or weekly updates to Mr. Haskins and Mr. Haney regarding progress and will report on any technical or logistical issues that arise
- Maintaining and implementing the site-specific Health, Safety, and Environmental Plan (HASEP)
- Approving any changes in the HASEP due to modifications of procedures or newly proposed site activities related to the RFI Workplan

- Providing health and safety issues coordination between the WSP Project Manager, the NIPSCO Project Manager, and other contractors on the project
- Resolving outstanding safety issues which arise during the conduct of site work
- Assigning health and safety-related duties to qualified field team individuals
- Checking that before personnel work on Site, acceptable medical examinations are current
- Checking the acceptability of health and safety training
- Issuing authorization, in cooperation with the project manager, to proceed with work after a STOP WORK action has been issued on Site

2.4.2 Additional Field Technical Staff

The Field Team will be composed of technical staff drawn from WSP's pool of company resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All the designated technical team members are experienced professionals who possess the degree of specialization and technical competences required to perform the required work effectively and efficiently. Specific individual responsibilities will include:

- Provision of day-to-day assistance to the RFI Implementation Manager on technical issues in specific areas of expertise
- Maintaining field logs and transferring data for permanent storage
- Coordination and oversight of technical efforts of subcontractors assisting the field team
- Identifying problems at the field team level, resolving difficulties in consultation with the Project Manager, implementing and documenting corrective action procedures, and providing communication between team members and upper management
- Participating in preparation of the final report

Mr. Joe Kutch, NIPSCO, will provide on-site coordination and logistical support to WSP to facilitate the field sampling program.

2.5 Special Training Requirements and Certification

All WSP and subcontractor field personnel on-site shall have completed OSHA training in accordance with the Code of Federal Regulations (CFR) in 40CFR 1910.120 and will have been trained regarding the requirements stated in this QAPP, and the WSP HASEP. Field auditors will require knowledge of this QAPP, Field Sampling Plan, and the Site activities to provide a complete review of field procedures.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this program is to provide defensible results to assess groundwater conditions and to support additional project needs (e.g., remediation system design and monitoring). To meet this objective, procedures for field sampling, laboratory analysis, COC and reporting have been developed and will be implemented that will result in data of known and acceptable quality. All aspects of the sampling and testing will adhere to rigorous QA/QC procedures.

The parameters that will be used to assess measurement data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. These parameters are discussed in the following sections. Media-specific evaluation criteria for these parameters may be specified in the analytical method, developed by the laboratory based on their historical performance or contained in EPA guidance for data validation. Table 3-1 summarizes the quality assurance measures that will be used to evaluate measurement data quality. Data quality objectives (DQOs) are established for these on method and matrix specific bases.

Table 3-1: Measurement Data Quality Evaluation Parameters

Data Quality Indicator	QA Parameter
Precision	Field Duplicate Laboratory Duplicate Laboratory Spike Duplicate Matrix Spike Duplicate
Accuracy	Standard Reference Materials Matrix Spike Surrogate Spikes Initial Calibration Standards and Blanks Laboratory Control Samples Trip Blank Field Blank Method Blank
Representativeness	Holding Times and Preservation Chain of Custody Field Blanks Method Blanks
Comparability	Method Detection Limits Method Reporting Limits Sample Collection Methods Laboratory Analytical Methods
Completeness	Sample Collection Records Reported Valid Results vs. Requested Data Qualifiers Laboratory Deliverables
Sensitivity	Method Detection and Reporting Limits Compared to Project Toxicity Benchmarks

3.1 Precision

Precision is the measure of the reproducibility among individual measurements of the same property, usually under similar conditions, such as multiple measurements of the same sample. Both sampling and laboratory precision will be evaluated using field duplicates; laboratory precision will also be evaluated using matrix spike/matrix spike duplicates (MS/MSDs), laboratory duplicates, and Laboratory Control Samples/Laboratory Control Sample Duplicates (LCS/LCSDs).

Precision for this program will be assessed by duplicate analyses for all parameters. The precision of measurements in environmental samples can be affected by the nearness of a chemical concentration to the method detection limit, relative percent difference (RPD) may be high for small absolute differences, or by sample non-homogeneity. The equations to be used for precision are found in Section 11 of this QAPP.

Field duplicates, which reflect the overall precision of the sampling and analysis scheme, will be collected at a rate of one duplicate per 10 field samples for each matrix. Table 6-1 includes precision control limits for field parameters. Precision related to sample collection in the field will be monitored as the concentration difference between field duplicates. The DQO for RPD between field duplicates for samples with analyte concentrations greater than five times the reporting limit (RL) will be less than or equal to 30% for aqueous samples. The DQO for absolute concentration difference between samples with concentrations less than five times the RL will be less than or equal to the corresponding RL. If these DQO goals are not met, WSP will investigate possible causes and will discuss the results of the investigation and any effect on data usability in the data quality evaluation report.

Laboratory precision for metals analyses will be evaluated through replicate analyses of one per 20 field samples. All sample batches that do not include matrix spikes will have duplicate laboratory control sample analyses to demonstrate precision. Tables 3-2 through 3-5 include precision control limits that will be applied to evaluate laboratory performance and data quality. For sample results less than five times the RL, the precision control limit is the absolute concentration difference should be less than the RL.

3.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy may be expressed as the percent difference between two measured values, as a percentage of the true or reference value, or as a percent recovery in those cases where spiked samples are analyzed.

Accuracy criteria for reference materials and calibration verification are specified in the analytical methods. Accuracy measurements for spiked samples can be affected by sample non-homogeneity when the compound spiked is already present in the sample as collected. In general, accuracy criteria are not applicable for matrix spikes unless the amount spiked is equal to or greater than 25% of the native concentration of that chemical.

Accuracy may also be affected by the presence of target analytes in laboratory or field blanks. Inadvertent contamination of field samples may cause false positives or bias sample results.

MS/MSD and LCS/LCSD samples are not required for total dissolved solids, alkalinity, or radium. Tables 3-2 through 3-5 provide accuracy and precision objectives for this Closure Application.

Table 3-2: QC Objectives for the Analyses of Metals by Inductively Coupled Plasma Mass Spectrometry

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)
SW846 6010C	Boron	75-125	20
	Calcium	75-125	20
	Lithium	75-125	20
	Iron	75-125	20
	Manganese	75-125	20
	Magnesium	75-125	20
	Potassium	75-125	20
	Sodium	75-125	20
SW846 6020A	Antimony	75-125	20
	Arsenic	75-125	20
	Barium	75-125	20
	Beryllium	75-125	20
	Cadmium	75-125	20
	Chromium	75-125	20
	Cobalt	75-125	20
	Lead	75-125	20
	Molybdenum	75-125	20
	Selenium	75-125	20
	Thallium	75-125	20

Table 3-3: QC Objectives for the Analyses of Mercury

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)
SW846 7470A	Mercury	75-125	20

Table 3-4: QC Objectives for the Analyses of Anions, Ion Chromatography

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)
SW846 9056A	Chloride	80-120	15
	Fluoride	80-120	15
	Sulfate	80-120	15

Table 3-5: QC Objectives for the Analyses of Nitrate and Phosphorus

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)
EPA 353.2	Nitrate	90-110	120
EPA 365.1	Phosphorus	90-110	20

3.3 Completeness

Completeness is the measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be evaluated for each method, matrix, and analyte combination to prevent misinterpretation of the data and to meet the needs of the sampling program.

The DQO for completeness for all components of this project is 90%. Data that have been qualified as estimated because the quality control criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

3.4 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents an environmental condition, characteristic of a population, parameter variations at a sampling point, or a process condition. Consideration of field conditions, sampling locations, numbers of samples, and analyses conducted are all required to ensure representativeness.

For this project, the parameters selected for analysis have been identified as metals and organics potentially associated with coal-fired utility generation. Representativeness will be ensured by compliance with the plans for both field and laboratory activities.

To achieve acceptable representativeness, sample results must not be affected by conditions that would lead to false positives or false negatives. Representativeness will also be evaluated through field and laboratory QA measures, including COC records, holding time and preservation, and field and method blanks.

3.5 Decision Rule

During future evaluation of post-closure groundwater monitoring data, NIPSCO may use appropriate risk screening criteria, cleanup objectives, and points of compliance under current and reasonably expected future

land use scenarios. NIPSCO and WSP will review groundwater results considering the nature of the constituents detected, background concentrations, potential human exposure and present ecological habitats and communities, if any. WSP will develop appropriate Site-specific criteria based on remediation goals and screening levels or benchmarks.

WSP may use the following Site-specific clean-up and risk screening levels, including but not limited to:

- IDEM Remediation Closure Guide (RCG) Commercial/Industrial Screening Levels (2022)
- U.S. EPA Maximum Containment Levels (MCLs)
- Great Lakes Screening Criteria (GLI) = Tier I and Tier II Criteria for the Great Lakes System Not Adopted into Rules and Calculated Using Methodologies at 327 IAC 2-1.5-11; 13-14
- Calculated background groundwater concentration levels

3.6 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. For this corrective action, comparability of data will be established using project-defined sampling and analytical methods and reporting limits and formats that are consistent with standard practices and with comparable monitoring programs. The use of common, traceable calibration and reference materials from the National Institute of Standards and Technology or other established sources will allow comparability of analytical results to those from other studies.

3.7 Sensitivity

A critical component of this post-groundwater monitoring program is the analytical sensitivity. To the extent feasible, analytical sensitivities as provided in Table 1.1 are consistent with potential screening criteria for human health, ecological risk and corrective measures requirements as included in the guidance cited in Section 3.5.

The MDL is defined as the minimum concentration at which a given target analyte can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Laboratory RLs are defined as the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. Laboratory MDLs and RLs have been used to evaluate the method sensitivity and/or applicability prior to the acceptance of a method for this program.

The sample-specific MDL and RL will be reported by the laboratory and will consider any factors relating to the sample analysis that might decrease or increase these values (e.g., dilution factor, percent moisture, sample volume, sparge volume). If the MDL and RL are elevated for a sample due to matrix interferences and subsequent dilution or reduction in the sample aliquot, the data will be evaluated by WSP and the laboratory to determine if an alternative course of action is required or possible.

3.8 Level of Quality Control Effort

Field and method blanks, field and laboratory duplicates, laboratory control samples, standard reference materials, matrix spike samples and surrogates are among those quality assurance samples critical to data quality assessment. Except where specified, the DQO goals for quality assurance parameters discussed below are not intended to be used as criteria for acceptance or rejection of data, but rather as guidance to indicate when further

evaluation of data quality is needed. A summary of Method Quality Objectives (MQOs) related to these DQOs may be found in Tables 6-2 through 6-9.

3.8.1 Field Quality Control

Field quality control samples used to evaluate data quality are described below. The frequency of their collection is summarized in Table 3-6. Acceptance criteria for laboratory duplicates are given in Section 3.2. No analytes should be detected above the RL in field blanks.

Field Blanks

The field or equipment blank is a sample of reagent grade, analyte free, water poured into, over, or pumped through the sampling equipment (and if applicable, homogenization container), collected in a sample container, and transported to the laboratory for analysis in the same manner as environmental samples. These blanks are used to assess the effectiveness of equipment decontamination procedures and the potential for false positives for target analytes. Equipment blanks are prepared in accordance with American Standard Testing Method (ASTM) D 5088-90 (Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites) protocol and are used to monitor the effectiveness of the decontamination process. The frequency of collection of equipment rinsate blanks depends on the type of sampling and the equipment used. The equipment rinsate blank shall be analyzed for the same parameters as requested for the environmental samples collected at the sampling location.

Duplicates

Duplicate samples are collected to monitor the precision of the field sampling and analytical process as well as to provide information regarding the homogeneity of the sample matrix. One duplicate sample will be collected for every 10 samples.

Table 3-6: Summary of Field QC Samples

Field QC Sample	Frequency	Comments
Field Duplicate	1 duplicate per 10 field samples of each matrix	Groundwater
Field or Equipment Blank	1 equipment blank per sample team per day based on sampling method using disposable equipment. 1 equipment blank per 10 samples with non- disposable sampling equipment. 1 field blank per 10 samples with dedicated sampling equipment.	Groundwater sampling with pumps and disposable tubing
Matrix Spike/Matrix Spike Duplicates (MS/MSD)	1 per 20 samples matrix & matrix spike duplicates per media on a sequential basis.	Groundwater

3.8.2 Laboratory Quality Control

Pace has written procedures addressing internal QA/QC. These procedures are detailed in the laboratory Quality Assurance Manuals, which are attached as Appendices A and B to this document. Pace QA/QC Coordinators are required to ensure that all personnel engaged in sample handling and analysis tasks have appropriate training.

Specific laboratory quality control measures are required to determine the precision and accuracy of the analyses and to demonstrate the absence of interferences or contamination by glassware or reagents. Laboratory quality control measures will, at a minimum, be consistent with specific method requirements. Requirements for the frequency of laboratory quality control samples, acceptance criteria and corrective action requirements are summarized in Tables 6-2 through 6-9.

If laboratory DQO goals are not met, the laboratory will investigate the cause of the DQO exceedances and include a discussion of the exceedances and any impact on data usability in the case narrative. If the cause of the DQO exceedances is determined to be laboratory error, the laboratory will re-prepare and/or reanalyze the sample as appropriate. This procedure is further detailed in Section 12.0

Recovery of analytes and surrogate compounds spiked into a sample matrix that do not meet the DQOs must be reflective of the sample matrix rather than laboratory procedural bias. All matrix-related recovery problems must be adequately documented in the laboratory report and raw data. Compliance with these DQOs will be assessed by comparison if analyte and surrogate recovery in the sample matrix to laboratory performance on method blanks and blank spikes, and through the data validation and verification process.

Laboratory Control Samples (LCS)

The LCS is a sample of analyte-free water spiked with known concentrations of all analytes listed in the QC acceptance criteria tables for each method. Each analyte in the LCS is to be spiked at a level less than or equal to the midpoint of the analyte calibration curve.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS is an aliquot of an environmental sample spiked with known concentrations of target analytes. The spiking occurs prior to sample preparation and analysis. Each analyte in the MS shall be spiked at a concentration less than or equal to the midpoint of the analyte calibration curve.

MS/MSD sets are prepared for organic analyses to provide measure of analytical precision and accuracy. Precision is evaluated for metals analysis by laboratory duplicates, so the MSD is not required.

Although the results of the project MS/MSDs are not used to control the analytical process, they are used to evaluate sample bias due to matrix.

Method Blank

The method blank is a sample of analyte-free matrix to which all reagents are added in the same volumes or proportions as are used in sample processing. The method blank monitors the presence or absence of contaminants originating from the laboratory and is required for each analysis and/or extraction batch. Method blanks for waters will be prepared from deionized laboratory water.

Internal Standards

Internal standards are measured amounts of certain compounds added after sample preparation or extraction. They are used in an internal standard calibration method to correct sample results for analysis efficiency. Internal standards shall be added to environmental samples, blanks, standards, and QC samples, in accordance with method requirements.

4.0 SAMPLING PROCEDURES

Site-specific sample identification numbers will be assigned prior to sample collection. Samples will be assigned unique field identifiers that provide information on the well location and whether the sample is a primary or QC sample. The sample/QA/QC naming conventions are detailed in Section 3.3 of the SAP and are summarized below. An example of the Site-specific sample number will consist of the following:

- Sample: GAMW-01-MMDDYY (two-digit month/day/year)
- MS: GAMW-01-MS-MMDDYY (matrix spike)
- MSD: GAMW-01-MSD-MMDDYY (matrix spike duplicate)
- FDNN-MMDDYY (Field Duplicate – NN is event blank number))
- FBNN-MMDDYY (Field Blank – NN is event blank number)

The laboratory will provide sample containers and will be certified clean, with traceability to specific certificate(s) from the commercial source. Bottle, preservation requirements and holding times are presented in Table 4-1.

Table 4-1: Sample Containers, Preservatives and Holding Times

Analysis	Container and Volume	Preservative	Holding Time
pH, Specific Conductance, temperature, ORP, turbidity	Flow-through cell	None	15 minutes (field analysis)
Mercury (total)	Plastic, 250 mL	HNO3 to pH<2	28 days
Metals (total) except mercury	Plastic, 250 mL	HNO3 to pH<2	6 months
Total Dissolved Solids (TDS)	Plastic, 500 mL	None	7 days
Fluoride, Chloride, Sulfate	Plastic, 500 mL	None	28 days
Alkalinity, Nitrate	Plastic, 500 mL	None	14 days, 48 hours
Phosphate, Phosphorus	Plastic, 250 mL	H2SO4	28 days
Radium 226/228	Plastic, 2 x 1 Liter	HNO2 to pH<2	6 months

Sample Labels:

Each sample will have an adhesive plastic or waterproof paper label affixed to the container and will be labeled at the time of collection. The following information will be recorded on the container label with a permanent marker at the time of collection:

- Project name
- Sample identification
- Date and time of sample collection
- Preservative type (if applicable)
- Initials of sampler
- Laboratory analysis requested

Shipment:

Samples to be shipped to the laboratory will be properly packaged in individual plastic bags and cushioned with bubble wrap to prevent damage. They will be placed in a cooler with a signed Chain of Custody (COC) form, ice (double bagged), a temperature blank, and shall be cooled to less than four degrees plus or minus two degrees Celsius (4° ± 2° C).

Samples may be shipped in coolers using an overnight courier, courier employed by the analytical laboratory, or delivered to the lab by field personnel. The shipping procedures for water samples will include the following steps:

- Place packing material (e.g., bubble wrap, etc.) in the bottom of a waterproof cooler
- Seal bottles in clear plastic bags and wrap each sample bottle using bubble wrap; place sample bottles in cooler and introduce packing material around and between bottles to prevent the bottles from touching each other or the sides of the cooler
- Place a temperature blank in the cooler
- Double-bag ice plastic bags and pack in the cooler on and around bottles
- Fill the cooler with packing material
- Sign and date the COC form and place paperwork in plastic bags and attach with masking tape or duct tape to the inside lid of the cooler
- Tape the drain shut
- Close the cooler and secure the lid by taping the cooler completely around with strapping tape at two locations
- Place the lab address on top of the cooler
- Put "This Side Up" labels and "Fragile" labels on the cooler

- Affix custody seals on the front right and back left corners of the cooler, sign, and date the seals, cover seals with wide, clear tape
- Attach shipping papers to the cooler

If samples are to be hand-delivered to the laboratory by field personnel, they should be sealed in plastic bags and placed securely in a cooler with double-bagged ice and with packaging material to protect them from breakage. A temperature blank is required. COC paperwork should be completed and dated, but it will not be necessary to affix custody seals or shipping labels on the cooler.

Upon shipment, the laboratory will be notified that a sample shipment is scheduled to arrive. An effort will be made to provide the laboratory with a one-week advance notice of sample shipment.

Each shipping container will be clearly marked with a sticker containing the originator's address. Any coolers that are not hand delivered will be shipped priority for overnight delivery. Coolers that are not hand delivered to the laboratory will have a custody seal affixed to the shipping container so that the shipping container cannot be opened without breaking the custody seal.

Shipments of samples from the field to the laboratory will typically occur within 48 hours of collection. Samples requiring analyses with short holding times will be identified and designated as such on the chain-of-custody forms and will be shipped on the date of collection, if possible.

5.0 CUSTODY PROCEDURES

Adherence to proper documentation and COC procedures is critical for data defensibility and quality. Samples and associated data must be traceable from the point of collection to the final reported laboratory results.

5.1 Field Documentation and Custody Procedures

WSP will use field forms and logbooks for data collection at the Site including the following information:

- Daily Drilling Summary
- Tailgate Safety Meetings
- Boring log and monitoring well information and associated sample collection points
- Groundwater Sampling Forms (Low-flow)

The field team will scan the field forms and logbook pages. Electronic data will be transferred either daily or weekly, depending on volume of data collected, via a password protected File Transfer Protocol Site (FTP) to the data management team for import into a commercially available environmental management system called EQuIS. Data will be backed up periodically to a secure remote server.

Field team members will also keep a daily record of significant events, observations, and measurements in bound field logbooks. The sampling documentation will contain information on each sample collected, and will include at a minimum the following information:

- Project name
- Field personnel on-Site

- Facility visitors
- Weather conditions
- Field observations and any deviations from the Facility Investigation Plan (Work Plan)
- Maps, listing of photographs taken, and/or drawings
- Date and time sample collected
- Sampling method and description of activities
- Identification or serial numbers of instruments or equipment used
- Deviations from the QAPP
- Conferences associated with field investigation activities

In general, sufficient information will be recorded during sampling to permit reconstruction of the event without relying on the memory of the field personnel.

The books will be permanently bound and durable for adverse field conditions. All pages will be numbered consecutively. All pages will remain intact, and no page will be removed for any reason. Notes will be taken in indelible waterproof, blue or black ink. Errors will be corrected by crossing out with a single line, dating, and initialing. The front and inside of each field logbook will be marked with the project name, number, and logbook number. The field logbooks will be stored in the project files when not in use and upon completion of each sampling event.

Sample collection checklists will be prepared prior to each sampling program. The checklist will include location designations, types of samples to be collected, and whether any QC samples are to be collected.

5.2 Chain of Custodies

Once collected, samples are in one's custody if they are: (1) in the custodian's possession or view; (2) in a secured location (under lock) with restricted access; or (3) in a container that is secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s).

Chain-of-custody records are used to document sample collection and shipment to a laboratory for analysis. The COC is an integral component of the sampling process and represents the permanent record of sample holding and shipment. COC(s) will be completed and sent with the samples for each shipment. If multiple coolers are sent to a single laboratory on a single day, forms will be completed and sent with each cooler.

The COC record will identify the contents of each shipment and maintain the custodial integrity of the samples. A locked seal will be placed across the front and back of each cooler containing samples when coolers are ready for shipment. All custody seals will be signed and dated. The chain-of-custody form will be cross-checked for errors and signed.

The WSP field representative will sign the "relinquished by" box and note the date, time, and air bill (if applicable). Until the samples are delivered, the custody of the samples will be the responsibility of the WSP field representative and will be kept in a secured area that is restricted to authorized personnel. A laboratory representative will check samples with their respective chain-of-custody form(s) into the laboratory, and the form

will be signed and dated appropriately. The WSP field representative or staff member will retain one copy of the signed chain-of-custody form for the project files. The original chain-of-custody form will be returned to the WSP Project Manager (PM) with the analytical results to go into the project files.

5.3 Laboratory Sample Custody Laboratory Receipt and Log-In

The COC form will be signed on receipt by the laboratory to complete the custody chain. The condition of the samples upon receipt by the laboratory will be documented on a cooler receipt log or sample condition upon receipt form (prepared by the lab). This form will note sample integrity, preservation, temperature, custody seal condition, and will note any discrepancies between information on the sample labels and that on the chain-of-custody form.

Each sample will be logged into the laboratory system by assigning it a unique sample number. This number and the field sample identification number will be recorded on the laboratory report. Samples will be stored and analyzed according to specified EPA Methods. The original chain-of-custody form will be returned to the WSP PM for permanent storage.

Laboratory Sample Handling

Field samples may be held at the laboratory to form an analytical batch consisting of a maximum of 20 field samples that are of the same matrix or of similar composition, with the constraint that the method extraction and analysis holding times are not exceeded or jeopardized. Unless prevented by matrix, associated QC samples, including equipment blanks, duplicates, and project specific MS/MSDs, are to be extracted and analyzed with the field samples.

Groundwater samples shall be stored in limited access, temperature-controlled areas (refrigerators and coolers 4° ± 2°C, freezers less than 0° C), which are monitored for temperature during business days. All the cold storage areas shall be monitored by thermometers which have been calibrated with a certified reference standard (the laboratory Quality Assurance Manual (QAM) may be referenced for details regarding their sample storage policies and procedures – see Appendices A and B).

The sample holding time begins with the date (and time for samples with holding times less than 48 hours) the sample is collected and continues until the date and time the sample analysis is complete. Sample type, sample preservation, container type, volume requirements, analytical methods, and extraction and analysis holding times are summarized on Table 4-1. Samples not preserved or analyzed in accordance with these requirements may necessitate expediting the analysis (in the event the holding time is reduced) or possible resampling and reanalysis. The laboratory PM shall be responsible for prioritizing work to assure that holding times and project commitments are met. Any discrepancies will be noted on the appropriate form, and the WSP PM, or designee, will be immediately notified.

If not entirely consumed during analysis, organic analytical samples shall be stored, at least, until the analysis holding time has expired. All other analytical samples shall be kept for at least 90 days after submittal of the laboratory report. After these dates, the laboratory may dispose of all analytical samples according to local, state, and federal regulations. Unless otherwise notified by WSP, samples may be disposed 90 days after submittal if the specified laboratory report has been provided to WSP.

Analytical data records will be retained by the laboratory and in the WSP central project files. For all analyses, the data reporting requirements will include those items necessary to complete data validation, including copies of all raw data. The hardcopy deliverable requirements are specified in the Appendices of this QAPP.

All instrument data shall be fully restorable at the laboratory from electronic backup. Laboratories will be required to maintain all records relevant to project analyses for a minimum of seven years.

5.4 Final Evidence Files

The final evidence file will be the central repository for all documents, which constitute evidence relevant to sampling and analysis activities as described by this QAPP and includes all relevant records, reports, logs, field forms, and subcontractor reports. WSP will be responsible for the custody of the evidence files and maintain the contents of the files for the duration of the project. The files will include at a minimum:

- Field logbooks
- Field data
- Laboratory data deliverables
- Data validation reports
- Data assessment reports
- Progress reports, QA reports, interim project reports
- All original custody documentation (COC forms, airbills, etc.)
- Copies of all communications with IDEM (letters, e-mails, telephone logs)

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 Field Instrument Calibration

Field instruments will be calibrated daily in accordance with the manufacturer's instructions. A log will be kept of the calibration check activities for all field instruments by the field personnel. It will include the date of the calibration check, description of the check standard, the reading obtained, and the initials of the person performing the calibration check. The standards used for calibration will be commercially prepared solutions and gases obtained from reputable vendors. Expiration of solutions and gases will be checked, and they will be discarded when expiration dates are reached. Field Sampling Team will perform all calibrations of the field equipment in accordance with manufacturers' recommendations. Calibration procedures for field instrumentation are described in SAP of the Closure Application. Calibration will be done at least daily. Table 6-1 details field calibration and quality assurance requirements for this program.

Table 6-1: Calibration and Quality Assurance Requirements for Field Analyses

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW9050A	Conductance	Calibration with KCl standard	Once per day at beginning of testing	± 5%	If calibration is not achieved, check meter, standards, and probe; recalibrate
		Field duplicate	10% of field samples	±5%	Correct problem, repeat measurement
SW9040C	pH (water)	2-point calibration with pH buffers	Once per day	± 0.05 pH units for every buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration
		pH 7 buffer	At each sample location	± 0.1 pH units	Correct problem, recalibrate
		Field duplicate	10% of field samples	± 0.1 pH units	Correct problem, repeat measurement
E170.1	Temperature	Field duplicate	10% of field samples	± 1.0❑C	Correct problem, repeat measurement
E180.1	Turbidity	Calibration with one standard per instrument range used	Once per day at beginning of testing	± 5 units, 0-100 range ± 0.5 units, 0-0.2 range ± 0.2 units, 0-1 range	If calibration is not achieved, check meter; replace if necessary, recalibrate
		Field duplicate	10% of field samples	RPD 20%	Correct problem, repeat measurement
ASTM D1498	Oxidation-reduction potential	Sensitivity verification	Daily	ORP should decrease when pH is increased	If ORP increases, correct the polarity of electrodes. If ORP still does not decrease, clean electrodes and repeat procedure
		Calibration with one standard	Once per day	Two successive readings ± 10 millivolts	Correct problem, recalibrate
		Field duplicate	10% of field samples	± 10 millivolts	Correct problem, repeat measurement
E360.1	Dissolved oxygen	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement

a. All corrective actions shall be documented, and the records shall be maintained by WSP.

6.2 Laboratory Instrument Calibration

All the methods cited for this program have specific calibration requirements. In addition, those methods which rely on mass spectrometry (volatile and semi-volatile organics and metals by ICP/mass spectrometry) define instrument tuning requirements which must be satisfied prior to sample analyses.

Tables 6-2 through 6-9 detail the laboratory calibration and quality assurance requirements for each method.

Table 6-2: Analytical Quality Control Requirements for the Analyses of Metals by EPA Method 6010C

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	If more than one standard is used, correlation coefficient must be 0.995	If applicable, correct problem and repeat initial calibration
Initial calibration verification (second source)	Daily after initial calibration	All analytes within ±10% of expected value	Correct problem then repeat initial calibration
Calibration verification (Instrument Check Standard)	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value and RSD of replicate integrations <5%	Repeat calibration and reanalyze all samples since last successful calibration
Calibration blank	After every calibration verification	No analytes detected above RL	Correct problem then analyze calibration blank and previous 10 samples
Low level calibration check standard (at or below RL)	Once per analytical batch prior to sample analysis unless multi-point (3+) calibration with low std at or below RL is performed	All analyte(s) with ± 50% of expected value	Correct problem then reanalyze
Linear range calibration (high) check standard	Every three months	Analyte within ± 10% of expected value	Correct problem then reanalyze or re-set linear range
Method blank	One per analytical batch	No analytes detected above RL	No corrective action taken if MB > RL if samples are ND or if sample conc. > 10x the MB contaminant level. If any samples have analytes detected at < 10x the blank, correct problem then re-prep and analyze method blank and affected samples processed with the contaminated blank
Interference check solution (ICS)	At the beginning of an analytical run	Within ±20% of expected value	Terminate analysis; correct problem; reanalyze ICS; reanalyze all affected samples

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, 80%-120% of expected results	Correct problem then reanalyze. If still out, re-prep and reanalyze the LCS and all samples in the affected NIPSCO batch
Dilution test	Each new sample matrix, at least once per analytical batch (only applicable for analytes with concentrations >50X MDL)	Fivefold (1+4) dilution must agree within ±10% of the original determination	Perform post digestion spike addition
Post digestion spike addition	When dilution test fails or if an analyte's concentration for all samples in a batch is less than 50X MDL	Recovery within 75-125% of expected results	Check for instrumental problem then reanalyze post digestion spike addition if appropriate
MS	One MS per every 20 NIPSCO project samples per matrix	QC acceptance criteria, 75-125% of expected results	none
MDL study	Once per 12-month period	Detection limits established shall be < the RLs	none

a. All corrective actions associated with NIPSCO project work shall be documented, and all records shall be maintained by the laboratory.

Table 6-3: Analytical Quality Control Requirements for the Analyses of Metals by EPA Method 6020A

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action°
MS tuning sample	Prior to initial calibration and calibration verification	SW6020A paragraph 5.8	Retune instrument then reanalyze tuning solution
Initial calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	If more than one standard is used, correlation coefficient must be 0.995	If applicable, correct problem and repeat initial calibration
Calibration blank	Before beginning a sample run, after every 10 samples and at end of the analysis sequence	No analytes detected above RL	Correct problem then analyze calibration blank and previous 10 samples
Initial Calibration verification (Second source standard)	After initial calibration before beginning a sample run — at a concentration other than used for calibration	All analytes within ±10% of expected value	Correct problem then repeat initial calibration
Continuing Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±10% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration
Low level calibration check standard (at or below RL)	Once per analytical batch prior to sample analysis unless multi-point (3+) calibration with low std at or below RL is performed	All analyte(s) with ± 50% of expected value	Correct problem then reanalyze
Linear range calibration (high) check standard	Every three months	Analyte within ± 10% of expected value	Correct problem then reanalyze or re-set linear range
Method blank	One per analytical batch	No analytes detected above RL	Correct problem re-prep and analyze method blank and all samples processed with the contaminated blank

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action°
Interference check solutions (ICS-A and ICS-AB)	At the beginning and end of an analytical run or once during a 12-hour period, whichever is more frequent	ICS-A: All non-spiked analytes < RL unless they are a verified trace impurity from one of the spiked analytes ICS-AB: Within ±20% of true value	Terminate analysis; locate and correct problem; reanalyze ICS; reanalyze all affected samples
LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, 80-120% of expected results.	Correct problem then reanalyze
Dilution test	Each matrix in an analytical batch (only applicable for analytes with concentrations >100X MDL)	Five-fold (1+4) dilution must agree within ±10% of the original determination	Perform post digestion spike addition
Post digestion spike addition	When dilution test fails or if an analyte's concentration for all samples in a batch is less than 100x MDL	Recovery within 75-125% of expected results	Dilute the sample; reanalyze post digestion spike addition
MS	One MS per every NIPSCO project samples per matrix	QC acceptance criteria, 75-125% of expected results.	none
Internal Standards (ISs)	Every sample	IS intensity within 30-120% of intensity of the IS in the initial calibration	Perform corrective action as described in method SW6020A, Section 8.3
IDL study	Every three months	Detection limits established shall be <1 the RLs in Table 7.2.16-1	none
MDL study	Every 12 months		

a. All corrective actions associated with NIPSCO project work shall be documented, and all records shall be maintained by the laboratory.

Table 6-4: Analytical Quality Control requirements for the Analyses of Mercury by EPA Methods 7470A/7471B

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
Initial multipoint calibration (minimum 5 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient >0.995 for linear regression	Correct problem then repeat initial calibration
Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration
Calibration blank	Once per initial daily multipoint calibration	No analyte detected above RL	Correct problem then reanalyze calibration blank and all samples associated with blank
Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration
Method blank	One per analytical batch	No analytes detected above RL	No corrective action taken if MB > RL if samples are ND or if sample conc. > 10x the MB contaminant level. If any samples have analytes detected at < 10x the blank, correct problem then reprep and analyze method blank and all affected samples processed with the contaminated blank
LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, 80-120% of expected results	Correct problem then reanalyze. If still out, re-prep and reanalyze the LCS and all samples in the affected AFCEE batch
Dilution Test	Each matrix in an analytical batch (only applicable for samples with concentrations >25X MDL)	Five-fold (1+4) dilution must agree within ±10% of the original determination	None
MS/MSD	One MS per every 20 NIPSCO project samples per matrix	QC acceptance criteria, 75-125% of expected results	None

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
MDL study	Once per 12-month period	Detection limits established shall be < the RLs	None

a. All corrective actions associated with NIPSCO project work shall be documented, and all records shall be maintained by the laboratory.

Table 6-5: Analytical Quality Control Requirements for the Analyses of Anions, Ion Chromatography 9056A_28D

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
Laboratory control standard/ Initial calibration verification	Daily initial calibration prior to sample analysis	Analyte within ±10% of expected value	Correct problem then repeat initial calibration
Calibration blank	Prior sample analysis, following every 10 samples, and at the end of the analytical set	No analyte detected above RL	Correct problem then reanalyze calibration blank and all samples associated with blank
Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration
Duplicate sample	One per every 10 samples or per sample set, whichever is greater	<20% RSD for samples greater than RL	Re-prepare & re-analyze sample and duplicate once. Visually check sample for homogeneity. Discuss in narrative.
MS/MSD	One MS per every 20 NIPSCO project samples per matrix	QC acceptance criteria, 80-120% of expected results	None

a. All corrective actions associated with NIPSCO project work shall be documented, and all records shall be maintained by the laboratory.

Table 6-6: Analytical Quality Control requirements for the Analyses of Total Dissolved Solids by EPA method 2540C_Calcd

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
Initial porcelain capsule check before analysis	Repeat weight measurement for 3 capsules per batch	Duplicate determination should agree within 5% of their average	Replace capsule
Analysis replicates	Triplicates every batch	RSD <20%	Re-run affected samples if possible or qualify data if re-run not possible.
Accuracy check laboratory fortified blank (LFB) containing NaCl 10 g/L	Once per batch	NaCl within ±20% of expected value	Re-run fresh LFB, if fails, re-run affected samples.
Laboratory blank	Once per batch	<2 mg/L	Investigate problem; reanalyze samples.

a. All corrective actions associated with NIPSCO project work shall be documented, and all records shall be maintained by the laboratory.

Table 6-7: Analytical Quality Control requirements for the Analyses of Alkalinity by SM 2320B

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
Laboratory control standard/ Initial calibration verification	Daily initial calibrationpriorto sample analysis	Analyte within ±10% of expected value	Correct problem then repeat initial calibration
Analysis replicates	Triplicates every batch	RSD <20%	Re-run affected samples if possible or qualify data if re-run not possible.
Laboratory blank	Once per batch	<2 mg/L	Investigate problem; reanalyze samples.
LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, 90-110% of expected results	Correct problem then reanalyze. If still out, re-prep and reanalyze the LCS and all samples in the affected AFCEE batch

a. All corrective actions associated with NIPSCO project work shall be documented, and all records shall be maintained by the laboratory.

Table 6-8: Analytical Quality Control Requirements for the Analyses of Nitrate by EPA 353.2 and Phosphorus by EPA 365.1

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
Laboratory control standard/ Initial calibration verification	Daily initial calibration prior to sample analysis	Analyte within ±10% of expected value	Correct problem then repeat initial calibration
Calibration blank	Prior sample analysis, following every 10 samples, and at the end of the analytical set	No analyte detected above RL	Correct problem then reanalyze calibration blank and all samples associated with blank
Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration
LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, 90-110% of expected results	Correct problem then reanalyze. If still out, re-prep and reanalyze the LCS and all samples in the affected AFCEE batch
MS/MSD	One MS per every 20 NIPSCO project samples per matrix	QC acceptance criteria, 90-110% of expected results	None

a. All corrective actions associated with NIPSCO project work shall be documented, and all records shall be maintained by the laboratory.

Table 6-9: Analytical Quality Control requirements for the Analyses of Radium 226 and 228 by EPA Methods 903.1 (Radium 226), EPA 904.0 (Radium 228)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
Method Blank	1 per batch of 20 (or 5% frequency)	No detects above MDC	Correct problem and reanalyze affected samples if possible or qualify data if re-run not possible.
Blank Spikes	1 per batch of 20 (or 5% frequency)	QC acceptance criteria 70-130% of expected results	Correct problem and reanalyze affected samples if possible or qualify data if re-run not possible.
Laboratory Duplicate	Minimum frequency of 10%	RER <3	Reanalyze affected samples once. If still high discuss in laboratory narrative.
Tracer/Carrier Limits	All blanks, QC samples, and samples	QC acceptance criteria of 40-110% of expected results	No corrective action taken if recovered above QC acceptance criteria and result is <MDC. Otherwise, correct problem then reanalyze associated samples.

a. All corrective actions associated with NIPSCO project work shall be documented, and all records shall be maintained by the laboratory.

7.0 INTERNAL QUALITY CONTROL CHECKS

7.1 Field Quality Control Checks

QC requirements and criteria for the field measurements are provided in Table 6-1 of this document. Assessment of field sampling precision and bias will be made by collecting field duplicates and equipment blanks. Collection of samples will be in accordance with the SAP provided in the Closure Application (Appendix E).

7.2 Laboratory Quality Control Checks

Each Pace lab has QC programs in place to ensure the reliability and validity of the analyses conducted and the data reported. All analytical procedures to be used for this program are documented in SOPs, as included in Appendices A and B to this QAPP.

All analysts supporting the NIPSCO program will have completed a demonstration of proficiency by meeting method criteria for accuracy and precision criteria through replicate preparation and analyses of check standards. Other internal QC checks required are method-specific and have been included in Tables 6-2 through 6-9 of this document. Those tables also provide required corrective actions when QC criteria are not met.

All data will be properly recorded and stored by the laboratory. Data package requirements, as listed in Appendices, will allow WSP to reconstruct the reported results and QC measurements from raw data. All samples for which QC results indicate noncompliance will be reanalyzed by the laboratory if sufficient volume is available.

8.0 PERFORMANCE AND SYSTEM AUDITS

System audits and performance audits of field and laboratory activities may be performed to check compliance with the sampling and analytical directives. These audits will verify that sampling and analysis activities are performed in accordance with the established procedures. The QA Coordinator will be responsible for these audits.

8.1 Field Audits

8.1.1 Internal Field Audits

At the beginning of the project, the WSP Field Team Leader or Project Manager will conduct a thorough audit of field calibration, sampling, decontamination, and documentation procedures to verify that all staff are compliant with the requirements of the Closure Application, SAP, and this QAPP.

Field audits shall be performed by WSP field staff daily by cross-checking the field logs, the Sample Collection Logs, the chain-of-custody, and the sample containers. Daily cross checking confirms sample identity, sample integrity, and sampling procedures and will be completed by the sampler prior to shipping the samples. Additionally, the field logs and the chain-of-custody will be sent to the WSP QA/QC Manager or Project Manager by facsimile for additional verification. NIPSCO staff may conduct field audits at any time during the program.

8.1.2 External Field Audits

External field audits may be conducted by the IDEM Program Manager or his designee at any time. These audits may or may not be announced.

8.2 Laboratory Audits

8.2.1 Internal Laboratory Audits

Laboratory performance and system audits are addressed in the laboratory QAM. Pace internal audits consist of general audits and specific procedure audits. A general audit is an overview of the whole laboratory from sample receipt to sample disposal for compliance with the QAM. A specific technical audit is a detailed in-depth review of an actual method or procedure. Internal audits are conducted on a scheduled basis both by the individual laboratory QC Managers and by Pace Corporate QA managers.

After the general and/or specific audits have been conducted, the laboratory QA manager completes a laboratory audit record form. Any issues, observations, and findings are discussed with the laboratory Manager. The laboratory Manager, laboratory QA Manager, and other laboratory staff as necessary, suggest and implement corrective actions. The results of the audit are kept on file along with any corrective action taken. If, because of the audit, there is uncertainty as to the validity or correctness of a test result, immediate corrective action will be taken, and the client notified in writing.

Pace internal audits also involve the preparation and analysis of blind QC samples submitted through Pace's Corporate Quality Assurance Program. Results of these are used to evaluate the ongoing performance of the laboratory.

8.2.2 External Laboratory Audits

NIPSCO maintains a formal laboratory audit program for their contracted laboratories. Independent environmental QA professionals are retained to support the NIPSCO Laboratory Coordinator by conducting comprehensive system and performance audits. NIPSCO has audited the Pace Indianapolis facility and determined that staff and instrumentation resources, procedures and systems are in place to provide data of the requisite quality for this program. Pace’s Greensburg, PA laboratory has been audited by state and federal agency auditors and hold appropriate certifications. Each lab routinely participates in performance testing programs.

9.0 PREVENTATIVE MAINTENANCE

9.1 Field Instrument Preventative Maintenance

In accordance with the QA program, WSP shall maintain an inventory of field instruments and equipment. The frequency and types of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The WSP Field Team Leader will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. WSP anticipates using rental equipment and will periodically switch out pieces of equipment to allow the required maintenance while not sacrificing productivity. The WSP Project Manager, or designee, shall maintain the equipment calibration records received from the rental company and be responsible for verifying compliance with this section.

9.2 Laboratory Preventative Maintenance

In accordance with the QA program, the laboratories shall maintain an inventory of instruments and equipment and the frequency of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The laboratory preventative maintenance program, as detailed in their QA Plan, is organized to maintain proper instrument and equipment performance, and to prevent instruments and equipment from failing during use. The program considers instrumentation, equipment and parts that are subject to wear, deterioration or other changes in operational characteristics, the availability of spare parts, and the frequency at which maintenance is required. Any equipment that has been overloaded, mishandled, gives suspect results, or has been determined to be defective will be taken out of service, tagged with the discrepancy noted, and stored in a designated area until the equipment has been repaired. After repair, the equipment will be tested to ensure that it is in proper operational condition. The client will be promptly notified in writing if defective equipment casts doubt on the validity of analytical data.

Laboratory Group Supervisors will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. All maintenance records will be checked according to the schedule on an annual basis and recorded by the responsible individual. The laboratory QA Officer, or designee, shall be responsible for verifying compliance.

10.0 SPECIFIC ROUTINE PROCEDURES TO EVALUATE DATA PRECISION, ACCURACY AND COMPLETENESS

As part of the data validation process, results for quality assurance measurements will be compared to the data quality objectives as presented in Section 3. In addition, the data will be reviewed for evidence of matrix interferences that may have biased results, cross contamination from field or laboratory activities, and any deviations from sampling and storage requirements that may have affected the integrity of the sample. The following calculations will be conducted as the first step of evaluating data quality for precision, accuracy, and completeness.

10.1 Precision

The relative percent difference between field duplicates, laboratory duplicates and matrix spike/matrix spike duplicates will be calculated as measures of precision.

$$RPD = \frac{\text{measured value} - \text{measured duplicate value}}{((\text{measured value}+\text{measured duplicate value})/2)} \times 100$$

Results that fall outside of the program objectives will be evaluated for evidence of possible sample non-homogeneity or possible bias from sampling or laboratory activities.

10.2 Accuracy

For calibration verification and continuing calibration check standards and laboratory control samples, recoveries are calculated in accordance with the following equation:

$$\% \text{ Recovery} = \frac{\text{Measured Concentration}}{\text{Known concentration}} \times 100$$

Surrogate spike recoveries are calculated according to a comparable equation:

$$\% \text{ Recovery} = \frac{\text{Measured concentration}}{\text{Expected concentration based on known amount added}} \times 100$$

Matrix spike recoveries will be calculated in accordance with the equation below:

Percent recovery = (amount in spike sample — amount in sample) x 100 Known amount added

10.3 Completeness

Completeness will be calculated as follows:

$$\text{Completeness} = \frac{\text{number of valid measurements}}{\text{total number of data points planned}} \times 100$$

Completeness will be calculated on an analysis basis. Although the program goal is greater than 90% completeness, professional judgment will be applied to evaluate the impact of any data gaps on the overall objectives of the program.

10.4 Assessment of Data

Data collected during the CCR groundwater monitoring program will be used to evaluate the nature and extent of possible impacts to Site groundwater. The QC results associated with each analytical parameter will be compared to the objectives of Section 3 in this QAPP. EPA guidance for data verification (EPA 2004) and for data usability in risk assessment (EPA 1992) will serve as the basis for final recommendations on data acceptance for decision making purposes.

Elements considered in this data usability report will include:

- Compliance of sampling methods with the SAP
- Compliance of analyses with QAPP methods and QC requirements
- Completeness of sampling effort
- Completeness of laboratory analyses
- Resolution of corrective action requirements
- Detection limits achieved
- Validation findings
- Specific needs for human health and ecological risk assessments, if needed
- Specific needs for remedial options

WSP will prepare a data usability report, incorporating the findings of the validation effort and other supporting information. This assessment will evaluate data on a matrix specific, analyte-specific, and location specific basis. The potential impact of any sampling discrepancies or data qualifications (rejected or estimated) on the intended uses for risk assessment will be discussed, with recommendations for further actions if necessary and appropriate.

11.0 CORRECTIVE ACTION

Any NIPSCO or WSP project team member may initiate the field corrective action process. This process consists of identifying a problem, acting to eliminate the problem, documenting the corrective action, monitoring the effectiveness of the corrective action, and verifying that the problem has been eliminated. Although not all inclusive, examples of corrective actions for field measurements may include the following:

- Repetition of a measurement to check the error
- Resample the groundwater monitoring well if the container breaks
- Check for all proper adjustments for ambient conditions such as temperature
- Check of batteries
- Calibration checks
- Recalibration
- Replace instruments or measurement devices
- Stop work (if necessary)
- Revisions to information submitted on chain-of-custody forms
- Amendment of sampling procedures or Work Plans

Technical staff and project personnel will be responsible for reporting all technical or QA non-conformances or suspected deficiencies of any activity or issued document by reporting the situation to the PM and the QA/QC Coordinator on a Nonconformance Report (NCR). The QA/QC Coordinator will be responsible for assessing the suspected deficiency based on the potential for the situation to impact the quality of the data.

The Field Team Leader, or a designee, will be responsible for correcting equipment malfunctions throughout the field sampling effort and resolving situations in the field that may result in nonconformance or noncompliance with the QAPP. All corrective measures will be immediately documented in the field logbook, and sample alteration forms will be completed.

Additional corrective actions, if necessary, will be determined by the Project Manager. The Project Manager has the authority to initiate stop work orders, if necessary, and is responsible for ensuring that a corrective action for a nonconformance is initiated.

If appropriate, the Project Manager will be responsible for ensuring that no additional work that is dependent on the nonconforming activity is performed until the corrective action(s) is completed.

Laboratory

All laboratories are required to comply with the standard operating procedures previously submitted to the Project QA/QC Manager. The laboratory project managers will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The Project QA/QC Manager will be notified immediately if any QC sample exceeds the project-specified control limits. The analyst will identify and correct the anomaly before continuing with the sample analysis. The

Laboratory Project Manager will document the corrective action taken in a memorandum submitted to the Project QA/QC Manager within five days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct it, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, re-extraction) will be submitted with the data package using a corrective action form. Copies of each laboratory's corrective action forms are found in their Quality Assurance Manuals.

12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality assurance reports to management include verbal status reports and written reports on field sampling activities, laboratory processes, data validation reports and final project reports. These reports shall be the responsibility of the QA/QC Manager.

Progress reports will be prepared by the Field Team Leader following each sampling event. The Project QA/QC Manager will also prepare progress reports after the sampling is completed and samples have been submitted for analysis, when information is received from the laboratory, and when analysis is complete. The status of the samples and analysis will be indicated with emphasis on any deviations from the QAPP. A data report will be written after validated data are available for each sampling event. These reports will be delivered electronically to the WSP and NIPSCO project managers.

13.0 DATA REDUCTION, VALIDATION AND REPORTING

This section describes the Data Management Plan (DMP) used by project staff responsible for field sampling, laboratory analysis, data validation, data evaluation and interpretation, and report preparation. Procedurally, all data generated by field and laboratory activities will be reduced and validated prior to reporting, including those data necessary for inclusion in both quarterly progress and investigation findings reports.

13.1 Data Reduction

Data reduction is the process by which original data (e.g., analytical measurements) are converted or reduced to a specified format or unit to facilitate analysis of the data.

13.1.1 Field Data Reduction Procedures

WSP will obtain RFI field measurements with instruments that provide direct readings for the parameters of interest (e.g., pH, specific conductivity). Field data will be recorded in a Site- and project-specific field logbook and/or field form immediately after measurements are made.

13.1.2 Laboratory Data Reduction Procedures

Laboratory data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be considered in the final result. It is the laboratory analyst's responsibility to reduce the data, which are subjected to further review by the Laboratory Project Manager, the Project Manager, the Project QA/QC Coordinator, and independent reviewers, if applicable. Data reduction may be performed manually or electronically. If data reduction is performed electronically, the user must demonstrate that the software is valid and free from unacceptable error.

13.2 Data Validation

13.2.1 Procedures Used to Validate Field Data

The Field Team Leader or designee will perform a review of field data and records as soon as reasonably possible following the completion of field activities and demobilization to confirm that they are complete and accurate including:

- Field Log Information
- Field Groundwater Measurement Results
- Groundwater Sample Collection Log
- Daily Sample Checklist
- Chain-of-Custody
- Sampling Methodology
- Instrument Selection and Use Including Calibration and Standardization
- Field Deviations
- Sampling Limitations

The sampling team member responsible for filing out the field forms and/or entering data into the logbook will sign the document(s). The Field Team leader will review and initial the field form and/or logbook to verify that the sample team followed the recording procedures.

13.2.2 Procedures Used to Validate Laboratory Data Laboratory Validation

Prior to submitting analytical data to WSP, the laboratory must verify compliance with the method requirements. The laboratory will follow their Quality Assurance Manual (QAM), Standard Operating Procedures (SOPs), and this project Quality Assurance Project Plan (QAPP) for all sample analyses. The laboratory will also be responsible for the oversight of the data quality for all analyses. The laboratory QA Officer will address and resolve any sample integrity issues, discrepancies with the chain of custody, or concerns with the analysis.

For each level, the review process shall be documented, signed, and dated by the reviewer. Each step of this review process shall include the evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review.

The first level of review, by the analyst, shall include QC review, method compliance, and documentation accuracy. For data that are manually processed, all steps in the computation shall be provided including equations used and the source of input parameters such as response factors, dilution factors, and calibration constants, and shall be initialed and dated by the analyst and attached to the data sheets. For data entered into the computer, the analyst shall verify the sample specific and project specific information (i.e., project numbers, sample numbers, units, dilution factors).

The second level of review shall be performed by a supervisor, another analyst, or data review specialist. The function of this review is to provide an independent, complete peer review of the analytical data. This review shall include the review of QC performance, method compliance, documentation, calibrations, and identifications.

A third level of review is performed by the laboratory Program Manager, QA Officer, or designee. This review shall provide a total overview of the data package to ensure its compliance with project requirements. All errors and nonconformances noted shall be corrected and/or documented.

Complete review of raw data and all records may be conducted on randomly selected data packages by the laboratory QA Manager or designee. Every hardcopy data deliverable in the selected package shall be reviewed to ensure compliance with all requirements and review performance.

Non-conformance reports (NCRs) will be required for any errors noted. In all cases, an NCR shall be issued with the name of the individual reporting the issue, a description of the noncompliance issue, the corrective action taken, the date the issue was discovered, and the affected project samples. All employees are responsible for reporting the nonconformance. The appropriate supervisor is responsible for assuring that the corrective actions are taken.

13.2.3 Independent Data Validation

The WSP QA Coordinator, or designee, will review the definitive analytical chemistry data provided by the subcontract laboratory for the groundwater samples to Stage 2A as defined by Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA-540-R-08-005, January 2009). As provided by a Stage 2A review, the sample-related QC for the samples will be reviewed for compliance with the measurement performance criteria defined in this QAPP. Specifically, the sample holding times, frequency of QC samples, method blanks, surrogate recoveries, LCS recoveries, MS/MSD recoveries, and field quality control samples such as trip blanks and field duplicates will be evaluated relative to the specific QC criteria presented in the QAPP and the current laboratory QC limits.

Should data quality deficiencies be identified, the data reviewer will qualify the results following USEPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review (USEPA, 2017) and USEPA CLP National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017), as applicable to the analytical methods utilized. Professional judgement will be used to account for any differences in QC criteria between the analytical methods used and the CLP methods underlying the Functional Guidelines. The data reviewer will prepare a summary of findings to be used as an input into the data usability evaluation.

13.3 Data Reporting

13.3.1 Field Data Reporting

Field data will be documented in field logbooks and/or field forms. These data will be incorporated into tables for the report.

13.3.2 Laboratory Data Reporting

Hard-copy data reports submitted to WSP will include at a minimum the following deliverables:

- A case narrative, discussing analytical problems, if any, and referencing or describing the preparation and analytical procedures and instrumentation used. In addition, the samples associated with the deliverable should be listed.
- Chain of Custody forms.
- Cross reference of laboratory IDs to Field IDs.

- Sample log-in/receipt records.
- Sample preparation records.
- Tabulated results, including final dilution volume of sample extracts, concentrations of compounds of interest, sample specific method detection limits and reporting limits.
- All data qualification codes assigned by the laboratory, their description, and explanations for all departures from the analytical protocols.
- Initial and continuing calibration summaries, data, and associated calculations.
- Method blanks associated with each sample, quantifying all compounds of interest identified in these blanks.
- Recovery assessments and replicate sample summaries, including surrogate and matrix spike recoveries and precision for sample duplicate analyses.
- Internal standard area and retention time summaries.
- GC Retention time summaries.
- Laboratory control samples associated with each sample, quantifying all compounds of interest.
- Copies of instrument run logs.
- Labeled chromatograms and integration tables for all samples, standards, blanks, and QC analyses.
- Copies of instrument tunes.

13.4 Data Management and Analysis

WSP will use EQuIS® (Environmental Quality Information System) to electronically manage groundwater quality, water level elevation, field information, and geological data. EQuIS® is an enterprise-wide environmental data management system written in the Microsoft NET Framework and is hosted at WSP in a Microsoft SQL Server environment. Only authorized WSP personnel have access to the database.

EQuIS® uses a variety of tools and business rules to enforce data quality and provides links to many third-party tools commonly used for data visualizations and data analysis (e.g., GIS, Surfer, EVS/MVS®). WSP will acquire, check, and load the laboratory analytical data into EQuIS® for secure tracking and reporting of data.

The laboratory analytical data will be acquired, checked, and loaded into EQuIS® using the following methods:

- Field samples will be collected following the procedures outlined in the SOPs and converted to PDF file format and stored on the network project directory.
- Boring log and monitoring well information will be imported into the project-specific EQuIS database application.
- Samples will be delivered to the laboratory for analytical testing. Copies of the COC and field sample forms will be sent by overnight courier or scanned to electronic copy and e-mailed to the WSP Project Manager.
- Survey information will be imported and managed in the EQuIS data management system.

- Following sample analysis, the laboratory will produce and e-mail Electronic Data Deliverables (EDDs) to the WSP Project Manager. WSP will upload the EDDs into the EQuIS® Data Processor (EDP) along with additional information from the field forms. The data added to the EDDs will include, but are not limited to:
  - Sample location codes
  - Sample matrix codes
  - Sample type codes
  - Parent sample codes for replicate samples
  - Sample delivery group codes

WSP personnel will check the information (e.g., time stamps for proper format and test information) and revise, as necessary. The EQuIS® EDP will check the EDDs for common laboratory errors, such as chronological event errors, duplicate rows, orphan samples, and inconsistencies with the EQuIS® system's valid value tables. Once the data are checked and reviewed, WSP will upload the EDD packages into the database. The data will then be available to be queried and reported by EQuIS® Enterprise or EQuIS® Professional.

WSP may perform data analysis using several different tools, including Geographical Information System (GIS). These tools will allow WSP to quantify both nature and extent of contamination at the site as well as statistical significance of existing sample data and potential future sample locations.

13.5 Data Presentation Format

EQuIS® Enterprise is a read-only web-based reporting function through which data will be processed and reported through a set of customizable pre-designed functions. EQuIS® Professional provides additional format functionality, such as cross-tabbing, trend graphs and isopleths for export to different formats, including Microsoft Excel®. WSP will use a combination of these tools to present analytical result data tables and trend graphs for the Work Plan reports.

Additionally, WSP will use EVS/MVS® modeling to evaluate the distribution of chemicals in groundwater. Three-dimensional simulations of chemical distribution, along with chemical mass estimates, will be useful to help evaluate potential future assessment needs and/or remedial measures, if needed.

Specifically, the use of EVS/MVS® will provide the following items in an efficient manner:

- Visual understanding of chemical distribution
- Potential source areas and volumes to focus remedial technology evaluations
- Information for assessment of future end use options, if applicable

13.6 Project Filing Procedures

Field and analytical data, and associated reports generated by WSP and its subcontractors in performance of the work will be maintained in the WSP Manchester, New Hampshire office. WSP will maintain the records in accordance with our standard document control protocols.

14.0 REFERENCES

IDEM Remediation Closure Guide – March 2018.

IDEM RISC Technical Guide — Appendix 1. January 2004.

IDEM Quality Assurance Project Plan Template, 2011.

Oak Ridge National Laboratory Risk Assessment Information Systems (RAIS) http://risk.lsd.ornl.gov/index.shtml.

U. S. EPA 1992 Guidance for Data Usability in Risk Assessment (Part A) Final EPA, OERP. 9285.7-09A. April 1992.

U. S. EPA, 1996. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), 3rd Edition, Updates 1-IIIB December 1996.

U. S. EPA Region V. RCRA QAPP Instructions. April 1998.

U. S. EPA, 1998. Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA 540-R-99/008. October 1999.

U. S. EPA, July 2000. Guidance for Data Quality Assessment (EPA QA/G-9).

U. S. EPA, August 2000. Guidance for the Data Quality Objectives (DQO) Process (EPA QA/G-4).

U. S. Environmental Protection Agency (EPA), March 2001. Requirements for Quality Assurance Project Plans (EPA QA/R-5).

EPA, 2002 Guidance for Quality Assurance Project Plans, EPA QA/G5, EPA/240/R-02/009.

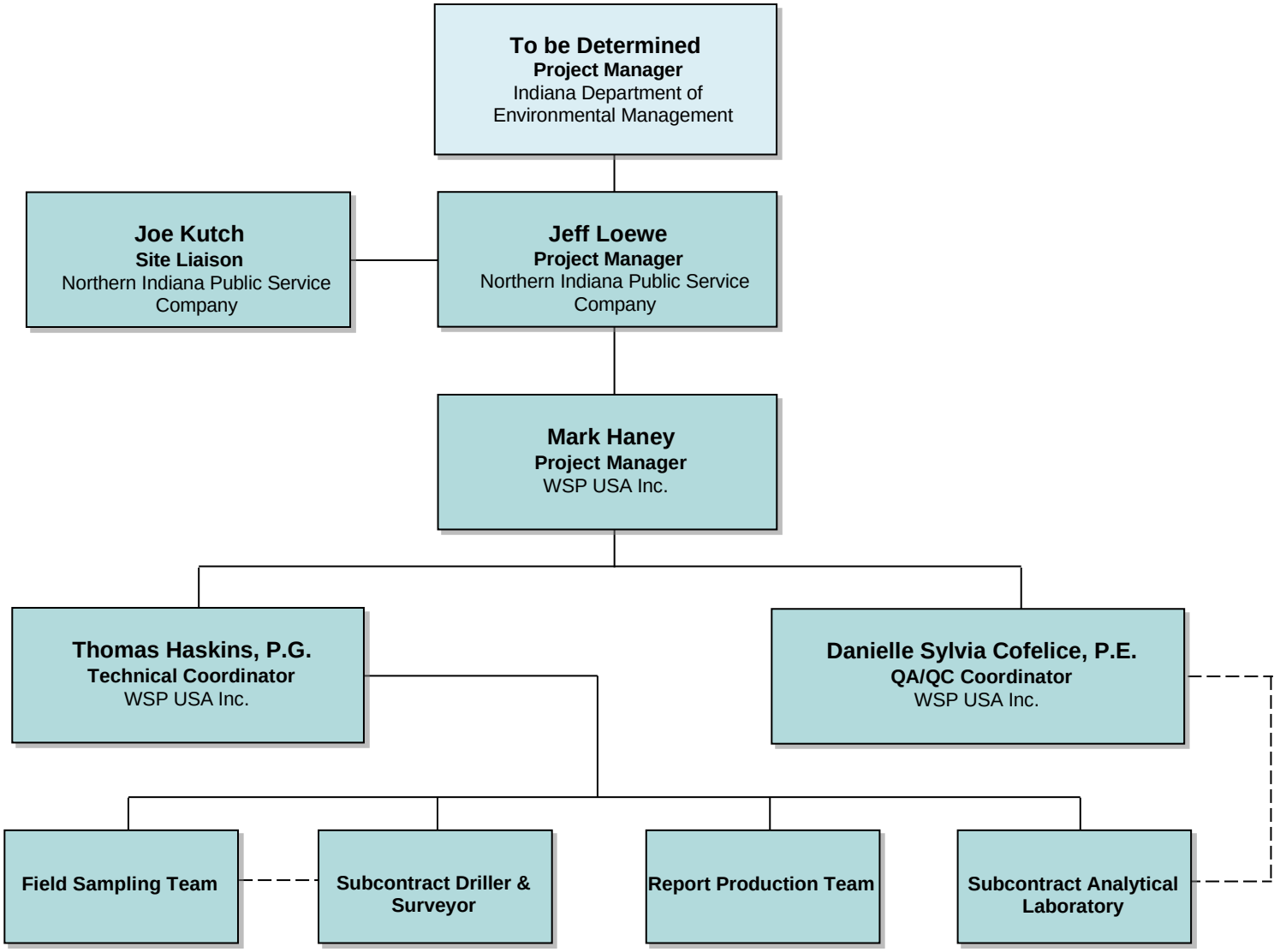
U. S. EPA, 2002. Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA 540-R-01-008. July 2002.

U. S. EPA 2002. National Recommended Water Quality Criteria: 2002 EPA-822-R-02-047 U. S. EPA Region 5 RCRA. Ecological Screening Levels. August 2003.

U. S. EPA Region 9. Regional Screening Levels, November 2013.

EPA. 2004. Guidance in Environmental Data Verification and Data Validation. EPA QA/G-8.

NIPSCO LLC RMSGS
CLOSURE APPLICATION
QUALITY ASSURANCE PROJECT PLAN
Project Organization Chart
Figure 1



ATTACHMENT A

Pace Indianapolis, Indiana
Quality Assurance Manual

Document Information

Document Number: ENV-MAN-IND1-0001 **Revision:** 02

Document Title: Quality Manual

Department(s): Quality

Date Information

Effective Date: 03 Feb 2020

Notes

Document Notes:

All Dates and Times are listed in: Central Time Zone

Signature Manifest

Document Number: ENV-MAN-IND1-0001 **Revision:** 02

Title: Quality Manual

All dates and times are in Central Time Zone.

ENV-MAN-IND1-0001 Quality Manual

QM Approval

Name/Signature	Title	Date	Meaning/Reason
Elizabeth Schrage (008534)	Manager - Quality	31 Jan 2020, 10:41:35 AM	Approved

Management Approval

Name/Signature	Title	Date	Meaning/Reason
Kelly Jones (005070)	Manager	31 Jan 2020, 10:50:41 AM	Approved
Scott Bryan (003661)	Quality Analyst 3	31 Jan 2020, 11:26:14 AM	Approved
Felicia Walker (005354)	Manager	31 Jan 2020, 11:52:22 AM	Approved
Anne Troyer (008754)	Quality Analyst 3	31 Jan 2020, 12:17:51 PM	Approved
Joyce Sarapata (008874)	Supervisor	31 Jan 2020, 12:53:26 PM	Approved
Sarah Potts (007977)	Manager	31 Jan 2020, 01:07:01 PM	Approved
Melanie Booms (005590)	Project Manager 1	31 Jan 2020, 01:55:14 PM	Approved
Timothy Pinckert (003677)	Manager	03 Feb 2020, 09:22:20 AM	Approved
Rachel Wrede (008235)	Manager	03 Feb 2020, 09:22:46 AM	Approved
Steven Sayer (004775)	General Manager 2	03 Feb 2020, 09:22:52 AM	Approved
Jeffrey Worm (005618)	Scientist Team Lead	03 Feb 2020, 09:47:00 AM	Approved
Richard Bowman (009334)	Systems Administrator	03 Feb 2020, 11:05:03 AM	Approved
Jennifer Rice (005579)	Supervisor	03 Feb 2020, 03:35:28 PM	Approved
Karl Anderson (004767)	Regional Director - Operations	03 Feb 2020, 03:59:58 PM	Approved

TITLE PAGE

LABORATORY QUALITY MANUAL

Prepared for:

Pace Analytical Services, LLC
7726 Moller Road
Indianapolis, IN 46268
Phone: 317-228-3100

Pace Analytical Services, LLC
5560 Corporate Exchange Ct. SE
Grand Rapids, MI 49512
Phone: 616-975-4500

Pace Analytical Services, LLC
4860 Blazer Parkway
Dublin, OH 43017
Phone: 614-486-5421

Manual Approval Signatories

Approval of this manual by managerial personnel is recorded on the Signature Manifest located before the Title Page of this manual.

The individuals listed below represent the management team that was in place on the effective date of this version of the manual for the following location:

Pace Analytical Services, LLC
7726 Moller Road
Indianapolis, IN 46268
Phone: 317-228-3100

Each of the following individuals is a signatory for the manual for the location listed above. The application of their signature to the manual signifies their commitment to communicate, implement, and uphold the requirements, policies and procedures specified in this manual and their commitment to continuously improve the effectiveness of the quality management system based on customer feedback and internal assessment.

Name[1]	Title	Address[2]	Phone[2]
Karl Anderson	Regional Director – Operations		
Steve Sayer	General Manager		
Beth Schrage	Quality Manager		
Kelly Jones	Manager – Client Services		
Felicia Walker	Manager – Metals Department		
Tim Pinckert	Manager – Semivolatiles Department		
Rachel Wrede[3]	Manager – Volatiles Department		
Sarah Potts	Manager – Wet Chemistry Department		
Anne Troyer[3]	Quality Assurance Analyst		
Rick Bowman	Systems Administrator		
Scott Bryan	Quality Assurance Analyst/Safety Officer		

[1] Members of the local management team are subject to change during the life-cycle of this document version.
[2] Include if different from the physical address and phone number of the facility.
[3] This individual serves as an Acting Technical Manager for TNI for one or more fields of accreditation.

Manual Approval Signatories

Approval of this manual by managerial personnel is recorded on the Signature Manifest located before the Title Page of this manual.

The individuals listed below represent the management team that was in place on the effective date of this version of the manual for the following location:

Pace Analytical Services, LLC
5560 Corporate Exchange Ct. SE
Grand Rapids, MI 49512
Phone: 616-975-4500

Each of the following individuals is a signatory for the manual for the location listed above. The application of their signature to the manual signifies their commitment to communicate, implement, and uphold the requirements, policies and procedures specified in this manual and their commitment to continuously improve the effectiveness of the quality management system based on customer feedback and internal assessment.

Name[1]	Title	Address[2]	Phone[2]
Karl Anderson	Regional Director – Operations	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Steve Sayer	General Manager	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Beth Schrage	Quality Manager	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Jennifer Rice[3]	Supervisor		
Jeff Worm[3]	Scientist – Team Lead		
Rick Bowman	Systems Administrator	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Melanie Booms	Project Manager/Safety Officer		

[1] Members of the local management team are subject to change during the life-cycle of this document version.
[2] Include if different from the physical address and phone number of the facility.
[3] This individual serves as an Acting Technical Manager for TNI for one or more fields of accreditation.

Manual Approval Signatories

Approval of this manual by managerial personnel is recorded on the Signature Manifest located before the Title Page of this manual.

The individuals listed below represent the management team that was in place on the effective date of this version of the manual for the following location:

Pace Analytical Services, LLC
4860 Blazer Parkway
Dublin, OH 43017
Phone: 614-486-5421

Each of the following individuals is a signatory for the manual for the location listed above. The application of their signature to the manual signifies their commitment to communicate, implement, and uphold the requirements, policies and procedures specified in this manual and their commitment to continuously improve the effectiveness of the quality management system based on customer feedback and internal assessment.

Name[1]	Title	Address[2]	Phone[2]
Karl Anderson	Regional Director – Operations	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Steve Sayer	General Manager	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Beth Schrage	Quality Manager	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Joyce Sarapata	Supervisor		
Rick Bowman	Systems Administrator	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100
Scott Bryan	Quality Assurance Analyst/Safety Officer	7726 Moller Rd., Indianapolis, IN 46268	317-228-3100

[1] *Members of the local management team are subject to change during the life-cycle of this document version.*
[2] *Include if different from the physical address and phone number of the facility.*

Table of Contents

1.0 PURPOSE AND SCOPE

1.1 Purpose

This quality manual (manual) outlines the quality management system and management structure of the laboratories and service centers affiliated with Pace Analytical Services, LLC (PAS). A laboratory is defined by PAS as any PAS facility, however named, that provides testing, sampling, or field measurement services. When the term 'laboratory" is used in this manual, the term refers to all locations listed on the Title Page of this manual and in Section 4.1.3 unless otherwise specified.

The PAS quality management system is also referred to as the quality program throughout this document. In this context, the phrase "quality management system" and "quality program" are synonymous.

The quality management system is the collection of policies and processes established by PAS management to consistently meet customer requirements and expectations, and to achieve the goals to provide PAS customers with high quality, cost-effective, analytical measurements and services.

The quality management system is also intended to establish conformance[1] and compliance with the current versions of the following international and national quality system standards:

- ISO/IEC 17025: *General requirements for the competence of testing and calibration laboratories*
- NELAC/TNI Standard Volume 1: *Management and Technical Requirements for Laboratories Performing Environmental Analysis*

[1]The statement of conformity to these Standards pertains only to testing and sampling activities carried out by the laboratory at its physical address, in temporary or mobile facilities, in-network, or by laboratory personnel at a customer's facility.

In addition to the international and national standards, the quality management system is designed to achieve regulatory compliance with the various federal and state programs for which the laboratory provides compliance testing and/or holds certification or accreditation. When federal or state requirements do not apply to all PAS locations, the requirements for compliance are provided in addendum to this manual or in other documents that supplement the manual. Customer-specific project and program requirements are not included in the manual in order to maintain client confidentiality.

- A list of accreditation and certifications held by each laboratory associated with this manual is provided in Appendix A.
- A list of analytical testing capabilities offered by each laboratory associated with this manual is provided in Appendix B.

1.2 Scope and Application

This manual applies to each of the PAS locations listed on the Title Page and in Section 4.1.3.

The manual was prepared from a quality manual template (template) created by PAS corporate quality personnel. The template outlines the minimum requirements PAS management considers necessary for every PAS laboratory, regardless of scope of services or number of personnel, established in order to maintain a quality management system that achieves the objectives of PAS's Quality Policy (See 4.2.2). In this regard, the template is the mechanism used by the corporate officers (a.k.a. 'top management') to communicate their expectations and commitment for the PAS quality program to all PAS personnel.

The laboratory also has the responsibility to comply with federal and state regulatory and program requirements for which it provides analytical services and holds certification or accreditation. When those requirements are more stringent than the template, the requirements for compliance are provided in addendum to this manual or in other documents that supplement the manual. This document structure maintains consistency in the presentation of the quality management system across the network while providing the laboratory a mechanism to describe and achieve compliance requirements on a program basis.

1.2.1 Quality Manual Template

The quality manual template is developed by the Corporate Quality Director with contribution and input from corporate quality personnel and the corporate officers. Approval of the template by the corporate officers (aka "top management") confirms their commitment to develop and maintain a quality management system appropriate for the analytical services offered by the organization and to communicate their expectations of the quality program to all personnel.

The template and instructions for use of the template are released by corporate quality personnel to quality assurance manager(s) responsible for each laboratory (Local QA). Local QA uses the template to prepare the laboratory's manual by following the instructions provided. Since the template provides the minimum requirements by which all PAS locations must abide, the laboratory may not alter the font, structure or content of the template except where specified by instruction to do so. As previously stated, program specific requirements are provided in addendum or in documents that supplement this manual.

The template is reviewed by corporate quality personnel every two years and updated if needed. More frequent review and revision may be necessary to manage change, to maintain conformance and compliance to relevant standards, or to meet customer expectations.

See standard operating procedure (SOP) ENV-SOP-CORQ-00015 *Document Management and Control* for more information.

1.2.2 Laboratory Quality Manual

The manual is approved and released to personnel under the authority of local management. The manual is reviewed annually and location specific information is updated, if needed. More frequent review and revision may be necessary when there are significant changes to the organizational structure, capabilities, and resources of the laboratory. Review and revision of the manual is overseen by local QA. If review indicates changes to the main body of the manual are necessary to maintain conformance and compliance to relevant standards, or to meet customer expectations, local QA will notify corporate quality personnel to initiate review and/or revision of the template.

See SOP ENV-SOP-CORQ-00015 *Document Management and Control* for more information.

1.2.3 References to Supporting Documents

The template and the manual include references to other laboratory documents that support the quality management system such as policies and standard operating procedures (SOPs). These references include the document's document control number and may include the document title.

This information is subject to change. For example, an SOP may be converted to a policy or the document's title may change. For these types of administrative changes, the manual and template are updated to reflect the editorial change during the document's next scheduled review/revision cycle or the next time a new version of the document is released, whichever is sooner.

Local QA maintains a current list of controlled documents used at each PAS location to support the quality management system. This list, known as the Master List, lists each document used by document control number, title, version, effective date, and reference to any document(s) that the current version supersedes. When there is a difference between the template and/or manual and the Master List, the document information in the Master List takes precedence. The current Master List is readily available to personnel for their use and cross-reference. Parties external to the laboratory should contact the laboratory for the most current version.

2.0 REFERENCES

References used to prepare this manual include:

- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act." Federal Register, 40 CFR Part 136, most current version.
- "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846.
- "Methods for Chemical Analysis of Water and Wastes", EPA 600-4-79-020, 1979 Revised 1983, U.S. EPA.
- U.S. EPA Contract Laboratory Program Statement of Work for Organic Analysis, current version.
- U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Analysis, current version.
- "Standard Methods for the Examination of Water and Wastewater." Current Edition APHA-AWWA-WPCF.
- "Annual Book of ASTM Standards", Section 4: Construction, Volume 04.04: Soil and Rock; Building Stones, American Society of Testing and Materials.
- "Annual Book of ASTM Standards", Section 11: Water and Environmental Technology, American Society of Testing and Materials.
- "NIOSH Manual of Analytical Methods", U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, most current version.
- "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water", U.S. EPA, Environmental Monitoring and Support Laboratory – Cincinnati (Sep 1986).
- Quality Assurance of Chemical Measurements, Taylor, John K.; Lewis Publishers, Inc. 1987.
- Methods for Non-conventional Pesticides Chemicals Analysis of Industrial and Municipal Wastewater, Test Methods, EPA-440/1-83/079C.
- Environmental Measurements Laboratory (EML) Procedures Manual, HASL-300, US DOE, February, 1992.
- Requirements for Quality Control of Analytical Data, HAZWRAP, DOE/HWP-65/R1, July, 1990.

- Quality Assurance Manual for Industrial Hygiene Chemistry, AIHA, most current version.
- National Environmental Laboratory Accreditation Conference (NELAC) Standard- most current version.
- ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories- most current version.

  The following are implemented by normative reference to ISO/IEC 17025:

  - ISO/IEC Guide 99, *International vocabulary of metrology –Basic and general concepts and associated terms*
  - ISO/IEC 17000, *Conformity assessment – Vocabulary and general principles*
- Department of Defense Quality Systems Manual (QSM), most current version.
- TNI (The NELAC Institute) Standard- most current version applicable to each lab.
- UCMR Laboratory Approval Requirements and Information Document, most current version.
- US EPA Drinking Water Manual, most current version.

3.0 TERMS AND DEFINITIONS

Refer to Appendix C for terms, acronyms, and definitions used in this manual and in other documents used by the laboratory to support the quality management system.

4.0 MANAGEMENT REQUIREMENTS

4.1 Organization

4.1.1 Legal Identity

Pace Analytical Services, LLC is authorized under the State of Minnesota to do business as a limited liability company.

4.1.1.1 Change of Ownership

If there is a change of ownership, if a location goes out of business, or if the entire organization ceases to exist, Pace Analytical Services, LLC ensures that regulatory authorities are notified of the change within the time-frame required by each state agency for which the location is certified or accredited.

Requirements for records and other business information are addressed in the ownership transfer agreement or in accordance with appropriate regulatory requirements, whichever takes precedence.

4.1.2 Compliance Responsibility

Laboratory management has the responsibility and authority to establish and implement procedures and to maintain sufficient resources necessary to assure its activities are carried out in such a way to meet the compliance requirements of the quality management system.

4.1.3 Scope of the Quality Management System

The quality management system applies to work carried out at each location covered by this manual including permanent facilities, at sites away from its permanent facilities, or in associated temporary or mobile facilities.

The permanent and mobile facilities to which this manual applies include:

Name	Pace Analytical Services, LLC
Address:	7726 Moller Road
City, State, Zip	Indianapolis, IN 46268
Phone Number	317-228-3100
Service Type:	Laboratory

Name	Pace Analytical Services, LLC
Address:	5560 Corporate Exchange Ct. SE
City, State, Zip	Grand Rapids, MI 49512
Phone Number	616-975-4500
Service Type:	Laboratory

Name	Pace Analytical Services, LLC
Address:	4860 Blazer Parkway
City, State, Zip	Dublin, OH 43017
Phone Number	614-486-5421
Service Type:	Laboratory

4.1.4 Organization History and Information

Founded in 1978, Pace Analytical Services, LLC (PAS) is a privately held scientific services firm operating one of the largest full service contract laboratory and service center networks in the United States. The company's network offer inorganic, organic and radiochemistry testing capabilities; specializing in the analysis of trace level contamination in air, drinking water, groundwater, wastewater, soil, biota, and waste.

With over 90 laboratories and services centers in the contiguous US and in Puerto Rico, the network provides project support for thousands of industry, consulting, engineering and government professionals.

Pace delivers the highest standard of testing and scientific services in the market. We offer the most advanced solutions in the industry, backed by truly transparent data, a highly trained team, and the service and support that comes from four decades of experience.

4.1.4.1 Organization Structure

Each location maintains a local management structure under the oversight and guidance of corporate personnel. Local management is responsible for making day-to-day decisions regarding the operations of the facility, implementing the quality management system, upholding the requirements of the quality program, and for supervision of personnel.

Local management is provided by a General Manager (GM), Quality Manager (QM), Client Services Manager (CSM), Information Technology (IT) Manager, and/or Department Managers (DM), however named.

Some locations may also have any one of the following management positions: Operations Manager (OM), Technical Director (TD), or Technical Manager (TM). When the location does not have a TD or TM, technical management is provided jointly by the GM, QM, DM, and DS.

The GM, however named reports to a Senior General Manager (SGM), who is responsible for the management of multiple laboratories and service centers within a geographical region, and who reports directly to the Chief Operating Officer (COO). The QM has indirect reporting relationship to the Corporate Director of Quality.

Refer to the organization charts provided in Appendix D to view the management structure, reporting relationships, and the interrelationships between positions.

4.1.5 Management Requirements

4.1.5.1 Personnel

The laboratory is staffed with administrative and technical personnel who perform and verify work under the supervision of managerial personnel.

- Technical personnel include analysts and technicians that generate or contribute to the generation of analytical data and managerial personnel that oversee day to day supervision of laboratory operations, including the reporting of analytical data and results, monitoring QA/QC performance, and monitoring the validity of analysis to maintain data integrity and reliability.
- Administrative personnel support the day-to-day activities of the laboratory.
- IT personnel maintain the information technology systems and software used at the laboratory.
- Client services personnel include project managers and support staff that manage projects.
- Managerial personnel make day-to-day and longer term decisions regarding the operations of the facility, supervise personnel, implement the quality management system and uphold the requirements of the quality program.

All personnel regardless of responsibilities are expected to carry out their duties in accordance with the policies and processes outlined in this manual and in accordance with standard operating procedures (SOPs) and other quality system documents. The laboratory's policies and procedures are designed for impartiality and integrity. When these procedures are fully implemented, personnel remain free from undue pressure and other influences that adversely impact the quality of their work or data.

4.1.5.1.1 Key Personnel

Key personnel include the management positions that have the authority and responsibility to plan, direct, and control, activities of the division (corporate) or the laboratory.

The following tables list key personnel positions by PAS job title and the position's primary deputy:

Key Personnel: Corporate

Key Personnel	Primary Deputy
Chief Executive Officer	Chief Operating Officer
Chief Operating Officer	Chief Executive Officer
Chief Compliance Officer	Quality Director
Corporate Quality Director	Chief Compliance Officer
Health and Safety Director	Chief Compliance Officer
IT Director	LIMS Administrator, however named.

Key Personnel: Laboratory

Key Personnel	Primary Deputy
General Manager	Regional Director of Operations or as designated
Quality Manager	Corporate Quality Manager
Client Services Manager	General Manager
Local IT	Corporate IT Director or as designated.
Department Manager	General Manager

Some state certification programs require the agency to be notified when there has been a change in key personnel. Program-specific requirements and time-frames for notification by agency, are tracked and upheld by local QA, when these requirements apply.

4.1.5.2 Roles and Responsibilities

The qualifications, duties, and responsibilities for each position are detailed in job descriptions maintained by PAS's corporate Human Resource's Department (HR).

The following summaries briefly identify the responsibility of key personnel positions in relation to the quality management system.

Chief Executive Officer (CEO): The CEO has overall responsibility for performance of the organization and endorses the quality program. Working with corporate and laboratory management, the CEO provides the leadership and resources necessary for PAS locations to achieve the goals and objectives of the quality management system and quality policy statement.

Chief Operating Officer (COO): The COO oversees all aspects of operations management including, strategic planning, budget, capital expenditure, and management of senior management personnel. In this capacity, the COO provides leadership and resources necessary to help top management at each PAS location achieve the goals and objectives of the quality management system and quality policy statement.

Chief Compliance Officer (CCO): The CCO oversees the quality assurance and environmental health and safety programs (HSE) for each business unit. The CCO is responsible for planning and policy development for these groups to ensure regulatory compliance and to manage risk. The position provides leadership and guidance necessary for all PAS locations to achieve the goals and objectives of the quality and HSE programs.

The CCO also serves as the Ethics Officer (ECO). The ECO develops the Ethics and Data Integrity Policy and Training Program, and provides oversight for reporting and investigation of ethical misconduct to maintain employee confidentiality during the process. The ECO provide guidance and instruction for follow-up actions necessary to remedy the situation and deter future recurrence.

Corporate Director of Quality: The Corporate Director of Quality is responsible for developing and maintaining the PAS quality program under guidance and assistance from the CEO, COO, and CCO. This position helps develop corporate quality policy and procedure and analyzes metric data and other performance indicators to assess and communicate the effectiveness of the quality program to top management. The position provides leadership and guidance for implementation of the quality program across all PAS locations.

Corporate Director of Information Technology: The Corporate Director of IT oversees the systems and processes of information technology used to support the quality program. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, communication tools, and ensuring the integrity and security of electronic data.

Regional Director – Operations: The Regional Director of Operations has full responsibility for administrative and operations management and performance of a group of PAS laboratories and service centers. Working with the COO and local laboratory management, the Regional Director of Operations provides leadership, guidance and resources, including allocation of personnel, necessary to achieve the goals of PAS quality program.

General Manager (GM): The GM is responsible for the overall performance and administrative and operations management of a PAS location and associated service center(s). This position is responsible to provide leadership and resources, including allocation and supervision of personnel, necessary for the location to implement and achieve the goals of the PAS quality program. In this capacity, the position assures laboratory personnel are trained on and understand the structure and components of the quality program defined in this manual as well as the policies and procedures in place to implement the quality management system.

The GM of NELAC/TNI Accredited laboratories are also responsible for the designation of technical personnel to serve as acting technical managers for TNI for the fields of accreditation held by the laboratory (See Section 4.1.5.2.1) and for notifying the accreditation body (AB) of any extended absence or reassignment of these designations.

Quality Manager (QM): The QM oversees and monitors implementation of the quality management system and communicates deviations to laboratory management. The QM is independent of the operation activities for which they provide oversight and has the authority to carry out the roles and responsibilities of their position without outside influence.

Additionally, in accordance with the TNI Standard, the QM:

- serves as the focal point for QA/QC and oversees review of QC data for trend analysis;
- evaluates data objectively and perform assessments without outside influence;
- has documented training and experience in QA/QC procedures and the laboratory's quality system;
- has a general knowledge of the analytical methods offered by the laboratory;
- coordinates and conducts internal systems and technical audits;
- notifies laboratory management of deficiencies in the quality system;
- monitors corrective actions;
- provides support to technical personnel and may serve as the primary deputy for the acting TNI Technical Manager(s).

Client Services Manager (CSM): The CSM oversees project management personnel. This position is responsible for training and management of client facing staff that serve as the liaison between PAS and the customer to ensure that projects are successfully managed to meet the expectations and needs of PAS customers. This position is also responsible for sharing positive and negative customer feedback with laboratory management so that this information may be used to improve the quality program.

Systems Administrator: Local Systems Administrators are responsible for maintaining the IT systems used to support the quality program, ensuring the integrity and security of electronic data. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, and communication systems.

Department Manager (DM): The DM is responsible for administrative and operations management and implementation of the quality management system in the work area he/she oversees. These responsibilities include but are not limited to: training and supervision of personnel, monitoring work activity to maintain compliance with this manual, SOPs, policies and other instructional documents that support the quality management system; method development, validation and the establishment and implementation of SOPs to assure regulatory compliance and suitability for intended purpose; monitoring QA/QC performance, proper handling and reporting of nonconforming work, purchasing of supplies and equipment adequate for use, maintaining instrumentation and equipment in proper working

order and calibration, and general maintenance of administrative and technical processes and procedures established by the laboratory.

Technical Director (TD): The TD provides technical oversight and guidance to laboratory personnel. Responsibilities may include but are not limited to: research and development, method development and validation, development of standard operating procedures, proposal and contract review. The TD may also be responsible for QA/QC trend analysis, technical training, and technology improvement.

4.1.5.2.1 Acting Technical Manager (TNI Accreditation):

For PAS locations that are NELAC/TNI accredited:

The TNI Standard specifies requirements for the qualification and duties of technical personnel with managerial responsibility. These requirements are associated in the Standard to the designation 'technical manager(s), however named'. These responsibilities may be assigned to multiple individuals and are not associated with any specific job title.

For PAS, these TNI requirements for personnel that provide technical oversight correlate with PAS's job descriptions for Department Manager or Supervisor. However, the duties may be assigned to any PAS employee that meets the TNI specified qualifications.

Personnel assigned this designation retain their PAS assigned job title. The job title may be appended with *"acting as technical manager for TNI"* and the technology or field of accreditation for which the employee is approved, if necessary.

When TNI Accreditation Bodies (AB) refer to these employees as 'technical manager' or 'technical director' on the official certificate or the scope of accreditation, this reference is referring to their approval to carry out duties of the 'technical manager, however named' as specified in the TNI Standard.

In accordance with the TNI Standard, the acting Technical Manager(s) for TNI are responsible for monitoring the performance of QC/QA in the work areas they oversee.

If the absence of any employee that is approved as acting technical manager for TNI exceeds 15 calendar days, the duties and responsibilities specified in the TNI Standard are reassigned to another employee that meets the qualifications for the technology or field of accreditation or they are assigned to the position's deputy, the Quality Manager.

4.1.5.3 Conflict of Interest

A conflict of interest is a situation where a person has competing interests. Laboratory management looks for potential conflict of interest and undue pressures

that might arise in work activities and then includes countermeasures in policies and procedures to mitigate or eliminate the conflict.

See policy COR-POL-0004 *Ethics Policy* for more information.

4.1.5.4 Confidentiality

Laboratory management is committed to preserving the confidentiality of PAS customers and confidentiality of business information.

Procedures used by the laboratory to maintain confidentiality include:

- A Confidentiality Agreement which all employees are required to sign at the time of employment and abide by its conditions throughout employment;
- Record retention and disposal procedures that assure confidentiality is maintained;
- Physical access controls and encryption of electronic data; and
- Protocol for handling Confidential Business Information (CBI).

Client information obtained or created during work activities is considered confidential and is protected from intentional release to any person or entity other than the client or the client's authorized representative information provided to PAS, except when the laboratory is required by law to release confidential information to another party, such as a regulatory agency or for litigation purposes. In which case, the laboratory will notify the client of the release of information and the information provided.

The terms of client confidentiality are included in PAS Standard Terms and Conditions (T&C). With the acceptance of PAS Terms and Conditions and/or the implicit contract for analytical services that occurs when the client sends samples to the laboratory for testing, the client authorizes PAS to release confidential information when required.

See policy COR-POL-0004 *Ethics Policy* for more information.

4.1.5.5 Communication

Management ensures that appropriate communication processes are established within the laboratory and that communication takes place regarding the effectiveness of the management system.

4.1.5.5.1 Workplace Communication

Good communication in the workplace is necessary to assure work is done correctly, efficiently, and in accordance with client expectations.

Instructions for how to carry out work activities are communicated to personnel via written policy, standard operating procedures, and standard work instructions.

Information about laboratory performance (positive and negative) and ideas for improvement are communicated using various communication channels such as face to face meetings, video conferencing, conference calls, email, memoranda, written reports, and posters.

4.1.5.5.2 External Communication

Communication with external parties such as customers, vendors, business partners, and regulatory agencies takes place every day.

Laboratory management ensures personnel learn to communicate in professional and respectful ways in order to build strong relationships, and learn to communicate effectively to avoid misunderstanding.

4.2 Quality Management System

4.2.1 Quality Management System Objectives

The objectives of the laboratory's quality management system are to provide clients with consistent, exemplary professional service, and objective work product that is of known and documented quality that meets their requirements for data usability and regulatory compliance.

Objective work product is analytical services, data, test results, and information that is not influenced by personal feeling or opinions. The quality of being objective is also known as 'impartiality'.

4.2.1.1 Impartiality

The laboratory achieves and maintains impartiality by implementing and adhering to the policies and processes of the quality management system, which are based on industry accepted standards and methodologies.

The laboratory's procedures for handling nonconforming work (See 4.9), corrective and preventive actions (See 4.12) and management review (See 4.15) are the primary mechanisms used to identify risk to impartiality and to prompt actions necessary to eliminate or reduce the threat when risk to impartiality is suspected or confirmed.

4.2.1.2 Risk and Opportunity Assessment

Risks are variables that make achieving the goals and objectives of the quality management system uncertain. An opportunity is something that has potentially positive consequences for the laboratory.

Laboratory personnel manage risks and opportunities on a daily basis by carrying out the processes that make up the quality management system. Some of the ways in which the quality management system is designed to identify, minimize, or eliminate risk on a daily basis include but are not limited to:

- Capability and capacity reviews of each analytical service request to assure the laboratory can meet the customer's requirements;

- Maintenance of accreditation and certification for test methods in multiple states and programs to cover a broad range of jurisdiction for regulatory compliance;
- SOPs and other controlled instructional documents provided to personnel to eliminate variability in process. These documents include actions to counter risk factors inherent in the process and are reviewed on a regular basis for on-going suitability and relevancy;
- Participation in proficiency testing programs and auditing activities to verify on-going competency and comparability in performance;
- Provision of on-the-job training and established protocol for quality control (QC) corrective action for nonconforming events;
- An established program for ethics, and data integrity;
- Tiered data review process;
- Culture of continuous improvement;
- Monitoring activities to assess daily and long term performance; and
- Annual critical review of the effectiveness the quality management system.

PAS also promotes a continuous improvement culture based on the principles of lean manufacturing. These principles include 3P (Process, Productivity, Performance) and Kaizen. 3P is a platform used by Pace to share best practices and to promote standardization across the network to achieve operational excellence. Kaizen is a team based process used to implement tools and philosophies of lean to reduce waste and achieve flow with the purpose of improving both external and internal customer satisfaction. PAS's lean programs and activities help to mitigate risk because they generate a collective understanding of vulnerabilities and utilize group-effort to develop and implement solutions at all levels.

Risk and opportunities may also be formally identified using specific risk and opportunity assessment methods such as SWOT Analysis (Strength, Weakness, Opportunity, Threats) and 3-Stage Impact/Probability Grids.

4.2.1.3 Communication of the Quality Management System

This manual is the primary mechanism used by laboratory management to communicate the quality management system to laboratory personnel.

To assure personnel understand and implement the quality program outlined in the manual:

- All laboratory personnel are required to sign a Read and Acknowledgement Statement to confirm the employee has: 1) been informed of the manual by laboratory management, 2) has access to the manual, 3) has read the manual 4) understands the content of the manual, and 5) agrees to abide by the requirements, policies and procedures therein.

- Personnel are informed that the manual provides the "what" of the quality management system. The "how to" implementation of the quality management system is provided in policies, SOPs, standard work instructions, and other controlled instructional documents.

4.2.2 Quality Policy Statement

The quality policy of the laboratory is to provide customers with data of known and documented quality fit for their intended purpose. The laboratory achieves this policy by implementing the quality management system defined in this manual, by following industry accepted protocol for analytical testing and quality assurance and quality control (QA/QC) activities, by conformance with published and industry accepted testing methodologies, and by compliance with international and national standards for the competency and/or accreditation of testing laboratories.

Intrinsic to this policy statement is each of the following principles:

- The laboratory will provide customers with reliable, consistent, and professional service. This is accomplished by making sure the laboratory has the resources necessary to maintain capability and capacity; that staff are trained and competent to perform the tasks they are assigned; that client-facing staff are trained and prepared to find solutions to problems and to assist customers with their needs for analytical services. Customer feedback, both positive and negative, is shared with personnel and used to identify opportunities for improvement.
- The laboratory maintains a quality program that complies with applicable, state, federal, industry standards for analytical testing and competency.

  ISO/IEC 17025 and the TNI (The NELAC Institute) Standard are used by PAS to establish the minimum requirements of the PAS quality program.

  ISO/IEC 17025 is a competency standard that outlines the general requirements for the management system for calibration and testing laboratories. It is the primary quality system standard from which other quality system standards, such as the TNI Standard, are based. The TNI Standards are consensus standards that provide management and technical requirements for laboratories performing environmental analysis.
- Laboratory management provides training to personnel so that all personnel are familiar with the quality management system outlined in this manual and that they understand that implementation of the quality management system is achieved by adherence to the organization's policies and procedures.
- Laboratory management continuously evaluates and improves the effectiveness of the quality management system by responding to customer feedback, and other measures of performance, such as but not limited to: the results of internal/external audits, proficiency testing, metrics, trend reports, and annual and periodic management reviews.

4.2.2.1 Ethics Policy / Data Integrity Program

PAS has established a comprehensive ethics and data integrity program that is communicated to all PAS employees to ensure that they understand what is expected

of them. The program is designed to promote a mindset of ethical behavior and professional conduct that is applied to all work activities.

The key elements of the PAS Ethics / Data Integrity Program include:

- Ethics Policy (COR-POL-0004);
- Ethics Compliance Officer;
- Standardized data integrity training course taken by all new employees on hire and a yearly refresher data integrity training course for all existing employees;
- Policy Acknowledgement Statements that all PAS personnel, including contract and temporary, are required to sign at the time of employment and again during annual refresher training to document the employee's commitment and obligation to abide by the company's standards for ethics, data integrity and confidentiality;
- SOPs that provide instructions for how to carry out a test method or process to assure tasks are done correctly and consistently by each employee;
- On the Job Training;
- Data integrity monitoring activities which include, but are not limited to, secondary and tertiary data review, internal technical and system audits, raw data audits, data mining scans, and proficiency testing; and
- Confidential reporting process for alleged ethics and data integrity issues.

All laboratory managers are expected to provide a work environment where personnel feel safe and can report unethical or improper behavior in complete confidence without fear of retaliation. Retaliation against any employee that reports a concern is not tolerated.

PAS has engaged Lighthouse Services, Inc. to provide personnel with an anonymous reporting process available to them 24 hours a day/7 days per week. The alert line may be used by any employee to report possible violations of the company's ethics and data integrity program. When using the reporting process, the employee does need to specify the location of concern and when reporting by email, also include the company name. Messages are collected, documented, reviewed, and will be followed up on by the Ethics Compliance Officer to resolve the matter. Investigations concerning data integrity are kept confidential.

Lighthouse Compliance Alert Lines:

English Speaking US & Canada	(844) 940-0003
Spanish Speaking North America	(800) 216-1288
Internet	www/lighthouse-services.com/pacelabs
Email	reports@lighthouse-services.com

4.2.3 Management Commitment: Quality Management System

Evidence of management's commitment for the development, maintenance, and on-going improvement of the quality management system is provided by the application of their signature of approval to this manual. Their signature confirms they understand their responsibility to implement the quality management system outlined in this manual, to communicate the quality program to personnel, and to uphold requirements of the program during work activities.

4.2.4 Management Commitment: Customer Service

Management communicates the importance of meeting customer and regulatory requirements to personnel by training personnel on the quality management system outlined in this manual, implementing the quality management system outlined in this manual, and upholding these requirements for all work activities.

4.2.5 Supporting Procedures

Documents that support this manual and quality management system are referenced throughout this manual. The structure of the document management system is outlined in SOP ENV-SOP-CORQ-0015 *Document Management and Control* and summarized in the following subsections.

4.2.5.1 Quality Management System Document Structure

Documents associated with the quality management system are classified into document types that identify the purpose of the document and establish how the document is managed and controlled.

Document types are ranked to establish which documents takes precedence when there is an actual or perceived conflict between documents and to establish the hierarchal relationships between documents. The ranking system also provides information to document writers and reviewers to assure downline documents are in agreement with documents of higher rank. Project-specific documents are not ranked because client-specific requirements are not incorporated into general use documents in order to maintain client confidentiality.

PAS Quality Management System Documents: Internal

Document Type	Purpose
Quality Manual	Outlines the laboratory's quality management system and structure and how it works for a system including policy, goals, objectives and detailed explanation of the system and the requirements for implementation of system. Includes roles and responsibilities, relationships, procedures, systems and other information necessary to meet the objectives of the system described.
Policy	Provide requirements and rules for a PAS process and is used to set course of actions and to guide and influence decisions. Policy describes the "what", not the "how".
Standard Operating Procedure	Provide written and consistent set of instructions or steps for execution of a routine process, method, or set of tasks performed by PAS. Includes both fundamental and operational elements for implementation of the systems described in PAS manual(s). Assures that activities are performed properly in accordance with applicable requirements. Designed to ensure consistency, protect HSE of employees and environment, prevent failure in the process and ensure compliance with company and regulatory requirements. SOPs describes the "how" based on policy.

Document Type	Purpose
Standard Work Instruction	Provide step by step visual and/or written instruction to carry out a specific task to improve competency, minimize variability, reduce work injury and strain, or to boost efficiency and quality of work (performance). SWI are associated with an SOP unless the task described is unrelated to generation of or contribution to environmental data or analytical results.
Template	Pre-formatted document that serves as a starting point for a new document.
Guide	Provide assistance to carry out a task. Most often used for software applications.
Form	Used for a variety of purposes such as to provide a standardized format to record observations, to provide information to supplement an SOP.

PAS Quality Management System Documents: External

Document Type	Purpose
Certificate	Lists parameters, methods, and matrices for which the laboratory is certified/accredited to perform within the jurisdiction of the issuing regulatory agency or accreditation body.
Reference Document	Provide information, protocol, instructions, and/or requirements. Examples include quality system standards such as ISO/IEC, TNI, DoD and published referenced methods such as Standard Methods, ASTM, SW846, EPA, and federal and state regulatory bodies.
Project Document	Provides requirements necessary to meet individual client expectations for intended use of data. Examples include: project quality assurance plans (QAPP), client program technical specifications, contracts, and other agreements.

Document Hierarchy

Rank	Document
1	Reference Documents
2	Corporate Manual
3	Corporate Policy
4	Corporate SOP
5	Corporate SWI, Templates & Forms
6	Laboratory Manual
7	Laboratory SOP
8	Laboratory SWI, Templates, & Forms
NA	Project Documents

4.2.6 Roles and Responsibilities

The roles and responsibilities of technical management and of the Quality Manager are provided in section 4.1.5.2.

4.2.7 Change Management

When significant changes to the quality management system are planned, these changes are managed by corporate quality personnel to assure that the integrity of the quality management system is maintained.

4.3 Document Control

4.3.1 General

The laboratory's procedures for document control are provided in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

The documents that support the quality management system include internally generated documents such as manuals, policies, standard operating procedures, standard work instructions, forms, guides, and templates and external source documents such as but not limited to, regulations, standards, reference methods, manuals, and project-specific documents.

The laboratory uses electronic document management software (eDMS)to administer SOPs and other training documents. eDMS automates the process for unique document identification, version control, approval, access, and archival.

4.3.2 Document Approval and Issue

Documents that are part of the quality management system are reviewed by qualified personnel and approved by laboratory management prior by to release for general use.

Local QA maintains a master list of controlled documents used at the laboratory. The master list includes the document control number, document title, and current revision status and is made available to personnel for their reference.

Only the approved versions of documents are available to personnel for use. The eDMS system does not allow user access to draft versions of documents except to personnel assigned to work on the draft. eDMS also restricts access to archived documents except to authorized users, such as local QA, in order to prevent the use of obsolete documents.

See SOP ENV-SOP-CORQ-0015 *Document Management and Control* for more information.

4.3.3 Document Review and Change

Unless a more frequent review is required by regulatory, certification or accreditation program, the laboratory formally reviews documents at least every two years to ensure the document remains current, appropriate, and relevant.

Documents are also informally reviewed every time the document is used. Personnel are expected to refer to and follow instructions in controlled documents when they carry out their work activities. Consequently, any concerns or problems with the document should be caught and brought to the attention of laboratory management on an on-going basis.

Documents are revised whenever necessary to ensure the document remains usable and correct. Older document versions and documents no longer needed are made obsolete and archived for historical purposes.

The laboratory does not allow manual-edits to documents. If an interim change is needed pending re-issue of the document, the interim change is communicated to those that use the document using a formal communication channel, such as SOP Change in Progress form, email, or memorandum.

The document review, revision, and archival process is managed by local QA at the location from which the document was released using the procedures established in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

4.4 Analytical Service Request, Tender, and Contract Review

The laboratory's management and/or client service personnel perform thorough reviews of requests and contracts for analytical services to verify the laboratory has the capability, capacity, and resources

necessary to successfully meet the customer's needs. These review procedures are described in laboratory SOP ENV-SOP-IND1-0011 *Review of Analytical Requests*.

The procedures in this SOP(s) are established to ensure that:

- The laboratory understands the purpose of data collection in order to ensure the test methods requested are appropriate for the intended use of the data and capable of meeting the client's data quality objectives;
- The laboratory and any subcontractor has the capability, capacity, and resources to meet the project requirements and expectations within the requested time frame for delivery of work product;
- Any concerns that arise from review are discussed and resolved with the client; and
- The results of review and any correspondence with the client related to this process and/or any changes made to the contract are recorded and retained for historical purposes.

Capability review confirms that the in-network laboratories and any potential subcontractors hold required certification/accreditation for the test method, matrix, and analyte and verifies the laboratory can achieve the client's target compound list and data quality objectives (DQOs) for analytical sensitivity and reporting limits, QA/QC protocol, and hardcopy test report and electronic data deliverable (EDD) formats.

Capacity review verifies that the in-network laboratories and any potential subcontractors are able to handle the sample load and deliver work production within the delivery time-frame requested.

Resource review verifies that the laboratory and any potential subcontractors have adequate qualified personnel with the skills and competency to perform the test methods and services requested and sufficient and proper equipment and instrumentation needed to perform the services requested.

4.5 Subcontracting and In-Network Work Transfer

The terms 'subcontract' and "subcontracting" refers to work sent to a business external to PAS Analytical Services, LLC (PAS) and the term 'subcontractor' refers to these external businesses, which are also called vendors.

Work transferred within the PAS network is referred to as interregional work orders (IRWO) and network laboratories are referred to as IRWO or network laboratory.

The network of PAS laboratories offers comprehensive analytical capability and capacity to ensure PAS can meet a diverse range of client needs for any type of project. If the laboratory receives a request for analytical services and it cannot fulfill the project specifications, the laboratory's client services team will work with the client to place the work within the PAS network. When it is not possible to place the work within network, the laboratory will, with client approval, subcontract the work to a subcontractor that has the capabilities to meet the project specifications and can meet the same commitment agreed to between the laboratory and the client. Some client programs require client consent even for IRWO work transfer, and when this applies, the client services team obtains consent as required. The laboratory retains the record of client notification and their consent in the project record for historical purposes.

Whenever work is transferred to a subcontractor or an IRWO laboratory, the laboratory responsible for management of the project verifies each of these qualifications:

- The subcontractor or IRWO laboratory has the proper accreditation/certifications required for the project and these are current; and
- The use of the subcontractor or IRWO laboratory is approved by the client and/or regulatory agency, when approval is required. Record of approval is retained in the project record.

When possible, the laboratory selects subcontractors that maintain a quality management system similar to PAS and that complies with ISO/IEC 17025 and the TNI Standard(s).

PAS also evaluates and pre-qualifies subcontractors as part of company's procurement program. The complete list of approved vendors is maintained by the corporate procurement department and is made available to all PAS locations. Pre-qualification of a subcontractor does not replace the requirement for the subcontracting laboratory to verify the capability, capacity, and resources of any selected subcontractor on a project-specific basis to confirm the subcontractor can meet the client's needs.

For both subcontracting and in-network work transfer, the project specifications are always communicated to the subcontractor or the IRWO laboratory by the project manager so that the laboratory performing the work is aware of and understands these requirements.

The procedures for subcontracting are outlined in laboratory SOP ENV-SOP-IND1-0005 *Subcontracting Samples*.

4.6 Purchasing Services and Supplies

Vendors that provide services and supplies to the laboratory are prequalified by corporate procurement personnel to verify the vendor's capability to meet the needs of PAS. These needs include but are not limited to: competitive pricing, capacity to fill purchase orders, quality of product, customer service, and business reputation and stability. The records of vendor evaluation and the list of approved vendors is maintained by the corporate procurement department.

The laboratory may purchase goods and services from any supplier on the approved vendor list.

The specifications (type, class, grade, tolerance, purity, etc.) of supplies, equipment, reagents, standard reference materials and other consumables used in the testing process are specified in SOPs. The SOP specifications are based on the governing requirements of the approved reference methods and any additional program driven regulatory specification, such as drinking water compliance. All requisitions for materials and consumables are approved by the department supervisor to confirm the purchase conforms with specified requirements. After approval the requisition is handled by the laboratory's designated purchasing agent. On receipt, the product is inspected and verified before use, when applicable.

The laboratory's procedure for the purchase of services and supplies is specified in laboratory SOP ENV-SOP-IND1-0084 *Purchasing, Receipt, and Storage of Laboratory Supplies*.

4.7 Customer Service

Project details and management is handled by the laboratory's customer service team. Each customer is assigned a Project Manager (PM) that is responsible for review of contract requirements and handling laboratory to customer communication about the project status.

4.7.1 Commitment to Meet Customer Expectations

The laboratory cooperates and works closely with our customers to ensure their needs are met and to establish their confidence in the laboratory's capability to meet their needs for analytical services and expectations for service.

Each customer's project is handled by a project manager (PM) that is the customer's primary point of contact. The PM gathers information from the customer to ensure the details of their request are understood. After samples are received, the PM monitors the progress of the project and alerts the customer of any delays or excursions that may adversely impact data usability. Laboratory supervisors are expected to keep the PM informed of project status and any delays or major issues, so that the PM can keep the client informed.

PAS also has a team of subject matter experts (SME) available to provide customers with advice and guidance and any other assistance needed. SME are selected by top management based on their knowledge, experience, and qualifications.

The laboratory encourages customers to visit the laboratory to learn more about the laboratory's capabilities, observe performance and to meet laboratory personnel.

PAS customers expect confidentiality. Laboratory personnel will not divulge or release information to a third party without proper authorization unless the information is required for litigation purposes. See Section 4.1.5.4 of this manual and policy COR-POL-0004 *Ethics Policy* for more information on the laboratory's policy for client confidentiality.

4.7.2 Customer Feedback

The laboratory actively seeks positive and negative feedback from customers through surveys and direct communication. Information from the client about their experience working with the laboratory and their satisfaction with work product is used to enhance processes and practices and to improve decision making. Customer feedback is communicated to laboratory management and corporate personnel in monthly reports and analyzed yearly during management review (See 4.15) to identify risk and opportunity. Corrective, preventive, or continuous improvement actions are taken based on nature of and/or feedback trends.

Also see sections 4.9, 4.10, 4.11, 4.12, 4.14, and 4.15 for more information about how customer feedback is managed by the laboratory and used to enhance the quality management system.

4.8 Complaints

Complaints provide opportunities to improve processes and build stronger working relationships with our clients.

The laboratory's complaint resolution process includes three steps. First, handle and resolve the complaint to mutual satisfaction. Second, perform corrective action to prevent recurrence (See 4.11). Third, record and track the complaint and use these records for risk and opportunity assessment and preventive action (See 4.12)

4.9 Nonconforming Work

4.9.1 Definition of Nonconforming Work

Nonconforming work is work that does not conform to customer requirements, standard specifications, laboratory policies and procedures, or that does not meet acceptance criteria.

The discovery of non-conforming work comes from various sources which include, but are not limited to:

- results of quality control samples and instrument calibrations;
- quality checks on consumables and materials;
- general observations of laboratory personnel;
- data review;
- proficiency testing;
- internal and external audits;
- complaints and feedback;
- management review and reports; and
- regulatory and certification and accreditation actions.

The way in which the laboratory handles nonconforming work depends on the significance and impact (risk) of the issue. Some issues may simply require correction, others may require investigation, corrective action (See 4.11) and/or data recall (See 4.16). Data and test results associated with nonconforming QC and acceptance criteria are qualified or non-conformances are noted in the final analytical report to apprise the data user of the situation. (See 5.10)

Nonconforming work also includes unauthorized departure from laboratory policies, procedures and test methods. Authorized departures are explained in the following subsections. Situations that do not conform to these conditions are considered unauthorized departure(s).

4.9.1.1 Authorized Departure from SOP

An authorized departure from a test method SOP is one that has been reviewed and approved by the Department Manager, Technical Manager, Acting Technical Manager for TNI, Quality Manager, or the General Manager. Review is conducted to confirm the departure does not conflict with regulatory compliance requirements for which the data will be used or does not adversely affect data integrity. The departure may originate from client request or may be necessary to overcome a problem.

Departure requests are reviewed and pre-approved by the local Quality Manager. Documentation of SOP departures and approval decisions are retained by the laboratory as evidence that the departure was authorized. When necessary, approved departures from test method SOPs are noted in the final test report to advise the data user of any ramification to data quality.

4.9.1.2 Authorized Departure from Test Methods (Method Modifications)

When test results are associated to a published reference test method, the laboratory's test method SOP must be consistent with the test method. If the test method is mandated for use by a specific regulatory program such as drinking water or wastewater or a certification or accreditation program, such as TNI/NELAC, the SOP must also comply with or include these requirements. If the procedures in the SOP are modified from the test method, these modifications must be clearly identified

in the SOP. The conditions under which the laboratory may establish an SOP that is modified from these reference documents, and what is considered a modification are specified in ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification*. Modifications that do not meet the requirements of this SOP (ENV-SOP-CORQ-0011) are unauthorized.

4.9.1.3 Stop Work Authority

Stop Work Authority provides laboratory personnel with the responsibility and obligation to stop work when there is a perceived unsafe condition or behavior that may result in an unwanted event.

All laboratory and corporate personnel have the authority to stop work when needed to preserve data integrity or safety of workers.

Once a stop work order has been initiated and the reason for doing so is confirmed valid; laboratory management is responsible for immediate correction and corrective action (see section 4.11) before resumption of work.

4.10 Continuous Improvement

The laboratory's quality management system is designed to achieve continuous improvement through the implementation of the quality policy and objectives outlined in this manual. Information about the laboratory's activities and performance is gained from many sources such as customer feedback, audits, QC, trend analysis, business analytics, management reports, proficiency testing, and management systems review. This information is subsequently used during the laboratory's corrective action (see section 4.11) and preventive action (see section 4.12) processes and to establish goals and objectives during annual review of the management system (see section 4.15).

PAS also promotes a continuous improvement culture based on the principles of lean manufacturing. These principles include 3P (Process, Productivity, Performance) and Kaizen. 3P is a platform used by Pace to share best practices and standardization across the network to achieve operational excellence. Kaizen is a team based process used to implement tools and philosophies of lean to reduce waste and achieve flow with the purpose of improving both external and internal customer satisfaction.

4.11 Corrective Action

Corrective action is the process used to eliminate the cause of a detected nonconformity. It is not the same as a correction. A correction is an action taken to fix an immediate problem. The goal of the corrective action process is to find the underlying cause(s) of the problem and to put in place fixes to prevent the problem from happening again. The corrective action process, referred to as CAPA by PAS, is one of the most effective tools used by the laboratory to prevent nonconforming work, identify risk and opportunity, and improve service to our customers.

The laboratory has two general processes for corrective action:

Day-to-day quality control (QC) and acceptance criteria exceptions (nonconformance) are handled as corrections. These events do not usually include formal methods for root cause analysis; instead the reason for the failure is investigated through troubleshooting or other measures. Required actions for correction of routine nonconformance are specified in laboratory SOPs. When correction is not performed, cannot be performed, or is not successful, test results associated with the nonconforming

work are qualified in the final test report. Documentation of the nonconformance and correction performed are included in the analytical record.

A formal 7 step corrective action process is used when there is a problem or departure from the quality management system, technical activities, or when the extent of a single problem has significant impact on data, regulatory compliance or customer needs. These problems are identified through various activities such as but not limited to: quality control trends, internal and external audits, management review, customer feedback, and general observation.

The laboratory's 7 Step CAPA Process includes:

1) Define the Problem
2) Define the Scope of the Problem
3) Contain the Problem
4) Root Cause Analysis
5) Plan Corrective Action
6) Implement Corrective Action
7) Follow Up / Effectiveness Check

The formal CAPA process may be initiated by any employee. Once the process is initiated it is overseen and coordinated by laboratory management. The CAPA process is documented using an electronic or paper-based system. The CAPA record includes tracking information, dates, individuals involved, those responsible for action plan implementation and follow-up, and timelines and due dates.

For more information about the laboratory's procedure for corrective action, see laboratory SOP ENV-SOP-IND1-0020 *Corrective and Preventive Actions.* Additional explanation about certain aspects of the laboratory's corrective action process are outlined in the next three subsections.

4.11.1 Root Cause Analysis

Root cause analysis (RCA) is the process of investigation used by the laboratory to identify the underlying cause(s) of the problem. Once causal factors are identified, ways to mitigate the causal factors are reviewed and corrective action(s) most likely to eliminate the problem are selected.

The laboratory uses different methods to conduct this analysis. The most common approach is 5-Why, but fishbone diagrams, or even brainstorming may be appropriate depending on the situation. The method used is documented in the CAPA record.

4.11.2 Effectiveness Review

Monitoring corrective actions for effectiveness is shared by laboratory supervisors and quality assurance personnel. Effectiveness means the actions taken were sustainable and appropriate. Sustainable means the change is still in place. Appropriate means the action(s) taken prevented recurrence of the problem since the time corrective action was taken.

The time-frame in which effectiveness review takes place depends on the event and is recorded in the CAPA record with any addition actions that need to be taken.

Corrective action trends are also monitored by laboratory management and used to identify opportunities for preventive action or to gain lessons learned when actions taken were not adequate to solve the problem. See Section 4.12 (Preventive Action) and 4.15 (Management Review) for more information.

4.11.3 Additional Audits

When non-conformances or other problems cast doubt on compliance with the laboratory's policies, procedures, or compliance to regulatory requirements; laboratory management schedules a special audit of the area of activity in accordance with Section 4.14.1 as soon as possible. These special audits are used to determine the scope of the problem and to provide information for the CAPA process. Additional full-scale audits are done when a serious issue or risk to the laboratory's business is identified.

4.12 Preventive Action

Preventive action is an action taken to eliminate the cause of a potential nonconformity and to achieve improvement. Preventive action is a forward thinking process designed to prevent problems opposed to reacting to them after they have occurred (corrective action).

Some examples of preventative action include, but are not limited to:

- Scheduled instrument maintenance (Preventative maintenance)
- Addition of Staff and Equipment
- Professional Development Activities
- Implementation of New Technology

The laboratory looks for opportunities for preventive action from a variety of sources including but not limited to: employee ideas, customer feedback, input from business partners, trend analysis, business analytics, management reviews, proficiency testing results, lean management events, and risk-benefit analysis.

The process for preventive actions follows the same 7 step process for corrective action except "problem" is replaced with "opportunity", "root cause analysis" is replaced with "benefit analysis", and "corrective action" is replaced with "preventive action".

Laboratory management evaluates the success of preventive actions taken in any given year during annual management review. See Section 4.15 for more information.

4.12.1 Change Management

Preventive actions may sometimes result in significant changes to processes and procedures used by the laboratory. Laboratory management evaluates the risks and benefits of change and includes in its implementation of change process, actions to minimize or eliminate any risk. The types of changes for which risk are considered and managed include: infrastructure change, change in analytical service offerings, certification or accreditation status, instrumentation, LIMS changes, and changes in key personnel.

For more information about the laboratory's procedures for preventive action see laboratory SOP ENV-SOP-IND1-0020 *Corrective and Preventive Actions.*

4.13 Control of Records

A record is a piece of evidence about the past, especially an account of an act or occurrence kept in writing or some other permanent form. Laboratory records document laboratory activities and

provide evidence of conformity to the requirements established in the quality management system. These records may be hardcopy or electronic on any form of media.

4.13.1 General Requirements

4.13.1.1 Procedure

The laboratory's procedures for control of records are provided in laboratory SOP ENV-SOP-IND1-0047 *Data Backup and Records Archival.*

The procedures in the SOP are established to assure quality and technical records are identified, retained, indexed, and filed to allow for retrieval during the entire retention time frame. During storage, records are kept secure and protected from deterioration. At the end of the retention time, the records are disposed of properly in order to maintain client confidentiality and to protect the interests of the company.

In general, laboratory records fall into three categories: quality, technical, and administrative.

Examples of each are provided in the following table:

Record Type	Includes Records of:
Quality	Documents: Document Types listed in SOP ENV-SOP-CORQ-016 Audits: Internal and External Certificates and Scopes of Accreditation Corrective & Preventive Action Management Review Data Investigations Method Validation Instrument Verification Training Records
Technical	Raw Data Logbooks Certificates of Traceability Analytical Record Test Reports & Project Information Technical Training Records & Demonstration of Capability
Administrative	Personnel Records Finance/Business

4.13.1.2 Record Legibility and Storage

Records are designed to be legible and to clearly identify the information recorded. Manual entries are made in indelible ink; automated entries are in a typeface and of sufficient resolution to be read. The records identify laboratory personnel that performed the activity or entered the information.

Records are archived and stored in a way that they can be retrieved. Access to archived records is controlled and managed.

For records stored electronically, the capability to restore or retrieve the electronic record is maintained for the entire retention period. Hardcopy records are filed and stored in a suitable environment to protect from damage, deterioration, or loss. Hardcopy records may be scanned to PDF for retention. Scanned records must be checked against the hardcopy to verify the scan is complete and legible.

Records are kept for a minimum of 10 years unless otherwise specified by the client or regulatory program.

The date from which retention time is calculated depends on the record. In general, the retention time of technical records of original observation and measurement is calculated from the date the record is created. If the technical record is kept in a chronological logbook, the date of retention may be calculated from the date the logbook is archived. The retention time of test reports and project records, which are considered technical records, is calculated from the date the test report was issued. The retention time of quality records is usually calculated from the date the record is archived.

Refer to the laboratory's record management SOP for more information.

4.13.1.3 Security

The laboratory is a secure facility and access to records is restricted to laboratory personnel.

4.13.1.4 Electronic Records

The data systems used to store electronic records are backed up in accordance with laboratory SOP ENV-SOP-IND1-0047 *Data Backup and Records Archival.* Access to archived records stored electronically is maintained by personnel responsible for management of the electronic system.

4.13.2 Technical Records

In addition to the requirements identified in subsections 4.13.1.1 through 4.13.1.4, the requirements in the following subsections also apply to technical records.

4.13.2.1 Description

Technical records are the accumulation of data and information generated from the analytical process. These records may include forms, worksheets, workbooks, checklists, notes, raw data, calibration records, final test reports, and project records. The accumulated records need to provide sufficient detail to historically reconstruct the process and identify the personnel that performed the tasks associated with a test result.

4.13.2.2 Real Time Recordkeeping

Personnel are instructed and expected to always record observations, data, and calculations at the time they are made. Laboratory managers are responsible to assure that data entries, whether made electronically or on hardcopy, are relevant and complete.

4.13.2.3 Error Correction

Errors in records must never be erased, deleted or made illegible. Use of correction fluid, such as white-out is prohibited. In hardcopy records, the error is corrected by a single line through the original entry and the new entry recorded alongside or footnoted to allow for readability. Corrections are initialed and dated by the person

making the correction. If the correction is not self-explanatory, a reason for the correction is recorded.

For electronic records, equivalent measures of error correction or traceability of changes is maintained. For example, audit trails provide records of change.

Maintenance of proper practices for error correction is monitored through the tiered data review process described in Section 5.9.3. Laboratory records are reviewed throughout the data review process. Individuals performing these reviews flag errors that are not properly corrected and bring these to the attention of the department manager or supervisor of the work area in which the record was generated so that the problem may be addressed and corrected with the individual(s) that made the improper correction.

4.14 Audits

The laboratory performs internal systems and technical audits to assess compliance to this manual and to other laboratory procedures, such as policy, SOP and SWI. Since the processes in this manual are based on the relevant quality system standards and regulatory and accreditation/certification program requirements the laboratory provides services for, the internal audits also assess on-going compliance to these programs.

The laboratory is also audited by external parties such as regulatory agencies, customers, consultants and non-government assessment bodies (NGAB).

Information from internal and external audits is used by laboratory management to address compliance concerns and opportunities where improvement will increase the reliability of data.

Deficiencies, observations, and recommendations from audits are managed by local QA using the laboratory's formal CAPA process. See Section 4.11 for more information.

4.14.1 Internal Audit

The laboratory's internal audit program is managed by local QA in accordance with a pre-determined audit schedule established at the beginning of each calendar year. The schedule is prepared to assure that all areas of the laboratory are reviewed over the course of the year. Conformance to the schedule is reported to both laboratory management and corporate quality personnel in a monthly QA report prepared by the Quality Manager.

Although the Quality Manager creates the audit schedule, it is the shared responsibility of local QA and laboratory managers to assure the schedule is maintained. Laboratory supervisors cooperate with QA to provide the auditors with complete access to the work area, personnel, and records needed.

Internal audits are performed by personnel approved by the Quality Manager. In general, personnel may not audit their own activities unless it can be demonstrated that an effective and objective audit will be carried out. The auditor must be trained, qualified, and familiar enough with the objectives, principles, and procedures of laboratory operations to be able to perform a thorough and effective evaluation.

The laboratory's internal audit program includes:

- System Audits & Method Audits: The purpose of these audits is to determine if daily practice is consistent with laboratory's SOPs and if SOPs are compliant with adjunct

policy and procedures. Auditing techniques include analyst interviews and observation and records review. These audits are performed per the pre-determined schedule.

- Raw Data / Final Test Report Audits: The purpose of these audits is to review raw data and/or final test reports to verify the final product is consistent with customer/project requirements and compliant with SOPs and reference methods. Test results should be properly qualified when necessary, should be accurate, and should be of known and documented quality. The reviews should also identify opportunities for improvement and best practices.

- Special Audits: Special audits are those performed ad hoc to follow up on a specific issue such as a client complaint, negative feedback, concerns of data integrity or ethics, or a problem identified through other audits. Special audits may be scheduled or unscheduled. Unscheduled internal audits are conducted whenever doubts are cast on the laboratory's compliance with regulatory requirements or its own policies and procedures. These unscheduled internal audits may be conducted at any time and may be performed without an announcement to laboratory personnel.

When observations and findings from any audit (internal or external) cast doubt on the validity of the laboratory's testing results, the laboratory takes immediate action to investigate the problem and take corrective action. (Also see 4.11 and 4.16)

The laboratory's internal audit program and auditing procedures are further described in laboratory SOP ENV-SOP-IND1-0018 *Internal and External Audits*.

4.14.1.1 Corporate Compliance Audit

The laboratory may also be audited by corporate quality personnel to assess the laboratory's compliance to the company's quality management program and to evaluate the effectiveness of implementation of the policies and procedures that make up the quality management system. The purpose of the compliance audit is to identify risks and opportunities and to assist laboratory management in achieving the goals and objectives of the company's quality program.

4.15 Management Review

The laboratory's management team formally reviews the management system on an annual basis to assess for on-going suitability and effectiveness and to establish goals, objectives, and action plans for the upcoming year.

At a minimum, the following topics are reviewed and discussed:

- The on-going suitability of policies and procedures including HSE (Health, Safety and Environment) and waste management;

- Reports from managerial and supervisory personnel including topics discussed at regular management meetings held throughout the year;

- The outcome of recent internal audits;

- Corrective and preventive actions;

- Assessments by external bodies;

- The results of proficiency tests;
- Changes in the volume and type of the work;
- Customer and personnel feedback, including complaints;
- Recommendations for improvement / preventive actions made since last review;
- Internal and external issues of relevance and risk identification;
- A review of the status of actions from prior management reviews; and
- Other relevant factors, such as quality control activities, resources, and staff training.

The discussion and results of this review are documented in a formal report prepared by laboratory management. This report includes a determination of the effectiveness of the management system and its processes; goals and objectives for improvements in the coming year with timelines and responsibilities, any other need for change. See laboratory SOP ENV-SOP-CORQ-0005 *Management Review* for more information.

Goals and action items from annual management systems review are shared with employees to highlight focus areas for improvement in addition to areas in which the laboratory has excelled.

4.16 Data Integrity

The laboratory's procedures for data integrity reviews are described in SOP ENV-SOP-CORQ-0010 *Data Recall*.

Customers whose data are affected by these events are notified in a timely manner, usually within 30 days of discovery. Some accreditation programs also require notification to the accreditation body (AB) within a certain time-frame from date of discovery when the underlying cause of the issue impacts accreditation. The laboratory follows any program or project-specific client requirements for notification, when applicable.

5.0 TECHNICAL REQUIREMENTS

5.1 General

Many factors contribute to the correctness and reliability of the technical work performed by the laboratory. These factors are fall under these general categories:

- Human Performance
- Facility and Environmental Conditions
- Test Method Performance and Validation
- Measurement Traceability
- Handling of Samples

The impact of each of these factors varies based on the type of work performed. To minimize negative effects from each these factors, the laboratory takes into account the contribution from each of these categories when developing test method and process (administrative) SOPs, evaluating personnel qualifications and competence, and in the selection of equipment and supplies.

5.2 Personnel

5.2.1 Personnel Qualifications

The laboratory's program for personnel management is structured to ensure personnel are selected, qualified, and competent to perform the roles and responsibilities of their position based on education, experience, and training.

Qualifications, duties, responsibilities, and authorities of each position are specified in job descriptions maintained by corporate HR (See Section 5.2.4). These job descriptions provide the general basis for the selection of personnel for hire and are used by the laboratory to communicate to personnel the duties, responsibilities, and authorities of their position.

The term "personnel" refers to individuals employed by the laboratory directly as full-time, part-time, or temporary employees and individuals employed by the laboratory by contract through an employment agency. The term "personnel" is used interchangeably with the term "employee" throughout this manual. For purposes of this manual, these terms are equivalent.

The personnel management program is structured to establish and maintain records for each of the following:

- Selection of personnel;
- Training of personnel;
- Supervision of personnel;
- Authorization of personnel; and
- Monitoring Competence of personnel.

5.2.1.1 Competence

Competence is the ability to apply a skill or series of skills to complete a task or series of tasks correctly within defined expectations.

Competence for technical personnel, authorized by PAS to provide opinion and interpretation of data to customers, also includes the demonstrated ability to:

- Apply knowledge, experience, and skills needed to safely and properly use equipment, instrumentation, and materials required to carry out testing and other work activities in accordance with manufacturer specifications and laboratory SOPs;
- Understand and apply knowledge of general regulatory requirements necessary to achieve regulatory compliance in work product; and
- Understand the significance of departures and deviations from procedure that may occur during the analytical testing process and the capability and initiative to troubleshoot and correct the problem, document the issue, and to properly qualify the data and analytical results.

The laboratory's requirements for the competence of personnel (education, qualification, work experience, technical skills, and responsibilities) are specified in job descriptions created by management and kept by human resources (HR). The job description provides the basis for the selection of personnel for each position.

An employee is considered competent when he/she has completed documented required training.

The policies and standard operating procedures (SOPs) for the following topics are established by management as minimum required training for all personnel:

- Ethics and Data Integrity
- Quality Manual
- Safety Manual
- Technical Process and Procedure relevant to their job tasks
- Successful Demonstration of Capability (DOC) – Analytical Personnel Only

Records of training and qualification provide the record of competence for the individual. Qualification records may include but are not limited to diploma, transcripts, and curriculum vitae (CV).

The on-going competence of each employee is monitored by laboratory management through on-the-job performance. Analytical employees are also required to successfully complete another demonstration capability for each test method performed on an annual basis.

5.2.2 Training

Training requirements are outlined in policies COR-POL-0023 *Mandatory Training Policy*. COR-POL-0004 *Ethics Policy*, and laboratory SOP ENV-SOP-IND1-0027 *Employee Orientation and Training*. Additional training requirements may also be specified in other documents, such as manuals.

5.2.2.1 Training Program and Goals

The laboratory's training program includes 4 elements:

- Identification of Training Needs
- Training Plan Development and Execution
- Documentation and Tracking
- Evaluation of Training Effectiveness

Laboratory management establishes goals and training needs for individual employees based on their role, education, experience, and on-the-job performance.

Training needs for all employees are based on business performance measures that include but are not limited to:

- Quality Control Trends
- Process Error / Rework Trends
- Proficiency Testing Results
- Internal & External Audit Performance

- Management Review Goals

Training is delivered using various methods that incorporate techniques that appeal to the main learning styles: visual, aural, linguistic, and kinesthetic. Techniques include on-the-job, instructor-led, self-study, eLearning, and blended.

The employee's direct supervisor is responsible for oversight of the employee's training plan and for providing adequate time to the employee to complete training assignments. Both the supervisor and employee are responsible to make sure the employee's training status and training records are current and complete.

The laboratory's QA department monitors the training status of personnel and provides the status to the General Manager (GM or AGM) at least monthly or more frequently, if necessary. The status report is used by laboratory management to identify overdue training assignments, the reasons for the gaps, and to make arrangements for completion.

The following subsections highlight specific training requirements:

5.2.2.1.1 New Hire Training

New hire training requirements apply to new personnel and to existing employee's starting in a new position or different work area.

Required new hire training includes each of the following:

- Ethics and Data Integrity (See 5.2.2.1.3)
- Quality Manual / Quality Management System (See 5.2.2.1.4)
- Safety Manual and any training requirements specified in the manual.
- Policies & SOPs relevant to their job tasks
- Technical personnel that test samples must also successfully complete an initial demonstration of capability (IDOC) for the test methods performed before independently testing customer samples. (See 5.2.2.1.5). Independent testing means handling of client samples without direct supervision of the work activity by the supervisor or a qualified trainer.

All required training must be current and complete before the employee is authorized to work independently. Until then, the employee's direct supervisor is responsible for review and acceptance of the employee's work product.

5.2.2.1.2 On-Going Training

Personnel receive on-going training in each of the following topics:

- Ethics and Data Integrity (See 5.2.2.1.3)
- Quality Manual / Quality Management System (See 5.2.2.1.4)

- Safety Training
- Changes to Policies & SOPs
- Specialized Training
- Technical personnel that carry out testing must also successfully complete continuing demonstration of capability (DOC) for all test methods performed on an annual basis. (See 5.2.2.1.5)

Personnel are expected to maintain their training status and records of training current and complete and to complete training assignments in a timely manner.

5.2.2.1.3 Ethics and Data Integrity Training

Initial data integrity training is provided to all new personnel and refresher data integrity training is provided to all employees on an annual basis. Personnel are required to acknowledge they understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment, or civil/criminal prosecution.

The initial data integrity training and the annual refresher training is documented with a signature attendance sheet or other form of documentation to provide evidence that the employee has participated in training on this topic and understands their obligations related to data integrity.

The following topics and activities are covered:

- Policy for honesty and full disclosure in all analytical reporting;
- Prohibited Practices;
- How and when to report data integrity issues;
- Record keeping. The training emphasizes the importance of proper written documentation on the part of the analyst;
- Training Program, including discussion regarding all data integrity procedures;
- Data integrity training documentation;
- In-depth procedures for data monitoring; and
- Specific examples of breaches of ethical behavior such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards.

All PAS personnel, including contract and temporary, are required to sign an "Attestation of Ethics and Confidentiality" at the time of

employment and during annual refresher training. This document clearly identifies inappropriate and questionable behavior. Violations of this document result in serious consequences, including termination and prosecution, if necessary.

Also see SOP-ENV-COR-POL-0004 *Ethics Policy* for more information.

5.2.2.1.4 Management System Documents Training

PAS Manuals, policies, and SOPs are the primary documents used by regulatory bodies and PAS customers to verify the laboratory's capability, competency, and compliance with their requirements and expectations.

In addition to on-the-job training, employees must have a signed Read and Acknowledgement Statement on record for the laboratory Quality Manual and the policies and SOPs relating to his/her job responsibilities. This statement, when signed by the employee electronically or on paper, confirms that the employee has received, read, and understands the contents of the document, that the employee agrees to follow the document when carrying out their work tasks, and that the employee understands that unauthorized change to procedures in an SOP is not allowed except in accordance with the SOP departure policy (See 4.9.1.1) and SOP ENV-CORQ-0016 *Standard Operating Procedures and Standard Work Instructions* for more information.

5.2.2.1.5 Demonstration of Capability (DOC)

Technical personnel must also complete an initial demonstration of capability (IDOC) prior to independent work on client samples analyzed by the test methods they perform. After successful IDOC, the employee must demonstrate continued proficiency (DOC) for the test method on an annual basis. If more than a year has passed since the employee last performed the method; then capability must be re-established with an IDOC.

Demonstration of capability (IDOC and DOC) is based on the employee's capability to achieve acceptable precision and accuracy for each analyte reported by the laboratory for the test method using the laboratory's test method SOP.

Records of IDOC and DOC are kept in the employee's training file.

For more information, see laboratory SOP ENV-SOP-IND1-0027 *Employee Orientation and Training.*

5.2.2.2 Effectiveness of Training

The results of the performance measures used to identify training needs are the same measures used by the laboratory to measure effectiveness of the training program.

Improvements in key performance measures suggest the training program is successful. (See 5.2.2.1)

Effectiveness of individual employee training is measured by their demonstrated ability to comprehend the training material and apply the knowledge and skills gained to their job task. Measurements include but are not limited to:

- Testing of the employee's knowledge of the quality management system, policies, and technical and administrative procedures through various mechanisms, such as quizzes, observation, and interviews.
- Demonstrated ability to convey information correctly and factually in written and verbal communication to internal and external parties.
- Demonstrated ability to carry out tasks in accordance with SOPs and other work instructions.
- Demonstrated ability to make sound decisions based on guidance and information available.
- Demonstrated initiative to seek help or guidance when the employee is unsure of how to proceed.

5.2.3 Personnel Supervision

Every employee is assigned a direct supervisor, however named, who is responsible for their supervision. Supervision is the set of activities carried out by the supervisor to oversee the progress and productivity of the employees that report to them.

General supervisory responsibilities may include but are not limited to:

- Hiring Employees
- Training Employees
- Performance Management
- Development, oversight, and execution of personnel training plans
- Monitoring personnel work product to assure the work is carried out in accordance with this quality manual, policies, SOPs, and other documents that support the quality management system.

5.2.4 Job Descriptions

Job Descriptions that define the required education, qualifications, experience, skills, roles and responsibilities, and reporting relationships for each PAS position are established by top management and kept by corporate HR. The job descriptions apply to employees who are directly employed by PAS, part-time, temporary, technical and administrative and by those that are under contract with PAS through other means.

The job descriptions include the education, expertise, and experience required for the position and the responsibilities and duties, including any supervisory or managerial duties assigned to the position.

5.2.5 Authorization of Technical Personnel

Laboratory management authorizes technical personnel to perform the technical aspects of their position after it has been verified that the employee meets the qualifications for the position, has successfully completed required training, and the employee has demonstrated capability. After initial authorization, technical personnel are expected to maintain a current and complete training record, demonstrate on-going capability at least annually for each test method performed, and produce reliable results through accurate analysis of certified reference materials, proficiency testing samples, and/or routine quality control samples in order to remain authorized to continue to perform their duties.

Records to support authorization including education, experience, training, and other evaluations are kept by the laboratory.

5.3 Accommodations and Facilities

5.3.1 Facilities

The laboratory is designed to appropriately support the performance of procedures and to not adversely affect measurement integrity or safety. Access to the laboratory is controlled by various measures, such as card access, locked doors, and main entry. Visitors to the laboratory are required to sign-in and to be escorted by laboratory personnel during their visit. A visitor is any person that is not an employee of the laboratory.

5.3.2 Environmental Conditions

The laboratory is equipped with energy sources, lighting, heating, and ventilation necessary to facilitate proper performance of calibrations and tests. The laboratory ensures that housekeeping, electromagnetic interference, humidity, line voltage, temperature, sound and vibration levels are appropriately controlled to ensure the integrity of specific measurement results and to prevent adverse effects on accuracy or increases in the uncertainty of each measurement.

Environmental conditions are monitored, controlled, and recorded as required by the relevant specifications, methods, and procedures. Laboratory operations are stopped if it is discovered that the laboratory's environmental conditions jeopardize the analytical results.

5.3.3 Separation of Incompatible Activities

The layout and infrastructure of each work area including air handling systems, power supplies, and gas supplies of each laboratory work area is specifically designed for the type of analytical activity performed. Effective separation between incompatible work activities is maintained. For example, sample storage, preparation, and chemical handling for volatile organic analysis (VOA) is kept separate from semi-volatile organic analysis (SVOA).

The laboratory separates samples known or suspected to contain high concentration of analytes from other samples to avoid the possibility for cross-contamination. If contamination is found, the source of contamination is investigated and resolved in accordance with laboratory SOPs.

5.3.4 Laboratory Security

Security is maintained by controlled access to the building and by surveillance of work areas by authorized personnel. Access is controlled to each area depending on the required

personnel, the sensitivity of the operations performed, and possible safety concerns. The main entrance is kept unlocked during normal business hours for visitors, and is continuously monitored by laboratory staff. All visitors must sign a visitor's log and a staff member must accompany them during their stay.

5.3.5 Good Housekeeping

The laboratory ensures good housekeeping practices in work areas to maintain a standard of cleanliness necessary for analytical integrity and personnel health and safety. Minimally, these measures include regular cleaning of the work area. Where necessary, areas are periodically monitored to detect and resolve specific contamination and/or possible safety issues.

5.4 Test Methods

5.4.1 General Requirements

The laboratory uses test methods and procedures that are appropriate for the scope of analytical services the laboratory offers.

Instructions on the use and operation of equipment and sample handling, preparation, and analysis of samples are provided in SOPs. The instructions in SOPs may be supplemented with other documents including but not limited to, standard work instructions (SWI), manuals, guides, project documents and reference documents.

These documents are managed using the procedures described in SOP ENV-SOP-CORQ-0015 *Document Management and Control* and SOP ENV-SOP-CORQ-0016 *Standard Operating Procedures and Standard Work Instructions.*

Deviations to test method and SOPs are allowed under certain circumstances. See sections 4.9.1.1 and 4.9.1.2 for more information.

5.4.2 Method Selection

The test methods and protocols used by the laboratory are selected to meet the needs of the customer and to conform with regulatory requirements, if applicable.

In general, the test methods offered are industry accepted methods published by international, regional, or national standards. The laboratory bases its procedure on the latest approved edition of a method unless it is not appropriate or possible to do so or unless regulatory requirements allow otherwise.

The laboratory confirms that it can perform the test method and achieve desired outcome before analyzing samples (see section 5.4.5). If there is a change in the published analytical method, then the confirmation is repeated.

When a customer does not specify the test method(s) to be used, the laboratory may suggest test methods that are appropriate for the intended use of the data and the type of samples to be tested. The laboratory will also inform customers when test methods requested are considered inappropriate for their purpose and/or out of date. This discourse takes place during review of analytical requests (See Section 4.4).

5.4.3 Laboratory Developed Methods

A laboratory developed method is a method developed from scratch (no published source method), a procedure that modifies the chemistry from the source method, or a procedure that exceeds the scope and application of the source method.

Laboratory developed methods must be validated prior to use (see section 5.4.5) and the procedure documented in a test method SOP.

The requirements for non-standard methods (Section 5.4.4) also apply to laboratory developed methods.

5.4.4 Non-standard Methods

A non-standard method is a method that is not published or approved for use by conventional industry standards for the intended purpose of the data. Non-standard methods must be validated prior to use (see section 5.4.5) and the procedure developed and documented in a test method SOP.

At a minimum, the following information must be included in the procedure:

- Title / Identification of Method;
- Scope and Application;
- Description of the type of item to be analyzed;
- Parameters or quantities and ranges to be determined;
- Apparatus and equipment, including technical performance requirements;
- Reference standards and reference materials required;
- Environmental conditions required and any stabilization period needed
- Description of the procedure, including:
    - Affixing identification marks, handling, transporting, storing and preparing of items;
    - Checks to be made before the work is started;
    - Verifying equipment function and, where required, calibrating and/or adjusting the equipment before each use;
    - Method of recording the observations and results;
    - Any safety measures to be observed;
    - Criteria and/or requirements for approval/rejection of data;
    - Data to be recorded and method of analysis and presentation; and
    - Uncertainty or procedure for estimating uncertainty.

Use of a non-standard method for testing must be agreed upon with the customer. The agreement, which is retained by the laboratory in the project record, must include the specifications of the client's requirements, the purpose of testing, and their authorization for use of the non-standard method.

5.4.5 Method Validation

5.4.5.1 Validation Description

Validation is the process of conformation and the provision of objective evidence that the stated requirements for a specific method/procedure are fulfilled.

The laboratory's requirements and procedures for method validation are outlined in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

5.4.5.2 Validation Summary

All test methods offered by the laboratory are validated before use to confirm the procedure works and the data and results achieved meet the goals for the method. The extent of validation performed is based on technology and other factors as defined in the validation SOP (ENV-SOP-CORQ-0011).

Results of validation are retained are kept in accordance with the laboratory's SOP ENV-SOP-IND1-0047 *Data Backup and Records Archival* for retention of technical records.

The need to repeat validation is assessed by laboratory management when there are changes to the test method.

5.4.5.3 Validation of Customer Need

Laboratory management reviews the results of test method validation, which include accuracy, precision, sensitivity, selectivity, linearity, repeatability, reproducibility, and robustness, against general customer needs to ensure the laboratory's procedure for the test method will meet those needs.

The review procedure is detailed in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

The following subsections highlight some of these concepts:

5.4.5.3.1 Accuracy

Accuracy is the degree to which the result of a measurement, calculation, or specification conforms to the correct value of a standard. When the result recovers within a specified range from the known value (control limit); the result generated using the laboratory's test method SOP is considered accurate.

5.4.5.3.2 Precision

Precision refers to the closeness of two or more measurements to each other. It is generally measured by calculating the relative percent difference (RPD) or relative standard deviation (RSD) from results of separate analysis of the same sample. Precision provides information about repeatability, reproducibility, and robustness of the laboratory's procedure.

5.4.5.3.3 Limits of Detection (LOD)

The LOD is the minimum result which can be reliably differentiated from a blank with a predetermined confidence level. The LOD establishes the limit of method sensitivity and is also known as the detection limit (DL) or the method detection limit (MDL).

Values below the LOD cannot be reliably measured and are not reported by the laboratory unless otherwise specified by regulatory program or test method. If reported, values below the LOD are qualified as estimated.

The LOD is established during method validation and after major changes to the analytical system or procedure that affect sensitivity are made.

The laboratory's procedure for LOD determination is detailed in laboratory SOP ENV-SOP-IND1-0009 *Determination of Detection and Quantitation Limits*. The SOP complies with 40 CFR 136 Appendix B or the current industry approved and accepted guidance for this process.

5.4.5.3.4 Limits of Quantitation (LOQ) and Reporting Limit (RL)

The LOQ is the minimum level, concentration, or quantity of a target analyte that can be reported with a specified degree of confidence. The LOQ is established at the same time as the LOD. The laboratory's procedure for determination and verification of the LOQ is detailed in laboratory SOP ENV-SOP-IND1-0009 *Determination of Detection and Quantitation Limits*.

The Lowest Limit of Quantitation (LLOQ) is the value of the lowest calibration standard. The LOQ establishes the routine limit of quantitation.

The LOQ and LLOQ represent quantitative sensitivity of the test method.

- The LOQ must always be equal to or greater than the LLOQ and the LLOQ must always be greater than the LOD.
- Any reported value (detect or non-detect) less than the LLOQ is a qualitative value.

The RL is the value to which the presence of a target analyte is reported as detected or not-detected. The RL is project-defined based on project data quality objectives (DQO). In the absence of project specific requirements, the RL is usually set to the LOQ or the LLOQ.

For more information, refer to laboratory SOP ENV-SOP-IND1-0009 *Determination of Detection and Quantitation Limits*.

5.4.5.3.5 Linearity

Linearity is a mathematical concept applied to calibration models that employ multiple points to establish a calibration range used for quantitative analysis. Linearity is measured differently based on the calibration model. The accuracy of the linear regression and non-linear curves is verified by checking percent error or relative standard error (RSE), which is the process of refitting calibration data back to the model to determine if the results are accurate. For linear curves that use average calibration or response factor, error is measured by relative standard difference (RSD).

Linearity also establishes the range of quantitation for the test method used which directly impacts the sensitivity of the test method and uncertainty in measurement results. As previously noted, the LLOQ establishes the lower limit of quantitation. Similarly, the upper range of linearity establishes the upper limit of quantitation. In general, results outside of this range are considered qualitative values. However, some inorganic methods allow for extension of the linear range above the upper limit of quantitation when accuracy at this value is verified.

Linearity can also be used to establish repeatability, reproducibility, and robustness of the laboratory's test method. When linearity is demonstrated using a specific calibration model during method validation, then use of this same calibration model to achieve linearity on a day to day basis confirms the laboratory's method is repeatable, reproducible, and robust.

5.4.5.3.6 Demonstration of Capability (DOC)

The DOC performed during method validation confirms that the test method demonstrates acceptable precision and accuracy. The procedure used for DOC for method validation is the same as described in section 5.2.2.1.5 for demonstration of analyst capability.

5.4.6 Measurement Uncertainty

The laboratory provides an estimate of uncertainty in testing measurements when required or on client request. In general, the uncertainty of the test method is reflected in the control limits used to evaluate QC performance. (See 5.9.1.1.10).

When measurement uncertainty cannot be satisfied through control limits, the laboratory will provide a reasonable estimation of uncertainty. A reasonable estimation is based on knowledge of method performance and previous experience. When estimating the analytical uncertainty, all uncertainty components which are of importance in the given situation are taken into account.

5.4.7 Control of Data

The laboratory has policies and processes in place to assure that reported data is free from calculation and transcription errors, that quality control is reviewed and evaluated before data is reported, and to address manual calculation and integration.

5.4.7.1 Calculations, Data Transfer, Reduction and Review

Whenever possible, calculations, transfer of data, and data reduction are performed using validated software programs. (See 5.4.7.2)

If manual calculations are necessary, the results of these calculations are verified during the data review process outlined in section 5.9.3.

5.4.7.1.1 Manual Integration

The laboratory's policy and procedures for manual integration are provided in SOP ENV-SOP-CORQ-0006 *Manual Integration*.

This SOP includes the conditions under which manual integration is allowed and the requirements for documentation.

Required documentation of manual integration includes:

- complete audit trail to permit reconstruction of before and after results;
- identification of the analyst that performed the integration and the reason the integration was performed; and
- the individual(s) that reviewed the integration and verified the integration was done and documented in compliance with the SOP.

5.4.7.2 Use of Computers and Automated Acquisition

Whenever possible the laboratory uses software and automation for the acquisition, processing, recording, reporting, storage, and/or retrieval of data.

Software applications developed by PAS are validated by corporate IT for adequacy before release for general use. Commercial off-the-shelf software is considered sufficiently validated when the laboratory follows the manufacturer's or vendor's manual for set-up and use. Records of validation are kept by the corporate information technology (IT) group or by the local laboratory, whichever group performed the validation.

The laboratory's process for the protection of data stored in electronic systems includes:

- Individual user names and passwords for Laboratory Information Management Systems (LIMS) and auxiliary systems used to store or process data.
- Employee Training in Computer Security Awareness

- Validation of spreadsheets used for calculations to verify formulas and logic yield correct results and protection of these cells to prevent unauthorized change.
- Operating system and file access safeguards
- Protection from Computer Viruses
- Regular system backup; and testing of retrieved data

The laboratory's process for software development and testing process includes:

- Verification the software application works as expected and is adequate for use and fulfills compliance requirements, such as the need to record date/time of data generation.
- Change control to assure requests for changes are reviewed and approved by management before the change is made.
- Communication channels to assure all staff are aware of changes made.
- Version Control and maintenance of historical records.

5.5 Equipment

5.5.1 Availability of Equipment

The laboratory is furnished with all equipment and instrumentation necessary to perform the tests offered in compliance with the specifications of the test method and to achieve the accuracy and sensitivity required.

5.5.2 Calibration

Equipment and instrumentation is checked prior to use to verify it performs within tolerance for its intended application.

Laboratory management is made aware of the status of equipment and instrumentation and any needs for either on a daily basis. This information is obtained during laboratory Lean Daily Management (LDM) walkthroughs that are conducted as part of the laboratory's lean program.

5.5.2.1 Support Equipment

The laboratory confirms support equipment is in proper working order and meets the specifications for general laboratory use prior to placement in service and with intermediate checks thereafter. Equipment that does not meet specifications is removed from service until repaired or replaced. Records of repair and maintenance activities are maintained.

Procedures used to carry out and record these checks are outlined laboratory SOP ENV-SOP-IND1-0086 *Support Equipment*.

5.5.2.2 Analytical Instruments

Analytical instruments are checked prior to placement in service in accordance with SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.* After the

initial service date, the calibration of instruments and verification calibration is performed in accordance with local test method SOPs.

The calibration procedures in the test method SOPs comply with the requirements for acceptable calibration practices outlined in corporate document ENV-SOT-CORQ-0026 *Calibration Procedures*, the reference methods, and any applicable regulatory or program requirements.

5.5.3 Equipment Use and Operation

Equipment is operated and maintained by laboratory personnel that are trained on the test method SOP. Up-to-date instructions and procedures for the use and maintenance of analytical equipment are included in SOPs and/or supplemental documents such as standard work instructions (SWI), maintenance logbooks, or instrument manuals which are made readily accessible in the work area to all laboratory personnel.

5.5.4 Equipment Identification

The laboratory uniquely identifies equipment by serial number or any other unique ID system, when practical.

5.5.5 Equipment Lists and Records

5.5.5.1 Equipment List

The laboratory maintains a master list of equipment that includes equipment description, manufacturer, model, associated methods, and the year it was placed into service. The date of purchase is tracked by the procurement record. The equipment list(s) for each location covered by this manual is provided in Appendix E.

5.5.5.2 Equipment Records

In addition to the equipment list, the laboratory maintains records of equipment that include:

- Verification that equipment conforms with specifications.
- Calibration records including dates, results, acceptance criteria, and next calibration date, if scheduled.
- Maintenance plan and records
- Records of damage, malfunction, or repair

The laboratory follows an equipment maintenance program designed to optimize performance and to prevent instrument failure which is described in laboratory SOPs, instrument maintenance logbooks, or instrument user manuals.

The maintenance program includes routine maintenance activities which are performed as recommended by the manufacturer at the frequency recommended and non-routine maintenance, which is performed to resolve specific problems such as loss of sensitivity or repeated failure of instrument performance checks and quality control samples.

Maintenance is performed by laboratory personnel or by outside service providers.

All maintenance activities performed by laboratory personnel are recorded by the individual(s) that performed the activity at the time the maintenance was performed in an instrument maintenance log.

The maintenance record minimally includes the date of maintenance, the initials of the person(s) performing maintenance, the problem encountered, a description of the activity performed, and evidence of return to analytical control. When maintenance is performed by an external vendor, the laboratory staples the service record into hardcopy maintenance logs or scans the record for easy retrieval. The laboratory provides unrestricted access to instrument maintenance logs in order to promote good instrument maintenance and recordkeeping practices.

If an instrument must be moved, the laboratory will use safe practices for handling and transport to minimize damage and contamination.

5.5.6 Out of Service Protocol

Equipment that has been subjected to overloading, mishandling, gives suspect results, has been shown to be defective, or is performing outside of specified limits is taken out of service. The equipment is either removed from the work area or labeled to prevent accidental use until it has been repaired and verified to perform correctly.

When analytical equipment is taken out of service, the laboratory examines the potential effect it may have had on previous analytical results to identify any non-conforming work. (See section 4.9).

5.5.7 Calibration Status

The laboratory labels support equipment to indicate calibration status, whenever practicable, or otherwise maintains the calibration status in a visible location in the work area. These procedures are described in laboratory SOP ENV-SOP-IND1-0086 *Support Equipment*.

The calibration status of analytical instruments is documented in the analytical record. Analysts verify on-going acceptability of calibration status prior to use and with instrument performance check standards. These procedures are described in test method SOPs.

5.5.8 Returned Equipment Checks

When equipment or instruments are sent out of the laboratory for service, the laboratory ensures that the function and calibration status of the equipment is checked and shown to be satisfactory before the equipment is returned to service. These procedures are outlined in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

5.5.9 Intermediate Equipment Checks

The laboratory performs intermediate checks on equipment to verify the on-going calibration status. For example, most test methods require some form of continuing calibration verification check and these procedures are included in the test method SOP. Periodic checks of support equipment are also performed.

5.5.10 Safeguarding Equipment Integrity

The laboratory safeguards equipment integrity using a variety of mechanisms that include but are not limited to:

- Adherence to manufacturer's specifications for instrument use so that settings do not exceed manufacturer's recommendations or stress the performance of the equipment.
- Established maintenance programs.
- Transparent maintenance records and unrestricted access to maintenance logs.
- Validation and approval of software before use.
- Audits to confirm instrument settings are consistent with SOPs.
- On-the-job training for safe and proper use of laboratory equipment.

5.6 Measurement Traceability

5.6.1 General

Measurement traceability refers to a property of a measurement result whereby the result can be related to a reference through an unbroken chain of calibration, each contributing to the measurement uncertainty. Traceability requires an established calibration of equipment used during testing including support equipment. The laboratory assures this equipment is calibrated prior to being put into service and that the reference standard and materials used for calibration are traceable to the international standard of units (SI) or national measurement standard.

When strict traceability to SI units cannot be made, the laboratory establishes traceability with the use of reference standards and equipment obtained from competent suppliers that provide calibration certificates and/or certificates of analysis (COA).

5.6.2 Equipment Correction Factors

When correction factors are used to adjust results the laboratory will assure that results in computer software are also updated. For example, if the direct instrument or reading output must be corrected based on preparation factor or concentration factors, laboratory management will assure the corrected result is also updated in the software, whenever possible.

5.6.3 Specific Requirements

5.6.3.1 Requirements for Calibration Laboratories

The laboratory does not offer calibration services to customers.

5.6.3.2 Requirements for Testing Laboratories

The laboratory has procedures in place to verify equipment is calibrated prior to being put into service (See 5.5.2), and ensures the reference standard and materials used for calibration are traceable to the international standard of units (SI) or national measurement standard. When strict traceability to SI units cannot be made, the laboratory establishes traceability with the use of reference standards and equipment obtained from competent suppliers that provide calibration certificates and/or certificates of analysis (COA).

5.6.4 Reference Standards and Reference Materials

5.6.4.1 Reference Standards

The laboratory uses reference standards of measurement to verify adequacy of working weights and thermometers. The working weight is the weight(s) used for daily balance calibration checks and the working thermometers are used for temperature measurements on a daily basis.

The measurements from working weights and thermometers are compared to measurement taken by the reference standard which is traceable to SI or a national standard. The reference weights and thermometers are used solely for verification purposes unless the laboratory can prove that daily use does not adversely affect performance of the reference standard.

The laboratory performs intermediate checks of the working weights at least annually.

Working thermometers are checked against the reference thermometer annually (glass) or quarterly (digital).

The calibration of liquid in glass reference thermometers is verified every 5 years and the calibration of digital reference thermometers is verified bi-annually by an ISO/IEC 17025 accredited calibration laboratory or service provider that provides traceability to a national standard.

The calibration of the reference weight(s) is verified every 5 years by an ISO/IEC 17025 accredited calibration laboratory.

See laboratory ENV-SOP-IND1-0086 *Support Equipment* for more information about this process.

5.6.4.2 Reference Materials

The laboratory purchases chemical reference materials used as analytical standards and reagents from vendors that are accredited to ISO 17034 or Guide 34. Purchased reference materials must be received with a Certificate of Analysis (COA), where available. If a reference material cannot be purchased with a COA, it must be verified by analysis and comparison to a certified reference material and/or there must be a demonstration of capability for characterization. COA are reviewed for adequacy and retained by the laboratory for future reference.

The laboratory procedure for traceability and use of these materials is provided in laboratory SOP ENV-SOP-IND1-0031 *Standard and Reagent Management and Traceability*.

This SOP includes each of the following requirements:

- Procedures for documentation of receipt and tracking. The record of entry includes name of the material, the lot number, receipt date, and expiration date.
- Storage conditions and requirements. Reference materials must be stored separately from samples, extracts, and digestates.

- Requirements to assure that preparations of intermediate or working solutions are recorded and assigned a unique identification number for tracking. Records of preparation include the lot number of the stock standard(s) used, the type and lot number of the solvent, the formulation, date, expiration date, and the preparer's initials. The lot number of the working standards is recorded in the analytical record to provide traceability to the standard preparation record. The preparation record provides traceability to the COA, which is traceable to SI or the national measurement standard.

- A requirement that the expiration dates of prepared standards may not exceed the expiration date of the parent standard. Standards, reference materials, and reagents are not used after their expiration dates unless their reliability is thoroughly documented and verified by the laboratory. If a standard exceeds its expiration date and is not re-certified, the laboratory removes the standard and/or clearly designates it as acceptable for qualitative/troubleshooting purposes only. All prepared standards, reference materials, and reagents are verified to meet the requirements of the test method through routine analysis of quality control samples.

- The second source materials used for verification of instrument calibration are obtained from a different manufacturer or different lot from the same manufacturer.

- Procedures to check reference materials for degradation and replacement of material if degradation or evaporation is suspected.

- Procedures for labeling. At a minimum the container must identify the material, the ID of the material and the expiration date. Original containers should also be labeled with date opened.

5.6.4.3 Intermediate Checks

Checks to confirm the calibration status of standards and materials are described in laboratory SOPs. These checks include use of second source standards and reference materials reserved only for the purpose of calibration checks.

5.6.4.4 Transport and Storage

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials. Standards and reference materials are stored separately from samples, extracts, and digestates. All standards are stored according to the manufacturer's recommended conditions. Temperatures colder than the manufacturer's recommendation are acceptable if it does not compromise the integrity of the material (e.g. remains in liquid state and does not freeze solid). In the event a standard is made from more than a single source with different storage conditions, the standard will be stored according to the conditions specified in the analytical method.

See the applicable analytical SOPs for specific reference material storage and transport protocols.

5.7 Sampling

Sampling refers to the field collection of samples for analytical testing.

Subsampling refers to a measured portion of sample used for analysis. Procedures are included SOP ENV-SOP-IND1-0028 *Sample Homogenization, Subsampling, and Compositing* to assure the portion used for testing is representative of the field collected sample.

The requirements in the following subsections apply when field sampling is performed by the laboratory.

5.7.1 Sampling Plans and SOPs

When the laboratory performs field collection of samples, sampling is carried out in accordance with a written sample plan prepared by the customer or by the laboratory and by relevant sampling SOPs. These documents are made readily accessible at the sampling location. Sampling plans and SOPs are, whenever reasonable, based on appropriate governing methods and addresses the factors to be controlled to ensure the validity of the analytical results.

5.7.2 Customer Requested Deviations

When the customer requires deviations, additions, or exclusions from the documented laboratory sampling plan and/or procedure, the laboratory records the client's change request in detail with the sampling record, communicates the change to sampling personnel, and may include this information in the final test report.

5.7.3 Recordkeeping

The laboratory assures the sampling record includes the sampling procedure used, any deviations from the procedure, the date and time of sampling, the identification of the sampler, environmental conditions (if relevant), and the sampling location.

5.8 Sample Management & Handling

5.8.1 Procedures

The laboratory's procedures for sample management and handling are outlined in laboratory SOP ENV-SOP-IND1-0001 *Sample Management*.

The procedures in this SOP are established to maintain the safe handling and integrity of samples from receipt, transport, storage, to disposal and during all processing steps in-between; to maintain client confidentiality, and to protect the interests of PAS and its customers.

5.8.1.1 Chain of Custody

All samples received by the laboratory must be accompanied with a Chain of Custody (COC) record. The COC provides information about the samples collected and submitted for testing and it documents the possession of samples from time of collection to receipt by the laboratory.

The COC record must minimally include the following information:

- Client name, address, phone number
- Project Reference
- Client Sample Identification (Client ID)
- Date, Time, and Location of Sampling
- Samplers Name or Initials
- Matrix of samples
- Type of container, and total number of containers collected for each sample
- Preservatives, if applicable
- Analyses Requested
- Any special instructions
- The date, time, and signature documenting each sample transfer from the time of collection to receipt in the laboratory. When the COC is transported inside the cooler, independent couriers do not sign the COC. Shipping manifests and/or air bills are the records of possession during transport.

A complete and legible COC is required. If the laboratory observes that the COC is incomplete or illegible, the client is contacted for resolution. The COC must be filled out in indelible ink. Personnel correct errors by drawing a single line through the original entry so the entry is not obscured, entering the correct information, and initialing and dating the change.

5.8.1.2 Legal Chain of Custody

Legal chain of custody is a chain of custody protocol used for evidentiary or legal purposes. The protocol is followed by the laboratory when requested by customer or where mandated by a regulatory program.

Legal chain of custody (COC) protocol establishes an intact, continuous record of the physical possession*, storage, and disposal of "samples" which includes sample aliquots and sample extracts/digestates/distillates.

Legal COC records account for all time periods associated with the samples, and identify all individuals who physically handled individual samples. Legal COC begins at the point established by legal authority, which is usually at the time the sample containers are provided by the laboratory for sample collection or when sample collection begins.

*A sample is in someone's custody if:

- It is in one's physical possession;
- It is in one's view after being in one's physical possession;
- It has been in one's physical possession and then locked or sealed so that no one can tamper with it; and/or

- It is kept in a secure area, restricted to authorized personnel only.

Refer to laboratory SOP ENV-SOP-IND1-0051 *Internal Chain-of-Custody* for more information.

5.8.2 Unique Identification

Each sample is assigned a unique identification number by the laboratory (Lab ID) after the sample has been checked and accepted by the laboratory in accordance with the laboratory's sample acceptance policy (See 5.8.3). The Lab ID is affixed to the sample container using a durable label.

The unique identification of samples also applies to subsamples, and prepared samples, such as extracts, digestates, etc.

The lab ID is linked to the field ID (client ID) in the laboratory's record. Both IDs are linked to the testing activities performed on the sample and the documentation records of the test.

For additional information, see 5.8.4.

5.8.3 Sample Receipt Checks and Sample Acceptance Policy

The laboratory checks the condition and integrity of samples at the time of receipt and compares the labels on the sample containers to the COC record. Any problem or discrepancy is recorded. If the problem impacts the suitability of the sample for analysis or if the documentation is incomplete, the client is notified for resolution. Decisions and instructions from the client are documented in the project record.

5.8.3.1 Sample Receipt Checks

The following checks are performed:

- Verification that the COC is complete and legible.
- Verification that each sample's container label includes the client sample ID, the date and time of collection and the preservative, if applicable, in indelible ink.
- The container type and preservative, if applicable, is appropriate for each test requested.
- Adequate volume is received for each test requested.
- Visual inspection for damage or evidence of tampering.
- Visual inspection for presence of headspace in VOA vials. (VOA = volatile organic analysis).
- Thermal Preservation: For chemical testing methods for which thermal preservation is required, temperature on receipt is acceptable if the measurement is above freezing but $\leq$6°C. For samples that are hand-delivered to the laboratory immediately after sample collection, there must be evidence that the chilling process has begun, such as arrival on ice. The requirements for thermal preservation vary based on the scope of testing performed. For example, for microbiology, temperature on receipt is acceptable if the measurement is <10°C. Refer to the laboratory's SOP for sample receipt for more information.

- Chemical Preservation, if applicable
- Holding Time: Sample receiving personnel are trained to recognize tests with holding time ≤48 hours and to expedite the login of these samples. When samples are received out of hold, the laboratory will notify the client and request instruction. If the decision is made to proceed with analysis, the final test report will include documentation of this instruction. Samples that include tests with a holding time of 15 minutes or less from collection are processed without client approval and final test report is qualified.

5.8.3.2 Sample Acceptance Policy

The laboratory maintains a sample acceptance policy in accordance with regulatory guidelines to clearly establish the circumstances in which sample receipt is accepted or rejected. When receipt does not meet acceptance criteria for any one of these conditions, the laboratory must document the noncompliance, contact the customer, and either reject the samples or fully document any decisions to proceed with testing. In accordance with regulatory specifications, receipt conditions that do not meet criteria are documented in the final test report.

All samples received must meet each of the following:

- Be listed on a complete and legible COC.
- Be received in properly labeled sample containers.
- Be received in appropriate containers that identify preservative, if applicable.
- The COC must include the date and time of collection for each sample.
- The COC must include the test requested for each sample.
- Be received within holding time. Any samples received beyond the holding time will not be processed without prior customer approval. An exception to this policy is made for tests with a 15 minute holding time, such as pH, residual chlorine, and ferrous iron. Those tests are performed without customer approval and the data is qualified.
- Have sufficient sample volume to proceed with the analytical testing. If insufficient sample volume is received, analysis will not proceed without customer approval.
- Be received within appropriate temperature ranges (not frozen but ≤6°C) unless program requirements or customer contractual obligations mandate otherwise. The cooler temperature is recorded directly on the COC. For samples that are hand-delivered to the laboratory immediately after sample collection, there must be evidence that the chilling process has begun, such as arrival on ice. If samples arrive that are not compliant with these temperature requirements, the customer will be notified. The analysis will NOT proceed unless otherwise directed by the customer. If less than 72 hours remain in the hold time for the analysis, the analysis may be started while the customer is contacted to avoid missing the hold time.

5.8.4 Sample Control and Tracking

The samples are controlled and tracked using the Laboratory Information Management System (LIMS). The LIMS stores information about the samples and the project. The process of entering information into the LIMS is called login and these procedures are described in laboratory SOP ENV-SOP-IND1-0001 *Sample Management*. After login, a label is generated and affixed to each sample container. Information on this label, such as the lab ID, links the sample container to the information in LIMS.

At a minimum, the following information is entered during login:

- Client Name and Contact Information;
- The laboratory ID linked to the client ID;
- Date and time of sample collection;
- Date and time of sample receipt;
- Matrix of sample;
- Tests Requested.

5.8.5 Sample Storage, Handling, and Disposal

The laboratory procedures for sample storage, handling and disposal are detailed in laboratory SOPs ENV-SOP-IND1-0001 *Sample Management* and ENV-SOP-IND1-0004 *Waste Handling and Management.*

5.8.5.1 Sample Storage

The samples are stored according to method and regulatory requirements as per test method SOPs. Samples are stored away from all standards, reagents, or other potential sources of contamination and stored in a manner that prevents cross contamination. Volatile samples are stored separately from other samples. All sample fractions, extracts, leachates, and other sample preparation products are stored in the same manner as actual samples or as specified by the analytical method.

Refrigerated storage areas are maintained at ≤6°C (but not frozen) and freezer storage areas are maintained at <-10°C (unless otherwise required per method or program). The temperature of each storage area is checked and documented at least once each day of use. If the temperature falls outside the acceptable limits, then corrective actions are taken and appropriately documented.

The laboratory is operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted at all times. Samples are taken to the appropriate storage location immediately after sample receipt and login procedures are completed. All sample storage areas have limited access. Samples are removed from storage areas by designated personnel and returned to the storage areas as soon as possible after the required sample quantity has been taken.

5.8.5.2 Sample Retention and Disposal

The procedures used by the laboratory for sample retention and disposal are detailed in laboratory SOP ENV-SOP-IND1-0004 *Waste Handling and Management*.

In general, unused sample volume and prepared samples such as extracts, digestates, distillates and leachates are retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

Samples may be stored at ambient temperature when all analyses are complete, the hold time is expired, the report has been delivered, and/or when allowed by the customer or program. Samples requiring storage beyond the minimum sample retention time due to special requests or contractual obligations may be stored at ambient temperature unless the laboratory has sufficient capacity to store them refrigerated or frozen and their presence does not compromise the integrity of other samples.

After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposition of hazardous samples is to return the excess sample to the customer.

5.9 Assuring the Quality of Test Results

5.9.1 Quality Control (QC) Procedures

The laboratory monitors the validity and reliability of test results using quality control (QC) samples that are prepared and analyzed concurrently with field samples in the same manner as field samples. See the glossary for definition of preparation and analytical batch.

The results of QC performed during the testing process are used by the laboratory to assure the results of analysis are consistent, comparable, accurate, and/or precise within a specified limit. When the results are not within acceptance criteria or expectations for method performance, correction and corrective action(s) are taken. These actions may include retesting samples or reporting data with qualification to alert the end user of the situation.

Other QC measures performed include the use of certified reference materials (see 5.6.4), participation in interlaboratory proficiency testing (see 5.9.1.2), verification that formulae used for reduction of data and calculation of results is accurate (see 5.9.3), on-going monitoring of environmental conditions that could impact test results (see 5.3.2), and evaluation and verification of method selectivity and sensitivity (see 5.4.5).

QC results are also used by the laboratory to monitor statistical trends in performance over time and to establish acceptance criteria when no method or regulatory criteria exist (see 5.9.1.4).

5.9.1.1 Essential QC

Although the general principles of QC for the testing process apply to all testing, the QC protocol used for each test depends on the type of test performed.

QC protocol used by the laboratory to monitor the validity of the test are specified in test method SOPs. The SOP includes QC type, frequency, acceptance criteria, corrective actions, and procedures for reporting of nonconforming work.

These requirements in the SOP conform to the reference method and any applicable regulations or certification and accreditation program requirement for which results of the test are used. When a project requires more stringent QC protocol than specified in the SOP, project specification is followed.

The following are examples of essential QC for Chemistry:

5.9.1.1.1 Second-Source Standard (ICV/QCS)

The second-source standard is obtained from a different vendor than the standards used for calibration or is a different standard lot from the same vendor. It is a positive control used to verify the accuracy of a new calibration. This check is referred to in test method and quality system standards as the Initial Calibration Verification (ICV) or Quality Control Sample (QCS). The second source standard is analyzed immediately after the calibration and before analysis of any samples. When the ICV is not within acceptance criteria, a problem with the purity or preparation of the standards may be indicated.

5.9.1.1.2 Continuing Calibration Verification (CCV)

CCV is analyzed to determine if the analytical response has significantly changed since initial calibration. If the response of the CCV is within criteria, the initial calibration is considered valid. If not, there is a problem that requires further investigation. Actions taken are technology and method specific.

5.9.1.1.3 Method Blank (MB) / Other Blanks

A method blank is a negative control used to assess for contamination during the prep/analysis process. The MB consists of a clean matrix, similar to the associated samples, that is known to be free of analytes of interest. The MB is processed along with and under the same conditions as the associated samples to include all steps of the analytical procedure.

In general, contamination is suspected when the target analyte is detected in the MB above the reporting limit. Some programs may require evaluation of the MB to ½ the reporting limit or to the detection limit (LOD). When contamination is evident, the source is investigated and corrections are taken to reduce or eliminate it. Analytical results associated with a MB that does not meet criteria are qualified in the final test report when applicable.

Other types of blanks that serve as negative controls in the process may include:

- Trip Blanks (VOA)
- Storage Blanks
- Equipment Blanks
- Field Blanks

- Calibration Blanks
- Cleanup Blanks
- Instrument Blanks

5.9.1.1.4 Laboratory Control Sample (LCS)

The LCS is positive control used to evaluate the performance of the total analytical system, including all preparation and analytical steps. The LCS is spiked by the laboratory with a known amount of analyte. The spike is a standard solution that is pre-made or prepared from a certified reference standard.

When the percent recovery (%R) of the LCS is within the established control limit, sufficient accuracy has been achieved. If not, the source of the problem is investigated and corrected and the procedure may be repeated. Analytical results associated with LCS that does not meet criteria are qualified in the final test report when applicable.

5.9.1.1.5 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

Matrix spikes measure the effect the sample matrix has on precision and accuracy of the determinative test method. The MS and MSD are replicates of a client sample that are spiked with a known amount of target analyte.

Due to the heterogeneity of matrices even of the same general matrix type, matrix spike results mostly provide information on the effect of the matrix to the client whose sample was used and on samples of the same matrix from the same sampling site. Therefore, MS should be client-specific when the impact of matrix on accuracy and precision is a project data quality objective. When there is not a client-specified MS for any sample in the batch, the laboratory randomly selects a sample from the batch; the sample selected at random is called a "batch" matrix spike.

The MS/MSD results for percent recovery and relative percent difference are checked against control limits. Because the performance of matrix spikes is matrix-dependent, the result of the matrix spike is not used to determine the acceptability of the test batch.

5.9.1.1.6 Sample Duplicate (SD)

A sample duplicate is a second replicate of sample that is prepared and analyzed in the laboratory along another replicate. The SD is used to measure precision.

The relative percent difference between replicates is evaluated against the method or laboratory derived criteria for relative percent difference (RPD), when this criterion is applicable. If RPD is not met, associated test results are reported with qualification.

5.9.1.1.7 Surrogates

Surrogates, when required, are compounds that mimic the chemistry of target analytes but are not expected to occur naturally in real world samples. Surrogates are added to each sample and matrix QC samples (MS, MSD, SD) at known concentration to measure the impact of the matrix on the accuracy of method performance. Surrogates are also added to the positive and negative control samples (MB, LCS) to evaluate performance in a clean matrix, and included in the calibration standards and calibration check standards.

The percent recovery of surrogates is evaluated against method-specified limits or statistically derived in-house limits. Project-specific limits and/or program-specific limits are used when required. Results with surrogate recovery out of limits in samples are reported with qualification. Samples with surrogate failures can also be re-extracted and/or re-analyzed to confirm that the out-of-control value was caused by the matrix of the sample and not by some other systematic error.

5.9.1.1.8 Internal Standards

Internal Standards are compounds not expected to occur naturally in field samples. They are added to every standard and sample at a known concentration prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes. The laboratory follows specific guidelines for the treatment of internal standard recoveries and further information can be found in the applicable laboratory SOP.

5.9.1.1.9 QC Acceptance Criteria and Control Limits

The QC acceptance criteria are specified in test method SOPs. The criteria in the SOP are based on the requirements in the published test method or regulatory program. When there are no established acceptance criteria, the laboratory develops acceptance criteria in accordance with recognized industry standards.

Some methods and programs require the laboratory to develop and use control limits for LCS, MS/MSD and surrogate evaluation. Laboratory-developed limits are referred to as "in-house" control limits or statistical control limits. Statistical control limits represent ± 3 Standard Deviations (99% confidence level) from the average recovery of at least 20 data points generated using the same preparation and analytical procedure in a similar matrix.

See laboratory SOP ENV-SOP-IND1-0039 *Control Chart Generation* for more information.

5.9.1.2 Proficiency Testing (PT)

The laboratory participates in proficiency testing (PT) studies to measure performance of the test method and to identify or solve analytical problems. PT samples measure laboratory performance through the analysis of unknown samples provided by an external source.

The PT samples are obtained from accredited proficiency testing providers (PTP) and handled as field samples which means they are included in the laboratory's normal analytical processes and do not receive extraordinary attention due to their nature.

The laboratory does not share PT samples with other laboratories, does not communicate with other laboratories regarding current PT sample results during the duration of the study, and does not attempt to obtain the assigned value of any PT sample from the PT provider.

The laboratory initiates an investigation and corrective action plan whenever PT results are deemed unacceptable by the PT provider.

The frequency of PT participation is based on the certification and accreditation requirements held by the laboratory.

5.9.2 QC Corrective Action

When the results of QC are not within acceptance criteria or expectations for method performance, correction and corrective action(s) are taken per the specifications in the test method SOP. These actions may include retesting or reporting of data with qualification to alert the end user of the situation.

5.9.3 Data Review

The laboratory uses a tiered system for data review. The tiered process provides sequential checks to verify data transfer is complete; manual calculations, if performed, are correct, manual integrations are appropriate and documented, calibration and QC requirements are met, appropriate corrective action was taken when required, test results are properly qualified, process and test method SOPs were followed, project specific requirements were met, when applicable, and the test report is complete.

The sequential process includes three tiers referred to as primary review, secondary review, and administrative/completeness review.

Detailed procedures for the data review process are described in laboratory SOP ENV-SOP-IND1-0023 *Data Review Process*. The general expectations for the tiered review process are described in the following sections:

5.9.3.1 Primary Review

Primary review is performed by the individual that performed the analytical testing. All laboratory personnel are responsible for review of their work product to assure it is complete, accurate, documented, and consistent with policy and SOPs.

Checks performed during primary review include but are not limited to:

- Verification that data transfer and acquisition is complete

- Manual calculations, if performed, are documented and accurate
- Manual integrations, if performed, are documented and comply with SOP ENV-SOP-CORQ-006 *Manual Integration*
- Calibration and QC criteria were met, and/or proper correction and corrective actions were taken, and data and test results associated with QC and criteria exceptions are properly qualified
- Work is consistent with SOPs and any other relevant instructional document such as SWI, program requirements, or project QAPP

5.9.3.2 Secondary Review

Secondary review is performed by qualified peer or supervisor. Secondary review is essentially a repeat of the checks performed during primary review by another person. In addition to the checks of primary review, secondary review includes chromatography review to check the accuracy of analyte identification.

5.9.3.3 Completeness Review

Completeness review is an administrative review performed prior to release of the test report to the customer. Completeness review verifies that the final test report is complete and meets project specification. This review also assures that information necessary for the client's interpretation of results are explained in the case narrative, if applicable, or qualified in the test report.

5.9.3.4 Data Audits

In addition to the 3 tier data review process, test reports may be audited by local QA to verify compliance with SOPs and to check for data integrity, technical accuracy, and regulatory compliance. These audits are not usually done prior to issuance of the test report to the customer. The reports chosen for the data audits are selected at random.

If any problems with the data or test results are found during the data audit, the impact of the nonconforming work is evaluated using the process described in Section 4.9.

Also see Section 4.14 for internal audits.

5.10 Reporting

5.10.1 General Requirements

The laboratory reports the results of testing in a way that assures the results are clear and unambiguous. All data and results are reviewed prior to reporting to assure the results reported are accurate and complete.

Test results are summarized in test reports that include all information necessary for the customer's interpretation of the test results. Additional information necessary to clarify the data or disclose nonconformance, exceptions, or deviations that occurred during the analytical process are also reported to the customer in the test report.

The specifications for test reports and electronic data deliverables (EDD) are established between the laboratory and the customer at the time the request for analytical services is

initiated. The report specifications include the test report format, protocol for the reporting limit (RL) and conventions for the reporting of results less than the limit of quantitation (LOQ). Information about review of analytical service requests is provided in Section 4.4.

5.10.2 Test Reports: Required Items

Test Reports are prepared by the laboratory at the end of the testing process. The format of the report depends on the level of reporting requested by the customer. The laboratory offers a variety of standardized test report formats and can also provide custom test report formats, when necessary.

The level of detail required in the test report depends on the customer's needs for data verification, validation, and usability assessments that occur after the laboratory releases the test report to the customer. The test report formats offered by the laboratory provide gradient levels of detail to meet the unique needs of each customer. The laboratory project manager helps the customer select the test report format that best meets their needs. When a specific report format or protocol is required for regulatory or program compliance, the laboratory project manager must ensure the test report selected meets those requirements.

Every test report issued by the laboratory includes each of the following items:

a) Title

b) Name and phone number of a point of contact from the laboratory issuing the report.

c) Name and address of the laboratory where testing was performed. When testing is done at multiple locations within network (IRWO), the report must clearly identify which network laboratory performed each test and must include the physical address of each laboratory.

d) Unique identification of the test report, an identifier on each page of the report, and clear identification of the end of the report.

e) The name and address of the customer

f) Identification of test methods used

g) Cross reference between client sample identification number (Sample ID) and the laboratory's identification number for the sample (Lab ID) to provide unambiguous identification of samples.

h) The date of receipt of samples, condition of samples on receipt, and identification of any instance where receipt of the samples did not meet sample acceptance criteria.

i) Date and times of sample collection, receipt, preparation, and analysis.

j) Test results and units of measurement.

k) Qualifiers appended to results, when required.

l) Name, title, signature of the person(s) authorizing release of the test report and date of release.

m) A statement that the results in the test report relate only to the items tested.

n) Statement that the test report may not be reproduced except in full without written approval from the laboratory.

5.10.3 Test Reports: Supplemental Items

5.10.3.1 Supplemental Requirements

The following items are included in the test report when required or relevant:

a) Explanation of departure from test method SOPs including, what the departure was and why it was necessary.

b) Statistical methods used. (Required for Whole Effluent Toxicity)

c) For solid samples, specification that results are reported on a dry weight or wet weight basis.

d) Signed Affidavit, when required by client or regulatory agency.

e) A statement of compliance / non-compliance with requirements or specifications (client, program, or standard) that includes identification of test results that did not meet acceptance criteria.

f) When requested by the client, statement of estimated measurement uncertainty. In general, for environmental testing, estimated uncertainty of measurement is extrapolated from LCS control limits. Control limits incorporate the expected variation of the data derived from the laboratory's procedure. When the control limits are specified by the test method or regulatory program, the control limits represent the expected variation of the test method and/or matrices for which the test method was designed.

g) Opinions and Interpretations (See Section 5.10.5).

h) If a claim of accreditation/certification is included in the test report, identification of any test methods or analytes for which accreditation/certification is not held by the laboratory. The fields of accreditation/certification vary between agencies and it cannot be presumed that because accreditation/certification is not held that it is offered or required.

i) Certification Information, including certificate number and issuing body.

5.10.3.2 Test Reports: Sampling Information

The following items are included in the test report when samples are collected by the laboratory or when this information is necessary for the interpretation of test results:

a) Date of Sampling.

b) Unambiguous identification of material samples.

c) Location of sampling including and diagrams, sketches, or photographs.

d) Reference to the sampling plan and procedures used.

e) Details of environmental conditions at time of sample that may impact test results.

f) Any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

g) Results of field measurements, if requested.

5.10.4 Calibration Certificates

The laboratory does not perform calibration activities for its customers and calibration certificates are not offered or issued.

5.10.5 Opinions and Interpretations

The laboratory provides objective data and information to its customers of sufficient detail for their interpretation and decision making. Objective data and information is based solely on fact and does not attempt to explain the meaning (interpret) or offer a view or judgment (opinion). Sometimes the customer may request the laboratory provide opinion or interpretation to assist them with their decisions about the data.

When opinions and interpretations are included in the test report, the laboratory will document the basis upon which the opinions and interpretations have been made and clearly identify this content as opinion or interpretation in the test report.

Examples of opinion and interpretation include but are not limited to:

- The laboratory's viewpoint on how a nonconformance impacts the quality of the data or usability of results.
- The laboratory's judgment of fulfillment of contractual requirements.
- Recommendations for how the customer should use the test results and information.
- Suggestions or guidance to the customer for improvement.

When opinions or interpretations are verbally discussed with the customer, the content of these conversations is summarized by the laboratory and kept in the project record.

5.10.6 Subcontractor Reports

When analytical work has been subcontracted to an organization external to PAS, the test report from the subcontractor is included in its entirety as an amendment to the final test report.

Note: Test results for analytical work performed within the PAS network may be merged into a single test report. The merged test report issued clearly identifies the location and address of each network laboratory that performed testing and which tests they performed. (See 5.10.2)

5.10.7 Electronic Transmission of Results

When test results and/or reports are submitted to the customer through electronic transmission, the procedures established in this manual are followed for confidentiality and protection of data.

5.10.8 Format of Test Reports

The test formats offered by the laboratory are designed to accommodate each type of analytical test method carried out by the laboratory and to minimize the possibility of misunderstanding or misuse of analytical results. The format of electronic data deliverables (EDD) follows the specifications for the EDD.

5.10.9 Amendments to Test Reports

Test reports that are revised or amended by the laboratory after date of release of the final test report to the customer are issued as a new test report that is clearly identified as an amendment or revision and that includes a reference to the originally issued final test report.

Changes made to test results and data before the final test report is issued to the customer are not amendments or revisions, these are corrections to errors found during the laboratory's data verification and review process.

The laboratory's procedure for report amendments and revision are outlined in laboratory SOP ENV-SOP-IND1-0048 *Final Report and Data Deliverable Content*.

6.0 REVISION HISTORY

This Version:

Section	Description of Change
All	This version is a complete rewrite of the document this version supersedes.

This document supersedes the following documents:

Document Number	Title	Version
ENV-MAN-CORQ-0001	Quality Assurance Manual	01

7.0 APPENDICES

7.1 Appendix A: Certification / Accreditation Listing

The certifications / accreditation lists provided in this manual represent those that were held by the named location on the effective date of this manual. This information is subject to change without notice and must not be considered valid proof of certification or accreditation status. Current certificates are maintained by Local QA and a copy of the certificate is posted to PAS's eDMS Portal for access by all PAS employees. External parties should contact the laboratory for the most current information.

7.1.1 PAS-Indianapolis and PAS-Grand Rapids

Indianapolis Laboratory Certifications			
Accrediting Authority	**Program Category**	**Accrediting Agency**	**Accreditation #**
Illinois (Secondary TNI)	Hazardous Waste	IL-EPA	200074
Illinois (Secondary TNI)	Non-Potable Water	IL-EPA	200074
Indiana	Drinking Water	IN-SDH	C-49-06
Kansas (Primary TNI)	Hazardous Waste	KS-DHE	E-10177
Kansas (Primary TNI)	Non-Potable Water	KS-DHE	E-10177
Kentucky	UST	KY-DEP	80226
Kentucky	Wastewater	KY-DEP	KY98019
Michigan	Drinking Water	MI-DEQ/EGLE	9050
Ohio	VAP-Hazardous Waste	OH-EPA	CL0065
Ohio	VAP-Non-Potable Water	OH-EPA	CL0065
Oklahoma	Non-Potable Water	OK-DEQ	9204
Oklahoma	Solids	OK-DEQ	9204
Texas (Secondary TNI)	Non-Potable Water	TX-CEQ	T104704355
Texas (Secondary TNI)	Solid Chemical Mat.	TX-CEQ	T104704355
USDA	Foreign Soil Permit	USDA	P330-19-00257
West Virginia	Hazardous Waste	WV-DEP	330
West Virginia	Non-Potable Water	WV-DEP	330
Wisconsin	Non-Potable Water	WI-DNR	999788130
Wisconsin	Potable Water	WI-DNR	999788130
Grand Rapids Laboratory Certifications			
Accrediting Authority	**Program Category**	**Accrediting Agency**	**Accreditation #**
Minnesota (Primary TNI)	Non-Potable Water	MDH	026-999-161
Michigan	Drinking Water	MI-EGLE	0034

7.2 Appendix B: Capability Listing

The capabilities listed in this Appendix were held by the location referenced on the effective date of this manual. This information is subject to change without notice. External parties should contact the laboratory for the most current information regarding laboratory capabilities and certifications.

Table Legend:

- DW = Drinking Water
- NPW = Non-Potable Water
- SCM = Solid and Chemical Materials
- Waste = Non-Aqueous Phase Liquid (NAPL), Oil

7.2.1 PAS-Indianapolis

Parameter	Method	Matrices			
		DW	NPW	SCM	Waste
Specific Conductance	EPA 120.1/SM 2510B		x		
Mercury, Low-Level	EPA 1631E		x		
Oil and Grease, HEM/SGT-HEM	EPA 1664A		x		
Turbidity	EPA 180.1		x		
ICP Metals	EPA 200.7	x	x		
ICP Metals	SW 6010B		x	x	x
ICP-MS Metals	EPA 200.8	x	x		
ICP-MS Metals	SW 6020		x	x	x
Apparent Color	SM 2120B		x		
Acidity	SM 2310B		x		
Alkalinity	SM 2320B		x		
Hardness	SM 2340B		x		
Mercury	EPA 245.1	x	x		
Mercury	SW 7470A		x		
Mercury	SW 7471A			x	x
Total Solids	SM 2540B		x	x	x
Total Dissolved Solids	SM 2540C		x		
Total Suspended Solids	SM 2540D		x		
Total Volatile Solids	SM 2540E		x		
Settleable Solids	SM 2540F		x		
Percent Moisture/Percent Solids/Total Volatile Solids	SM 2540G			x	x
Anions	EPA 300.0	x	x		

Parameter	Method	Matrices			
		DW	NPW	SCM	Waste
Anions	SW 9056A		x	x	
Cyanide	EPA 335.4	x	x		
Cyanide	SM 4500CN-E/SW 9012A		x	x	x
Cyanide, Amenable	EPA 335.4		x		
Cyanide, Amenable	SM 4500CN-G/SW 9012A		x	x	x
Cyanide, Free	SW 9014/OIA 1677		x	x	
Cyanide, Available	OIA 1677		x	x	
Hexavalent Chromium	SM 3500Cr-B		x		
Hexavalent Chromium	SW 7196A		x	x	x
Ferrous Iron	Hach 8146		x		
Ammonia	EPA 350.1/SM 4500NH3-G		x	x	
Total Kjeldahl Nitrogen	EPA 351.2		x	x	
Nitrogen, Nitrate/Nitrite	EPA 353.2	x	x	x	
Total Phosphorus	EPA 365.1		x	x	
Chemical Oxygen Demand (COD)	EPA 410.4		x		
Total Recoverable Phenolics	EPA 420.4/SW 9066		x	x	
Chloride	SM 4500Cl-E		x		
Residual Chlorine	SM 4500Cl-G		x		
Fluoride	SM 4500F-C		x		
pH	SM 4500H+-B		x		
pH	SW 9045C			x	x
Orthophosphate as P	SM 4500P-E		x		
Sulfide	SM 4500S2- D		x		
Sulfate	SW 9038/ASTM D516		x		
Biochemical Oxygen Demand (BOD)	SM 5210B		x		
Total Organic Carbon (TOC)	SM 5310C		x		
Anionic Surfactants (MBAS)	SM 5540C		x		
Volatile Organic Compounds (VOCs)	EPA 524.2	x			
Volatile Organic Compounds (VOCs)	EPA 624.1		x		
Volatile Organic Compounds (VOCs)	SW 8260C		x	x	x
Polynuclear Aromatic Hydrocarbons (PAHs)	SW 8270C SIM		x	x	
Semivolatile Organic Compounds (SVOCs)	EPA 625.1		x		

Parameter	Method	Matrices			
		DW	NPW	SCM	Waste
Semivolatile Organic Compounds (SVOCs)	SW 8270C		x	x	x
Organochlorine Pesticides	EPA 608.3		x		
Organochlorine Pesticides	SW 8081B		x	x	x
Polychlorinated Biphenyls (PCBs)	EPA 608.3		x		
Polychlorinated Biphenyls (PCBs)	SW 8082A		x	x	x
EDB and DBCP	SW 8011		x		
Diesel Range Organics (DRO/ERO)	SW 8015D		x	x	
Gasoline Range Organics (GRO)	SW 8015D		x	x	
Alcohols and Glycols	SW 8015D		x	x	
Organophosphorus Pesticides	SW 8141B		x	x	
Chlorinated Herbicides	SW 8151A		x	x	
Flash Point	EPA 1010A			x	x
Toxicity Characteristic Leaching Procedure (TCLP)	SW 1311		x	x	x
Synthetic Precipitation Leaching Procedure (SPLP)	SW 1312		x	x	x
Free Liquids (Paint Filter Test)	SW 9095			x	x
Dissolved Gases	RSK 175		x		

7.2.2 PAS-Grand Rapids

Parameter	Method	Matrices			
		DW	NPW	SCM	Waste
Apparent Color	SM 2120B		x		
Turbidity	SM 2130B		x		
Hexavalent Chromium	SM 3500Cr-B/SW 7196A		x		
Ferrous Iron	SM 3500Fe-B		x		
Nitrogen, Nitrate/Nitrite	SM 4500NO3-F	x	x		
Orthophosphate as P	SM 4500P-E		x		
Sulfite	SM 4500SO3-B		x		
Biochemical Oxygen Demand (BOD)	SM 5210B		x		
Carbon Dioxide	SM 4500CO2-C		x		
Fecal Coliform	SM 9222D	x	x		
Total Coliform	SM 9223B	x	x		
True Color	NCASI 71.01		x		

7.3 Appendix C: Glossary

This glossary provides common terms and definitions used in the laboratory. **It is not intended to be a complete list of all terms and definitions used.** The definitions have been compiled mostly from the TNI Standard and DoD QSM. Although this information has been reproduced with care, errors cannot be entirely excluded. Definitions for the same term also vary between sources. When the meaning of a term used in a laboratory document is different from this glossary or when the glossary does not include the term, the term and definition is included or defined in context in the laboratory document.

Term	Definition
3P Program	PAS-The continuous improvement program used by PAS that focuses on Process, Productivity, and Performance.
Acceptance Criteria	TNI- Specified limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation	TNI- The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. DoD- Refers to accreditation in accordance with the DoD ELAP.
Accreditation Body (AB)	TNI- The organization having responsibility and accountability for environmental laboratory accreditation and which grants accreditation under this program. DoD- Entities recognized in accordance with the DoD-ELAP that are required to operate in accordance with ISO/IEC 17011, *Conformity assessment: General requirements for accreditation bodies accrediting conformity assessment bodies.* The AB must be a signatory, in good standing, to the International Laboratory Accreditation Cooperation (ILAC) mutual recognition arrangement (MRA) that verifies, by evaluation and peer assessment, that its signatory members are in full compliance with ISO/IEC 17011 and that its accredited laboratories comply with ISO/IEC 17025.
Accuracy	TNI- The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.
Activity, Absolute	TNI- Rate of nuclear decay occurring in a body of material, equal to the number of nuclear disintegrations per unit time. NOTE: Activity (absolute) may be expressed in becquerels (Bq), curies (Ci), or disintegrations per minute (dpm), and multiples or submultiples of these units.
Activity, Areic	TNI- Quotient of the activity of a body of material and its associated area.
Activity, Massic	TNI- Quotient of the activity of a body of material and its mass; also called specific activity.
Activity, Volumic	TNI- Quotient of the activity of a body of material and its volume; also called activity concentration. NOTE: In this module [TNI Volume 1, Module 6], unless otherwise stated, references to activity shall include absolute activity, areic activity, massic activity, and volumic activity.
Activity Reference Date	TNI- The date (and time, as appropriate to the half-life of the radionuclide) to which a reported activity result is calculated. NOTE: The sample collection date is most frequently used as the Activity Reference Date for environmental measurements, but different programs may specify other points in time for correction of results for decay and ingrowth.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
American Society for Testing and Materials (ASTM)	An international standards organization that develops and publishes voluntary consensus standards for a wide range of materials, products, systems and services.
Analysis	DoD- A combination of sample preparation and instrument determination.
Analysis Code (Acode)	All the set parameters of a test, such as Analytes, Method, Detection Limits and Price.
Analysis Sequence	A compilation of all samples, standards and quality control samples run during a specific amount of time on a particular instrument in the order they are analyzed.
Analyst	TNI- The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analyte	TNI- A substance, organism, physical parameter, property, or chemical constituent(s) for which an environmental sample is being analyzed. DoD- The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family and are analyzed together.
Analytical Method	DoD- A formal process that identifies and quantifies the chemical components of interest (target analytes) in a sample.
Analytical Uncertainty	TNI- A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
Annual (or Annually)	Defined by PAS as every 12 months ± 30 days.
Assessment	TNI - The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its system to defined criteria (to the standards and requirements of laboratory accreditation). DoD- An all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection, or surveillance conducted on-site.
Atomic Absorption Spectrometer	Instrument used to measure concentration in metals samples.
Atomization	A process in which a sample is converted to free atoms.
Audit	TNI- A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.
Batch	TNI- Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours or the time-frame specified by the regulatory program. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed 20 samples.
Batch, Radiation Measurements (RMB)	TNI- An RMB is composed of 1 to 20 environmental samples that are counted directly without preliminary physical or chemical processing that affects the outcome of the test (e.g., non-destructive gamma spectrometry, alpha/beta counting of air filters, or swipes on gas proportional detectors). The samples in an RMB share similar physical and chemical parameter, and analytical configurations (e.g., analytes, geometry, calibration, and background corrections). The maximum time between the start of processing of the first and last in an RMB is 14 calendar days.
Bias	TNI- The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	TNI and DoD- A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results (See Method Blank). DoD- Blank samples are negative control samples, which typically include field blank samples (e.g., trip blank, equipment (rinsate) blank, and temperature blank) and laboratory blank samples (e.g., method blank, reagent blank, instrument blank, calibration blank, and storage blank).
Blind Sample	A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.
BNA (Base Neutral Acid compounds)	A list of semi-volatile compounds typically analyzed by mass spectrometry methods. Named for the way they can be extracted out of environmental samples in an acidic, basic or neutral environment.
BOD (Biochemical Oxygen Demand)	Chemical procedure for determining how fast biological organisms use up oxygen in a body of water.

Calibration	TNI- A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. 1) In calibration of support equipment, the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI); 2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.
Calibration Curve	TNI- The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.
Calibration Method	A defined technical procedure for performing a calibration.
Calibration Range	DoD- The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.
Calibration Standard	TNI- A substance or reference material used for calibration.
Certified Reference Material (CRM)	TNI- Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.
Chain of Custody	An unbroken trail of accountability that verifies the physical security of samples, data, and records.
Chain of Custody Form (COC)	TNI- Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and type of containers; the mode of collection, the collector, time of collection; preservation; and requested analyses.
Chemical Oxygen Demand (COD)	A test commonly used to indirectly measure the amount of organic compounds in water.
Client (referred to by ISO as Customer)	Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations.
Code of Federal Regulations (CFR)	A codification of the general and permanent rules published in the Federal Register by agencies of the federal government.
Comparability	An assessment of the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	The percent of valid data obtained from a measurement system compared to the amount of valid data expected under normal conditions. The equation for completeness is: % Completeness = (Valid Data Points/Expected Data Points)*100
Confirmation	TNI- Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second-column confirmation; alternate wavelength; derivatization; mass spectral interpretation; alternative detectors; or additional cleanup procedures. DoD- Includes verification of the identity and quantity of the analyte being measured by another means (e.g., by another determinative method, technology, or column). Additional cleanup procedures alone are not considered confirmation techniques.
Conformance	An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.
Congener	A member of a class of related chemical compounds (e.g., PCBs, PCDDs).
Consensus Standard	DoD- A standard established by a group representing a cross-section of a particular industry or trade, or a part thereof.
Continuing Calibration Blank (CCB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method.
Continuing Calibration Check Compounds (CCC)	Compounds listed in mass spectrometry methods that are used to evaluate an instrument calibration from the standpoint of the integrity of the system. High variability would suggest leaks or active sites on the instrument column.
Continuing Calibration Verification	DoD- The verification of the initial calibration. Required prior to sample analysis and at periodic intervals. Continuing calibration verification applies to both external and internal standard calibration techniques, as well as to linear and non-linear calibration models.
Continuing Calibration Verification (CCV) Standard	Also referred to as a Calibration Verification Standard (CVS) in some methods, it is a standard used to verify the initial calibration of compounds in an analytical method. CCVs are analyzed at a frequency determined by the analytical method.

Continuous Emission Monitor (CEM)	A flue gas analyzer designed for fixed use in checking for environmental pollutants.
Continuous Improvement Plan (CIP)	The delineation of tasks for a given laboratory department or committee to achieve the goals of that department.
Contract Laboratory Program (CLP)	A national network of EPA personnel, commercial labs, and support contractors whose fundamental mission is to provide data of known and documented quality.
Contract Required Detection Limit (CRDL)	Detection limit that is required for EPA Contract Laboratory Program (CLP) contracts.
Contract Required Quantitation Limit (CRQL)	Quantitation limit (reporting limit) that is required for EPA Contract Laboratory Program (CLP) contracts.
Control Chart	A graphic representation of a series of test results, together with limits within which results are expected when the system is in a state of statistical control (see definition for Control Limit)
Control Limit	A range within which specified measurement results must fall to verify that the analytical system is in control. Control limit exceedances may require corrective action or require investigation and flagging of non-conforming data.
Correction	DoD- Action taken to eliminate a detected non-conformity.
Corrective Action	DoD- The action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. A root cause analysis may not be necessary in all cases.
Corrective and Preventative Action (CAPA)	The primary management tools for bringing improvements to the quality system, to the management of the quality system's collective processes, and to the products or services delivered which are an output of established systems and processes.
Critical Value	TNI- Value to which a measurement result is compared to make a detection decision (also known as critical level or decision level). NOTE: The Critical Value is designed to give a specified low probability α of false detection in an analyte-free sample, which implies that a result that exceeds the Critical Value, gives high confidence $(1 - \alpha)$ that the radionuclide is actually present in the material analyzed. For radiometric methods, α is often set at 0.05.
Customer	DoD- Any individual or organization for which products or services are furnished or work performed in response to defined requirements and expectations.
Data Integrity	TNI- The condition that exists when data are sound, correct, and complete, and accurately reflect activities and requirements.
Data Quality Objective (DQO)	Systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use or end user.
Data Reduction	TNI- The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more usable form.
Definitive Data	DoD- Analytical data of known quantity and quality. The levels of data quality on precision and bias meet the requirements for the decision to be made. Data that is suitable for final decision-making.
Demonstration of Capability (DOC)	TNI- A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. DoD- A procedure to establish the ability of the analyst to generate analytical results by a specific method that meet measurement quality objectives (e.g., for precision and bias).
Department of Defense (DoD)	An executive branch department of the federal government of the United States charged with coordinating and supervising all agencies and functions of the government concerned directly with national security.
Detection Limit (DL)	DoD- The smallest analyte concentration that can be demonstrated to be different than zero or a blank concentration with 99% confidence. At the DL, the false positive rate (Type 1 error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence.
Detection Limit (DL) for Safe Drinking Water Act (SDWA) Compliance	TNI- Laboratories that analyze drinking-water samples for SDWA compliance monitoring must use methods that provide sufficient detection capability to meet the detection limit requirements established in 40 CFR 141. The SDWA DL for radioactivity is defined in 40 CFR Part 141.25.c as the radionuclide concentration, which can be counted with a precision of plus or minus 100% at the 95% confidence level (1.96σ where σ is the standard deviation of the net counting rate of the sample).
Deuterated Monitoring Compounds (DMCs)	DoD- SIM specific surrogates as specified for GC/MS SIM analysis.
Diesel Range Organics (DRO)	A range of compounds that denote all the characteristic compounds that make up diesel fuel (range can be state or program specific).

Digestion	DoD- A process in which a sample is treated (usually in conjunction with heat and acid) to convert the target analytes in the sample to a more easily measured form.
Document Control	The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.
Documents	DoD- Written components of the laboratory management system (e.g., policies, procedures, and instructions).
Dry Weight	The weight after drying in an oven at a specified temperature.
Duplicate (also known as Replicate or Laboratory Duplicate)	The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results of duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.
Electron Capture Detector (ECD)	Device used in GC methods to detect compounds that absorb electrons (e.g., PCB compounds).
Electronic Data Deliverable (EDD)	A summary of environmental data (usually in spreadsheet form) which clients request for ease of data review and comparison to historical results.
Eluent	A solvent used to carry the components of a mixture through a stationary phase.
Elute	To extract, specifically, to remove (absorbed material) from an absorbent by means of a solvent.
Elution	A process in which solutes are washed through a stationary phase by movement of a mobile phase.
Environmental Data	DoD- Any measurements or information that describe environmental processes, locations, or conditions; ecological or health effects and consequences; or the performance of environmental technology.
Environmental Monitoring	The process of measuring or collecting environmental data.
Environmental Protection Agency (EPA)	An agency of the federal government of the United States which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.
Environmental Sample	A representative sample of any material (aqueous, non-aqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required. Environmental samples can generally be classified as follows: • Non Potable Water (Includes surface water, ground water, effluents, water treatment chemicals, and TCLP leachates or other extracts) • Drinking Water - Delivered (treated or untreated) water designated as potable water • Water/Wastewater - Raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents • Sludge - Municipal sludges and industrial sludges. • Soil - Predominately inorganic matter ranging in classification from sands to clays. • Waste - Aqueous and non-aqueous liquid wastes, chemical solids, and industrial liquid and solid wastes
Equipment Blank	A sample of analyte-free media used to rinse common sampling equipment to check effectiveness of decontamination procedures.
Extracted Internal Standard Analyte	Isotopically labeled analogs of analytes of interest added to all standards, blanks and samples analyzed. Added to samples and batch QC samples prior to the first step of sample extraction and to standards and instrument blanks prior to analysis. Used for isotope dilution methods.
Facility	A distinct location within the company that has unique certifications, personnel and waste disposal identifications.
False Negative	DoD- A result that fails to identify (detect) an analyte or reporting an analyte to be present at or below a level of interest when the analyte is actually above the level of interest.
False Positive	DoD- A result that erroneously identifies (detects) an analyte or reporting an analyte to be present above a level of interest when the analyte is actually present at or below the level of interest.
Field Blank	A blank sample prepared in the field by filling a clean container with reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken.
Field Measurement	Determination of physical, biological, or radiological properties, or chemical constituents that are measured on-site, close in time and sPAS to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.
Field of Accreditation	TNI- Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Field of Proficiency Testing (FoPT)	TNI- Matrix, technology/method, analyte combinations for which the composition, spike concentration ranges and acceptance criteria have been established by the PTPEC.
Finding	TNI- An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement. DoD- An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive, negative, or neutral and is normally accompanied by specific examples of the observed condition. The finding must be linked to a specific requirement (e.g., this standard, ISO requirements, analytical methods, contract specifications, or laboratory management systems requirements).
Flame Atomic Absorption Spectrometer (FAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the fact that ground state metals absorb light at different wavelengths. Metals in a solution are converted to the atomic state by use of a flame.
Flame Ionization Detector (FID)	A type of gas detector used in GC analysis where samples are passed through a flame which ionizes the sample so that various ions can be measured.
Gas Chromatography (GC)	Instrumentation which utilizes a mobile carrier gas to deliver an environmental sample across a stationary phase with the intent to separate compounds out and measure their retention times.
Gas Chromatograph/ Mass Spectrometry (GC/MS)	In conjunction with a GC, this instrumentation utilizes a mass spectrometer which measures fragments of compounds and determines their identity by their fragmentation patterns (mass spectra).
Gasoline Range Organics (GRO)	A range of compounds that denote all the characteristic compounds that make up gasoline (range can be state or program specific).
Graphite Furnace Atomic Absorption Spectrometry (GFAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the absorption of light at different wavelengths that are characteristic of different analytes.
High Pressure Liquid Chromatography (HPLC)	Instrumentation used to separate, identify and quantitate compounds based on retention times which are dependent on interactions between a mobile phase and a stationary phase.
Holding Time	TNI- The maximum time that can elapse between two specified activities. 40 CFR Part 136- The maximum time that samples may be held prior to preparation and/or analysis as defined by the method and still be considered valid or not compromised. For sample prep purposes, hold times are calculated using the time of the start of the preparation procedure. DoD- The maximum time that may elapse from the time of sampling to the time of preparation or analysis, or from preparation to analysis, as appropriate.
Homogeneity	The degree to which a property or substance is uniformly distributed throughout a sample.
Homologue	One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member. For instance, methanol, ethanol, propanol, butanol, etc., form a homologous series.
Improper Actions	DoD- Intentional or unintentional deviations from contract-specified or method-specified analytical practices that have not been authorized by the customer (e.g., DoD or DOE).
Incremental Sampling Method (ISM)	Soil preparation for large volume (1 kg or greater) samples.
In-Depth Data Monitoring	TNI- When used in the context of data integrity activities, a review and evaluation of documentation related to all aspects of the data generation process that includes items such as preparation, equipment, software, calculations, and quality controls. Such monitoring shall determine if the laboratory uses appropriate data handling, data use and data reduction activities to support the laboratory's data integrity policies and procedures.
Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Analytical technique used for the detection of trace metals which uses plasma to produce excited atoms that emit radiation of characteristic wavelengths.
Inductively Coupled Plasma- Mass Spectrometry (ICP/MS)	An ICP that is used in conjunction with a mass spectrometer so that the instrument is not only capable of detecting trace amounts of metals and non-metals but is also capable of monitoring isotopic speciation for the ions of choice.
Infrared Spectrometer (IR)	An instrument that uses infrared light to identify compounds of interest.

Initial Calibration (ICAL)	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response relationship of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method.
Initial Calibration Blank (ICB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method. This blank is specifically run in conjunction with the Initial Calibration Verification (ICV) where applicable.
Initial Calibration Verification (ICV)	DoD- Verifies the initial calibration with a standard obtained or prepared from a source independent of the source of the initial calibration standards to avoid potential bias of the initial calibration.
Injection Internal Standard Analyte	Isotopically labeled analogs of analytes of interest (or similar in physiochemical properties to the target analytes but with a distinct response) to be quantitated. Added to all blanks, standards, samples and batch QC after extraction and prior to analysis.
Instrument Blank	A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
Instrument Detection Limits (IDLs)	Limits determined by analyzing a series of reagent blank analyses to obtain a calculated concentration. IDLs are determined by calculating the average of the standard deviations of three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day.
Interference, spectral	Occurs when particulate matter from the atomization scatters incident radiation from the source or when the absorption or emission from an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible.
Interference, chemical	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte.
Internal Standard	TNI and DoD- A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.
International Organization for Standardization (ISO)	An international standard-setting body composed of representatives from various national standards organizations.
Intermediate Standard Solution	Reference solutions prepared by dilution of the stock solutions with an appropriate solvent.
International System of Units (SI)	The coherent system of units adopted and recommended by the General Conference on Weights and Measures.
Ion Chromatography (IC)	Instrumentation or process that allows the separation of ions and molecules based on the charge properties of the molecules.
Isomer	One of two or more compounds, radicals, or ions that contain the same number of atoms of the same element but differ in structural arrangement and properties. For example, hexane (C6H14) could be n-hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane.
Laboratory	A body that calibrates and/or tests.
Laboratory Control Sample (LCS)	TNI- (also known as laboratory fortified blank (LFB), spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to evaluate the performance of all or a portion of the measurement system.
Laboratory Duplicate	Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.
Laboratory Information Management System (LIMS)	DoD- The entirety of an electronic data system (including hardware and software) that collects, analyzes, stores, and archives electronic records and documents.
Learning Management System (LMS)	A web-based database used by the laboratories to track and document training activities. The system is administered by the corporate training department and each laboratory's learn centers are maintained by a local administrator.
Legal Chain-of-Custody Protocols	TNI- Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain-of-Custody (COC) Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Limit(s) of Detection (LOD)	TNI- The minimum result, which can be reliably discriminated from a blank with predetermined confidence level. DoD- The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. A LOD may be used as the lowest concentration for reliably reporting a non-detect of a specific analyte in a specific matrix with a specific method at 99% confidence.
Limit(s) of Quantitation (LOQ)	TNI- The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. DoD- The smallest concentration that produces a quantitative result with known and recorded precision and bias. For DoD/DOE projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard and within the calibration range.
Linear Dynamic Range	DoD- Concentration range where the instrument provides a linear response.
Liquid chromatography/ tandem mass spectrometry (LC/MS/MS)	Instrumentation that combines the physical separation techniques of liquid chromatography with the mass analysis capabilities of mass spectrometry.
Lot	TNI- A definite amount of material produced during a single manufacturing cycle, and intended to have uniform character and quality.
Management	Those individuals directly responsible and accountable for planning, implementing, and assessing work.
Management System	System to establish policy and objectives and to achieve those objectives.
Manager (however named)	The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual.
Matrix	TNI- The substrate of a test sample.
Matrix Duplicate	TNI- A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.
Matrix Spike (MS) (spiked sample or fortified sample)	TNI- A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Matrix Spike Duplicate (MSD) (spiked sample or fortified sample duplicate)	TNI- A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.
Measurement Performance Criteria (MPC)	DoD- Criteria that may be general (such as completion of all tests) or specific (such as QC method acceptance limits) that are used by a project to judge whether a laboratory can perform a specified activity to the defined criteria.
Measurement Quality Objective (MQO)	TNI- The analytical data requirements of the data quality objectives are project- or program-specific and can be quantitative or qualitative. MQOs are measurement performance criteria or objectives of the analytical process. Examples of quantitative MQOs include statements of required analyte detectability and the uncertainty of the analytical protocol at a specified radionuclide activity, such as the action level. Examples of qualitative MQOs include statements of the required specificity of the analytical protocol, e.g., the ability to analyze for the radionuclide of interest given the presence of interferences.
Measurement System	TNI- A method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s). DoD- A test method, as implemented at a particular laboratory, and which includes the equipment used to perform the sample preparation and test and the operator(s).
Measurement Uncertainty	DoD- An estimate of the error in a measurement often stated as a range of values that contain the true value within a certain confidence level. The uncertainty generally includes many components which may be evaluated from experimental standard deviations based on repeated observations or by standard deviations evaluated from assumed probability distributions based on experience or other information. For DoD/DOE, a laboratory's Analytical Uncertainty (such as use of LCS control limits) can be reported as the minimum uncertainty.
Method	TNI- A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.
Method Blank	TNI- A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit (MDL)	TNI- One way to establish a Detection Limit; defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method of Standard Additions	A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration.
Minimum Detectable Activity (MDA)	TNI- Estimate of the smallest true activity that ensures a specified high confidence, 1 – β, of detection above the Critical Value, and a low probability β of false negatives below the Critical Value. For radiometric methods, β is often set at 0.05. NOTE 1: The MDS is a measure of the detection capability of a measurement process and as such, it is an a priori concept. It may be used in the selection of methods to meet specified MQOs. Laboratories may also calculate a "sample specific" MDA, which indicates how well the measurement process is performing under varying real-world measurement conditions, when sample-specific characteristics (e.g., interferences) may affect the detection capability. However, the MDA must never be used instead of the Critical Value as a detection threshold. NOTE 2: For the purpose of this Standard, the terms MDA and minimum detectable concentration (MDC) are equivalent.
MintMiner	Program used by PAS to review large amounts of chromatographic data to monitor for errors or data integrity issues.
Mobile Laboratory	TNI- A portable enclosed structure with necessary and appropriate accommodation and environmental conditions for a laboratory, within which testing is performed by analysts. Examples include but are not limited to trailers, vans, and skid-mounted structures configured to house testing equipment and personnel.
National Environmental Laboratory Accreditation Conference (NELAC)	See definition of The NELAC Institute (TNI).
National Institute of Occupational Safety and Health (NIOSH)	National institute charged with the provision of training, consultation and information in the area of occupational safety and health.
National Institute of Standards and Technology (NIST)	TNI- A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (or NMI).
National Pollutant Discharge Elimination System (NPDES)	A permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.
Negative Control	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.
Nitrogen Phosphorus Detector (NPD)	A detector used in GC analyses that utilizes thermal energy to ionize an analyte. With this detector, nitrogen and phosphorus can be selectively detected with a higher sensitivity than carbon.
Nonconformance	An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.
Not Detected (ND)	The result reported for a compound when the detected amount of that compound is less than the method reporting limit.
Operator Aid	DoD- A technical posting (such as poster, operating manual, or notepad) that assists workers in performing routine tasks. All operator aids must be controlled documents (i.e., a part of the laboratory management system).
Performance Based Measurement System (PBMS)	An analytical system wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.
Physical Parameter	TNI- A measurement of a physical characteristic or property of a sample as distinguished from the concentrations of chemical and biological components.
Photo-ionization Detector (PID)	An ion detector which uses high-energy photons, typically in the ultraviolet range, to break molecules into positively charged ions.
Polychlorinated Biphenyls (PCB)	A class of organic compounds that were used as coolants and insulating fluids for transformers and capacitors. The production of these compounds was banned in the 1970's due to their high toxicity.
Positive Control	Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.
Post-Digestion Spike	A sample prepared for metals analyses that has analytes spike added to determine if matrix effects may be a factor in the results.

Power of Hydrogen (pH)	The measure of acidity or alkalinity of a solution.
Practical Quantitation Limit (PQL)	Another term for a method reporting limit. The lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions.
Precision	TNI- The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.
Preservation	TNI and DoD- Any conditions under which a sample must be kept in order to maintain chemical, physical, and/or biological integrity prior to analysis.
Primary Accreditation Body (Primary AB)	TNI- The accreditation body responsible for assessing a laboratory's total quality system, on-site assessment, and PT performance tracking for fields of accreditation.
Procedure	TNI- A specified way to carry out an activity or process. Procedures can be documented or not.
Proficiency Testing (PT)	TNI- A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.
Proficiency Testing Program (PT Program)	TNI- The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.
Proficiency Testing Provider (PT Provider)	TNI- A person or organization accredited by a TNI-approved Proficiency Testing Provider Accreditor to operate a TNI-compliant PT Program.
Proficiency Testing Provider Accreditor (PTPA)	TNI- An organization that is approved by TNI to accredit and monitor the performance of proficiency testing providers.
Proficiency Testing Reporting Limit (PTRL)	TNI- A statistically derived value that represents the lowest acceptable concentration for an analyte in a PT sample, if the analyte is spiked into the PT sample. The PTRLs are specified in the TNI FoPT tables.
Proficiency Testing Sample (PT)	TNI- A sample, the composition of which is unknown to the laboratory, and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.
Proficiency Testing (PT) Study	TNI- a) Scheduled PT Study: A single complete sequence of circulation and scoring of PT samples to all participants in a PT program. The study must have the same pre-defined opening and closing dates for all participants; b) Supplemental PT Study: A PT sample that may be from a lot previously released by a PT Provider that meets the requirements for supplemental PT samples given in Volume 3 of this Standard [TNI] but that does not have a pre-determined opening date and closing date.
Proficiency Testing Study Closing Date	TNI- a) Scheduled PT Study: The calendar date by which all participating laboratories must submit analytical results for a PT sample to a PT Provider; b) Supplemental PT Study: The calendar date a laboratory submits the results for a PT sample to the PT Provider.
Proficiency Testing Study Opening Date	TNI- a) Scheduled PT Study: The calendar date that a PT sample is first made available to all participants of the study by a PT Provider; b) Supplemental PT Study: The calendar date the PT Provider ships the sample to a laboratory.
Protocol	TNI- A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed.
Qualitative Analysis	DoD- Analysis designed to identify the components of a substance or mixture.
Quality Assurance (QA)	TNI- An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.
Quality Assurance Manual (QAM)	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality Assurance Project Plan (QAPP)	A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.
Quality Control (QC)	TNI- The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.
Quality Control Sample (QCS)	TNI- A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.

Quality Manual	TNI- A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality System	TNI and DoD- A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control activities.
Quality System Matrix	TNI and DoD- These matrix definitions shall be used for purposes of batch and quality control requirements and may be different from a field of accreditation matrix: • **Air and Emissions**: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device • **Aqueous**: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts. • **Biological Tissue**: Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin. • **Chemical Waste**: A product or by-product of an industrial process that results in a matrix not previously defined. • **Drinking Water**: Any aqueous sample that has been designated a potable or potentially potable water source. • **Non-aqueous liquid**: Any organic liquid with <15% settleable solids • **Saline/Estuarine**: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake. • **Solids**: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
Quantitation Range	DoD- The range of values (concentrations) in a calibration curve between the LOQ and the highest successively analyzed initial calibration standard used to relate instrument response to analyte concentration. The quantitation range (adjusted for initial sample volume/weight, concentration/dilution and final volume) lies within the calibration range.
Quantitative Analysis	DoD- Analysis designed to determine the amounts or proportions of the components of a substance.
Random Error	The EPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test due to random error. As the number of compounds measured increases in a given sample, the probability for statistical error also increases.
Raw Data	TNI- The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.
Reagent Blank (method reagent blank)	A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.
Reagent Grade	Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Records	DoD- The output of implementing and following management system documents (e.g., test data in electronic or hand-written forms, files, and logbooks).
Reference Material	TNI- Material or substance one or more of whose property values are sufficiently homogenized and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.
Reference Method	TNI- A published method issued by an organization generally recognized as competent to do so. (When the ISO language refers to a "standard method", that term is equivalent to "reference method"). When a laboratory is required to analyze by a specified method due to a regulatory requirement, the analyte/method combination is recognized as a reference method. If there is no regulatory requirement for the analyte/method combination, the analyte/method combination is recognized as a reference method if it can be analyzed by another reference method of the same matrix and technology.
Reference Standard	TNI- Standard used for the calibration of working measurement standards in a given organization or at a given location.

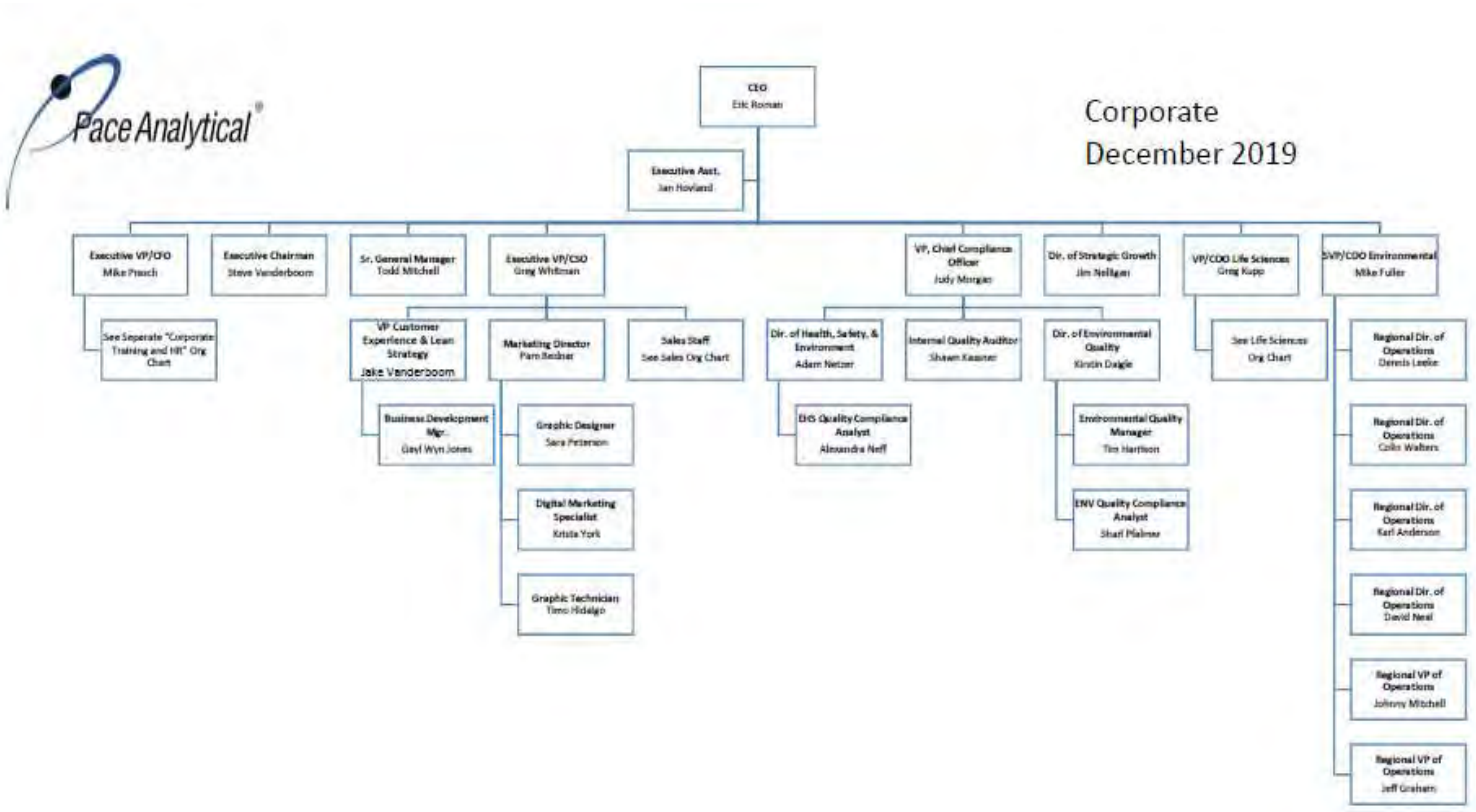
Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
Reporting Limit (RL)	The level at which method, permit, regulatory and customer-specific objectives are met. The reporting limit may never be lower than the Limit of Detection (i.e., statistically determined MDL). Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified. There must be a sufficient buffer between the Reporting Limit and the MDL. DoD- A customer-specified lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.
Reporting Limit Verification Standard (RLVS)	A standard analyzed at the reporting limit for an analysis to verify the laboratory's ability to report to that level.
Representativeness	A quality element related to the ability to collect a sample reflecting the characteristics of the part of the environment to be assessed. Sample representativeness is dependent on the sampling techniques specified in the project work plan.
Requirement	Denotes a mandatory specification; often designated by the term "shall" or "must".
Retention Time	The time between sample injection and the appearance of a solute peak at the detector.
Revocation	TNI- The total or partial withdrawal of a laboratory's accreditation by an accreditation body.
Sample	Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis.
Sample Condition Upon Receipt Form (SCURF)	Form used by sample receiving personnel to document the condition of sample containers upon receipt to the laboratory (used in conjunction with a COC).
Sample Delivery Group (SDG)	A unit within a single project that is used to identify a group of samples for delivery. An SDG is a group of 20 or fewer field samples within a project, received over a period of up to 14 calendar days. Data from all samples in an SDG are reported concurrently.
Sample Receipt Form (SRF)	Letter sent to the client upon login to show the tests requested and pricing.
Sample Tracking	Procedures employed to record the possession of the samples from the time of sampling until analysis, reporting and archiving. These procedures include the use of a chain-of-custody form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.
Sampling	TNI- Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.
Selected Ion Monitoring (SIM)	A mode of analysis in mass spectrometry where the detector is set to scan over a very small mass range, typically one mass unit. The narrower the range, the more sensitive the detector. DoD- Using GC/MS, characteristic ions specific to target compounds are detected and used to quantify in applications where the normal full scan mass spectrometry results in excessive noise.
Selectivity	TNI- The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.
Sensitivity	TNI- The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.
Serial Dilution	The stepwise dilution of a substance in a solution.
Shall (also Must)	Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification as long as the requirement is fulfilled.
Should (also May)	Denotes a guideline or recommendation whenever noncompliance with the specification is permissible.
Signal-to-Noise Ratio (S/N)	DoD- A measure of signal strength relative to background noise. The average strength of the noise of most measurements is constant and independent of the magnitude of the signal. Thus, as the quantity being measured (producing the signal) decreases in magnitude, S/N decreases and the effect of the noise on the relative error of a measurement increases.
Source Water	TNI- When sampled for drinking water compliance, untreated water from streams, rivers, lakes, or underground aquifers, which is used to supply private and public drinking water supplies.
Spike	A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.
Standard (Document)	TNI- The document describing the elements of a laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.

Standard (Chemical)	Standard samples are comprised of a known amount of standard reference material in the matrix undergoing analysis. A standard reference material is a certified reference material produced by US NIST and characterized for absolute content, independent of analytical test method.
Standard Blank (or Reagent Blank)	A calibration standard consisting of the same solvent/reagent matrix used to prepare the calibration standards without the analytes. It is used to construct the calibration curve by establishing instrument background.
Standard Method	A test method issued by an organization generally recognized as competent to do so.
Standard Operating Procedure (SOP)	TNI- A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks.
Standard Reference Material (SRM)	A certified reference material produced by the US NIST or other equivalent organization and characterized for absolute content, independent of analytical method.
Statement of Qualifications (SOQ)	A document that lists information about a company, typically the qualifications of that company to compete on a bid for services.
Stock Standard	A concentrated reference solution containing one or more analytes prepared in the laboratory using an assayed reference compound or purchased from a reputable commercial source.
Storage Blank	DoD- A sample of analyte-free media prepared by the laboratory and retained in the sample storage area of the laboratory. A storage blank is used to record contamination attributable to sample storage at the laboratory.
Supervisor	The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses.
Surrogate	DoD- A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.
Suspension	TNI- The temporary removal of a laboratory's accreditation for a defined period of time, which shall not exceed 6 months or the period of accreditation, whichever is longer, in order to allow the laboratory time to correct deficiencies or area of non-conformance with the Standard.
Systems Audit	An on-site inspection or assessment of a laboratory's quality system.
Target Analytes	DoD- Analytes or chemicals of primary concern identified by the customer on a project-specific basis.
Technical Director	Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory.
Technology	TNI- A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.
Test	A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate.
Test Method	DoD- A definitive procedure that determines one or more characteristics of a given substance or product.
Test Methods for Evaluating Solid Waste, Physical/ Chemical (SW-846)	EPA Waste's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with RCRA regulations.
Test Source	TNI- A radioactive source that is tested, such as a sample, calibration standard, or performance check source. A Test Source may also be free of radioactivity, such as a Test Source counted to determine the subtraction background, or a short-term background check.
The NELAC Institute (TNI)	A non-profit organization whose mission is to foster the generation of environmental data of known and documented quality through an open, inclusive, and transparent process that is responsive to the needs of the community. Previously known as NELAC (National Environmental Laboratory Accreditation Conference).
Total Petroleum Hydrocarbons (TPH)	A term used to denote a large family of several hundred chemical compounds that originate from crude oil. Compounds may include gasoline components, jet fuel, volatile organics, etc.
Toxicity Characteristic Leaching Procedure (TCLP)	A solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching of compounds through a landfill.

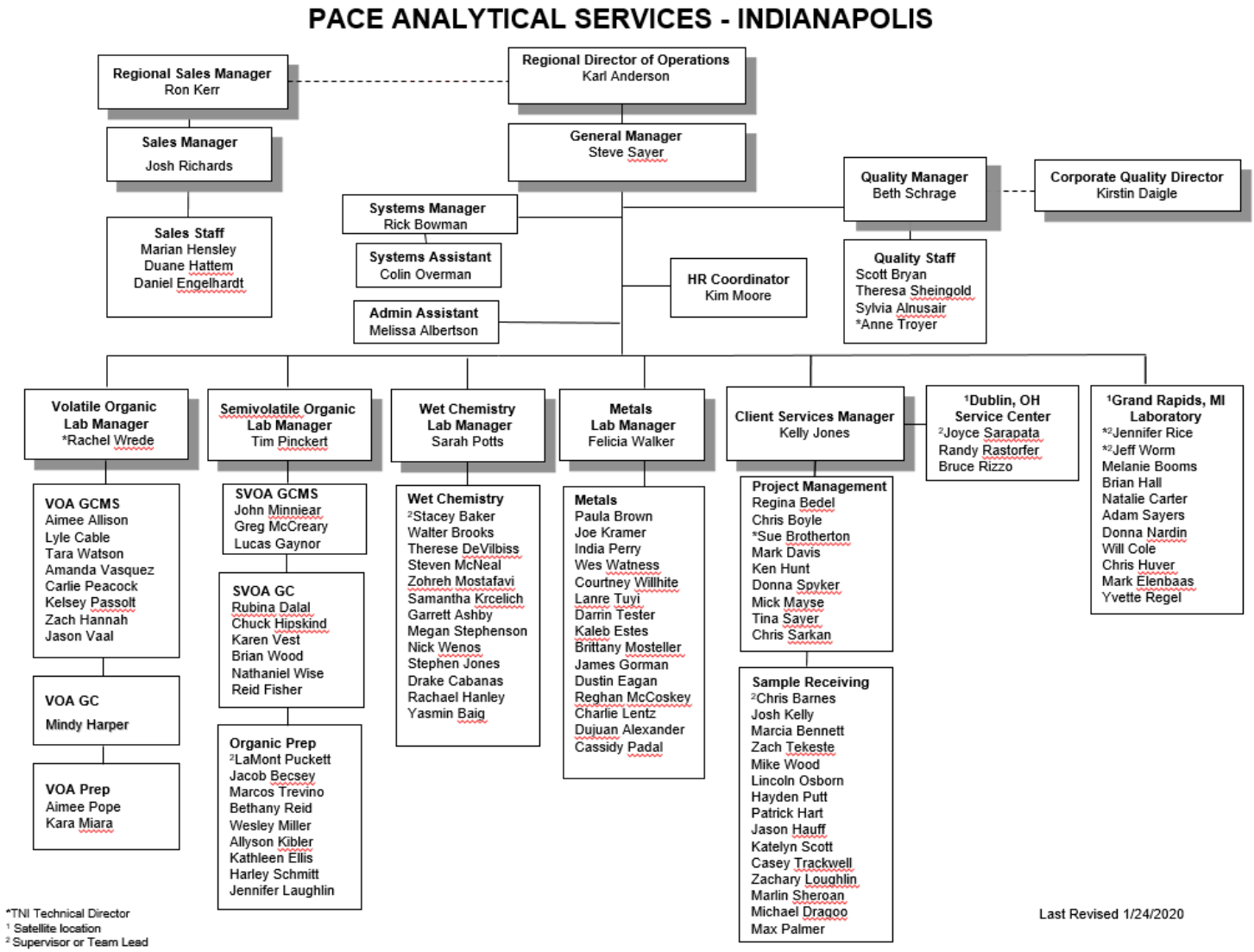
Traceability	TNI- The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical conditions or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.
Training Document	A training resource that provides detailed instructions to execute a specific method or job function.
Trip Blank	This blank sample is used to detect sample contamination from the container and preservative during transport and storage of the sample. A cleaned sample container is filled with laboratory reagent water and the blank is stored, shipped, and analyzed with its associated samples.
Tuning	A check and/or adjustment of instrument performance for mass spectrometry as required by the method.
Ultraviolet Spectrophotometer (UV)	Instrument routinely used in quantitative determination of solutions of transition metal ions and highly conjugated organic compounds.
Uncertainty, Counting	TNI- The component of Measurement Uncertainty attributable to the random nature of radioactive decay and radiation counting (often estimated as the square root of observed counts (MARLAP). Older references sometimes refer to this parameter as Error, Counting Error or Count Error (c.f., Total Uncertainty).
Uncertainty, Expanded	TNI- The product of the Standard Uncertainty and a coverage factor, k, which is chosen to produce an interval about the result that has a high probability of containing the value of the measurand (c.f., Standard Uncertainty). NOTE: Radiochemical results are generally reported in association with the Total Uncertainty. Either if these estimates of uncertainty can be reported as the Standard Uncertainty (one-sigma) or as an Expanded Uncertainty (k-sigma, where k > 1).
Uncertainty, Measurement	TNI- Parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand.
Uncertainty, Standard	TNI- An estimate of the Measurement Uncertainty expressed as a standard deviation (c.f., Expanded Uncertainty).
Uncertainty, Total	TNI- An estimate of the Measurement Uncertainty that accounts for contributions from all significant sources of uncertainty associated with the analytical preparation and measurement of a sample. Such estimates are also commonly referred to as Combined Standard Uncertainty or Total Propagated Uncertainty, and in some older references as the Total Propagated Error, among other similar items (c.f., Counting Uncertainty).
Unethical actions	DoD- Deliberate falsification of analytical or quality control results where failed method or contractual requirements are made to appear acceptable.
United States Department of Agriculture (USDA)	A department of the federal government that provides leadership on food, agriculture, natural resources, rural development, nutrition and related issues based on public policy, the best available science, and effective management.
United States Geological Survey (USGS)	Program of the federal government that develops new methods and tools to supply timely, relevant, and useful information about the Earth and its processes.
Unregulated Contaminant Monitoring Rule (UCMR)	EPA program to monitor unregulated contaminants in drinking water.
Validation	DoD- The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
Verification	TNI- Confirmation by examination and objective evidence that specified requirements have been met. In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.
Voluntary Action Program (VAP)	A program of the Ohio EPA that gives individuals a way to investigate possible environmental contamination, clean it up if necessary and receive a promise from the State of Ohio that no more cleanup is needed.
Whole Effluent Toxicity (WET)	The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent).

7.4 Appendix D: Organization Chart(s)

7.4.1 PAS-Corporate



7.4.2 PAS-Indianapolis/Grand Rapids/Dublin



7.5 Appendix E: Equipment Listing

The equipment listed represents equipment held by each location on the effective date of this manual. This information is subject to change without notice. External parties should contact the location for the most current information.

7.5.1 PAS-Indianapolis and PAS-Grand Rapids

Pace Analytical - Indianapolis Equipment/Instrumentation List

INSTRUMENT	MANUFACTURER	MODEL NUMBER	DETECTOR	AUTOSAMPLER	SERVICE ANALYSIS	YEAR
GC/MS	Agilent	6890	MS 5973	Centurion W/S	8260/624 VOC	2003
GC/MS	Agilent	6890	MS 5973	Centurion	8260/624/524.2 VOC	2007
GC/MS	Agilent	6890	MS 5973	Centurion W/S	8260/624 VOC	2003
GC/MS	Agilent	6850N	MS 5975	Centurion	8260/624/524.2 VOC	2007
GC/MS	Agilent	6890	MS 5973	Centurion W/S	8260/624 VOC	2004
GC/MS	Agilent	6850N	MS 5975	Centurion	8260/624 VOC	2010
GC/MS	Agilent	6890	MS 5973	Archon	8260/624 VOC	2010
GC/MS	Agilent	6890N	MS 5975	Centurion	8260/624/524.2 VOC	2010
GC/MS	Hewlett-Packard	6890	MS 5973	7683	8270 PAH SIM	2000
GC/MS (2)	Agilent	7890	MS 5975	7683	8270/625 BNA	2008
GC/MS (2)	Agilent	6890	MS 5975	7683	8270 PAH SIM	2009
GC/MS (3)	Agilent	6890	MS 5973	7683	8270/625 BNA	2008
GC/MS	Agilent	7890	MS 5975	7683	8270 PAH SIM	2009
GC/MS (2)	Hewlett-Packard	5890	MS 5971	7673	Solvent Screen	2007
GC/MS	Agilent	7890B	MS 5977	7693	8270/PAH SIM	2017
GC/MS	Agilent	7890B	MS 5977	7693	8270/PAH SIM	2018
Gas Chromatograph	Agilent	6890	FID	7683	8015 Alcohols	2006
Gas Chromatograph	Hewlett-Packard	6890	FID	6890	8015 Glycols	2008
Gas Chromatograph	Agilent	7890A	FID	7693	8015 DRO/ERO	2009
Gas Chromatograph	Agilent	7890A	Dual ECD	7693	8082/608 PCBs/8011 EDB/DBCP	2009/2013
Gas Chromatograph	Hewlett-Packard	5890	FID	6890	Benzene	2006
Gas Chromatograph	Hewlett-Packard	5890	FID	8100	8015 GRO	2011
Gas Chromatograph	Hewlett-Packard	5890	FID	EST LGX50	RSK175 Dissolved gases	2006
Gas Chromatograph	Agilent	6890N	FID	Archon	8015 GRO	2008
Gas Chromatograph	Agilent	6890	Dual NPD	7683	Pesticides	2008
Gas Chromatograph (2)	Agilent	6890	Dual ECD	7683	PCBs	2008
Gas Chromatograph	Hewlett-Packard	6890	Dual ECD	7683	Herbicides	2008
Gas Chromatograph	Agilent	7890	Dual ECD	7693	Pesticides	2010
Microwave Extractors (2)	CEM	230/60	n/a	n/a	soil extraction	2008/2011
Spe-Dex	Horizon	4790	n/a	n/a	1664A Oil & Grease	2008
Trace ICP (2)	Thermo Scientific	ICAP 6500	n/a	ASX520	6010/200.7 Metals	2008/2011
Trace ICP	Thermo Scientific	ICAP 6500	n/a	ESI SC-4 FAST	6010/200.7 Metals	2011
ICP/MS	Agilent	7700	n/a	ASX520	6020/200.8 Metals	2012
ICP/MS	Agilent	7800	n/a	ASX520	6020/200.8 Metals	2018
Mercury Analyzer	CETAC	M-6100	n/a	ASX520	7470/7471/245 Mercury	2012/2010
Mercury Analyzer	Teledyne Leeman	M-7600	n/a	ASX520	7470/7471/245 Mercury	2016
Low-Level Mercury Analyzer (2)	CETAC	M-8000	n/a	ASX520/ASX560	Low-Level Mercury	2015/2018
Auto Analyzer (2)	Lachat	Quick Chem	n/a	n/a	NO3,Cl,Phenol, NH3,TKN	2010/2012
Titrosampler	Metrohm	855	n/a	n/a	Alkalinity, Acidity	2014
Automated Flash Point	Tanaka	APM-8	n/a	n/a	flash point	2010
Spectrophotometer	Hach	DR5000	n/a	n/a	Sulfate,Cr6+,Fe2+, PO4	2007
Spectrophotometer	Thermo	AquaMatePlus	n/a	n/a	Surfactants, COD	2005
Turbidimeter	Hach	2100P	n/a	n/a	Turbidity	2006
pH/ISE Meter (2)	Accumet	AR25/XL25	n/a	n/a	pH, Fluoride, Redox	2003/2010
pH/ISE Meter	Thermo Orion Star	A214	n/a	n/a	pH, Fluoride, Redox	2013
Conductivity Meter	Oakton	CON 700	n/a	n/a	Conductivity	2016
Dissolved Oxygen/pH Meter	Hach	HQ440d	n/a	n/a	BOD, cBOD	2014
BOD Analyzer	Thermo	AutoEz	n/a	n/a	BOD, cBOD	2013
TOC Analyzer	Shimadzu	TOC-Vwp	n/a	n/a	TOC, DOC	2008
Discrete Analyzer	Smart Chem	200	n/a	n/a	Cyanide, Phosphorus	2006
Flow Analyzer	OIA	FS3100	n/a	n/a	Free and Available Cyanide	2018
Ion Chromatograph	Dionex	ICS2100	n/a	AS-AP	Cl-, F-, SO4-, Br-, NO3/NO2	2013
Ion Chromatograph (3)	Dionex	AQUION	n/a	AS-AP	Cl-, F-, SO4-, Br-, NO3/NO2	2019
Pace Analytical - Grand Rapids Equipment/Instrumentation List						
pH/ISE Meter (2)	Accumet	AB150	n/a	n/a	pH	2017
BOD Meter and Probe	Hach	HQ40d	n/a	n/a	BOD, cBOD	2017
FIA Analyzer	OIA	FS-3100	n/a	n/a	Nitrate and Nitrite	2017
Spectrophotometer	Shimadzu	UV-1800	n/a	n/a	Cr6+,Fe2+, PO4, Color	2017
Turbidimeter	Hach	2100N	n/a	n/a	Turbidity	2017

ATTACHMENT B

Pace Greensburg, Pennsylvania
Quality Assurance Manual

Document Information

Document Number: ENV-MAN-IND1-0001 **Revision:** 02

Document Title: Quality Manual

Department(s): Quality

Date Information

Effective Date: 03 Feb 2020

Notes

Document Notes:

All Dates and Times are listed in: Central Time Zone

Signature Manifest

Document Number: ENV-MAN-PITTS-0001 **Revision:** 01

Title: Quality Manual

All dates and times are in Central Time Zone.

ENV-MAN-PITTS-0001

QM Approval

Name/Signature	Title	Date	Meaning/Reason
Charlotte Washlaski (003467)	Manager - Quality	20 Feb 2020, 11:35:54 AM	Approved

Management Approval

Name/Signature	Title	Date	Meaning/Reason
Ruth Welsh (003453)	General Manager 1	20 Feb 2020, 11:24:03 AM	Approved
Charlotte Washlaski (003467)	Manager - Quality	20 Feb 2020, 11:36:07 AM	Approved
Patrick McLoughlin (003466)	Manager	20 Feb 2020, 02:33:07 PM	Approved
Aaron Kerr (003454)	Scientist 2	24 Feb 2020, 09:03:31 AM	Approved
Mark Mikesell (003456)	Manager	25 Feb 2020, 03:19:04 PM	Approved
Colin Walters (005945)	Regional Director - Operations	26 Feb 2020, 07:39:36 AM	Approved

TITLE PAGE

LABORATORY QUALITY MANUAL

Prepared for:

Pace Analytical Energy Services, LLC.
220 William Pitt Way
Pittsburgh, PA 15238
Phone: 412-826-5245

Manual Approval Signatories

Approval of this manual by managerial personnel is recorded on the Signature Manifest located before the Title Page of this manual.

The individuals listed below represent the management team that was in place on the effective date of this version of the manual for the following location:

Pace Analytical Energy Services, LLC
220 William Pitt Way
Pittsburgh, PA 15238
Phone: 412-826-5245

Each of the following individuals is a signatory for the manual for the location listed above. The application of their signature to the manual signifies their commitment to communicate, implement, and uphold the requirements, policies and procedures specified in this manual and their commitment to continuously improve the effectiveness of the quality management system based on customer feedback and internal assessment.

Name[1]	Title	Address[2]	Phone[2]
Colin Walters	Senior General Manager		724-433-5223
Ruth Welsh	Assistant General Manager		
Charlotte Washlaski	Manager-Quality/ Safety Officer		
Aaron Kerr	IT		
Mark Mikesell	Manager-Lab Services[3]		
Patrick McLoughlin	Manager- Lab Services		

[1] Members of the local management team are subject to change during the life-cycle of this document version.
[2] Include if different from the physical address and phone number of the facility.
[3] This individual serves as an Acting Technical Manager for TNI for one or more fields of accreditation.

Table of Contents

1.0 PURPOSE AND SCOPE

1.1 Purpose

This quality manual (manual) outlines the quality management system and management structure of the laboratories and service centers affiliated with Pace Analytical Services, LLC (PAS). A laboratory is defined by PAS as any PAS facility, however named, that provides testing, sampling, or field measurement services. When the term 'laboratory" is used in this manual, the term refers to all locations listed on the Title Page of this manual and in Section 4.1.3 unless otherwise specified.

The PAS quality management system is also referred to as the quality program throughout this document. In this context, the phrase "quality management system" and "quality program" are synonymous.

The quality management system is the collection of policies and processes established by PAS management to consistently meet customer requirements and expectations, and to achieve the goals to provide PAS customers with high quality, cost-effective, analytical measurements and services.

The quality management system is also intended to establish conformance[1] and compliance with the current versions of the following international and national quality system standards:

- ISO/IEC 17025: *General requirements for the competence of testing and calibration laboratories*
- NELAC/TNI Standard Volume 1: *Management and Technical Requirements for Laboratories Performing Environmental Analysis*

[1]The statement of conformity to these Standards pertains only to testing and sampling activities carried out by the laboratory at its physical address, in temporary or mobile facilities, in-network, or by laboratory personnel at a customer's facility.

In addition to the international and national standards, the quality management system is designed to achieve regulatory compliance with the various federal and state programs for which the laboratory provides compliance testing and/or holds certification or accreditation. When federal or state requirements do not apply to all PAS locations, the requirements for compliance are provided in addendum to this manual or in other documents that supplement the manual. Customer-specific project and program requirements are not included in the manual in order to maintain client confidentiality.

- A list of accreditation and certifications held by each laboratory associated with this manual is provided in Appendix A.
- A list of analytical testing capabilities offered by each laboratory associated with this manual is provided in Appendix B.

1.2 Scope and Application

This manual applies to each of the PAS locations listed on the Title Page and in Section 4.1.3.

The manual was prepared from a quality manual template (template) created by PAS corporate quality personnel. The template outlines the minimum requirements PAS management considers necessary for every PAS laboratory, regardless of scope of services or number of personnel, to establish in order to maintain a quality management system that achieves the objectives of PAS's Quality Policy (See 4.2.2). In this regard, the template is the mechanism used by the corporate officers (a.k.a. 'top

management') to communicate their expectations and commitment for the PAS quality program to all PAS personnel.

The laboratory also has the responsibility to comply with federal and state regulatory and program requirements for which it provides analytical services and holds certification or accreditation. When those requirements are more stringent than the template, the requirements for compliance are provided in addendum to this manual or in other documents that supplement the manual. This document structure maintains consistency in the presentation of the quality management system across the network while providing the laboratory a mechanism to describe and achieve compliance requirements on a program basis.

1.2.1 Quality Manual Template

The quality manual template is developed by the Corporate Quality Director with contribution and input from corporate quality personnel and the corporate officers. Approval of the template by the corporate officers (aka "top management") confirms their commitment to develop and maintain a quality management system appropriate for the analytical services offered by the organization and to communicate their expectations of the quality program to all personnel.

The template and instructions for use of the template are released by corporate quality personnel to quality assurance manager(s) responsible for each laboratory (Local QA). Local QA uses the template to prepare the laboratory's manual by following the instructions provided. Since the template provides the minimum requirements by which all PAS locations must abide, the laboratory may not alter the font, structure or content of the template except where specified by instruction to do so. As previously stated, program specific requirements are provided in addendum or in documents that supplement this manual.

The template is reviewed by corporate quality personnel every two years and updated if needed. More frequent review and revision may be necessary to manage change, to maintain conformance and compliance to relevant standards, or to meet customer expectations.

See standard operating procedure (SOP) ENV-SOP-CORQ-00015 *Document Management and Control* for more information.

1.2.2 Laboratory Quality Manual

The manual is approved and released to personnel under the authority of local management. The manual is reviewed annually and location specific information is updated, if needed. More frequent review and revision may be necessary when there are significant changes to the organizational structure, capabilities, and resources of the laboratory. Review and revision of the manual is overseen by local QA. If review indicates changes to the main body of the manual are necessary to maintain conformance and compliance to relevant standards, or to meet customer expectations, local QA will notify corporate quality personnel to initiate review and/or revision of the template.

See SOP ENV-SOP-CORQ-00015 *Document Management and Control* for more information.

1.2.3 References to Supporting Documents

The template and the manual include references to other laboratory documents that support the quality management system such as policies and standard operating procedures (SOPs).

These references include the document's document control number and may include the document title.

This information is subject to change. For example, an SOP may be converted to a policy or the document's title may change. For these types of administrative changes, the manual and template are updated to reflect the editorial change during the document's next scheduled review/revision cycle or the next time a new version of the document is released, whichever is sooner.

Local QA maintains a current list of controlled documents used at each PAS location to support the quality management system. This list, known as the Master List, lists each document used by document control number, title, version, effective date, and reference to any document(s) that the current version supersedes. When there is a difference between the template and/or manual and the Master List, the document information in the Master List takes precedence. The current Master List is readily available to personnel for their use and cross-reference. Parties external to the laboratory should contact the laboratory for the most current version.

2.0 REFERENCES

References used to prepare this manual include:

- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act." Federal Register, 40 CFR Part 136, most current version.
- "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846.
- "Methods for Chemical Analysis of Water and Wastes", EPA 600-4-79-020, 1979 Revised 1983, U.S. EPA.
- U.S. EPA Contract Laboratory Program Statement of Work for Organic Analysis, current version.
- U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Analysis, current version.
- "Standard Methods for the Examination of Water and Wastewater." Current Edition APHA-AWWA-WPCF.
- "Annual Book of ASTM Standards", Section 4: Construction, Volume 04.04: Soil and Rock; Building Stones, American Society of Testing and Materials.
- "Annual Book of ASTM Standards", Section 11: Water and Environmental Technology, American Society of Testing and Materials.
- "NIOSH Manual of Analytical Methods", U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, most current version.
- "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water", U.S. EPA, Environmental Monitoring and Support Laboratory – Cincinnati (Sep 1986).
- Quality Assurance of Chemical Measurements, Taylor, John K.; Lewis Publishers, Inc. 1987.
- Methods for Non-conventional Pesticides Chemicals Analysis of Industrial and Municipal Wastewater, Test Methods, EPA-440/1-83/079C.

- Environmental Measurements Laboratory (EML) Procedures Manual, HASL-300, US DOE, February, 1992.
- Requirements for Quality Control of Analytical Data, HAZWRAP, DOE/HWP-65/R1, July, 1990.
- Quality Assurance Manual for Industrial Hygiene Chemistry, AIHA, most current version.
- National Environmental Laboratory Accreditation Conference (NELAC) Standard- most current version.
- ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories- most current version.

  The following are implemented by normative reference to ISO/IEC 17025:

  - ISO/IEC Guide 99, *International vocabulary of metrology –Basic and general concepts and associated terms*
  - ISO/IEC 17000, *Conformity assessment – Vocabulary and general principles*
- Department of Defense Quality Systems Manual (QSM), most current version.
- TNI (The NELAC Institute) Standard- most current version applicable to each lab.
- UCMR Laboratory Approval Requirements and Information Document, most current version.
- US EPA Drinking Water Manual, most current version.

3.0 TERMS AND DEFINITIONS

Refer to Appendix C for terms, acronyms, and definitions used in this manual and in other documents used by the laboratory to support the quality management system.

4.0 MANAGEMENT REQUIREMENTS

4.1 Organization

4.1.1 Legal Identity

Pace Analytical Services, LLC is authorized under the State of Minnesota to do business as a limited liability company.

4.1.1.1 Change of Ownership

If there is a change of ownership, if a location goes out of business, or if the entire organization ceases to exist, Pace Analytical Services, LLC ensures that regulatory authorities are notified of the change within the time-frame required by each state agency for which the location is certified or accredited.

Requirements for records and other business information are addressed in the ownership transfer agreement or in accordance with appropriate regulatory requirements, whichever takes precedence.

4.1.2 Compliance Responsibility

Laboratory management has the responsibility and authority to establish and implement procedures and to maintain sufficient resources necessary to assure its activities are carried out in such a way to meet the compliance requirements of the quality management system.

4.1.3 Scope of the Quality Management System

The quality management system applies to work carried out at each location covered by this manual including permanent facilities, at sites away from its permanent facilities, or in associated temporary or mobile facilities.

The permanent and mobile facilities to which this manual applies includes:

Name	Pace Analytical Energy Services, LLC
Address:	220 William Pitt Way
City, State, Zip	Pittsburgh, PA 15238
Phone Number	412-826-5245
Service Type:	Laboratory

4.1.4 Organization History and Information

Founded in 1978, Pace Analytical Services, LLC (PAS) is a privately held scientific services firm operating one of the largest full service contract laboratory and service center networks in the United States. The company's network offer inorganic, organic and radiochemistry testing capabilities; specializing in the analysis of trace level contamination in air, drinking water, groundwater, wastewater, soil, biota, and waste.

With over 90 laboratories and services centers in the contiguous US and in Puerto Rico, the network provides project support for thousands of industry, consulting, engineering and government professionals.

Pace delivers the highest standard of testing and scientific services in the market. We offer the most advanced solutions in the industry, backed by truly transparent data, a highly trained team, and the service and support that comes from four decades of experience.

4.1.4.1 Organization Structure

Each location maintains a local management structure under the oversight and guidance of corporate personnel. Local management is responsible for making day-to-day decisions regarding the operations of the facility, implementing the quality management system, upholding the requirements of the quality program, and for supervision of personnel.

Local management is provided by a General Manager (GM) or Assistant (AGM), Quality Manager (QM), Client Services Manager (CSM), Information Technology (IT) Manager, Department Managers (DM) and/or Department Supervisors (DS), however named.

Some locations may also have any one of the following management positions: Senior Quality Manager (SQM), Operations Manager (OM), Technical Director (TD), or Technical Manager (TM). When the location does not have a TD or TM, technical management is provided jointly by the GM, QM, DM, and DS.

The GM (or AGM), however named reports to a Senior General Manager (SGM), who is responsible for the management of multiple laboratories and service centers within a geographical region, and who reports directly to the Chief Operating Officer (COO). The QM and SQM have indirect reporting relationship to the Corporate Director of Quality.

Refer to the organization charts provided in Appendix D to view the management structure, reporting relationships, and the interrelationships between positions.

4.1.5 Management Requirements

4.1.5.1 Personnel

The laboratory is staffed with administrative and technical personnel who perform and verify work under the supervision of managerial personnel.

- Technical personnel include analysts and technicians that generate or contribute to the generation of analytical data and managerial personnel that oversee day to day supervision of laboratory operations. Including the reporting of analytical data and results, monitoring QA/QC performance, and monitoring the validity of analysis to maintain data integrity and reliability.
- Administrative personnel support the day-to-day activities of the laboratory.
- IT personnel maintain the information technology systems and software used at the laboratory.
- Client services personnel include project managers and support staff that manage projects.
- Managerial personnel make day-to-day and longer term decisions regarding the operations of the facility, supervise personnel, implement the quality management system and uphold the requirements of the quality program.

All personnel regardless of responsibilities are expected to carry out their duties in accordance with the policies and processes outlined in this manual and in accordance with standard operating procedures (SOPs) and other quality system documents. The laboratory's policies and procedures are designed for impartiality and integrity. When these procedures are fully implemented, personnel remain free from undue pressure and other influences that adversely impact the quality of their work or data.

4.1.5.1.1 Key Personnel

Key personnel include the management positions that have the authority and responsibility to plan, direct, and control, activities of the division (corporate) or the laboratory.

The following tables list key personnel positions by PAS job title and the position's primary deputy:

Key Personnel: Corporate

Key Personnel	Primary Deputy
Chief Executive Officer	Chief Operating Officer
Chief Operating Officer	Chief Executive Officer
Chief Compliance Officer	Quality Director
Corporate Quality Director	Chief Compliance Officer
Health and Safety Director	Chief Compliance Officer
IT Director	LIMS Administrator, however named.

Key Personnel: Laboratory

Key Personnel	Primary Deputy
Senior General Manager	Chief Operating Officer or as designated.
General Manager / Assistant GM	Senior General Manager
Quality Manager	Corporate Quality Manager or as designated.
Client Services Manager	General Manager
Local IT	Corporate IT Director or as designated.
Department Manager	General Manager
Senior Quality Manager[1]	Corporate Quality Manager
Technical Director[1]/Manager[1] Acting Technical Manager TNI	Quality Manager
Operations Manager[1]	General Manager or Assistant GM.

[1] *Position may not be staffed at each location.*

Some state certification programs require the agency to be notified when there has been a change in key personnel. Program-specific requirements and time-frames for notification by agency, are tracked and upheld by local QA, when these requirements apply.

4.1.5.2 Roles and Responsibilities

The qualifications, duties, and responsibilities for each position are detailed in job descriptions maintained by PAS's corporate Human Resource's Department (HR).

The following summaries briefly identify the responsibility of key personnel positions in relation to the quality management system.

Chief Executive Officer (CEO): The CEO has overall responsibility for performance of the organization and endorses the quality program. Working with corporate and laboratory management, the CEO provides the leadership and resources necessary for PAS locations to achieve the goals and objectives of the quality management system and quality policy statement.

Chief Operating Officer (COO): The COO oversees all aspects of operations management including, strategic planning, budget, capital expenditure, and management of senior management personnel. In this capacity, the COO provides leadership and resources necessary to help top management at each PAS location achieve the goals and objectives of the quality management system and quality policy statement.

Chief Compliance Officer (CCO): The CCO oversees the quality assurance and environmental health and safety programs (HSE) for each business unit. The CCO is responsible for planning and policy development for these groups to ensure regulatory compliance and to manage risk. The position provides leadership and guidance necessary for all PAS locations to achieve the goals and objectives of the quality and HSE programs.

The CCO also serves as the Ethics Officer (ECO). The ECO develops the Ethics and Data Integrity Policy and Training Program, and provides oversight for reporting and investigation of ethical misconduct to maintain employee confidentiality during the process. The ECO provide guidance and instruction for follow-up actions necessary to remedy the situation and deter future recurrence.

Corporate Director of Quality: The Corporate Director of Quality is responsible for developing and maintaining the PAS quality program under guidance and assistance from the CEO, COO, and CCO. This position helps develop corporate quality policy and procedure and analyzes metric data and other performance indicators to assess and communicate the effectiveness of the quality program to top management. The position provides leadership and guidance for implementation of the quality program across all PAS locations.

Corporate Director of Information Technology: The Corporate Director of IT oversees the systems and processes of information technology used to support the quality program. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, communication tools, and ensuring the integrity and security of electronic data.

Senior General Manager (SGM): The SGM has full responsibility for administrative and operations management and performance of a group of PAS laboratories and service centers. Working with the COO and local laboratory management, the SGM provides leadership, guidance and resources, including allocation of personnel, necessary to achieve the goals of PAS quality program.

General Manager (GM) / Assistant General Manager (AGM): The GM or AGM is responsible for the overall performance and administrative and operations management of a PAS location and associated service center(s). This position is responsible to provide leadership and resources, including allocation and supervision of personnel, necessary for the location to implement and achieve the goals of the PAS quality program. In this capacity, the position assures laboratory personnel are trained on and understand the structure and components of the quality program defined in this manual as well as the policies and procedures in place to implement the quality management system.

The GM/AGM of NELAC/TNI Accredited laboratories are also responsible for the designation of technical personnel to serve as acting technical managers for TNI for the fields of accreditation held by the laboratory (See Section 4.1.5.2.2) and for notifying the accreditation body (AB) of any extended absence or reassignment of these designations.

Quality Manager (QM): The QM oversees and monitors implementation of the quality management system and communicates deviations to laboratory management. The QM is independent of the operation activities for which they provide oversight and has the authority to carry out the roles and responsibilities of their position without outside influence.

Additionally, in accordance with the TNI Standard, the QM:

- serves as the focal for QA/QC and oversees review of QC data for trend analysis;
- evaluates data objectively and perform assessments without outside influence;
- has document training and experience in QA/QC procedures and the laboratory's quality system;

- has a general knowledge of the analytical methods offered by the laboratory;
- coordinates and conducts internal systems and technical audits;
- notifies laboratory management of deficiencies in the quality system;
- monitors corrective actions;
- provides supports to technical personnel and may serve as the primary deputy for the acting TNI Technical Manager(s).

Client Services Manager (CSM): The CSM oversees project management personnel. This position is responsible for training and management of client facing staff that serve as the liaison between PAS and the customer to ensure that projects are successfully managed to meet the expectations and needs of PAS customers. This position is also responsible for sharing positive and negative customer feedback with laboratory management so that this information may be used to improve the quality program.

Local IT Manager, however named: Local IT managers are responsible for maintaining the IT systems used to support the quality program. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, communication tools, and ensuring the integrity and security of electronic data.

Department Manager (DM): The DM is responsible for administrative and operations management and implementation of the quality management system in the work area he/she oversees. These responsibilities include but are not limited to: training and supervision of personnel, monitoring work activity to maintain compliance with this manual, SOPs, policies and other instructional documents that support the quality management system; method development, validation and the establishment and implementation of SOPs to assure regulatory compliance and suitability for intended purpose; monitoring QA/QC performance, proper handling and reporting of nonconforming work, purchasing of supplies and equipment adequate for use, maintaining instrumentation and equipment in proper working order and calibration, and general maintenance of administrative and technical processes and procedures established by the laboratory.

Senior Quality Manager (SQM): The SQM provides support to the quality manager and assists the quality manager with implementation of the quality management system for one or more site locations.

Technical Director (TD): The TD provides technical oversight and guidance to laboratory personnel. Responsibilities may include but are not limited to: research and development, method development and validation, development of standard operating procedures, proposal and contract review. The TD may also be responsible for QA/QC trend analysis, technical training, and technology improvement.

Operations Manager (OM): The OM is responsible for management of production and/or other duties assigned by the GM or SGM.

4.1.5.2.1 Acting Technical Manager (TNI Accreditation):

For PAS locations that are NELAC/TNI accredited:

The TNI Standard specifies requirements for the qualification and duties of technical personnel with managerial responsibility. These requirements are associated in the Standard to the designation 'technical manager(s), however named'. These responsibilities may be assigned to multiple individuals and are not associated with any specific job title.

For PAS, these TNI requirements for personnel that provide technical oversight correlate with PAS's job descriptions for Department Manager or Supervisor. However, the duties may be assigned to any PAS employee that meets the TNI specified qualifications.

Personnel assigned this designation retain their PAS assigned job title. The job title may be appended with *"acting as technical manager for TNI"* and the technology or field of accreditation for which the employee is approved, if necessary.

When TNI Accreditation Bodies (AB) refer to these employees as 'technical manager' or 'technical director' on the official certificate or the scope of accreditation, this reference is referring to their approval to carry out duties of the 'technical manager, however named' as specified in the TNI Standard.

In accordance with the TNI Standard, the acting Technical Manager(s) for TNI are responsible for monitoring the performance of QC/QA in the work areas they oversee.

If the absence of any employee that is approved as acting technical manager for TNI exceeds 15 calendar days, the duties and responsibilities specified in the TNI Standard are reassigned to another employee that meets the qualifications for the technology or field of accreditation or they are assigned to the position's deputy, the quality manager.

4.1.5.3 Conflict of Interest

A conflict of interest is a situation where a person has competing interests. Laboratory management looks for potential conflict of interest and undue pressures that might arise in work activities and then includes countermeasures in policies and procedures to mitigate or eliminate the conflict.

See policy COR-POL-0004 *Ethics Policy* for more information.

4.1.5.4 Confidentiality

Laboratory management is committed to preserving the confidentiality of PAS customers and confidentiality of business information.

Procedures used by the laboratory to maintain confidentiality include:

- A Confidentiality Agreement which all employees are required to sign at the time of employment and abide by the conditions of throughout employment;
- Record retention and disposal procedures that assure confidentiality is maintained;
- Physical access controls and encryption of electronic data; and
- Protocol for handling Confidential Business Information (CBI).

Client information obtained or created during work activities is considered confidential and is protected from intentional release to any person or entity other than the client or the client's authorized representative information provided to PAS, except when the laboratory is required by law to release confidential information to another party, such as a regulatory agency or for litigation purposes. In which case, the laboratory will notify the client of the release of information and the information provided.

The terms of client confidentiality are included in PAS Standard Terms and Conditions (T&C). With the acceptance of PAS Terms and Conditions and/or the implicit contract for analytical services that occurs when the client sends samples to the laboratory for testing, the client authorizes PAS to release confidential information when required.

See policy COR-POL-0004 *Ethics Policy* for more information.

4.1.5.5 Communication

Communication is defined as the imparting or exchanging of news and information. Effective (good) communication occurs when the person(s) you are exchanging information with actively gets the point and understands it.

4.1.5.5.1 Workplace Communication

Good communication in the workplace is necessary to assure work is done correctly, efficiently, and in accordance with client expectations.

Instructions for how to carry out work activities are communicated to personnel via written policy, standard operating procedures, and standard work instructions.

Information about laboratory performance (positive and negative) and ideas for improvement are communicated using various communication channels such as face to face meetings, video conferencing, conference calls, email, memoranda, written reports, and posters.

4.1.5.5.2 External Communication

Communication with external parties such as customers, vendors, business partners, and regulatory agencies takes place every day.

Laboratory management ensure personnel learn to communicate in professional and respectful ways in order to build strong relationships, and learn to communicate effectively to avoid misunderstanding.

4.2 Quality Management System

4.2.1 Quality Management System Objectives

The objectives of the laboratory's quality management system are to provide clients with consistent, exemplary professional service, and objective work product that is of known and documented quality that meets their requirements for data usability and regulatory compliance.

Objective work product is analytical services, data, test results, and information that is not influenced by personal feeling or opinions. The quality of being objective is also known as 'impartiality'.

4.2.1.1 Impartiality

The laboratory achieves and maintains impartiality by implementing and adhering to the policies and processes of the quality management system, which are based on industry accepted standards and methodologies.

The laboratory's procedures for handling nonconforming work (See 4.9), corrective and preventive actions (See 4.11) and management review (See 4.15) are the primary mechanisms used to identify risk to impartiality and to prompt actions necessary to eliminate or reduce the threat when risk to impartiality is suspected or confirmed.

4.2.1.2 Risk and Opportunity Assessment

Risks are variables that make achieving the goals and objectives of the quality management system uncertain. An opportunity is something that has potential positive consequences for the laboratory.

Laboratory personnel manage risks and opportunities on a daily basis by carrying out the processes that make up the quality management system. Some of the ways in which the quality management system is designed to identify, minimize, or eliminate risk on a daily basis include but are not limited to:

- Capability and capacity reviews of each analytical service request to assure the laboratory can meet the customer's requirements;
- Maintenance of accreditation and certification for test methods in multiple states and programs to cover a broad range of jurisdiction for regulatory compliance;
- SOPs and other controlled instructional documents are provided to personnel to eliminate variability in process. These documents include actions to counter risk factors inherent in the process and are reviewed on a regular basis for on-going suitability and relevancy;
- Participation in proficiency testing programs and auditing activities to verify on-going competency and comparability in performance;

- Provision of on-the-job training and established protocol for quality control (QC) corrective action for nonconforming events;
- An established program for ethics, and data integrity;
- Tiered data review process;
- Culture of continuous improvement;
- Monitoring activities to assess daily and long term performance; and
- Annual critical review of the effectiveness of the quality management system.

PAS also promotes a continuous improvement culture based on the principles of lean manufacturing. These principles include 3P (Process, Productivity, Performance) and Kaizen. 3P is a platform used by Pace to share best practices and standardization across the network to achieve operational excellence. Kaizen is a team based process used to implement tools and philosophies of lean to reduce waste and achieve flow with the purpose of improving both external and internal customer satisfaction. PAS's lean programs and activities help to mitigate risk because they generate a collective understanding of vulnerabilities and utilize group-effort to develop and implement solutions at all levels.

Risk and opportunities may also be formally identified using specific risk and opportunity assessment methods such as SWOT Analysis (Strength, Weakness, Opportunity, Threats) and 3-Stage Impact/Probability Grids.

4.2.1.3 Communication of the Quality Management System

This manual is the primary mechanism used by laboratory management to communicate the quality management system to laboratory personnel.

To assure personnel understand and implement the quality program outlined in the manual:

- All laboratory personnel are required to sign a Read and Acknowledgement Statement to confirm the employee has: 1) been informed of the manual by laboratory management, 2) has access to the manual, 3) has read the manual 4) understands the content of the manual, and 5) agrees to abide by the requirements, policies and procedures therein.
- Personnel are informed that the manual provides the "what" of the quality management system. The "how to" implementation of the quality management system is provided in policy, SOPs, standard work instructions, and other controlled instructional documents.

4.2.2 Quality Policy Statement

The quality policy of the laboratory is to provide customers with data of known and documented quality fit for their intended purpose. The laboratory achieves this policy by implementing the quality management system defined in this manual, by following industry accepted protocol for analytical testing and quality assurance and quality control (QA/QC) activities, by conformance with published and industry accepted

testing methodologies, and by compliance with international and national standards for the competency and/or accreditation of testing laboratories.

Intrinsic to this policy statement is each of the following principles:

- The laboratory will provide customers with reliable, consistent, and professional service. This is accomplished by making sure the laboratory has the resources necessary to maintain capability and capacity; that staff are trained and competent to perform the tasks they are assigned; that client-facing staff are trained and prepared to find solutions to problems and to assist customers with their needs for analytical services. Customer feedback, both positive and negative, is shared with personnel and used to identify opportunities for improvement.
- The laboratory maintains a quality program that complies with applicable, state, federal, industry standards for analytical testing and competency.

  ISO/IEC 17025 and the TNI (The NELAC Institute) Standard is used by PAS to establish the minimum requirements of the PAS quality program.

  ISO/IEC 17025 is a competency standard that outlines the general requirements for the management system for calibration and testing laboratories. It is the primary quality system standard from which other quality system standards, such as the TNI Standard, are based. The TNI Standard are consensus standards that provides management and technical requirements for laboratories performing environmental analysis.
- Laboratory management provides training to personnel so that all personnel are familiar with the quality management system outlined in this manual and that they understand that implementation of the quality management system is achieved by adherence to the organization's policies and procedures.
- Laboratory management continuously evaluates and improves the effectiveness of the quality management system by responding to customer feedback, and other measures of performance, such as but not limited to: the results of internal/external audits, proficiency testing, metrics, trend reports, and annual and periodic management reviews.

4.2.2.1 Ethics Policy / Data Integrity Program

PAS has established a comprehensive ethics and data integrity program that is communicated to all PAS employees in order that they understand what is expected of them. The program is designed to promote a mindset of ethical behavior and professional conduct that is applied to all work activities.

The key elements of the PAS Ethics / Data Integrity Program include:

- Ethics Policy (COR-POL-0004);
- Ethics Compliance Officer;
- Standardized data integrity training course taken by all new employees on hire and a yearly refresher data integrity training course for all existing employees;

- Policy Acknowledgement Statements that all PAS personnel, including contract and temporary, are required to sign at the time of employment and again during annual refresher training to document the employee's commitment and obligation to abide by the company's standards for ethics, data integrity and confidentiality;
- SOPs that provide instructions for how to carry out a test method or process to assure tasks are done correctly and consistently by each employee;
- On the Job Training;
- Data integrity monitoring activities which include, but are not limited to, secondary and tertiary data review, internal technical and system audits, raw data audits, data mining scans, and proficiency testing; and
- Confidential reporting process for alleged ethics and data integrity issues.

All laboratory managers are expected to provide a work environment where personnel feel safe and can report unethical or improper behavior in complete confidence without fear of retaliation. Retaliation against any employee that reports a concern is not tolerated.

PAS has engaged Lighthouse Services, Inc. to provide personnel with an anonymous reporting process available to them 24 hours a day/7 days per week. The alert line may be used by any employee to report possible violations of the company's ethics and data integrity program. When using the reporting process, the employee does need to specify the location of concern and when reporting by email, also include the company name. Messages are collected, documented, reviewed, and will be followed up on by the Ethics Compliance Officer to resolve the matter. Investigations concerning data integrity are kept confidential.

Lighthouse Compliance Alert Lines:

English Speaking US & Canada	(844) 940-0003
Spanish Speaking North America	(800) 216-1288
Internet	www/lighthouse-services.com/pacelabs
Email	reports@lighthouse-services.com

4.2.3 Management Commitment: Quality Management System

Evidence of management's commitment for the development, maintenance, and on-going improvement of the quality management system is provided by the application of their signature of approval to this manual. Their signature confirms they understand their responsibility to implement the quality management system outlined in this manual, to communicate the quality program to personnel, and to uphold requirements of the program during work activities.

4.2.4 Management Commitment: Customer Service

Management communicates the importance of meeting customer and regulatory requirements to personnel by training personnel on the quality management system outlined in this manual,

implementing the quality management system outlined in this manual, and upholding these requirements for all work activities.

4.2.5 Supporting Procedures

Documents that support this manual and quality management system are referenced throughout this manual. The structure of the document management system is outlined in SOP ENV-SOP-CORQ-0015 *Document Management and Control* and summarized in the following subsections.

4.2.5.1 Quality Management System Document Structure

Documents associated with the quality management system are classified into document types that identify the purpose of the document and establish how the document is managed and controlled.

Document types are ranked to establish which documents takes precedence when there is an actual or perceived conflict between documents and to establish the hierarchal relationships between documents. The ranking system also provides information to document writers and reviewers to assure downline documents are in agreement with documents of higher rank. Project specific documents are not ranked because client specific requirements are not incorporated into general use documents in order to maintain client confidentiality.

PAS Quality Management System Documents: Internal

Document Type	Purpose
Quality Manual	Outlines the laboratory's quality management system and structure and how it works for a system including policy, goals, objectives and detailed explanation of the system and the requirements for implementation of system. Includes roles and responsibilities, relationships, procedures, systems and other information necessary to meet the objectives of the system described.
Policy	Provide requirements and rules for a PAS process and is used to set course of actions and to guide and influence decisions. Policy describes the "what", not the "how".
Standard Operating Procedure	Provide written and consistent set of instructions or steps for execution of a routine process, method, or set of tasks performed by PAS. Includes both fundamental and operational elements for implementation of the systems described in PAS manual(s). Assures that activities are performed properly in accordance with applicable requirements. Designed to ensure consistency, protect EHS of employees and environment, prevent failure in the process and ensure compliance with company and regulatory requirements. SOPs describes the "how" based on policy.
Standard Work Instruction	Provide step by step visual and/or written instruction to carry out a specific task to improve competency, minimize variability, reduce work injury and strain, or to boost efficiency and quality of work (performance). SWI are associated with an SOP unless the task described is unrelated to generation of or contribution to environmental data or analytical results.
Template	Pre-formatted document that serves as a starting point for a new document.
Guide	Provide assistance to carry out a task. Most often used for software applications.
Form	Used for a variety of purposes such as to provide a standardized format to record observations, to provide information to supplement an SOP.

PAS Quality Management System Documents: External

Certificate	Lists parameters, methods, and matrices for which the laboratory is certified/accredited to perform within the jurisdiction of the issuing regulatory agency or accreditation body.
Reference Document	Provide information, protocol, instructions, and/or requirements. Issued by the specifier. Examples include quality system standards such as ISO/IEC, TNI, DoD and published referenced methods such as Standard Methods, ASTM, SW846, EPA, and federal and state regulatory bodies.
Project Document	Provides requirements necessary to meet individual client expectations for intended use of data. Examples include: project quality assurance plans (QAPP), client-program technical specifications, contracts, and other agreements.

Document Hierarchy

Rank	Document
1	Reference Documents
2	Corporate Manual
3	Corporate Policy
4	Corporate SOP
5	Corporate SWI, Templates & Forms
6	Laboratory Manual
7	Laboratory SOP
8	Laboratory SWI, Templates, & Forms
NA	Project Documents[1]

4.2.6 Roles and Responsibilities

The roles and responsibilities of technical management and of the quality manager are provided in section 4.1.5.1.2.

4.2.7 Change Management

When significant changes to the quality management system are planned, these changes are managed by corporate quality personnel to assure that the integrity of the quality management system is maintained.

4.3 Document Control

4.3.1 General

The laboratory's procedures for document control are provided in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

The documents that support the quality management system include internally generated documents such as manuals, policies, standard operating procedures, standard work instructions, forms, guides, and templates and external source documents such as but not limited to, regulations, standards, reference methods, manuals, and project-specific documents.

The laboratory uses electronic document management software (eDMS) to carry out the procedures of the SOP. eDMS automates the process for unique document identification, version control, approval, access, and archival.

4.3.2 Document Approval and Issue

Documents that are part of the quality management system are reviewed by qualified personnel and approved by laboratory management prior by to release for general use.

Local QA maintains a master list of controlled documents used at the laboratory. The master list includes the document control number, document title, and current revision status and is made available to personnel for their reference.

Only the approved versions of documents are available to personnel for use. The eDMS system does not allow user access to draft versions of documents except to personnel assigned to work on the draft. eDMS also restricts access to archived documents except to authorized users, such as local QA, in order to prevent the use of obsolete documents.

See SOP ENV-SOP-CORQ-0015 *Document Management and Control* for more information.

4.3.3 Document Review and Change

Unless a more frequent review is required by regulatory, certification or accreditation program, the laboratory formally reviews documents at least every two years to ensure the document remains current, appropriate, and relevant.

Documents are also informally reviewed every time the document is used. Personnel are expected to refer to and follow instructions in controlled documents when they carry out their work activities. Consequently, any concerns or problems with the document should be caught and brought to the attention of laboratory management on an on-going basis.

Documents are revised whenever necessary to ensure the document remains usable and correct. Older document versions and documents no longer needed are made obsolete and archived for historical purposes.

The laboratory does not allow hand-edits to documents. If an interim change is needed pending re-issue of the document, the interim change is communicated to those that use the document using a formal communication channel, such as SOP Change in Progress form, email, or memorandum.

The document review, revision, and archival process is managed by local QA at the location from which the document was released using the procedures established in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

4.4 Analytical Service Request, Tender, and Contract Review

The laboratory's management and/or client service personnel perform thorough reviews of requests and contracts for analytical services to verify the laboratory has the capability, capacity, and resources necessary to successfully meet the customer's needs. These review procedures are described in laboratory SOP ENV-SOP-PITTS-0037 *Review of Analytical Requests.*

The procedures in this SOP(s) are established to ensure that:

- The laboratory understands the purpose of data collection in order to ensure the test methods requested are appropriate for the intended use of the data and capable of meeting the client's data quality objectives;

- The laboratory and any subcontractor has the capability, capacity, and resources to meet the project requirements and expectations within the requested time frame for delivery of work product;
- Any concerns that arise from review are discussed and resolved with the client; and
- The results of review and any correspondence with the client related to this process and/or any changes made to the contract are recorded and retained for historical purposes.

Capability review confirms that the in-network laboratories and any potential subcontractors hold required certification/accreditation for the test method, matrix, and analyte and verifies the laboratory can achieve the client's target compound list and data quality objectives (DQOs) for analytical sensitivity and reporting limits, QA/QC protocol, and hardcopy test report and electronic data deliverable (EDD) formats.

Capacity review verifies that the in-network laboratories and any potential subcontractors are able to handle the sample load and deliver work production within the delivery time-frame requested.

Resource review verifies that the laboratory and any potential subcontractors have adequate qualified personnel with the skills and competency to perform the test methods and services requested and sufficient and proper equipment and instrumentation needed to perform the services requested.

4.5 Subcontracting and In-Network Work Transfer

The terms 'subcontract' and "subcontracting" refers to work sent to a business external to PAS Analytical Services, LLC (PAS) and the term 'subcontractor' refers to these external businesses, which are also called vendors.

Work transferred within the PAS network is referred to as interregional work orders (IRWO) and network laboratories are referred to as IRWO or network laboratory.

The network of PAS laboratories offers comprehensive analytical capability and capacity to ensure PAS can meet a diverse range of client needs for any type of project. If the laboratory receives a request for analytical services and it cannot fulfill the project specifications, the laboratory's client services team will work with the client to place the work within the PAS network. When it is not possible to place the work within network, the laboratory will, with client approval, subcontract the work to a subcontractor that has the capabilities to meet the project specifications and can meet the same commitment agreed on between the laboratory and the client. Some client programs require client consent even for IRWO work transfer, and when this applies, the client services team obtains consent as required. The laboratory retains the record of client notification and their consent in the project record for historical purposes.

Whenever work is transferred to a subcontractor or an IRWO laboratory, the laboratory responsible for management of the project verifies each of these qualifications:

- The subcontractor or IRWO laboratory has the proper accreditation/certifications required for the project and these are current; and
- The use of the subcontractor or IRWO laboratory is approved by the client and/or regulatory agency, when approval is required. Record of approval is retained in the project record.

When possible, the laboratory selects subcontractors that maintain a quality management system similar to PAS and that complies with ISO/IEC 17025 and the TNI Standard(s).

PAS also evaluates and pre-qualifies subcontractors as part of company's procurement program. The complete list of approved vendors is maintained by the corporate procurement department and is made available to all PAS locations. Pre-qualification of a subcontractor does not replace the requirement for the placing laboratory to verify the capability, capacity, and resources of any selected subcontractor on a project-specific basis to confirm the subcontractor can meet the client's needs.

For both subcontracting and in-network work transfer, the project specifications are always communicated to the subcontractor or the IRWO laboratory by the project manager so that the laboratory performing the work is aware of and understands these requirements.

The procedures for subcontracting are outlined in laboratory SOP ENV-SOP-PITTS-0025 *Subcontracting*.

4.6 Purchasing Services and Supplies

Vendors that provide services and supplies to the laboratory are prequalified by corporate procurement personnel to verify the vendor's capability to meet the needs of PAS. These needs include but are not limited to: competitive pricing, capacity to fill purchase orders, quality of product, customer service, and business reputation and stability. The records of vendor evaluation and the list of approved vendors is maintained by the corporate procurement department.

The laboratory may purchase goods and services from any supplier on the approved vendor list.

The specifications (type, class, grade, tolerance, purity, etc.) of supplies, equipment, reagents, standard reference materials and other consumables used in the testing process are specified in SOPs. The SOP specifications are based on the governing requirements of the approved reference methods and any additional program driven regulatory specification, such as drinking water compliance. All requisitions for materials and consumables are approved by the department supervisor to confirm the purchase conforms with specified requirements. After approval the requisition is handled by the laboratory's designated purchasing agent. On receipt, the product is inspected and verified before use, when applicable.

The laboratory's procedure for the purchase of services and supplies is specified in laboratory SOP ENV-SOP-PITTS-0013 *Purchasing of Lab Supplies*.

4.7 Customer Service

Project details and management is handled by the laboratory's customer service team. Each customer is assigned a Project Manager (PM) that is responsible for review of contract requirements and handling laboratory to customer communication about the project status.

4.7.1 Commitment to Meet Customer Expectations

The laboratory cooperates and works closely with our customers to ensure their needs are met and to establish their confidence in the laboratory's capability to meet their needs for analytical services and expectations for service.

Each customer's project is handled by a project manager (PM) that is the customer's primary point of contact. The PM gathers information from the customer to ensure the details of their request are understood. After samples are received, the PM monitors the progress of the project and alerts the customer of any delays or excursions that may adversely impact data usability. Laboratory supervisors are expected to keep the PM informed of project status and any delays or major issues, so that the PM can keep the client informed.

PAS also has a team of subject matter experts (SME) available to provide customers with advice and guidance and any other assistance needed. SME are selected by top management based on their knowledge, experience, and qualifications.

The laboratory encourages customers to visit the laboratory to learn more about the laboratory's capabilities, observe performance and to meet laboratory personnel.

PAS customers expect confidentiality. Laboratory personnel will not divulge or release information to a third party without proper authorization unless the information is required for litigation purposes. See Section 4.1.5.3 of this manual and policy COR-POL-0004 *Ethics Policy* for more information on the laboratory's policy for client confidentiality.

4.7.2 Customer Feedback

The laboratory actively seeks positive and negative feedback from customers through surveys and direct communication. Information from the client about their experience working with the laboratory and their satisfaction with work product is used to enhance processes and practices and to improve decision making. Customer feedback is communicated to laboratory management and corporate personnel in monthly reports and analyzed yearly during management review (See 4.15) to identify risk and opportunity. Corrective, preventive, or continuous improvement actions are taken based on nature of and/or feedback trends.

Also see sections 4.9, 4.10, 4.11, 4.12, 4.14, and 4.15 for more information about how customer feedback is managed by the laboratory and used to enhance the quality management system.

4.8 Complaints

Complaints provide opportunities to improve processes and build stronger working relationships with our clients.

The laboratory's complaint resolution process includes three steps. First, handle and resolve the complaint to mutual satisfaction. Second, perform corrective action to prevent recurrence (See 4.11). Third, record and track the complaint and use these records for risk and opportunity assessment and preventive action (See 4.12)

4.9 Nonconforming Work

4.9.1 Definition of Nonconforming Work

Nonconforming work is work that does not conform to customer requirements, standard specifications, laboratory policies and procedures, or that does not meet acceptance criteria.

The discovery of non-conforming work comes come from various sources which include, but are not limited to:

- results of quality control samples and instrument calibrations;
- quality checks on consumables and materials;
- general observations of laboratory personnel;
- data review;
- proficiency testing;
- internal and external audits;

- complaints and feedback;
- management review and reports; and
- regulatory and certification and accreditation actions.

The way in which the laboratory handles nonconforming work depends on the significance and impact (risk) of the issue. Some issues may simply require correction, others may require investigation, corrective action (See 4.11) and/or data recall (See 4.16). When the laboratory releases data and test results associated with nonconforming QC and acceptance criteria test results are qualified or non-conformances are noted in the final analytical report to apprise the data user of the situation. (See 5.10)

Nonconforming work also includes unauthorized departure from laboratory policies, procedures and test methods. Authorized departures are explained in the following subsections. Situations that do not conform to these conditions are considered unauthorized departure(s).

4.9.1.1 Authorized Departure from SOP

An authorized departure from a test method SOP is one that has been reviewed and approved by the Department Manager, Technical Manager, Acting Technical Manager for TNI, Quality Manager, or the General Manager. Review is conducted to confirm the departure does not conflict with regulatory compliance requirements for which the data will be used or does not adversely affect data integrity. The departure may originate from client request or may be necessary to overcome a problem.

An authorized departure from administrative or process-oriented SOP is typically necessary to correct an error in the SOP. These departure requests are reviewed and pre-approved by the local QA Manager. Documentation of SOP departures and approval decisions are retained by the laboratory as evidence that the departure was authorized. When necessary, approved departures from test method SOPs are noted in the final test report to advise the data user of any ramification to data quality.

4.9.1.2 Authorized Departure from Test Methods (Method Modifications)

When test results are associated to a published reference test method, the laboratory's test method SOP must be consistent with the test method. If the test method is mandated for use by a specific regulatory program such as drinking water or wastewater or a certification or accreditation program, such as TNI/NELAC, the SOP must also comply with or include these requirements. If the procedures in the SOP are modified from the test method, these modifications must be clearly identified in the SOP. The conditions under which the laboratory may establish an SOP that is modified from these reference documents, and what is considered a modification are specified in ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification*.

Modifications that do not meet the requirements of this SOP (ENV-SOP-CORQ-0011) are unauthorized. Client requests to deviate from the test method are handled as client requests to depart from the test method SOP since it is the SOP that the laboratory follows when performing work.

4.9.1.3 Stop Work Authority

Stop Work Authority provides laboratory personnel with the responsibility and obligation to stop work when there is a perceived unsafe condition or behavior that may result in an unwanted event.

All laboratory and corporate personnel have the authority to stop work when needed to preserve data integrity or safety of workers.

Once a stop work order has been initiated and the reason for doing so is confirmed valid; laboratory management is responsible for immediate correction and corrective action (see section 4.10) before resumption of work.

4.10 Continuous Improvement

The laboratory's quality management system is designed to achieve continuous improvement through the implementation of the quality policy and objectives outlined in this manual. Information about the laboratory's activities and performance is gained from many sources such as customer feedback, audits, QC, trend analysis, business analytics, management reports, proficiency testing, and management systems review. This information is subsequently used during the laboratory's corrective action (see section 4.11) and preventive action (see section 4.12) processes and to establish goals and objectives during annual review of the management system (see section 4.15).

PAS also promotes a continuous improvement culture based on the principles of lean manufacturing. These principles include 3P (Process, Productivity, Performance) and Kaizen. 3P is a platform used by Pace to share best practices and standardization across the network to achieve operational excellence. Kaizen is a team based process used to implement tools and philosophies of lean to reduce waste and achieve flow with the purpose of improving both external and internal customer satisfaction.

4.11 Corrective Action

Corrective action is process used to eliminate the cause of a detected nonconformity. It is not the same as a correction. A correction is an action taken to fix an immediate problem. The goal of the corrective action process is to find the underlying cause(s) of the problem and to put in place fixes to prevent the problem from happening again. The corrective action process, referred to as CAPA by PAS, is one of the most effective tools used by the laboratory to prevent nonconforming work, identify risk and opportunity, and improve service to our customers.

The laboratory has two general processes for corrective action:

The process used for actions taken in response to day to day quality control (QC) and acceptance criteria exceptions (nonconformance) that occur during the day to day testing process are called corrections. These events do not usually include formal methods for cause analysis; instead the reason for the failure is investigated through troubleshooting or other measures. Required actions for correction of routine nonconformance is specified in laboratory SOPs. When corrective action is not taken, cannot be taken, or is not successful, test results associated with the nonconforming work are qualified in the final test report. Documentation of the nonconformance and corrective action taken is documented in the analytical record.

A formal 7 step corrective action process is used when there is a problem or departure from the quality management system, technical activities, or when the extent of a single problem has significant

impact on data, regulatory compliance or customer needs. These problems are identified through various activities such as but not limited to: quality control trends, internal and external audits, management review, customer feedback, and general observation.

The laboratory's 7 Step CAPA Process includes:

1) Define the Problem
2) Define the Scope of the Problem
3) Contain the Problem
4) Root Cause Analysis
5) Plan Corrective Action
6) Implement Corrective Action
7) Follow Up / Effectiveness Check

The formal CAPA process may be initiated by any employee. Once the process is initiated it is overseen and coordinated by laboratory management. The CAPA process is documented using an electronic or paper-based system. The CAPA record includes tracking information, dates, individuals involved, those responsible for action plan implementation and follow-up, and timelines and due dates.

For more information about the laboratory's procedure for corrective action, see laboratory SOP ENV-SOP-PITTS-0004 *Corrective Action*. Additional explanation about certain aspects of the laboratory's corrective action process are outlined in the next three subsections.

4.11.1 Root Cause Analysis

Root cause analysis (RCA) is the process of investigation used by the laboratory to identify the underlying cause(s) of the problem. Once causal factors are identified, ways to mitigate the causal factors are reviewed and corrective action(s) most likely to eliminate the problem are selected.

The laboratory uses different methods to conduct this analysis. The most common approach is 5-Why, but fishbone diagrams, or even brainstorming may be appropriate depending on the situation. The method used is documented in the CAPA record.

4.11.2 Effectiveness Review

Monitoring corrective actions for effectiveness is shared by laboratory supervisors and quality assurance personnel. Effectiveness means the actions taken were sustainable and appropriate. Sustainable means the change is still in place. Appropriate means the action(s) taken prevented recurrence of the problem since the time corrective action was taken.

The time-frame in which effectiveness review takes place depends on the event and is recorded in the CAPA record with any addition actions that need to be taken.

Corrective action trends are also monitored by laboratory management and used to identify opportunities for preventive action or to gain lessons learned when actions taken were not adequate to solve the problem. See Section 4.12 (Preventive Action) and 4.15 (Management Review) for more information.

4.11.3 Additional Audits

When non-conformances or other problems cast doubt on compliance with the laboratory's policies, procedures, or compliance to regulatory requirements; laboratory management

schedules a special audit of the area of activity in accordance with Section 4.14.1 as soon as possible. These special audits are used to determine the scope of the problem and to provide information for the CAPA process. Additional full-scale audits are done when a serious issue or risk to the laboratory's business is identified.

4.12 Preventive Action

Preventive action is an action taken to eliminate the cause of a potential nonconformity and to achieve improvement. Preventive action is a forward thinking process designed to prevent problems opposed to reacting to them (corrective action).

Some examples of preventative action include, but are not limited to:

- Scheduled instrument maintenance (Preventative maintenance)
- Addition of Staff and Equipment
- Professional Development Activities
- Implementation of New Technology

The laboratory looks for opportunities for preventive action from a variety of sources including but not limited to: employee idea's, customer feedback, business partners input, trend analysis, business analytics, management reviews, proficiency testing results, lean management events, and risk-benefit analysis.

The process for preventive actions follows the same 7 step process for corrective action except "problem" is replaced with "opportunity", "cause analysis" is replaced with "benefit analysis", and "corrective action" is replaced with "preventive action".

Laboratory management evaluates the success of preventive actions taken in any given year during annual management review. See Section 4.15 for more information.

4.12.1 Change Management

Preventive actions may sometimes result in significant changes to processes and procedures used by the laboratory. Laboratory management evaluates the risks and benefits of change and includes in its implementation of change process, actions to minimize or eliminate any risk. The types of changes for which risk are considered and managed include: infrastructure change, change in analytical service offerings, certification or accreditation status, instrumentation, LIMS changes, and changes in key personnel.

For more information about the laboratory's procedures for preventive action see laboratory SOP ENV-SOP-PITTS-0038 *Management of Change*.

4.13 Control of Records

A record is a piece of evidence about the past, especially an account of an act or occurrence kept in writing or some other permanent form. Laboratory records document laboratory activities and provide evidence of conformity to the requirements established in the quality management system. These records may be hardcopy or electronic on any form of media.

4.13.1 General Requirements

4.13.1.1 Procedure

The laboratory's procedures for control of records is provided in laboratory SOP for Data and Records Archival.

The procedures in the SOP are established to assure quality and technical records are identified, retained, indexed, and filed to allow for retrieval during the entire retention time frame. During storage, records are kept secure and protected from deterioration. At the end of the retention time, the records are disposed of properly in order to maintain client confidentiality and to protect the interests of the company.

In general, laboratory records fall into three categories: quality, technical, and administrative.

Examples of each are provided in the following table:

Record Type	Includes Records of:
Quality	Documents: Document Types listed in SOP ENV-SOP-CORQ-016 Audits: Internal and External Certificates and Scopes of Accreditation Corrective & Preventive Action Management Review Data Investigations Method Validation Instrument Verification Training Records
Technical	Raw Data Logbooks Certificates of Traceability Analytical Record Test Reports & Project Information Technical Training Records & Demonstration of Capability
Administrative	Personnel Records Finance/Business

4.13.1.2 Record Legibility and Storage

Records are designed to be legible and to clearly identify the information recorded. Manual entries are made in indelible ink; automated entries are in a typeface and of sufficient resolution to be read. The records identify laboratory personnel that performed the activity or entered the information.

Records are archived and stored in a way that they are retrieved. Access to archived records is controlled and managed.

For records stored electronically, the capability to restore or retrieve the electronic record is maintained for the entire retention period. Hardcopy record are filed and stored in a suitable environment to protect from damage, deterioration, or loss. Hardcopy records may be scanned to PDF for retention. Scanned records must be checked against the hardcopy to verify the scan is complete and legible.

Records are kept for a minimum of 10 years unless otherwise specified by the client or regulatory program.

The date from which retention time is calculated depends on the record. In general, the retention time of technical records of original observation and measurement is calculated from the date the record is created. If the technical record is kept in a chronological logbook, the date of retention may be calculated from the date the logbook is archived. The retention time of test reports and project records, which are considered technical records, is calculated from the date the test report was issued. The retention time of quality records is usually calculated from the date the record is archived.

Refer to the laboratory's record management SOP for more information.

4.13.1.3 Security

The laboratory is a secure facility and access to records is restricted to laboratory personnel.

4.13.1.4 Electronic Records

The data systems used to store electronic records is backed up in accordance with laboratory SOP ENV-SOP-PITTS-0033 *Horizon LIMS*. Access to archived records stored electronically is maintained by personnel responsible for management of the electronic system.

4.13.2 Technical Records

In addition to the requirements identified in subsections 4.13.1.1 through 4.13.1.4, the requirements in the following subsections also apply to technical records.

4.13.2.1 Description

Technical records are the accumulation of data and information generated from the analytical process. These records may include forms, worksheets, workbooks, checklists, notes, raw data, calibration records, final test reports, and project record. The accumulated record essentially needs to provide sufficient detail to historically reconstruct the process and identify the personnel that performed the tasks associated with a test result.

4.13.2.2 Real Time Recordkeeping

Personnel are instructed and expected to always record observations, data, and calculations at the time they are made. Laboratory managers are responsible to assure that data entries, whether made electronically or on hardcopy, are identifiable to the task.

4.13.2.3 Error Correction

Errors in records must never erased, deleted or made illegible. Use of correction fluid, such as white-out is prohibited. In hardcopy records, the error is corrected by a single-strike through the original entry and the new entry recorded alongside or footnoted to allow for readability. Corrections are initialed and dated by the person making the correction. If the correction is not self-explanatory, a reason for the correction is recorded.

For electronic records, equivalent measures of error correction or traceability of changes made is kept. For example, audit trails provide records of change.

Maintenance of proper practices for error correction is monitored through the tiered data review process described in Section 5.9.3. Laboratory records are reviewed throughout the data review process. Individuals performing these reviews flag errors that are not properly corrected and bring these to the attention of the department manager or supervisor of the work area in which the record was generated so that the problem may be addressed and corrected with the individual(s) that did not make the correction properly.

4.14 Audits

The laboratory performs internal systems and technical audits to assess compliance to this manual and to other laboratory procedures, such as policy, SOP and SWI. Since the processed in this manual are based on the relevant quality system standards and regulatory and accreditation/certification program requirements the laboratory provides services for, the internal audits also assess on-going compliance to these programs.

The laboratory is also audited by external parties such as regulatory agencies, customers, consultants and non-government assessment bodies (NGAB).

Information from internal and external audits is used by laboratory management to address compliance concerns and opportunities where improvement will increase the reliability of data.

Deficiencies, observations and recommendations from audits are managed by local QA using the laboratory's formal CAPA process. See Section 4.11 for more information.

4.14.1 Internal Audit

The laboratory's internal audit program is managed by local QA in accordance with a pre-determined audit schedule established at the beginning of each calendar year. The schedule is prepared to assure that all areas of the laboratory are reviewed over the course of the year. Conformance to the schedule is reported to both laboratory management and corporate quality personnel in a monthly QA report prepared by the quality manager.

Although the QA Manager creates the audit schedule, it is the shared responsibility of local QA and laboratory managers to assure the schedule is maintained. Laboratory supervisors cooperate with QA to provide the auditors with complete access to the work area, personnel, and records needed.

Internal audits are performed by personnel approved by the quality manager. In general, personnel may not audit their own activities unless it can be demonstrated that an effective and objective audit will be carried out. The auditor must be trained, qualified, and familiar enough with the objectives, principles, and procedures of laboratory operations to be able to perform a thorough and effective evaluation.

The laboratory's internal audit program includes:

- System Audits & Method Audits: The purpose of these audits is to determine if daily practice is consistent with laboratory's SOPs and if SOPs are compliant with adjunct policy and procedures. Auditing techniques includes analyst interviews and observation and records review. These audits are performed per the pre-determined schedule.

- Raw Data / Final Test Report Audits: The purpose of these audits is to review raw data and/or a final test reports to verify the final product is consistent with customer/project requirements and supported as compliant to SOPs, reference methods, with test results that are properly qualified when necessary, accurate, and of known and documented quality. The reviews should also identify opportunities for improvement and best practices.

- Special Audits: Special audits are those performed ad hoc to follow up on specific a specific issue such as a client complaint, negative feedback, concerns of data integrity or ethics, or a problem identified through other audits. Special audits may be scheduled or unscheduled. Unscheduled internal audits are conducted whenever doubts are cast on the laboratory's compliance with regulatory requirements or its own policies and procedures. These unscheduled internal audits may be conducted at any time and may be performed without an announcement to laboratory personnel.

When observations and findings from any audit (internal or external) cast doubt on the validity of the laboratory's testing results, the laboratory takes immediate action to initiate investigate the problem and take corrective action. (Also see 4.11 and 4.16)

The laboratory's internal audit program and auditing procedures are further described in laboratory SOP ENV-SOP-PITTS-0006 *Internal Audits*.

4.14.1.1 Corporate Compliance Audit

The laboratory may also be audited by corporate quality personnel to assess the laboratory's compliance to the company's quality management program and to evaluate the effectiveness of implementation of the policies and procedures that make up the quality management system. The purpose of the compliance audit is to identify risks and opportunities and to assist laboratory management achieve the goals and objectives of the company's quality program.

4.15 Management Review

The laboratory's management team formally reviews the management system on an annual basis to assess for on-going suitability and effectiveness and to establish goals, objectives, and action plans for the upcoming year.

At a minimum, following topics are reviewed and discussed:

- The on-going suitability of policies and procedures including HSE (Health, Safety and Environment) and waste management;

- Reports from managerial and supervisory personnel including topics discussed at regular management meetings held throughout the year;

- The outcome of recent internal audits;

- Corrective and preventive actions;

- Assessments by external bodies;

- The results of interlaboratory comparisons or proficiency tests;

- Changes in the volume and type of the work;
- Customer and personnel feedback, including complaints;
- Effectiveness of improvements / preventive actions made since last review;
- Internal and external issues of relevance and risk identification;
- A review of the status of actions from prior management reviews; and
- Other relevant factors, such as quality control activities, resources, and staff training.

The discussion and results of this review are documented in a formal report prepared by laboratory management. This report includes a determination of the effectiveness of the management system and its processes; goals and objectives for improvements in the coming year with timelines and responsibilities, any other need for change. See laboratory SOP ENV-SOP-CORQ-0005 for more information.

Goals and action items from annual management systems review are shared with employees to highlight focus areas for improvement in addition to areas in which the laboratory has excelled.

4.16 Data Integrity

The laboratory's procedures for data integrity reviews are described in SOP ENV-SOP-CORQ-0010 *Data Recall*.

Customers whose data are affected by these events are notified in a timely manner, usually within 30 days of discovery. Some accreditation programs also require notification to the accreditation body (AB) within a certain time-frame from date of discovery when the underlying cause of the issue impacts accreditation. The laboratory follows any program or project specific client notification requirements for notification, when applicable.

5.0 TECHNICAL REQUIREMENTS

5.1 General

Many factors contribute to the correctness and reliability of the technical work performed by the laboratory. These factors are fall under these general categories:

- Human Performance
- Facility and Environmental Conditions
- Test Method Performance and Validation
- Measurement Traceability
- Handling of Samples

The impact of each of these factors varies based on the type of work performed. To minimize negative effects from each these factors, the laboratory takes into account the contribution from each of these categories when developing test method and process (administrative) SOPs, evaluating personnel qualifications and competence, and in the selection of equipment and supplies used.

5.2 Personnel

5.2.1 Personnel Qualifications

The laboratory's program for personnel management is structured to ensure personnel are selected, qualified, and competent to perform the roles and responsibilities of their position based on education, experience, and training.

Qualifications, duties, responsibilities, and authorities of each position are specified in job descriptions maintained by corporate HR (See Section 5.2.4). These job descriptions provide the general basis for the selection of personnel for hire and are used by the laboratory to communicate to personnel the duties, responsibilities, and authorities of their position.

The term "personnel" refers to individuals employed by the laboratory directly as full-time, part-time, or temporary, and individuals employed by the laboratory by contract, such as through an employment agency. The term "personnel" is used interchangeably with the term "employee" throughout this manual. For purposes of this manual, these terms are equivalent.

The personnel management program is structured to establish and maintain records for each of the following:

- Selection of personnel;
- Training of personnel;
- Supervision of personnel;
- Authorization of personnel; and
- Monitoring Competence of personnel.

5.2.1.1 Competence

Competence is the ability to apply a skill or series of skills to complete a task or series of tasks correctly within defined expectations.

Competence for technical personnel authorized by PAS to provide opinion and interpretation of data to customers also includes the demonstrated ability to:

- Apply knowledge, experience, and skills needed to safely and properly use equipment, instrumentation, and materials required to carry out testing and other work activities in accordance with manufacturer specifications and laboratory SOPs;
- Understand and apply knowledge of general regulatory requirements necessary to achieve regulatory compliance in work product; and
- Understand the significance of departures and deviations from procedure that may occur during the analytical testing process and the capability and initiative to troubleshoot and correct the problem, document the situation and decision making process, and to properly qualify the data and analytical results.

The laboratory's requirements for the competence of personnel (education, qualification, work experience, technical skills, and responsibilities) are specified in job descriptions created by management and kept by human resources (HR). The job description provides the basis for the selection of personnel for each position.

An employee is considered competent when he/she has completed required training.

The policies and standard operating procedures (SOPs) for the following topics are established by management as minimum required training for all personnel:

- Ethics and Data Integrity
- Quality Manual
- Safety Manual
- Quality Management System
- Technical Process and Procedure relevant to their job tasks
- Successful Demonstration of Capability (DOC) – Analytical Personnel Only

Personnel are initially authorized competent to independently carry out their assigned duties when required training is complete and documented.

Records of training and qualification provide the record of competence for the individual. Qualification records may include but are not limited to diploma, transcripts, and curriculum vitae (CV).

The on-going competence of each employee is monitored by laboratory management through on-the-job performance. Analytical employees are also required to successfully complete another demonstration capability for each test method performed on an annual basis.

5.2.2 Training

Training requirements are outlined in policies COR-POL-0023 *Mandatory Training Policy*. COR-POL-0004 *Ethics Policy*, and laboratory SOP ENV-SOP-PITTS-0014 *Employee Orientation and Training*. Additional training requirements may also be specified in other documents, such as manuals

5.2.2.1 Training Program and Goals

The laboratory's training program includes 4 elements:

- Identification of Training Needs
- Training Plan Development and Execution
- Documentation and Tracking
- Evaluation of Training Effectiveness

Laboratory management establishes goals and training needs for individual employees based on their role, education, experience, and on-the-job performance.

Training needs for all employees are based on business performance measures that include but are not limited to:

- Quality Control Trends
- Process Error / Rework Trends

- Proficiency Testing Results
- Internal & External Audit Performance
- Management Review Goals

Training is delivered using various methods that incorporate techniques that appeal to the main learning styles: visual, aural, linguistic, and kinesthetic. Techniques include, on-the-job, instructor-led, self-study, eLearning, and blended.

The employee's direct supervisor is responsible for oversight of the employee's training plan and for providing adequate time to the employee to complete training assignments. Both the supervisor and employee are responsible to make sure the employee's training status and training records are current and complete.

The laboratory's QA department monitors the training status of personnel and provides the status to the General Manager (GM or AGM) at least monthly or more frequently, if necessary. The status report is used by laboratory management to identify overdue training assignments, the reasons for the gaps, and to make arrangements for completion.

The following subsections highlight specific training requirements:

5.2.2.1.1 New Hire Training

New hire training requirements apply to new personnel and to existing employee's starting in a new position or different work area.

Required new hire training includes each of the following:

- Ethics and Data Integrity (See 5.2.2.1.3)
- Quality Manual / Quality Management System (See 5.2.2.1.4)
- Safety Manual and any training requirements specified in the manual.
- Policies & SOPs relevant to their job tasks
- Technical personnel that test samples must also successfully complete an initial demonstration of capability (IDOC) for the test methods performed before independently testing customer samples. (See 5.2.2.1.5). Independent testing means handling of client samples without direct supervision of the work activity by the supervisor or a qualified trainer.

All required training must be current and complete before the employee is authorized to work independently. Until then, the employee's direct supervisor is responsible for review and acceptance of the employee's work product.

5.2.2.1.2 On-Going Training

Personnel receive on-going training in each of the following topics:

- Ethics and Data Integrity (See 5.2.2.1.3)
- Quality Manual / Quality Management System (See 5.2.2.1.4)
- Safety Training
- Changes to Policies & SOPs
- Specialized Training
- Technical employees that carry of testing must also successfully complete on-going demonstration of capability (ODOC) for all test methods performed on an annual basis. (See 5.2.2.1.5)

Personnel are expected to maintain their training status and records of training current and complete and to complete training assignments in a timely manner.

5.2.2.1.3 Ethics and Data Integrity Training

Data integrity training is provided to all new personnel and refresher data integrity training is provided to all employees on an annual basis. Personnel are required to acknowledge they understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment, or civil/criminal prosecution.

The initial data integrity training and the annual refresher training is documented with a signature attendance sheet or other form of documentation to provide evidence that the employee has participated in training on this topic and understand their obligations related to data integrity.

The following topics and activities are covered:

- Policy for honesty and full disclosure in all analytical reporting;
- Prohibited Practices;
- How and when to report data integrity issues;
- Record keeping. The training emphasizes the importance of proper written documentation on the part of the analyst with respect to those cases where analytical data may be useful, but are in one sense or another partially nonconforming;
- Training Program, including discussion regarding all data integrity procedures;
- Data integrity training documentation;
- In-depth procedures for data monitoring; and
- Specific examples of breaches of ethical behavior such as improper data manipulations, adjustments of instrument time

clocks, and inappropriate changes in concentrations of standards.

All PAS personnel, including contract and temporary, are required to sign an "Attestation of Ethics and Confidentiality" at the time of employment and during annual refresher training. This document clearly identifies inappropriate and questionable behavior. Violations of this document result in serious consequences, including prosecution and termination, if necessary.

Also see SOP-ENV-COR-POL-0004 *Ethics Policy* for more information.

5.2.2.1.4 Management System Documents Training

PAS Manuals, policies, and SOPs are the primary documents used by regulatory bodies and PAS customers to verify the laboratory's capability, competency. and compliance with their requirements and expectations.

In addition to on-the-job training, employees must have a signed Read and Acknowledgement Statement on record for the laboratory quality manual, and the policies and SOPs relating to his/her job responsibilities. This statement when signed by the employee electronically or by wet signature, confirms that the employee has received, read, and understands the content of the document, that the employee agrees to follow the document when carrying out their work tasks; and the employee understands that unauthorized change to procedures in an SOP is not allowed except in accordance with the SOP departure policy (See 4.9.9.1) and SOP ENV-CORQ-0016 *Standard Operating Procedures and Standard Work Instructions* for more information.

5.2.2.1.5 Demonstration of Capability (DOC)

Technical employees must also complete an initial demonstration of capability (IDOC) prior to independent work on client samples analyzed by the test methods they perform. After successful IDOC, the employee must demonstrate continued proficiency (CDOC) for the test method on an annual basis. If more than a year has passed since the employee last performed the method; then capability must be re-established with an IDOC.

Demonstration of capability (IDOC and DOC) is based on the employee's capability to achieve acceptable precision and accuracy for each analyte reported by the laboratory for the test method using the laboratory's test method SOP.

Records of IDOC and ODOC are kept in the employee's training file.

For more information, see laboratory SOP ENV-SOP-PITTS-0014.

5.2.2.2 Effectiveness of Training

The results of the performance measures used to identify training needs are the same measures used by the laboratory to measure effectiveness of the training program. Improvement in key performance measures suggest the training program is successful. (See 5.2.2.1)

Effectiveness of individual employee training is measured by their demonstrated ability to comprehend the training material and apply knowledge and skills gained to their job task. Measurements include but are not limited to:

- Testing of the employee's knowledge of the quality management system, policies, and technical and administrative procedures through various mechanisms, such as quizzes, observation, and interviews.
- Demonstrated ability to convey information correctly and factually in written and verbal communication to internal and external parties.
- Demonstrated ability to carry out tasks in accordance with SOPs and other work instructions.
- Demonstrated ability to make sound decisions based on guidance and information available.
- Demonstrated initiative to seek help or guidance when the employee is unsure of how to proceed.

5.2.3 Personnel Supervision

Every employee is assigned a direct supervisor, however named, who is responsible for their supervision. Supervision is the set of activities carried out by the supervisor to oversee the progress and productivity of the employees that report to them.

General supervisory responsibilities may include but are not limited to:

- Hiring Employees
- Training Employees
- Performance Management
- Development, oversight, and execution of personnel training plans
- Monitoring personnel work product to assure the work is carried out in accordance with this quality manual, policies, SOPs, and other documents that support the quality management system.

5.2.4 Job Descriptions

Job Descriptions that define the required education, qualifications, experience, skills, roles and responsibilities, and reporting relationships for each PAS position are established by top management and kept by corporate HR. PAS laboratories use these job descriptions as the source of positions and job titles for the laboratory. The job descriptions apply to employees who are directly employed by PAS, part-time, temporary, technical and administrative and by those that are under contract with PAS through other means.

The job descriptions include the education, expertise, and experience required for the position and the responsibilities and duties, including any supervisory or managerial duties assigned to the position.

5.2.5 Authorization of Technical Personnel

Laboratory management authorizes technical personnel to perform the technical aspects of their position after it has been verified that the employee meets the qualifications for the position, has successfully completed required training, and the employee has demonstrated capability. After initial authorization, technical personnel are expected to maintain a current and complete training record, demonstrate on-going capability at least annually for each test method performed, and produce reliable results through accurate analysis of certified reference materials, proficiency testing samples, and/or routine quality control samples in order to remain authorized to continue to perform their duties.

Records to support authorization including, education, experience, training, and other evaluations are kept by the laboratory.

5.3 Accommodations and Facilities

5.3.1 Facilities

The laboratory is designed to support the correct performance of procedures and to not adversely affect measurement integrity or safety. Access to the laboratory is controlled by various measures, such as card access, locked doors, main entry. Visitors to the laboratory are required to sign-in and to be escorted by laboratory personnel during their visit. A visitor is any person that is not an employee of the laboratory.

5.3.2 Environmental Conditions

The laboratory is equipped with energy sources, lighting, heating, and ventilation necessary to facilitate proper performance of calibrations and tests. The laboratory ensures that housekeeping, electromagnetic interference, humidity, line voltage, temperature, sound and vibration levels are appropriately controlled to ensure the integrity of specific measurement results and to prevent adverse effects on accuracy or increases in the uncertainty of each measurement.

Environmental conditions are monitored, controlled, and recorded as required by the relevant specifications, methods, and procedures. Laboratory operations are stopped if it is discovered that the laboratory's environmental conditions jeopardize the analytical results.

5.3.3 Separation of Incompatible Activities

The layout and infrastructure of each work area including air handling systems, power supplies, and gas supplies of each laboratory work area is specifically designed for the type of analytical activity performed. Effective separation between incompatible work activities is maintained. For example, sample storage, preparation, and chemical handling for volatile organic analysis (VOA) is kept separate from semi-volatile organic (SVOA).

The laboratory separates samples known or suspected to contain high concentration of analytes from other samples to avoid the possibility for cross-contamination. If contamination is found, the source of contamination is investigated and resolved in accordance with laboratory SOPs.

5.3.4 Laboratory Security

Security is maintained by controlled access to the building and by surveillance of work areas by authorized personnel. Access is controlled to each area depending on the required personnel, the sensitivity of the operations performed, and possible safety concerns. The main entrance is kept unlocked during normal business hours for visitors, and is continuously monitored by laboratory staff. All visitors must sign a visitor's log, and a staff member must accompany them during the duration of their stay.

5.3.5 Good Housekeeping

The laboratory ensures good housekeeping practices in work areas to maintain a standard of cleanliness necessary for analytical integrity and personnel health and safety. Minimally, these measures include regular cleaning of the work area. Where necessary, areas are periodically monitored to detect and resolve specific contamination and/or possible safety issues.

5.4 Test Methods

5.4.1 General Requirements

The laboratory uses test methods and procedures that are appropriate for the scope of analytical services the laboratory offers.

Instructions on the use and operation of equipment and sample handling, preparation, and analysis of samples are provided in SOPs. The instructions in SOPs may be supplemented with other documents including but not limited to, standard work instructions (SWI), manuals, guides, project documents and reference documents.

These documents are managed using the procedures described in SOP ENV-SOP-CORQ-0015 *Document Management and Control* and SOP ENV-SOP-CORQ-0016 *Standard Operating Procedures and Standard Work Instructions.*

Deviations to test method and SOPs are allowed under certain circumstances. See sections 4.9.1.1 and 4.9.1.2 for more information.

5.4.2 Method Selection

The test methods and protocols used by the laboratory are selected to meet the needs of the customer, are appropriate for the item tested and intended use of the data, and to conform with regulatory requirements when regulatory requirements apply.

In general, the test methods offered are industry accepted methods published by international, regional, or national standards. The laboratory bases its procedure on the latest approved edition of a method unless it is not appropriate or possible to do so or unless regulatory requirements specify otherwise.

The laboratory confirms that it can perform the test method and achieve desired outcome before analyzing samples (see section 5.4.5). If there is a change in the published analytical method, then the confirmation is repeated.

When a customer does not specify the test method(s) to be used, the laboratory may suggest test methods that are appropriate for the intended use of the data and the type of samples to be tested. The laboratory will also inform customers when test methods requested are

considered inappropriate for their purpose and/or out of date. This discourse takes place during review of analytical service requests (See Section 4.4).

5.4.3 Laboratory Developed Methods

A laboratory developed method is a method developed from scratch (no published source method), a procedure that modifies the chemistry from the source method, or a procedure that exceeds the scope and application of the source method.

Laboratory developed methods must be validated prior to use (see section 5.4.5) and the procedure documented in a test method SOP.

The requirements for non-standard methods (Section 5.4.4) also apply to laboratory developed methods.

5.4.4 Non-standard Methods

A non-standard method is a method that is not published or approved for use by conventional industry standards for the intended purpose of the data. Non-standard methods must be validated prior to use (see section 5.4.5) and the procedure developed and documented in a test method SOP.

At a minimum, the following information must be included in the procedure:

- Title / Identification of Method;
- Scope and Application;
- Description of the type of item to be analyzed;
- Parameters or quantities and ranges to be determined;
- Apparatus and equipment, including technical performance requirements;
- Reference standards and reference materials required;
- Environmental conditions required and any stabilization period needed
- Description of the procedure, including:
    - Affixing identification marks, handling, transporting, storing and preparing of items;
    - Checks to be made before the work is started;
    - Verifying equipment function and, where required, calibrating and/or adjusting the equipment before each use;
    - Method of recording the observations and results;
    - Any safety measures to be observed;
    - Criteria and/or requirements for approval/rejection;
    - Data to be recorded and method of analysis and presentation; and
    - Uncertainty or procedure for estimating uncertainty.

Use of a non-standard method for testing must be agreed upon with the customer. The agreement, which is retained by the laboratory in the project record, must include the

specifications of the client's requirements, the purpose of testing, and their authorization for use of the non-standard method.

5.4.5 Method Validation

5.4.5.1 Validation Description

Validation is the process of conformation and the provision of objective evidence that the stated requirements for a specific method/procedure are fulfilled.

The laboratory's requirements and procedures for method validation are outlined in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

5.4.5.2 Validation Summary

All test methods offered by the laboratory are validated before use to confirm the procedure works and the data and results achieved meet the goals for the method. The extent of validation performed is based on technology and other factors as defined in the validation SOP (ENV-SOP-CORQ-0011).

The need to repeat validation is assessed by laboratory management when there are changes to the test method.

5.4.5.3 Validation of Customer Need

Laboratory management reviews the results of test method validation, which include accuracy, precision, sensitivity, selectivity, linearity, repeatability, reproducibility, robustness, and cross-sensitivity, against general customer needs to ensure the laboratory's procedure for the test method will meet those needs.

The review procedure is detailed in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

The following subsections highlight some of these concepts:

5.4.5.3.1 Accuracy

Accuracy is the degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard. When the result recovers within a range from the known value (control limit); the result generated using the laboratory's test method SOP is considered accurate.

5.4.5.3.2 Precision

Precision refers to the closeness of two or more measurements to each other. It is generally measured by calculating the relative percent difference (RPD) or relative standard deviation (RSD) from results of separate analysis of the same sample. Precision provides information about repeatability, reproducibility, and robustness of the laboratory's procedure.

5.4.5.3.3 Limits of Detection (LOD) (Chemistry)

The LOD is the minimum result which can be reliably discriminated from a blank with a predetermined confidence level. The LOD establishes the limit of method sensitivity and is also known as the detection limit (DL) or the method detection limit (MDL).

Values below the LOD cannot be reliably measured and are not reported by the laboratory unless otherwise specified by regulatory program or test method.

The LOD is established during method validation and after major changes to the analytical system or procedure that affect sensitivity are made.

The laboratory's procedure for LOD determination is detailed in laboratory SOP ENV-SOP-PITTS-0009. The SOP complies with 40 CFR 136 Appendix B or the current industry approved and accepted guidance for this process.

5.4.5.3.4 Limits of Quantitation (LOQ) and Reporting Limit (RL)

The LOQ is the minimum level, concentration, or quantity of a target analyte that can be reported with a specified degree of confidence. The LOQ is established at the same time as the LOD. The laboratory's procedure for determination and verification of the LOQ is detailed in laboratory SOP ENV-SOP-PITTS-0009.

The LLOQ is the value of the lowest calibration standard. The LOQ establishes the lower limit of quantitation.

The LOQ and LLOQ represent quantitative sensitivity of the test method.

- The LOQ must always be equal to or greater than the LLOQ and the LLOQ must always be greater than the LOD.
- Any reported value (detect or non-detect) less than the LLOQ is a qualitative value.

The RL is the value to which the presence of a target analyte is reported as detected or not-detected. The RL is project-defined based on project data quality objectives (DQO). In the absence of project specific requirements, the RL is usually set to the LOQ or the LLOQ. Depending on the relationship of the RL to the LLOQ or LOQ, both the RL value may be or quantitative.

For more information, refer to laboratory SOP ENV-SOP-PITTS-0009.

5.4.5.3.5 Linearity

Linearity is a mathematical concept applied to calibration models that employ multiple points to establish a calibration range used for quantitative analysis. Linearity is measured differently based on the calibration model. In general, if linearity is demonstrated than the slope of the response of standards are sufficiently close to one another. The accuracy of the linear regression and non-linear curves is verified by checking percent error or relative standard error (RSE), which is the process of refitting calibration data back to the model to determine if the results are accurate. For linear curves that use average calibration or response factor, error is measured by relative standard difference (RSD).

Linearity also establishes the range of quantitation for the test method used which directly impacts the sensitivity of the test method and uncertainty in measurement results. As previously noted, the LLOQ establishes the lower limit of quantitation. Similarly, the upper range of linearity establishes the upper limit of quantitation. In general, results outside of this range are considered qualitative values. However, some inorganic methods allow for extension of the linear range above the upper limit of quantitation when accuracy at this value is verified.

Linearity can also be used to establish repeatability, reproducibility, and robustness of the laboratory's test method. When linearity is demonstrated using a specific calibration model during method validation, then use of this same calibration model to achieve linearity on a day to day basis confirms the laboratory's method is repeatable, reproducible, and robust.

5.4.5.3.6 Demonstration of Capability (DOC)

The DOC performed during method validation confirms that the test method acceptable precision and accuracy. The procedure used for DOC for method validation is the same as described in section 5.2.2.1.5 for demonstration of analyst capability.

5.4.6 Measurement Uncertainty

The laboratory provides an estimate of uncertainty in testing measurements when required or on client request. In general, the uncertainty of the test method is reflected in the control limits used to evaluate QC performance. (See 5.9.1.1.10). ISO/IEC supports this concept with language that reads when a well-recognized test method specifies limits to the values of the major source of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory has satisfied the requirements on analytical uncertainty by following the test method and reporting instructions.

When measurement uncertainty cannot be satisfied through control limits, the laboratory will provide a reasonable estimation of uncertainty. A reasonable estimation is based on knowledge of method performance and previous experience. When estimating the analytical

uncertainty, all uncertainty components which are of importance in the given situation are taken into account.

5.4.7 Control of Data

The laboratory has policies and processes in place to assure that reported data is free from calculation and transcription errors, that quality control is reviewed and evaluated before data is reported, and to address manual calculation and integration.

5.4.7.1 Calculations, Data Transfer, Reduction and Review

Whenever possible, calculations, transfer of data, and data reduction are performed using validated software programs. (See 5.4.7.2)

If manual calculations are necessary, the results of these calculations are verified during the data review process outlined in section 5.9.3.

5.4.7.1.1 Manual Integration

The laboratory's policy and procedures for manual integration are provided in SOP ENV-SOP-CORQ-0006 *Manual Integration*.

This SOP includes the conditions under which manual integration is allowed and the requirements for documentation.

Required documentation of manual integration includes:

- complete audit trail to permit reconstruction of before and after results;
- identification of the analyst that performed the integration and the reason the integration was performed; and
- the individual(s) that reviewed the integration and verified the integration was done and documented in compliance with the SOP.

5.4.7.2 Use of Computers and Automated Acquisition

Whenever possible the laboratory uses software and automation for the acquisition, processing, recording, reporting, storage, and/or retrieval of data.

Software applications developed by PAS are validated by corporate IT for adequacy before release for general use. Commercial off the shelf software is considered sufficiently validated when the laboratory follows the manufacturer or vendor's manual for set-up and use. Records of validation are kept by the corporate information technology (IT) group or by the local laboratory, whichever group performed the validation.

The laboratory's process for the protection of data stored in electronic systems include:

- Individual user names and passwords for Laboratory Information Management Systems (LIMS) and auxiliary systems used to store or process data.

- Employee Training in Computer Security Awareness
- Validation of spreadsheets used for calculations to verify formulas and logic yield correct results and protection of these cells to prevent unauthorized change.
- Operating system and file access safeguards
- Protection from Computer Viruses
- Regular system backup; and testing of retrieved data

The laboratory's process for software development and testing process includes:

- Verification the software application works as expected and is adequate for use and fulfills compliance requirements, such as the need to record date/time of data generation.
- Change control to assure requests for changes are reviewed and approved by management before the change is made.
- Communication channels to assure all staff are aware of changes made.
- Version Control and maintenance of historical records.

5.5 Equipment

5.5.1 Availability of Equipment

The laboratory is furnished with all equipment and instrumentation necessary to correctly perform the tests offered in compliance with the specifications of the test method and to achieve the accuracy and sensitivity required.

5.5.2 Calibration

Equipment and instrumentation is checked prior to use to verify it performs within tolerance for its intended application.

Laboratory management is made aware of the status of equipment and instrumentation and any needs for either on a daily basis. This information is obtained during laboratory walkthroughs (LDM) that are conducted as part of the laboratory's lean program.

5.5.2.1 Support Equipment

The laboratory confirms support equipment is in proper working order and meets the specifications for general laboratory use prior to placement in service and with intermediate checks thereafter. Equipment that does not meet specifications is removed from service until repaired or replaced. Records of repair and maintenance activities are maintained.

Procedures used to carry out and record these checks are outlined laboratory SOP ENV-SOP-PITTS-0008 *Support Equipment*.

5.5.2.2 Analytical Instruments

Analytical instruments are checked prior to placement in service in accordance with SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.* After the

initial service date, the calibration of instruments and verification calibration is performed in accordance with local test method SOPs.

The calibration procedures in the test method SOPs comply with the requirements for acceptable calibration practices outlined in corporate document ENV-SOT-CORQ-0026 *Acceptable Calibration Practices*, the reference methods, and any applicable regulatory or program requirements.

5.5.3 Equipment Use and Operation

Equipment is operated and maintained by laboratory personnel that are trained on the test method SOP. Up-to-date instructions and procedures for the use and maintenance of analytical equipment are included in SOPs and/or supplemental documents such as standard work instructions (SWI) or instrument manuals which are made readily accessible in the work area to all laboratory personnel.

5.5.4 Equipment Identification

The laboratory uniquely identifies equipment by serial number or any other unique ID system, when practical. The identifier is included in the equipment list maintained by QA.

5.5.5 Equipment Lists and Records

5.5.5.1 Equipment List

The laboratory maintains a master list of equipment that includes information about the equipment including a description, manufacturer, serial number, date placed in service, condition when received, identity, and the current location in the laboratory. The date of purchase is tracked by the procurement record. The equipment list(s) for each location covered by this manual is provided in Appendix F.

5.5.5.2 Equipment Records

In addition to the equipment list, the laboratory maintains records of equipment that include:

- Verification that equipment conforms with specifications.
- Calibration records including dates, results, acceptance criteria, and next calibration dates.
- Maintenance plan and records
- Records of damage, malfunction, or repair

The laboratory follows an equipment maintenance program designed to optimize performance and to prevent instrument failure which is described in laboratory SOP ENV-SOP-PITTS-0005 *Equipment Maintenance* or individual test method SOPs.

The maintenance program includes routine maintenance activities which are performed as recommended by the manufacturer at the frequency recommended and non-routine maintenance, which is performed to resolve a specific problem such as degradation of peak resolution, shift in calibration relationship, loss of sensitivity, or repeat failure of instrument performance checks and quality control samples.

Maintenance is performed by laboratory personnel or by outside service providers.

All maintenance activities performed by laboratory personnel are recorded by the individual(s) that performed the activity at the time the maintenance was performed in an instrument maintenance log.

The maintenance record minimally includes the date of maintenance, the initials of the person(s) performing maintenance, a description of the activity performed, why (when the maintenance is non-routine), and the return to analytical control. When maintenance is performed by an external vendor, the laboratory staples the service record into hardcopy maintenance logs or scans the record easy retrieval. The laboratory provides unrestricted access to instrument maintenance logs in order to promotes good instrument maintenance and recordkeeping practices.

If an instrument must be moved, the laboratory will use safe practices for handling and transport to minimize damage and contamination.

5.5.6 Out of Service Protocol

Equipment that has been subjected to overloading, mishandling, gives suspect results, has been shown to be defective, or is performing outside of specified limits is taken out of service and either removed from the work area or labeled to prevent accidental use until it has been repaired and verified to perform correctly.

When analytical equipment is taken out of service, the laboratory examines the potential effect it may have had on previous analytical results to identify any non-conforming work. (See section 4.9).

5.5.7 Calibration Status

The laboratory labels support equipment to indicate calibration status, whenever practicable or otherwise maintains the calibration status in a visible location in the work area. These procedures are described in laboratory SOP ENV-SOP-PITTS-0007.

The calibration status of analytical instruments is documented in the analytical record. Analysts verify on-going acceptability of calibration status prior to use and with instrument performance check standards. These procedures are described in test method SOPs.

5.5.8 Returned Equipment Checks

When equipment or instrument is sent out of the laboratory for service, the laboratory ensures that the function and calibration status of the equipment is checked and shown to be satisfactory before the equipment is returned to service. These procedures are outlined in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

5.5.9 Intermediate Equipment Checks

The laboratory performs intermediate checks on equipment to verify the on-going calibration status. For example, most test method require some form of continuing calibration verification check and these procedures are included in the test method SOP. Periodic checks of support equipment are also performed; see appendix E for more information.

5.5.10 Safeguarding Equipment Integrity

The laboratory safeguards equipment integrity using a variety of mechanisms that include but are not limited to:

- Adherence to manufacture's specification for instrument use so that settings do not exceed manufacturer's recommendation or stress the performance of the equipment.
- Established maintenance programs.
- Transparent maintenance records and unrestricted access to maintenance logs.
- Validation and approval of software before use.
- Audits to confirm instrument settings are consistent with SOPs.
- On-the-job training for safe and proper use of laboratory equipment.

5.6 Measurement Traceability

5.6.1 General

Measurement traceability refers to a property of a measurement result whereby the result can be related to a reference through an unbroken chain of calibration, each contributing to the measurement uncertainty. Traceability requires an established calibration hierarchy of equipment (instruments) used during testing including equipment used for subsidiary measurements. The laboratory assures this equipment is calibrated prior to being put into service and that the reference standard and materials used for calibration are traceable to the international standard of units (SI) or national measurement standard.

When strict traceability to SI units cannot be made, the laboratory establishes traceability with the use of reference standards and equipment obtained from competent supplier that provide calibration certificates and/or certificates of analysis (COA).

5.6.2 Equipment Correction Factors

When correction factors are used to adjust results the laboratory will assure that results in computer software are also updated. For example, if the direct instrument or reading output must be corrected based on preparation factor or concentration factors, laboratory management will assure the corrected result is also updated in the software, whenever possible.

5.6.3 Specific Requirements

5.6.3.1 Requirements for Calibration Laboratories

The laboratory does not offer calibration services to customers.

5.6.3.2 Requirements for Testing Laboratories

The laboratory has procedures in place to verify equipment is calibrated prior to being put into service. (See 5.5.2) and ensures the reference standard and materials used for calibration are traceable to the international standard of units (SI) or national measurement standard. When strict traceability to SI units cannot be made, the laboratory establishes traceability with the use of reference standards and equipment obtained from competent suppliers that provide calibration certificates and/or certificates of analysis (COA).

5.6.4 Reference Standards and Reference Materials

5.6.4.1 Reference Standards

The laboratory uses reference standards of measurement to verify adequacy of working weights and thermometers. The working weight is the weight(s) used for daily balance calibration checks and the working thermometers are used for temperature measurements on a daily basis.

Intermediate checks of the working reference measurement standards are performed to verify adequacy between calibration from an external calibration laboratory. The measurements from working weights and thermometers are compared to measurement taken by the reference standard which is traceable to SI or a national standard. The reference weights and thermometers are used solely for verification purposes unless the laboratory can prove that daily use does not adversely affect performance of the reference standard.

The laboratory performs intermediate checks of the working weights at least annually.

Working thermometers (glass and digital) are checked against the reference thermometer prior to placement in service to establish a correction factor and then rechecked annually (glass) or quarterly (digital) thereafter.

The calibration of liquid in glass reference thermometers is verified every 5 years and the calibration of digital reference thermometers is verified annually by an ISO/IEC 17025 accredited calibration laboratory or service provider that provides traceability to a national standard.

The calibration of the reference weight(s) is verified every 5 years by an ISO/IEC 17025 accredited calibration laboratory.

If criteria for the intermediate checks or recertification is not acceptable, the impact on previously reported results is evaluated using the process for evaluation of nonconforming work (See 4.9)

See laboratory SOP ENV-SOP-PITTS-0007 for more information about this process.

5.6.4.2 Reference Materials

The laboratory purchases chemical reference materials used (also known as stock standards) from vendors that are accredited to ISO 17034 or Guide 34. Purchased reference materials must be received with a Certificate of Analysis (COA) where available. If a reference material cannot be purchased with a COA, it must be verified by analysis and comparison to a certified reference material and/or there must be a demonstration of capability for characterization. COA are reviewed for adequacy and retained by the laboratory for future reference.

The laboratory procedure for traceability and use of these materials is provided in laboratory SOP ENV-SOP-PITTS-0010.

This SOP includes each of the following requirements:

- Procedures for documentation of receipt and tracking. The record of entry includes name of the material, the lot number, receipt date, and expiration date.
- Storage conditions and requirements. Reference materials must be stored separately from samples, extracts, and digestates.
- Requirements to assure that preparations of intermediate or working solutions are recorded and assigned a unique identification number for tracking. Records of preparation include the lot number of the stock standard(s) used, the type and lot number of the solvent, the formulation, date, expiration date, and the preparer's initials. The lot number of the working standards is recorded in the analytical record to provide traceability to the standard preparation record. The preparation record provides traceability to the COA, which is traceable to SI or the national measurement standard.
- A requirement that the expiration dates of prepared standards may not exceed the expiration date of the parent standard. Standards, reference materials, and reagents are not used after their expiration dates unless their reliability is thoroughly documented and verified by the laboratory. If a standard exceeds its expiration date and is not re-certified, the laboratory removes the standard and/or clearly designates it as acceptable for qualitative/troubleshooting purposes only. All prepared standards, reference materials, and reagents are verified to meet the requirements of the test method through routine analyses of quality control samples.
- The second source materials used for verification of instrument calibration are obtained from a different manufacturer or different lot from the same manufacturer.
- Procedures to check reference materials for degradation and replacement of material if degradation or evaporation is suspected.
- Procedures for labeling. At a minimum the container must identify the material, the ID of the material and the expiration date. Original containers should also be labeled with date opened.

5.6.4.3 Intermediate Checks

Checks to confirm the calibration status of standards and materials are described in laboratory SOPs. These checks include use of second source standards and reference materials reserved only for the purpose of calibration checks.

5.6.4.4 Transport and Storage

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials. Standards and reference materials are stored separately from samples, extracts, and digestates. All standards are stored according to the manufacturer's recommended conditions. Temperatures colder than the manufacturer's recommendation are acceptable if it does not compromise the integrity of the material (e.g. remains in liquid state and does not freeze solid). In the

event a standard is made from more than a single source with different storage conditions, the standard will be stored according to the conditions specified in the analytical method.

See the applicable analytical SOPs for specific reference material storage and transport protocols.

5.7 Sampling

Sampling refers to the field collection of samples and to subsamples taken by the laboratory for analysis from the field collected sample.

Subsampling procedures are included in each test method SOP or a stand-alone SOP to assure the aliquot used for testing is representative of the field collected sample.

The requirements in the following subsections apply when field sampling is performed by the laboratory.

5.7.1 Sampling Plans and SOPs

When the laboratory performs field collection of samples, sampling is carried out in accordance with a written sample plan prepared by the customer or by the laboratory and by relevant sampling SOPs. These documents are made readily accessible at the sampling location. Sampling plans and SOPs are, whenever reasonable, based on appropriate governing methods and addresses the factors to be controlled to ensure the validity of the analytical results.

5.7.2 Customer Requested Deviations

When the customer requires deviations, additions, or exclusions from the documented laboratory sampling plan and/or procedure, the laboratory records the client's change request in detail with the sampling record, communicates the change to sampling personnel, and includes this information in the final test report.

5.7.3 Recordkeeping

The laboratory assures the sampling record includes the sampling procedure used, any deviations from the procedure, the date and time of sampling, the identification of the sampler, environmental conditions (if relevant), and the sampling location.

5.8 Sample Management & Handling

5.8.1 Procedures

The laboratory's procedures for sample management and handling are outlined in laboratory SOP ENV-SOP-PITTS-0027.

The procedures in these SOPs are established to maintain the safe handling and integrity of samples from transport, storage, to disposal and during all processing steps in-between; to maintain client confidentiality, and to protect the interests of PAS and its customers.

5.8.1.1 Chain of Custody

All samples received by the laboratory must be accompanied with a Chain of Custody (COC) record. The COC provides information about the samples collected and

submitted for testing and documents the possession of samples from time of collection to receipt by the laboratory.

The COC record must minimally include the following information:

- Client name, address, phone number
- Project Reference
- Client Sample Identification (Client ID)
- Date, Time, and Location of Sampling
- Samplers Name or Initials
- Matrix
- Type of container, and total number collected each sample
- Preservatives
- Analyses Requested
- Mode of collection
- Any special instructions
- The date and time and signature of each sample transfer from time of collection to receipt in the laboratory. When the COC is transported inside the cooler, independent couriers do not sign the COC. Shipping manifests and/or air bills are the records of possession during transport.

A complete and legible COC is required. If the laboratory observes that the COC is incomplete or illegible, the client is contacted for resolution. The COC must be filled out in indelible ink. Personnel correct errors by drawing a single line through the initial entry so the entry is not obscured, entering the correct information, and initialing, and dating the change.

5.8.1.2 Legal Chain of Custody

Legal chain of custody is a chain of custody protocol used for evidentiary or legal purposes. The protocol is followed by the laboratory when requested by customer or where mandated by a regulatory program.

Legal chain of custody (COC) protocol establishes an intact, continuous record of the physical possession*, storage, and disposal of "samples" which includes, sample aliquots, and sample extracts/digestates/distillates.

Legal COC records account for all time periods associated with the samples, and identifies all individuals who physically handled individual samples. Legal COC begins at the point established by legal authority, which is usually at the time the sample containers are provided by the laboratory for sample collect or when sample collection begins.

*A sample is in someone's custody if:

- It is in one's physical possession;

- It is in one's view after being in one's physical possession;
- It has been in one's physical possession and then locked or sealed so that no one can tamper with it; and/or
- It is kept in a secure area, restricted to authorized personnel only.

Refer to laboratory SOP ENV-SOP-PITTS-0028 for more information.

5.8.2 Unique Identification

Each sample is assigned a unique identification number by the laboratory (Lab ID) after the sample has been checked and accepted by the laboratory in accordance with the laboratory's sample acceptance policy (See 5.8.3). The Lab ID is affixed to the sample container using a durable label.

The unique identification of samples also applies to subsamples, and prepared samples, such as extracts, digestates, etc.

The lab ID is linked to the field ID (client ID) in the laboratory's record. Both IDs are linked to the testing activities performed on the sample and the documentation records of the test.

Also see 5.8.4.

5.8.3 Sample Receipt Checks and Sample Acceptance Policy

The laboratory checks the condition and integrity of samples on receipt and compares the labels on the sample containers to the COC record. Any problem or discrepancy is recorded. If the problem impacts the suitability of the sample for analysis or if the documentation is incomplete, the client is notified for resolution. Decisions and instructions from the client are maintained in the project record.

5.8.3.1 Sample Receipt Checks

The following checks are performed:

- Verification that the COC is complete and legible.
- Verification that each sample's container label includes the client sample ID, the date and time of collection and the preservative in indelible ink.
- The container type and preservative is appropriate for each test requested.
- Adequate volume is received for each test requested.
- Visual inspection for damage or evidence of tampering.
- Visual inspection for presence of headspace in VOA vials. (VOA = volatile organic analysis).
- Thermal Preservation: For chemical testing methods for which thermal preservation is required, temperature on receipt is acceptable if the measurement is above freezing but <6°C. For samples that are hand-delivered to the laboratory immediately after sample collection, there must be evidence that the chilling process has begun, such as arrival on ice. The requirements for thermal preservation vary based on the scope of testing performed. For example, for

microbiology, temperature on receipt is acceptable if the measurement is <10°C. Refer to the laboratory's SOP for sample receipt for more information.

- Chemical Preservation
- Holding Time: Sample receiving personnel are trained to recognize tests with tests where the holding time is 48 hours or less and to expedite the log-in of these samples. Except for tests with immediate holding times (15 minutes from time of collection or less), when samples are received out of hold, the laboratory will notify the client and request instruction. If the decision is made to proceed with analysis, the final test report will include notation of this instruction.

5.8.3.2 Sample Acceptance Policy

The laboratory maintains a sample acceptance policy in accordance with regulatory guidelines to clearly establish the circumstances in which sample receipt is accepted or rejected. When receipt does not meet acceptance criteria for any one of these conditions, the laboratory must document the noncompliance, contact the customer, and either reject the samples or fully document any decisions to proceed with testing. In accordance with regulatory specifications, test results associated with receipt conditions that do not meet criteria are qualified in the final test report.

All samples received must meet each of the following:

- Be listed on a complete and legible COC.
- Be received in properly labeled sample containers.
- Be received in appropriate containers that identify preservative.
- The COC must include the date and time of collection for each sample.
- The COC must include the test requested for each sample.
- Be in appropriate sample containers with clear documentation of the preservatives used.
- Be received within holding time. Any samples received beyond the holding time will not be processed without prior customer approval.
- Have sufficient sample volume to proceed with the analytical testing. If insufficient sample volume is received, analysis will not proceed without customer approval.
- Be received within appropriate temperature ranges (not frozen but ≤6°C) unless program requirements or customer contractual obligations mandate otherwise. The cooler temperature is recorded directly on the COC. Samples that are delivered to the laboratory immediately after collection are considered acceptable if there is evidence that the chilling process has been started. For example, by the arrival of the samples on ice. If samples arrive that are not compliant with these temperature requirements, the customer will be notified. The analysis will NOT proceed unless otherwise directed by the customer. If less than 72 hours remain in the hold time for the analysis, the analysis may be started while the customer

is contacted to avoid missing the hold time. Data associated with any deviations from the above sample acceptance policy requirements will be appropriately qualified.

5.8.4 Sample Control and Tracking

The samples are controlled and tracked using the Laboratory Information Management System (LIMS). The LIMS stores information about the samples and project. The process of entering information into the LIMS is called login and these procedures are described in laboratory SOP ENV-SOP-PITTS-0033. After log-in, a label is generated and affixed to each sample container. Information on this label, such as the lab ID, links the sample container to the information in LIMS.

At a minimum, the following information is entered during log-in:

- Client Name and Contact Information;
- The laboratory ID linked to the client ID;
- Date and time of sample collection;
- Date and time of sample receipt;
- Matrix;
- Tests Requested.

5.8.5 Sample Storage, Handling, and Disposal

The laboratory procedures for sample storage, handling and disposal are detailed in laboratory SOPs ENV-SOP-PITTS-0027 and ENV-SOP-PITTS-0023.

5.8.5.1 Sample Storage

The samples are stored according to method and regulatory requirements as per test method SOPs. Samples are stored away from all standards, reagents, or other potential sources of contamination and stored in a manner that prevents cross contamination. Volatile samples are stored separately from other samples. All sample fractions, extracts, leachates, and other sample preparation products are stored in the same manner as actual samples or as specified by the analytical method.

Refrigerated storage areas are maintained at ≤6°C (but not frozen) and freezer storage areas are maintained at <-10°C (unless otherwise required per method or program). The temperature of each storage area is checked and documented at least once for each day of use. If the temperature falls outside the acceptable limits, then corrective actions are taken and appropriately documented.

The laboratory is operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted at all times. Samples are taken to the appropriate storage location immediately after sample receipt and login procedures are completed. All sample storage areas have limited access. Samples are removed from storage areas by designated personnel and returned to the storage areas as soon as possible after the required sample quantity has been taken.

5.8.5.2 Sample Retention and Disposal

The procedures used by the laboratory for sample retention and disposal are detailed in laboratory SOP ENV-SOP-PITTS-0023.

In general, unused sample volume and prepared samples such as extracts, digestates, distillates and leachates (samples) are retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

Samples may be stored at ambient temperature when all analyses are complete, the hold time is expired, the report has been delivered, and/or when allowed by the customer or program. Samples requiring storage beyond the minimum sample retention time due to special requests or contractual obligations may be stored at ambient temperature unless the laboratory has sufficient capacity and their presence does not compromise the integrity of other samples.

After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposition of hazardous samples is to return the excess sample to the customer.

5.9 Assuring the Quality of Test Results

5.9.1 Quality Control (QC) Procedures

The laboratory monitors the validity and reliability of test results using quality control (QC) samples that are prepared and analyzed concurrently with field samples in the same manner as field samples. QC results are always associated to and reported with the field samples they were prepared and analyzed with from the same preparation or analytical batch. See the glossary for definition of preparation and analytical batch.

The results of QC performed during the testing process are used by the laboratory to assure the results of analysis are consistent, comparable, accurate, and/or precise within a specified limit. When the results are not within acceptance criteria or expectations for method performance, correction and corrective action(s) are taken. These actions may include retesting or reporting of data with qualification to alert the end user of the situation.

Other QC measures performed include the use of certified reference materials (see 5.6.2), participation in interlaboratory proficiency testing (see 5.9.1.1), verification that formulae used for reduction of data and calculation of results is accurate (see 5.9.3), on-going monitoring of environmental conditions that could impact test results (see 5.3.2), and evaluation and verification of method selectivity and sensitivity (see 5.4.5).

QC results are also used by the laboratory to monitor performance statistical trends over time and to establish acceptance criteria when no method or regulatory criteria exist. (see 5.9.1.4).

5.9.1.1 Essential QC

Although the general principles of QC for the testing process apply to all testing, the QC protocol used for each test depends on the type of test performed.

QC protocol used by the laboratory to monitor the validity of the test are specified in test method SOPs. The SOP includes QC type, frequency, acceptance criteria, corrective actions, and procedures for reporting of nonconforming work.

These requirements in the SOP conform to the reference method and any applicable regulations or certification and accreditation program requirement for which results of the test are used. When a project requires more stringent QC protocol than specified in the SOP, project specification is followed. When the project requires less stringent QC protocol, the project specification may be followed as an authorized departure from the SOP when the project specifications meet the requirements in the mandated method and any regulatory compliance requirements for which the data will be used.

The following are examples of essential QC for Chemistry:

5.9.1.1.1 Second Source Standard (ICV/QCS)

The second source standard is a standard obtained from a different vendor than the vendor of the standards used for calibration. It is a positive control used to verify the accuracy of a new calibration relative to the purity of the standards used for calibration. This check is referred to in test method and quality system standards as the initial calibration verification (ICV) or quality control sample (QCS). The second source standard is analyzed immediately after the calibration and before analysis of any samples. When the ICV is not within acceptance criteria, a problem with the purity or preparation of the standards may be indicated.

5.9.1.1.2 Continuing Calibration Verification (CCV)

CCV is to determine if the analytical response has significantly changed since initial calibration. If the response of the CCV is within criteria, the calibration is considered valid. If not, there is a problem that requires further investigation. Actions taken are technology and method specific.

5.9.1.1.3 Method Blank (MB) / Other Blanks

A method blank is a negative control used to assess for contamination during the prep/analysis process. The MB consists of a clean matrix, similar to the associated samples that is known to be free of analytes of interest. The MB is processed with and carried through all preparation and analytical steps as the associated samples.

In general, contamination is suspected when the target analyte is detected in the MB above the reporting limit. Some programs may require evaluation of the MB to ½ the reporting limit or the detection limit. When contamination is evident, the source is investigated and corrections are taken to reduce or eliminate it. Analytical results associated with MB that does not meet criteria are qualified in the final test report.

Other types of blanks that serve as negative controls in the process may include:

- Trip Blanks (VOA)
- Storage Blanks
- Equipment Blanks
- Field Blanks
- Calibration Blanks
- Cleanup Blanks
- Instrument Blanks

5.9.1.1.4 Laboratory Control Sample (LCS)

The LCS is positive control used to measure the accuracy of process in a blank matrix. The LCS is spiked by the laboratory with a known amount of analyte. The spike is a standard solution that is pre-made or prepared from a certified reference standard. The LCS is processed with and carried through all preparation and analytical steps as the associated samples.

When the percent recovery (%R) of the LCS is within the established control limit, sufficient accuracy has been achieved. If not, the source of the problem is investigated and corrected and the procedure may be repeated. Analytical results associated with LCS that does not meet criteria are qualified in the final test report.

5.9.1.1.5 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

Matrix spikes measures the effect the sample matrix has on precision and accuracy of the determinative test method. The MS and MSD are replicates of a client sample that is spiked with known amount of target analyte.

Due to the heterogeneity of matrices even of the same general matrix type, matrix spike results mostly provide information on the effect of the matrix to the client whose sample was used and on samples of the same matrix from the same sampling site. Therefore, MS should be client-specific when the impact of matrix on accuracy and precision is a project data quality objective. When there is not a client-specified MS for any sample in the batch, the laboratory randomly selects a sample from the batch; the sample selected at random is called a "batch" matrix spike.

The MS/MSD results for percent recovery and relative percent difference are checked against control limits. Because the performance of matrix spikes is matrix-dependent, the result of the matrix spike is not used to determine the acceptability of the test.

5.9.1.1.6 Sample Duplicate (SD)

A sample duplicate is a second replicate of sample that is prepared and analyzed in the laboratory along another replicate. The SD is used to measure precision.

The relative percent difference between replicates are evaluated against the method or laboratory derived criteria for relative percent difference (RPD), when this criterion is applicable. If RPD is not met, associated test results are reported with qualification.

5.9.1.1.7 Surrogates

Surrogates are compounds that mimic the chemistry of target analytes but are not expected to occur naturally in real world samples. Surrogates are added to each sample and matrix QC samples (MS, MSD, SD) at known concentration to measure the impact of the matrix on the accuracy of method performance. Surrogates are also added to the positive and negative control samples (MB, LCS) to evaluate performance in a clean matrix, and included in the calibration standards and calibration check standards.

The percent recovery of surrogates is evaluated against method-specified limits or statistically derived in-house limits. Project-specific limits and/or program-specific limits are used when required. Results with surrogate recovery out of limits in samples are reported with qualification. Samples with surrogate failures can also be re-extracted and/or re-analyzed to confirm that the out-of-control value was caused by the matrix of the sample and not by some other systematic error.

5.9.1.1.8 Internal Standards

Internal Standards are compounds not expected to occur naturally in field samples. They are added to every standard and sample at a known concentration prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes. The laboratory follows specific guidelines for the treatment of internal standard recoveries and further information can be found in the applicable laboratory SOP.

5.9.1.1.9 QC Acceptance Criteria and Control Limits

The QC acceptance criteria are specified in test method SOPs. The criteria in the SOP are based on the requirements in the published test method or regulatory program. When there are no established acceptance criteria, the laboratory develops acceptance criteria in accordance with recognized industry standards.

Some methods and programs require the laboratory to develop and use control limits for LCS, MS/MSD and surrogate evaluation. In laboratory developed limits are referred to as "in-house" control limits. In-house control limits represent ± 3 Standard Deviations (99% confidence level) from the average recovery of at least 20 data points generated using the same preparation and analytical procedure in a similar matrix.

5.9.1.2 Proficiency Testing (PT)

The laboratory participates in interlaboratory proficiency testing (PT) studies to measure performance of the test method and to identify or solve analytical problems. PT samples measure laboratory performance through the analysis of unknown samples provided by an external source.

The PT samples are obtained from accredited proficiency testing providers (PTP) and handled as field samples which means they are included in the laboratory's normal analytical processes and do not receive extraordinary attention due to their nature.

The laboratory does not share PT samples with other laboratories, does not communicate with other laboratories regarding current PT sample results during the duration of the study, and does not attempt to obtain the assigned value of any PT sample from the PT provider.

The laboratory initiates an investigation and corrective action plan whenever PT results are deemed unacceptable by the PT provider.

The frequency of PT participation is based on the certification and accreditation requirements held by the laboratory.

5.9.2 QC Corrective Action

When the results of QC are not within acceptance criteria or expectations for method performance, correction and corrective action(s) are taken per the specifications in the test method SOP. These actions may include retesting or reporting of data with qualification to alert the end user of the situation.

5.9.3 Data Review

The laboratory uses a tiered system for data review. The tiered process provides sequential checks to verify data transfer is complete; manual calculations, if performed, are correct, manual integrations are appropriate and documented, calibration and QC requirements are met, appropriate corrective action was taken when required, test results are properly qualified, process and test method SOPs were followed, project specific requirements were met, when applicable, and the test report is complete.

The sequential process includes three tiers referred to as primary review, secondary review, and administrative/completeness review.

Detailed procedures for the data review process are described in laboratory SOP ENV-SOP-PITTS-0003. The general expectations for the tiered review process are described in the following sections:

5.9.3.1 Primary Review

Primary review is performed by the individual that performed the task. All laboratory personnel are responsible for review of their work product to assure it is complete, accurate, documented, and consistent with policy and SOPs.

Checks performed during primary review include but are not limited to:

- Verification that data transfer and acquisition is complete

- Manual calculations, if performed, are documented and accurate
- Manual integrations, if performed, are documented and comply with SOP ENV-SOP-CORQ-006 *Manual Integration*
- Calibration and QC criteria were met, and/or proper correction and corrective actions were taken, and data and test results associated with QC and criteria exceptions are properly qualified
- Work is consistent with SOPs and any other relevant instructional document such as SWI, program requirements, or project QAPP.

5.9.3.2 Secondary Review

Secondary review is performed by qualified peer or supervisor. Secondary review is essentially a repeat of the checks performed during primary review by another person. In addition to the checks of primary review, secondary review includes chromatography review to check the accuracy of quantitative analyte identification.

5.9.3.3 Completeness Review

Completeness review is an administrative review performed prior to release of the test report to the customer. Completeness review verifies that the final test report is complete and meets project specification. This review also assures that information necessary for the client's interpretation of results are explained in the case narrative or footnoted in the test report.

5.9.3.4 Data Audits

In addition to the 3 tier data review process, test reports may be audited by local QA to verify compliance with SOPs and to check for data integrity, technical accuracy, and regulatory compliance. These audits are not usually done prior to issuance of the test report to the customer. The reports chosen for the data audits are selected at random.

If any problems with the data or test results are found during the data audit, the impact of the nonconforming work is evaluated using the process described in Section 4.9.

Also see Section 4.14 for internal audits.

5.10 Reporting

5.10.1 General Requirements

The laboratory reports results of testing in a way that assures the results are clear, and unambiguous. All data and results are reviewed prior to reporting to assure the results reported are accurate and complete.

Test results are summarized in test reports that include all information necessary for the customer's interpretation of the test results. Additional information necessary to clarify the data or disclose nonconformance, exceptions, or deviations that occurred during the analytical process are also reported to the customer in the test report.

The specifications for test reports and electronic data deliverables (EDD) are established between the laboratory and the customer at the time the request for analytical services is initiated. The report specifications include the test report format, protocol for the reporting limit (RL), conventions for the reporting of results less than the limit of quantitation (LOQ), and specification for the use of project or program specific data qualifiers. Information about review of analytical service requests is provided in Section 4.4.

5.10.2 Test Reports: Required Items

Test Reports are prepared by the laboratory at the end of the testing process. The format of the report depends on the level of reporting requested by the customer. The laboratory offers a variety of standardized test report formats and can also provide custom test report formats, when necessary.

The level of detail required in the test report depends on the customer's needs for data verification, validation, and usability assessments that occur after the laboratory releases the test report to the customer. The test report formats offered by the laboratory provide gradient levels of detail to meet the unique needs of each customer. The laboratory project manager helps the customer select the test report format that best meets their needs. When a specific report format or protocol is required for a regulatory or program compliance, the laboratory project manager must ensure the test report selected meets those requirements.

Every test report issued by the laboratory includes each of the following items:

a) Title

b) Name and phone number of a point of contact from the laboratory issuing the report.

c) Name and address of the laboratory where testing was performed. When testing is done at multiple locations within network (IRWO), the report must clearly identify which network laboratory performed each test and must include the physical address of each laboratory.

d) Unique identification of the test report and an identifier on each page of the report to link each page to the test report and clear identification of the end of the report.

e) The name and address of the customer

f) Identification of test methods used

g) Cross reference between client sample identification number (Sample ID) and the laboratory's identification number for the sample (Lab ID) to provide unambiguous identification of samples.

h) The date of receipt of samples, condition of samples on receipt, and identification of any instance where receipt of the samples did not meet sample acceptance criteria.

i) Date and times of sample collection, receipt, preparation, and analysis.

j) Test results and units of measurement, and qualification of results associated with QC criteria exceptions, and identification of reported results outside of the calibration range.

k) Name, title, signature of the person(s) authorizing release of the test report and date of release.

l) A statement that the results in the test report relate only to the items tested.

m) Statement that the test report may not be reproduced except in full without written approval from the laboratory.

5.10.3 Test Reports: Supplemental Items

5.10.3.1 Supplemental Requirements

The following items are included in the test report when required or relevant:

a) Explanation of departure from test method SOPs including, what the departure was and why it was necessary.

b) Statistical methods used. (Required for Whole Effluent Toxicity)

c) For solid samples, specification that results are reported on a dry weight or wet weight basis.

d) Signed Affidavit, when required by client or regulatory agency.

e) A statement of compliance / non-compliance with requirements or specifications (client, program, or standard) that includes identification of test results that did not meet acceptance criteria.

f) When requested by the client, statement of estimated measurement uncertainty. In general, for environmental testing, estimated uncertainty of measurement is extrapolated from LCS control limits. Control limits incorporate the expected variation of the data derived from the laboratory's procedure. When the control limits are specified by the test method or regulatory program, the control limits represent the expected variation of the test method and/or matrices for which the test method was designed.

g) Opinions and Interpretations.

h) If a claim of accreditation/certification is included in the test report, identification of any test methods or analytes for which accreditation/certification is not held by the laboratory if the accrediting body offers accreditation/certification for the test method/analyte. The fields of accreditation/certification vary between agencies and it cannot be presumed that because accreditation/certification is not held that it is offered or required.

i) Certification Information, including certificate number and issuing body.

5.10.3.2 Test Reports: Sampling Information

The following items are included in the test report when samples are collected by the laboratory or when this information is necessary for the interpretation of test results:

a) Date of Sampling.

b) Unambiguous identification of material samples.

c) Location of sampling including and diagrams, sketches, or photographs.

d) Reference to the sampling plan and procedures used.

e) Details of environmental conditions at time of sample that may impact test results.

f) Any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

5.10.4 Calibration Certificates

The laboratory does not perform calibration activities for its customers and calibration certificates are not offered or issued.

5.10.5 Opinions and Interpretations

The laboratory provides objective data and information to its customers of sufficient detail for their interpretation and decision making. Objective data and information is based solely on fact and does not attempt to explain the meaning (interpret) or offer a view or judgement (opinion). Sometimes the customer may request the laboratory provide opinion or interpretation to assist them with their decisions about the data.

When opinions and interpretations are included in the test report, the laboratory will document the basis upon which the opinions and interpretations have been made and clearly identify this content as opinion or interpretation in the test report.

Examples of opinion and interpretation include but are not limited to:

- The laboratory's viewpoint on how a nonconformance impacts the quality of the data or usability of results.
- The laboratory's judgment of fulfillment of contractual requirements.
- Recommendations for how the customer should use the test results and information.
- Suggestions or guidance to the customer for improvement.

When opinions or interpretations are verbally discussed with the customer, the content of these conversations is summarized by the laboratory and kept in the project record.

5.10.6 Subcontractor Reports

When analytical work has been subcontracted to an organization external to PAS, the test report from the subcontractor is included in its entirety as an amendment to the final test report.

Note: Test results for analytical work performed within the PAS network may be are merged into a single test report. The test report issued clearly identifies the location and address of each network location that performed testing and which tests they performed. (See 5.10.2)

5.10.7 Electronic Transmission of Results

When test results and/or reports are submitted to the customer through electronic transmission, follow the procedures established in this manual for confidentiality and protection of data.

5.10.8 Format of Test Reports

The test formats offered by the laboratory are designed to accommodate each type of analytical test method carried out by the laboratory and to minimize the possibility of misunderstanding or misuse of analytical results. The format of electronic data deliverables (EDD) follow the specifications for the EDD.

5.10.9 Amendments to Test Reports

Test reports that are revised or amended by the laboratory after date of release of the final test report to the customer are issued as a new test report that is clearly identified as an amendment or revision and that includes a reference to the originally issued final test report.

The customer is the organization doing business with PAS external to PAS.

Changes made to test results and data before the final test report is issued to the customer are not amendments or revisions, these are corrections to errors found during the laboratory's data verification and review process,

The laboratory's procedure for report amendments and revision are outlined in laboratory SOP ENV-SOP-PITTS-0033.

6.0 REVISION HISTORY

This Version: ENV-MAN-PITTS-0001 Rev 01

Section	Description of Change
All	This version is a complete rewrite of the document this version supersedes.

This document supersedes the following documents:

Document Number	Title	Version
ENV-MAN-PITTS-0001	Quality Manual	00

7.0 APPENDICES

7.1 Appendix A: Certification / Accreditation Listing

The certifications / accreditation lists provided in this manual represent those that were held by the named location on the effective date of this manual. This information is subject to change without notice and must not be considered valid proof of certification or accreditation status. Current certificates are maintained by Local QA and a copy of the certificate is posted to PAS's eDMS Portal for access by all PAS employees. External parties should contact the laboratory for the most current information.

7.1.1 PAS-Pittsburgh

Authority	Certificate Number
Pennsylvania	02-00538
Connecticut	PH-0263
Virginia	8122
New Hampshire	299415
New Jersey	PA026
New York	11815
South Carolina	89009003
Texas	T104704453
West Virginia	395

7.2 Appendix B: Capability Listing

The capabilities listed in this Appendix were held by the location referenced on the effective date of this manual. This information is subject to change without notice. External parties should contact the laboratory for the most current information.

Table Legend:

- DW = Drinking Water
- NPW = Non-Potable Water
- SCM = Solid and Chemical Materials
- Waste = Non-Aqueous Phase Liquid (NAPL), Oil
- Tissue = Biota and Tissue

7.2.1 PAS-Pittsburgh

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Product	
Anions by IC	9056			x					
Cations by IC	Dionex Tech Note 10			x	x				
TOC	9060 and 5310C			x					
pH	SM4500 H+B			x					
Low Level Volatile Fatty Acids	AM23G			x	x				
VOC's in Vapor	AM4.02	x							
Organic Compunds in Vapor (Light hydrocarbons, Chlorinated volatiles, GRO, DRO)	AM4.02	x							
Hydrogen by Bubble Strip	SM9/AM20GAx	x							
Light Hydrocarbons by Bubble Strip	SM9/AM20GAx			x					
Methane, Ethane, Ethene, Propane, Propene, iso-Butane, n-Butane, Acetylene	PM01/AM20GAx			x					
Methane, Ethane, Ethene, Propane, Propene, iso-Butane, n-Butane	RSK175M			x					
Permanent Gases (Oxygen, Nitrogen, Carbon Dioxide, Carbon Monoxide)	PM01/AM20GAx			x					
Permanent Gases by Bubble Strip	PM01/AM20GAx	x							
Permanent Gases in Vapor	SM9/AM20GAx	x							
TIC	PM01/AM20GAx			x					
Whole Oil (C3-C36)	ASTM D3328							x	
Full Scan (C8-C40)	ASTM D5739 (GC/MS)			x	x			x	

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Product	
Organic Lead and Lead Scavengers	GC-ECD							x	
PIANO (C3-C12)	GC/MS			x	x			x	
Carbon Specific Isotope Analysis (CSIA)	AM24			x					
Methane, Ethane, Ethene, Propane, iso-Butane, n-Butane	ASTM D8028			x					
Parent and Alkylated PAHs	8270 Modified			X				x	
Oxygenated Blending Agents	EPA 1624 Modified							x	
Oxygenates on Product (GC/MS SIM)	1625 Modified							x	

7.3 Appendix C: Glossary

This glossary provides common terms and definitions used in the laboratory. **It is not intended to be a complete list of all terms and definitions used.** The definitions have been compiled mostly from the TNI Standard and DoD QSM. Although this information has been reproduced with care, errors cannot be entirely excluded. Definitions for the same term also vary between sources. When the meaning of a term used in a laboratory document is different from this glossary or when the glossary does not include the term, the term and definition is included or defined in context in the laboratory document.

Term	Definition
3P Program	PAS-The continuous improvement program used by PAS that focuses on Process, Productivity, and Performance.
Acceptance Criteria	TNI- Specified limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation	TNI- The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. DoD- Refers to accreditation in accordance with the DoD ELAP.
Accreditation Body (AB)	TNI- The organization having responsibility and accountability for environmental laboratory accreditation and which grants accreditation under this program. DoD- Entities recognized in accordance with the DoD-ELAP that are required to operate in accordance with ISO/IEC 17011, *Conformity assessment: General requirements for accreditation bodies accrediting conformity assessment bodies.* The AB must be a signatory, in good standing, to the International Laboratory Accreditation Cooperation (ILAC) mutual recognition arrangement (MRA) that verifies, by evaluation and peer assessment, that its signatory members are in full compliance with ISO/IEC 17011 and that its accredited laboratories comply with ISO/IEC 17025.
Accuracy	TNI- The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.
Activity, Absolute	TNI- Rate of nuclear decay occurring in a body of material, equal to the number of nuclear disintegrations per unit time. NOTE: Activity (absolute) may be expressed in becquerels (Bq), curies (Ci), or disintegrations per minute (dpm), and multiples or submultiples of these units.
Activity, Areic	TNI- Quotient of the activity of a body of material and its associated area.
Activity, Massic	TNI- Quotient of the activity of a body of material and its mass; also called specific activity.
Activity, Volumic	TNI- Quotient of the activity of a body of material and its volume; also called activity concentration. NOTE: In this module [TNI Volume 1, Module 6], unless otherwise stated, references to activity shall include absolute activity, areic activity, massic activity, and volumic activity.
Activity Reference Date	TNI- The date (and time, as appropriate to the half-life of the radionuclide) to which a reported activity result is calculated. NOTE: The sample collection date is most frequently used as the Activity Reference Date for environmental measurements, but different programs may specify other points in time for correction of results for decay and ingrowth.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
American Society for Testing and Materials (ASTM)	An international standards organization that develops and publishes voluntary consensus standards for a wide range of materials, products, systems and services.
Analysis	DoD- A combination of sample preparation and instrument determination.
Analysis Code (Acode)	All the set parameters of a test, such as Analytes, Method, Detection Limits and Price.
Analysis Sequence	A compilation of all samples, standards and quality control samples run during a specific amount of time on a particular instrument in the order they are analyzed.
Analyst	TNI- The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analyte	TNI- A substance, organism, physical parameter, property, or chemical constituent(s) for which an environmental sample is being analyzed. DoD- The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family and are analyzed together.
Analytical Method	DoD- A formal process that identifies and quantifies the chemical components of interest (target analytes) in a sample.
Analytical Uncertainty	TNI- A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
Annual (or Annually)	Defined by PAS as every 12 months ± 30 days.
Assessment	TNI - The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its system to defined criteria (to the standards and requirements of laboratory accreditation). DoD- An all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection, or surveillance conducted on-site.
Atomic Absorption Spectrometer	Instrument used to measure concentration in metals samples.
Atomization	A process in which a sample is converted to free atoms.
Audit	TNI- A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.
Batch	TNI- Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours or the time-frame specified by the regulatory program. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed 20 samples.
Batch, Radiation Measurements (RMB)	TNI- An RMB is composed of 1 to 20 environmental samples that are counted directly without preliminary physical or chemical processing that affects the outcome of the test (e.g., non-destructive gamma spectrometry, alpha/beta counting of air filters, or swipes on gas proportional detectors). The samples in an RMB share similar physical and chemical parameter, and analytical configurations (e.g., analytes, geometry, calibration, and background corrections). The maximum time between the start of processing of the first and last in an RMB is 14 calendar days.
Bias	TNI- The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	TNI and DoD- A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results (See Method Blank). DoD- Blank samples are negative control samples, which typically include field blank samples (e.g., trip blank, equipment (rinsate) blank, and temperature blank) and laboratory blank samples (e.g., method blank, reagent blank, instrument blank, calibration blank, and storage blank).
Blind Sample	A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.
BNA (Base Neutral Acid compounds)	A list of semi-volatile compounds typically analyzed by mass spectrometry methods. Named for the way they can be extracted out of environmental samples in an acidic, basic or neutral environment.
BOD (Biochemical Oxygen Demand)	Chemical procedure for determining how fast biological organisms use up oxygen in a body of water.

Calibration	TNI- A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. 1) In calibration of support equipment, the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI); 2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.
Calibration Curve	TNI- The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.
Calibration Method	A defined technical procedure for performing a calibration.
Calibration Range	DoD- The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.
Calibration Standard	TNI- A substance or reference material used for calibration.
Certified Reference Material (CRM)	TNI- Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.
Chain of Custody	An unbroken trail of accountability that verifies the physical security of samples, data, and records.
Chain of Custody Form (COC)	TNI- Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and type of containers; the mode of collection, the collector, time of collection; preservation; and requested analyses.
Chemical Oxygen Demand (COD)	A test commonly used to indirectly measure the amount of organic compounds in water.
Client (referred to by ISO as Customer)	Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations.
Code of Federal Regulations (CFR)	A codification of the general and permanent rules published in the Federal Register by agencies of the federal government.
Comparability	An assessment of the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	The percent of valid data obtained from a measurement system compared to the amount of valid data expected under normal conditions. The equation for completeness is: % Completeness = (Valid Data Points/Expected Data Points)*100
Confirmation	TNI- Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second-column confirmation; alternate wavelength; derivatization; mass spectral interpretation; alternative detectors; or additional cleanup procedures. DoD- Includes verification of the identity and quantity of the analyte being measured by another means (e.g., by another determinative method, technology, or column). Additional cleanup procedures alone are not considered confirmation techniques.
Conformance	An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.
Congener	A member of a class of related chemical compounds (e.g., PCBs, PCDDs).
Consensus Standard	DoD- A standard established by a group representing a cross-section of a particular industry or trade, or a part thereof.
Continuing Calibration Blank (CCB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method.
Continuing Calibration Check Compounds (CCC)	Compounds listed in mass spectrometry methods that are used to evaluate an instrument calibration from the standpoint of the integrity of the system. High variability would suggest leaks or active sites on the instrument column.
Continuing Calibration Verification	DoD- The verification of the initial calibration. Required prior to sample analysis and at periodic intervals. Continuing calibration verification applies to both external and internal standard calibration techniques, as well as to linear and non-linear calibration models.
Continuing Calibration Verification (CCV) Standard	Also referred to as a Calibration Verification Standard (CVS) in some methods, it is a standard used to verify the initial calibration of compounds in an analytical method. CCVs are analyzed at a frequency determined by the analytical method.

Continuous Emission Monitor (CEM)	A flue gas analyzer designed for fixed use in checking for environmental pollutants.
Continuous Improvement Plan (CIP)	The delineation of tasks for a given laboratory department or committee to achieve the goals of that department.
Contract Laboratory Program (CLP)	A national network of EPA personnel, commercial labs, and support contractors whose fundamental mission is to provide data of known and documented quality.
Contract Required Detection Limit (CRDL)	Detection limit that is required for EPA Contract Laboratory Program (CLP) contracts.
Contract Required Quantitation Limit (CRQL)	Quantitation limit (reporting limit) that is required for EPA Contract Laboratory Program (CLP) contracts.
Control Chart	A graphic representation of a series of test results, together with limits within which results are expected when the system is in a state of statistical control (see definition for Control Limit)
Control Limit	A range within which specified measurement results must fall to verify that the analytical system is in control. Control limit exceedances may require corrective action or require investigation and flagging of non-conforming data.
Correction	DoD- Action taken to eliminate a detected non-conformity.
Corrective Action	DoD- The action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. A root cause analysis may not be necessary in all cases.
Corrective and Preventative Action (CAPA)	The primary management tools for bringing improvements to the quality system, to the management of the quality system's collective processes, and to the products or services delivered which are an output of established systems and processes.
Critical Value	TNI- Value to which a measurement result is compared to make a detection decision (also known as critical level or decision level). NOTE: The Critical Value is designed to give a specified low probability α of false detection in an analyte-free sample, which implies that a result that exceeds the Critical Value, gives high confidence $(1 - \alpha)$ that the radionuclide is actually present in the material analyzed. For radiometric methods, α is often set at 0.05.
Customer	DoD- Any individual or organization for which products or services are furnished or work performed in response to defined requirements and expectations.
Data Integrity	TNI- The condition that exists when data are sound, correct, and complete, and accurately reflect activities and requirements.
Data Quality Objective (DQO)	Systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use or end user.
Data Reduction	TNI- The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more usable form.
Definitive Data	DoD- Analytical data of known quantity and quality. The levels of data quality on precision and bias meet the requirements for the decision to be made. Data that is suitable for final decision-making.
Demonstration of Capability (DOC)	TNI- A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. DoD- A procedure to establish the ability of the analyst to generate analytical results by a specific method that meet measurement quality objectives (e.g., for precision and bias).
Department of Defense (DoD)	An executive branch department of the federal government of the United States charged with coordinating and supervising all agencies and functions of the government concerned directly with national security.
Detection Limit (DL)	DoD- The smallest analyte concentration that can be demonstrated to be different than zero or a blank concentration with 99% confidence. At the DL, the false positive rate (Type 1 error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence.
Detection Limit (DL) for Safe Drinking Water Act (SDWA) Compliance	TNI- Laboratories that analyze drinking-water samples for SDWA compliance monitoring must use methods that provide sufficient detection capability to meet the detection limit requirements established in 40 CFR 141. The SDWA DL for radioactivity is defined in 40 CFR Part 141.25.c as the radionuclide concentration, which can be counted with a precision of plus or minus 100% at the 95% confidence level (1.96σ where σ is the standard deviation of the net counting rate of the sample).
Deuterated Monitoring Compounds (DMCs)	DoD- SIM specific surrogates as specified for GC/MS SIM analysis.
Diesel Range Organics (DRO)	A range of compounds that denote all the characteristic compounds that make up diesel fuel (range can be state or program specific).

Digestion	DoD- A process in which a sample is treated (usually in conjunction with heat and acid) to convert the target analytes in the sample to a more easily measured form.
Document Control	The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.
Documents	DoD- Written components of the laboratory management system (e.g., policies, procedures, and instructions).
Dry Weight	The weight after drying in an oven at a specified temperature.
Duplicate (also known as Replicate or Laboratory Duplicate)	The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results of duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.
Electron Capture Detector (ECD)	Device used in GC methods to detect compounds that absorb electrons (e.g., PCB compounds).
Electronic Data Deliverable (EDD)	A summary of environmental data (usually in spreadsheet form) which clients request for ease of data review and comparison to historical results.
Eluent	A solvent used to carry the components of a mixture through a stationary phase.
Elute	To extract, specifically, to remove (absorbed material) from an absorbent by means of a solvent.
Elution	A process in which solutes are washed through a stationary phase by movement of a mobile phase.
Environmental Data	DoD- Any measurements or information that describe environmental processes, locations, or conditions; ecological or health effects and consequences; or the performance of environmental technology.
Environmental Monitoring	The process of measuring or collecting environmental data.
Environmental Protection Agency (EPA)	An agency of the federal government of the United States which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.
Environmental Sample	A representative sample of any material (aqueous, non-aqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required. Environmental samples can generally be classified as follows: • Non Potable Water (Includes surface water, ground water, effluents, water treatment chemicals, and TCLP leachates or other extracts) • Drinking Water - Delivered (treated or untreated) water designated as potable water • Water/Wastewater - Raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents • Sludge - Municipal sludges and industrial sludges. • Soil - Predominately inorganic matter ranging in classification from sands to clays. • Waste - Aqueous and non-aqueous liquid wastes, chemical solids, and industrial liquid and solid wastes
Equipment Blank	A sample of analyte-free media used to rinse common sampling equipment to check effectiveness of decontamination procedures.
Extracted Internal Standard Analyte	Isotopically labeled analogs of analytes of interest added to all standards, blanks and samples analyzed. Added to samples and batch QC samples prior to the first step of sample extraction and to standards and instrument blanks prior to analysis. Used for isotope dilution methods.
Facility	A distinct location within the company that has unique certifications, personnel and waste disposal identifications.
False Negative	DoD- A result that fails to identify (detect) an analyte or reporting an analyte to be present at or below a level of interest when the analyte is actually above the level of interest.
False Positive	DoD- A result that erroneously identifies (detects) an analyte or reporting an analyte to be present above a level of interest when the analyte is actually present at or below the level of interest.
Field Blank	A blank sample prepared in the field by filling a clean container with reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken.
Field Measurement	Determination of physical, biological, or radiological properties, or chemical constituents that are measured on-site, close in time and sPAS to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.
Field of Accreditation	TNI- Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Field of Proficiency Testing (FoPT)	TNI- Matrix, technology/method, analyte combinations for which the composition, spike concentration ranges and acceptance criteria have been established by the PTPEC.
Finding	TNI- An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement. DoD- An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive, negative, or neutral and is normally accompanied by specific examples of the observed condition. The finding must be linked to a specific requirement (e.g., this standard, ISO requirements, analytical methods, contract specifications, or laboratory management systems requirements).
Flame Atomic Absorption Spectrometer (FAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the fact that ground state metals absorb light at different wavelengths. Metals in a solution are converted to the atomic state by use of a flame.
Flame Ionization Detector (FID)	A type of gas detector used in GC analysis where samples are passed through a flame which ionizes the sample so that various ions can be measured.
Gas Chromatography (GC)	Instrumentation which utilizes a mobile carrier gas to deliver an environmental sample across a stationary phase with the intent to separate compounds out and measure their retention times.
Gas Chromatograph/ Mass Spectrometry (GC/MS)	In conjunction with a GC, this instrumentation utilizes a mass spectrometer which measures fragments of compounds and determines their identity by their fragmentation patterns (mass spectra).
Gasoline Range Organics (GRO)	A range of compounds that denote all the characteristic compounds that make up gasoline (range can be state or program specific).
Graphite Furnace Atomic Absorption Spectrometry (GFAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the absorption of light at different wavelengths that are characteristic of different analytes.
High Pressure Liquid Chromatography (HPLC)	Instrumentation used to separate, identify and quantitate compounds based on retention times which are dependent on interactions between a mobile phase and a stationary phase.
Holding Time	TNI- The maximum time that can elapse between two specified activities. 40 CFR Part 136- The maximum time that samples may be held prior to preparation and/or analysis as defined by the method and still be considered valid or not compromised. For sample prep purposes, hold times are calculated using the time of the start of the preparation procedure. DoD- The maximum time that may elapse from the time of sampling to the time of preparation or analysis, or from preparation to analysis, as appropriate.
Homogeneity	The degree to which a property or substance is uniformly distributed throughout a sample.
Homologue	One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member. For instance, methanol, ethanol, propanol, butanol, etc., form a homologous series.
Improper Actions	DoD- Intentional or unintentional deviations from contract-specified or method-specified analytical practices that have not been authorized by the customer (e.g., DoD or DOE).
Incremental Sampling Method (ISM)	Soil preparation for large volume (1 kg or greater) samples.
In-Depth Data Monitoring	TNI- When used in the context of data integrity activities, a review and evaluation of documentation related to all aspects of the data generation process that includes items such as preparation, equipment, software, calculations, and quality controls. Such monitoring shall determine if the laboratory uses appropriate data handling, data use and data reduction activities to support the laboratory's data integrity policies and procedures.
Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Analytical technique used for the detection of trace metals which uses plasma to produce excited atoms that emit radiation of characteristic wavelengths.
Inductively Coupled Plasma- Mass Spectrometry (ICP/MS)	An ICP that is used in conjunction with a mass spectrometer so that the instrument is not only capable of detecting trace amounts of metals and non-metals but is also capable of monitoring isotopic speciation for the ions of choice.
Infrared Spectrometer (IR)	An instrument that uses infrared light to identify compounds of interest.

Initial Calibration (ICAL)	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response relationship of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method.
Initial Calibration Blank (ICB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method. This blank is specifically run in conjunction with the Initial Calibration Verification (ICV) where applicable.
Initial Calibration Verification (ICV)	DoD- Verifies the initial calibration with a standard obtained or prepared from a source independent of the source of the initial calibration standards to avoid potential bias of the initial calibration.
Injection Internal Standard Analyte	Isotopically labeled analogs of analytes of interest (or similar in physiochemical properties to the target analytes but with a distinct response) to be quantitated. Added to all blanks, standards, samples and batch QC after extraction and prior to analysis.
Instrument Blank	A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
Instrument Detection Limits (IDLs)	Limits determined by analyzing a series of reagent blank analyses to obtain a calculated concentration. IDLs are determined by calculating the average of the standard deviations of three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day.
Interference, spectral	Occurs when particulate matter from the atomization scatters incident radiation from the source or when the absorption or emission from an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible.
Interference, chemical	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte.
Internal Standard	TNI and DoD- A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.
International Organization for Standardization (ISO)	An international standard-setting body composed of representatives from various national standards organizations.
Intermediate Standard Solution	Reference solutions prepared by dilution of the stock solutions with an appropriate solvent.
International System of Units (SI)	The coherent system of units adopted and recommended by the General Conference on Weights and Measures.
Ion Chromatography (IC)	Instrumentation or process that allows the separation of ions and molecules based on the charge properties of the molecules.
Isomer	One of two or more compounds, radicals, or ions that contain the same number of atoms of the same element but differ in structural arrangement and properties. For example, hexane (C6H14) could be n-hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane.
Laboratory	A body that calibrates and/or tests.
Laboratory Control Sample (LCS)	TNI- (also known as laboratory fortified blank (LFB), spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to evaluate the performance of all or a portion of the measurement system.
Laboratory Duplicate	Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.
Laboratory Information Management System (LIMS)	DoD- The entirety of an electronic data system (including hardware and software) that collects, analyzes, stores, and archives electronic records and documents.
Learning Management System (LMS)	A web-based database used by the laboratories to track and document training activities. The system is administered by the corporate training department and each laboratory's learn centers are maintained by a local administrator.
Legal Chain-of-Custody Protocols	TNI- Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain-of-Custody (COC) Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Limit(s) of Detection (LOD)	TNI- The minimum result, which can be reliably discriminated from a blank with predetermined confidence level. DoD- The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. A LOD may be used as the lowest concentration for reliably reporting a non-detect of a specific analyte in a specific matrix with a specific method at 99% confidence.
Limit(s) of Quantitation (LOQ)	TNI- The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. DoD- The smallest concentration that produces a quantitative result with known and recorded precision and bias. For DoD/DOE projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard and within the calibration range.
Linear Dynamic Range	DoD- Concentration range where the instrument provides a linear response.
Liquid chromatography/ tandem mass spectrometry (LC/MS/MS)	Instrumentation that combines the physical separation techniques of liquid chromatography with the mass analysis capabilities of mass spectrometry.
Lot	TNI- A definite amount of material produced during a single manufacturing cycle, and intended to have uniform character and quality.
Management	Those individuals directly responsible and accountable for planning, implementing, and assessing work.
Management System	System to establish policy and objectives and to achieve those objectives.
Manager (however named)	The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual.
Matrix	TNI- The substrate of a test sample.
Matrix Duplicate	TNI- A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.
Matrix Spike (MS) (spiked sample or fortified sample)	TNI- A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Matrix Spike Duplicate (MSD) (spiked sample or fortified sample duplicate)	TNI- A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.
Measurement Performance Criteria (MPC)	DoD- Criteria that may be general (such as completion of all tests) or specific (such as QC method acceptance limits) that are used by a project to judge whether a laboratory can perform a specified activity to the defined criteria.
Measurement Quality Objective (MQO)	TNI- The analytical data requirements of the data quality objectives are project- or program-specific and can be quantitative or qualitative. MQOs are measurement performance criteria or objectives of the analytical process. Examples of quantitative MQOs include statements of required analyte detectability and the uncertainty of the analytical protocol at a specified radionuclide activity, such as the action level. Examples of qualitative MQOs include statements of the required specificity of the analytical protocol, e.g., the ability to analyze for the radionuclide of interest given the presence of interferences.
Measurement System	TNI- A method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s). DoD- A test method, as implemented at a particular laboratory, and which includes the equipment used to perform the sample preparation and test and the operator(s).
Measurement Uncertainty	DoD- An estimate of the error in a measurement often stated as a range of values that contain the true value within a certain confidence level. The uncertainty generally includes many components which may be evaluated from experimental standard deviations based on repeated observations or by standard deviations evaluated from assumed probability distributions based on experience or other information. For DoD/DOE, a laboratory's Analytical Uncertainty (such as use of LCS control limits) can be reported as the minimum uncertainty.
Method	TNI- A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.
Method Blank	TNI- A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit (MDL)	TNI- One way to establish a Detection Limit; defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method of Standard Additions	A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration.
Minimum Detectable Activity (MDA)	TNI- Estimate of the smallest true activity that ensures a specified high confidence, 1 – β, of detection above the Critical Value, and a low probability β of false negatives below the Critical Value. For radiometric methods, β is often set at 0.05. NOTE 1: The MDS is a measure of the detection capability of a measurement process and as such, it is an a priori concept. It may be used in the selection of methods to meet specified MQOs. Laboratories may also calculate a "sample specific" MDA, which indicates how well the measurement process is performing under varying real-world measurement conditions, when sample-specific characteristics (e.g., interferences) may affect the detection capability. However, the MDA must never be used instead of the Critical Value as a detection threshold. NOTE 2: For the purpose of this Standard, the terms MDA and minimum detectable concentration (MDC) are equivalent.
MintMiner	Program used by PAS to review large amounts of chromatographic data to monitor for errors or data integrity issues.
Mobile Laboratory	TNI- A portable enclosed structure with necessary and appropriate accommodation and environmental conditions for a laboratory, within which testing is performed by analysts. Examples include but are not limited to trailers, vans, and skid-mounted structures configured to house testing equipment and personnel.
National Environmental Laboratory Accreditation Conference (NELAC)	See definition of The NELAC Institute (TNI).
National Institute of Occupational Safety and Health (NIOSH)	National institute charged with the provision of training, consultation and information in the area of occupational safety and health.
National Institute of Standards and Technology (NIST)	TNI- A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (or NMI).
National Pollutant Discharge Elimination System (NPDES)	A permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.
Negative Control	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.
Nitrogen Phosphorus Detector (NPD)	A detector used in GC analyses that utilizes thermal energy to ionize an analyte. With this detector, nitrogen and phosphorus can be selectively detected with a higher sensitivity than carbon.
Nonconformance	An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.
Not Detected (ND)	The result reported for a compound when the detected amount of that compound is less than the method reporting limit.
Operator Aid	DoD- A technical posting (such as poster, operating manual, or notepad) that assists workers in performing routine tasks. All operator aids must be controlled documents (i.e., a part of the laboratory management system).
Performance Based Measurement System (PBMS)	An analytical system wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.
Physical Parameter	TNI- A measurement of a physical characteristic or property of a sample as distinguished from the concentrations of chemical and biological components.
Photo-ionization Detector (PID)	An ion detector which uses high-energy photons, typically in the ultraviolet range, to break molecules into positively charged ions.
Polychlorinated Biphenyls (PCB)	A class of organic compounds that were used as coolants and insulating fluids for transformers and capacitors. The production of these compounds was banned in the 1970's due to their high toxicity.
Positive Control	Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.
Post-Digestion Spike	A sample prepared for metals analyses that has analytes spike added to determine if matrix effects may be a factor in the results.

Power of Hydrogen (pH)	The measure of acidity or alkalinity of a solution.
Practical Quantitation Limit (PQL)	Another term for a method reporting limit. The lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions.
Precision	TNI- The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.
Preservation	TNI and DoD- Any conditions under which a sample must be kept in order to maintain chemical, physical, and/or biological integrity prior to analysis.
Primary Accreditation Body (Primary AB)	TNI- The accreditation body responsible for assessing a laboratory's total quality system, on-site assessment, and PT performance tracking for fields of accreditation.
Procedure	TNI- A specified way to carry out an activity or process. Procedures can be documented or not.
Proficiency Testing (PT)	TNI- A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.
Proficiency Testing Program (PT Program)	TNI- The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.
Proficiency Testing Provider (PT Provider)	TNI- A person or organization accredited by a TNI-approved Proficiency Testing Provider Accreditor to operate a TNI-compliant PT Program.
Proficiency Testing Provider Accreditor (PTPA)	TNI- An organization that is approved by TNI to accredit and monitor the performance of proficiency testing providers.
Proficiency Testing Reporting Limit (PTRL)	TNI- A statistically derived value that represents the lowest acceptable concentration for an analyte in a PT sample, if the analyte is spiked into the PT sample. The PTRLs are specified in the TNI FoPT tables.
Proficiency Testing Sample (PT)	TNI- A sample, the composition of which is unknown to the laboratory, and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.
Proficiency Testing (PT) Study	TNI- a) Scheduled PT Study: A single complete sequence of circulation and scoring of PT samples to all participants in a PT program. The study must have the same pre-defined opening and closing dates for all participants; b) Supplemental PT Study: A PT sample that may be from a lot previously released by a PT Provider that meets the requirements for supplemental PT samples given in Volume 3 of this Standard [TNI] but that does not have a pre-determined opening date and closing date.
Proficiency Testing Study Closing Date	TNI- a) Scheduled PT Study: The calendar date by which all participating laboratories must submit analytical results for a PT sample to a PT Provider; b) Supplemental PT Study: The calendar date a laboratory submits the results for a PT sample to the PT Provider.
Proficiency Testing Study Opening Date	TNI- a) Scheduled PT Study: The calendar date that a PT sample is first made available to all participants of the study by a PT Provider; b) Supplemental PT Study: The calendar date the PT Provider ships the sample to a laboratory.
Protocol	TNI- A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed.
Qualitative Analysis	DoD- Analysis designed to identify the components of a substance or mixture.
Quality Assurance (QA)	TNI- An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.
Quality Assurance Manual (QAM)	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality Assurance Project Plan (QAPP)	A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.
Quality Control (QC)	TNI- The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.
Quality Control Sample (QCS)	TNI- A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.

Quality Manual	TNI- A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality System	TNI and DoD- A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control activities.
Quality System Matrix	TNI and DoD- These matrix definitions shall be used for purposes of batch and quality control requirements and may be different from a field of accreditation matrix: • **Air and Emissions**: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device • **Aqueous**: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts. • **Biological Tissue**: Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin. • **Chemical Waste**: A product or by-product of an industrial process that results in a matrix not previously defined. • **Drinking Water**: Any aqueous sample that has been designated a potable or potentially potable water source. • **Non-aqueous liquid**: Any organic liquid with <15% settleable solids • **Saline/Estuarine**: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake. • **Solids**: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
Quantitation Range	DoD- The range of values (concentrations) in a calibration curve between the LOQ and the highest successively analyzed initial calibration standard used to relate instrument response to analyte concentration. The quantitation range (adjusted for initial sample volume/weight, concentration/dilution and final volume) lies within the calibration range.
Quantitative Analysis	DoD- Analysis designed to determine the amounts or proportions of the components of a substance.
Random Error	The EPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test due to random error. As the number of compounds measured increases in a given sample, the probability for statistical error also increases.
Raw Data	TNI- The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.
Reagent Blank (method reagent blank)	A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.
Reagent Grade	Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Records	DoD- The output of implementing and following management system documents (e.g., test data in electronic or hand-written forms, files, and logbooks).
Reference Material	TNI- Material or substance one or more of whose property values are sufficiently homogenized and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.
Reference Method	TNI- A published method issued by an organization generally recognized as competent to do so. (When the ISO language refers to a "standard method", that term is equivalent to "reference method"). When a laboratory is required to analyze by a specified method due to a regulatory requirement, the analyte/method combination is recognized as a reference method. If there is no regulatory requirement for the analyte/method combination, the analyte/method combination is recognized as a reference method if it can be analyzed by another reference method of the same matrix and technology.
Reference Standard	TNI- Standard used for the calibration of working measurement standards in a given organization or at a given location.

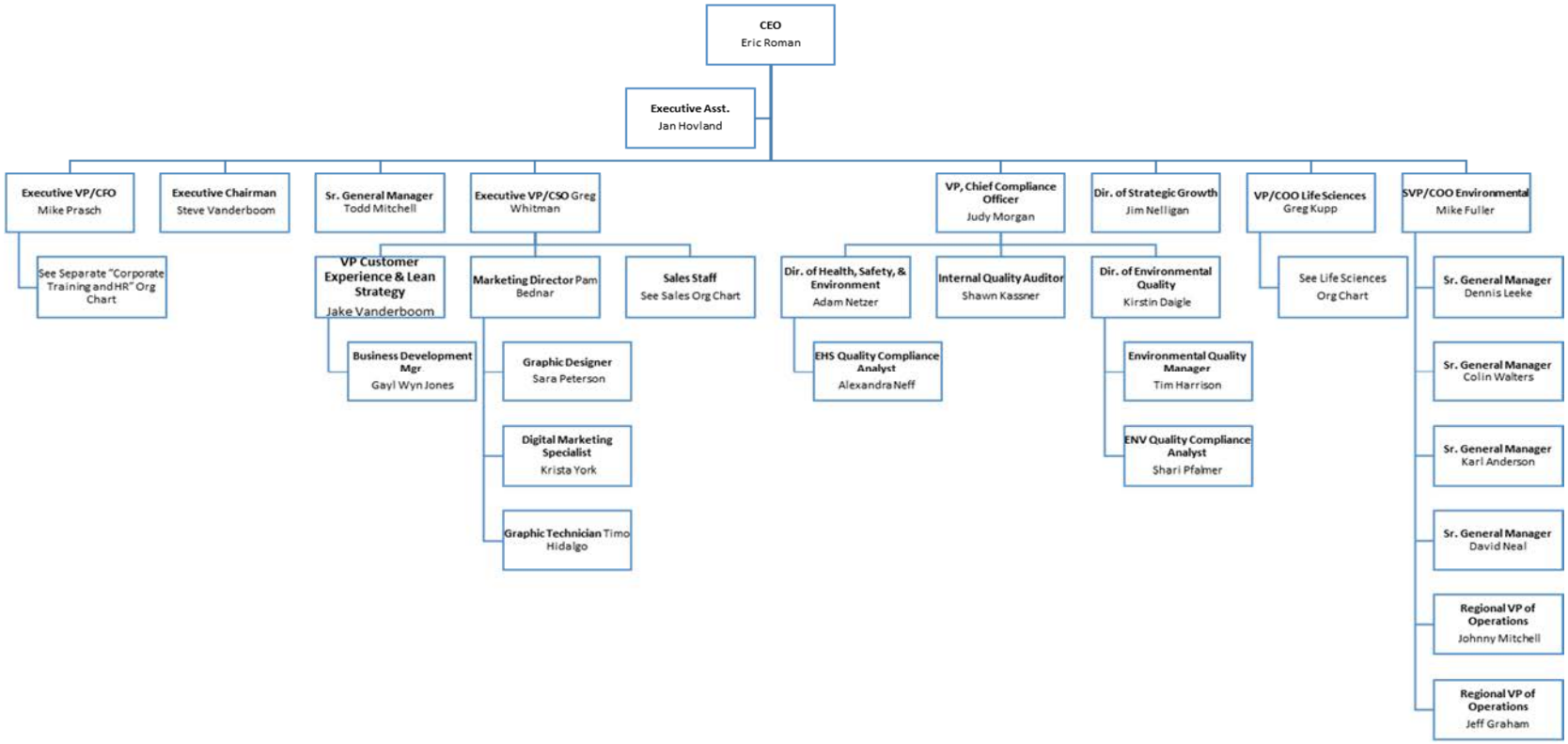
Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
Reporting Limit (RL)	The level at which method, permit, regulatory and customer-specific objectives are met. The reporting limit may never be lower than the Limit of Detection (i.e., statistically determined MDL). Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified. There must be a sufficient buffer between the Reporting Limit and the MDL. DoD- A customer-specified lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.
Reporting Limit Verification Standard (RLVS)	A standard analyzed at the reporting limit for an analysis to verify the laboratory's ability to report to that level.
Representativeness	A quality element related to the ability to collect a sample reflecting the characteristics of the part of the environment to be assessed. Sample representativeness is dependent on the sampling techniques specified in the project work plan.
Requirement	Denotes a mandatory specification; often designated by the term "shall".
Retention Time	The time between sample injection and the appearance of a solute peak at the detector.
Revocation	TNI- The total or partial withdrawal of a laboratory's accreditation by an accreditation body.
Sample	Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis.
Sample Condition Upon Receipt Form (SCURF)	Form used by sample receiving personnel to document the condition of sample containers upon receipt to the laboratory (used in conjunction with a COC).
Sample Delivery Group (SDG)	A unit within a single project that is used to identify a group of samples for delivery. An SDG is a group of 20 or fewer field samples within a project, received over a period of up to 14 calendar days. Data from all samples in an SDG are reported concurrently.
Sample Receipt Form (SRF)	Letter sent to the client upon login to show the tests requested and pricing.
Sample Tracking	Procedures employed to record the possession of the samples from the time of sampling until analysis, reporting and archiving. These procedures include the use of a chain-of-custody form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.
Sampling	TNI- Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.
Selected Ion Monitoring (SIM)	A mode of analysis in mass spectrometry where the detector is set to scan over a very small mass range, typically one mass unit. The narrower the range, the more sensitive the detector. DoD- Using GC/MS, characteristic ions specific to target compounds are detected and used to quantify in applications where the normal full scan mass spectrometry results in excessive noise.
Selectivity	TNI- The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.
Sensitivity	TNI- The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.
Serial Dilution	The stepwise dilution of a substance in a solution.
Shall	Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification as long as the requirement is fulfilled.
Should	Denotes a guideline or recommendation whenever noncompliance with the specification is permissible.
Signal-to-Noise Ratio (S/N)	DoD- A measure of signal strength relative to background noise. The average strength of the noise of most measurements is constant and independent of the magnitude of the signal. Thus, as the quantity being measured (producing the signal) decreases in magnitude, S/N decreases and the effect of the noise on the relative error of a measurement increases.
Source Water	TNI- When sampled for drinking water compliance, untreated water from streams, rivers, lakes, or underground aquifers, which is used to supply private and public drinking water supplies.
Spike	A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.
Standard (Document)	TNI- The document describing the elements of a laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.

Standard (Chemical)	Standard samples are comprised of a known amount of standard reference material in the matrix undergoing analysis. A standard reference material is a certified reference material produced by US NIST and characterized for absolute content, independent of analytical test method.
Standard Blank (or Reagent Blank)	A calibration standard consisting of the same solvent/reagent matrix used to prepare the calibration standards without the analytes. It is used to construct the calibration curve by establishing instrument background.
Standard Method	A test method issued by an organization generally recognized as competent to do so.
Standard Operating Procedure (SOP)	TNI- A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks.
Standard Reference Material (SRM)	A certified reference material produced by the US NIST or other equivalent organization and characterized for absolute content, independent of analytical method.
Statement of Qualifications (SOQ)	A document that lists information about a company, typically the qualifications of that company to compete on a bid for services.
Stock Standard	A concentrated reference solution containing one or more analytes prepared in the laboratory using an assayed reference compound or purchased from a reputable commercial source.
Storage Blank	DoD- A sample of analyte-free media prepared by the laboratory and retained in the sample storage area of the laboratory. A storage blank is used to record contamination attributable to sample storage at the laboratory.
Supervisor	The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses.
Surrogate	DoD- A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.
Suspension	TNI- The temporary removal of a laboratory's accreditation for a defined period of time, which shall not exceed 6 months or the period of accreditation, whichever is longer, in order to allow the laboratory time to correct deficiencies or area of non-conformance with the Standard.
Systems Audit	An on-site inspection or assessment of a laboratory's quality system.
Target Analytes	DoD- Analytes or chemicals of primary concern identified by the customer on a project-specific basis.
Technical Director	Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory.
Technology	TNI- A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.
Test	A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate.
Test Method	DoD- A definitive procedure that determines one or more characteristics of a given substance or product.
Test Methods for Evaluating Solid Waste, Physical/ Chemical (SW-846)	EPA Waste's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with RCRA regulations.
Test Source	TNI- A radioactive source that is tested, such as a sample, calibration standard, or performance check source. A Test Source may also be free of radioactivity, such as a Test Source counted to determine the subtraction background, or a short-term background check.
The NELAC Institute (TNI)	A non-profit organization whose mission is to foster the generation of environmental data of known and documented quality through an open, inclusive, and transparent process that is responsive to the needs of the community. Previously known as NELAC (National Environmental Laboratory Accreditation Conference).
Total Petroleum Hydrocarbons (TPH)	A term used to denote a large family of several hundred chemical compounds that originate from crude oil. Compounds may include gasoline components, jet fuel, volatile organics, etc.
Toxicity Characteristic Leaching Procedure (TCLP)	A solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching of compounds through a landfill.

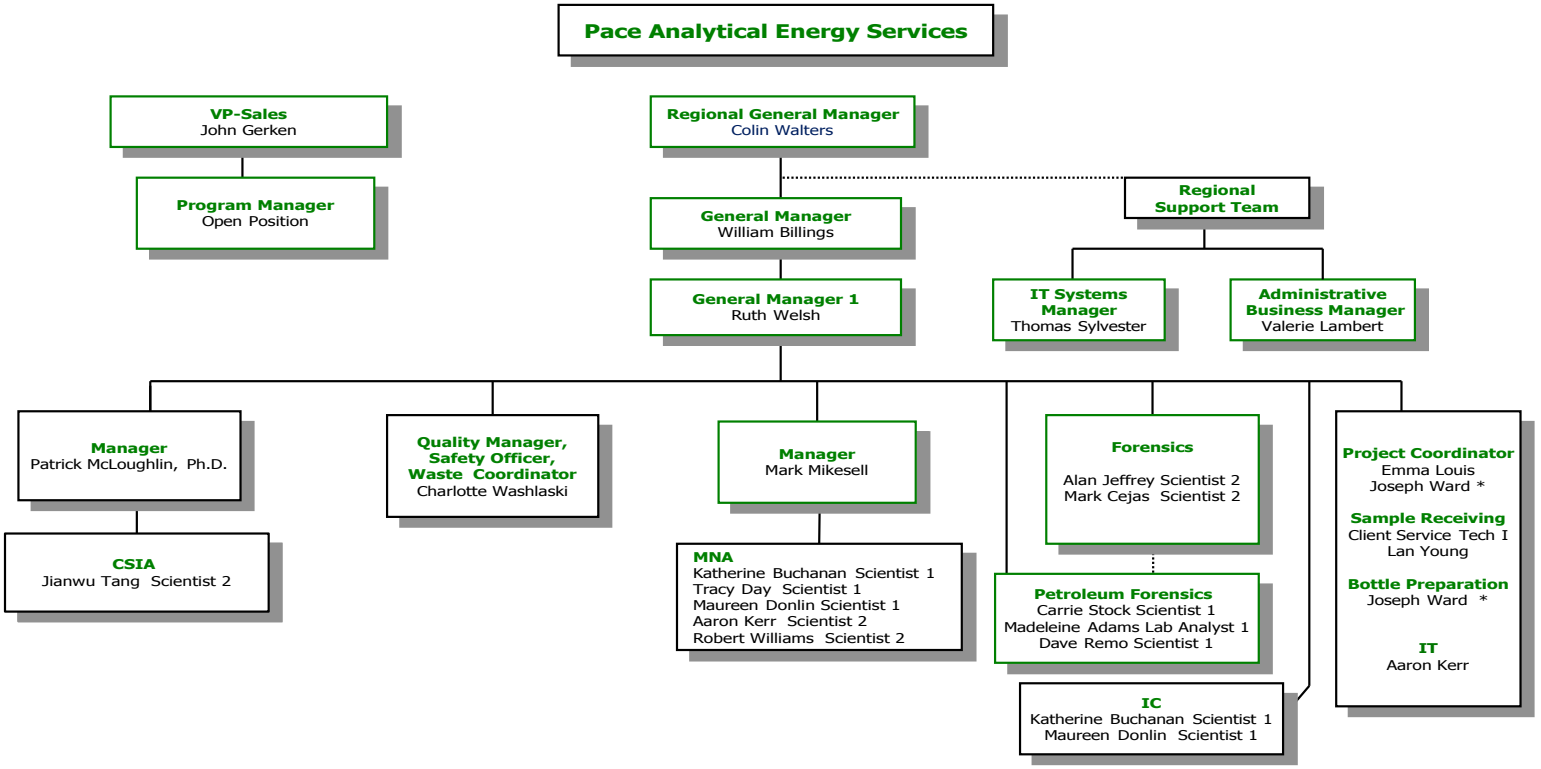
Traceability	TNI- The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical conditions or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.
Training Document	A training resource that provides detailed instructions to execute a specific method or job function.
Trip Blank	This blank sample is used to detect sample contamination from the container and preservative during transport and storage of the sample. A cleaned sample container is filled with laboratory reagent water and the blank is stored, shipped, and analyzed with its associated samples.
Tuning	A check and/or adjustment of instrument performance for mass spectrometry as required by the method.
Ultraviolet Spectrophotometer (UV)	Instrument routinely used in quantitative determination of solutions of transition metal ions and highly conjugated organic compounds.
Uncertainty, Counting	TNI- The component of Measurement Uncertainty attributable to the random nature of radioactive decay and radiation counting (often estimated as the square root of observed counts (MARLAP). Older references sometimes refer to this parameter as Error, Counting Error or Count Error (c.f., Total Uncertainty).
Uncertainty, Expanded	TNI- The product of the Standard Uncertainty and a coverage factor, k, which is chosen to produce an interval about the result that has a high probability of containing the value of the measurand (c.f., Standard Uncertainty). NOTE: Radiochemical results are generally reported in association with the Total Uncertainty. Either if these estimates of uncertainty can be reported as the Standard Uncertainty (one-sigma) or as an Expanded Uncertainty (k-sigma, where k > 1).
Uncertainty, Measurement	TNI- Parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand.
Uncertainty, Standard	TNI- An estimate of the Measurement Uncertainty expressed as a standard deviation (c.f., Expanded Uncertainty).
Uncertainty, Total	TNI- An estimate of the Measurement Uncertainty that accounts for contributions from all significant sources of uncertainty associated with the analytical preparation and measurement of a sample. Such estimates are also commonly referred to as Combined Standard Uncertainty or Total Propagated Uncertainty, and in some older references as the Total Propagated Error, among other similar items (c.f., Counting Uncertainty).
Unethical actions	DoD- Deliberate falsification of analytical or quality control results where failed method or contractual requirements are made to appear acceptable.
United States Department of Agriculture (USDA)	A department of the federal government that provides leadership on food, agriculture, natural resources, rural development, nutrition and related issues based on public policy, the best available science, and effective management.
United States Geological Survey (USGS)	Program of the federal government that develops new methods and tools to supply timely, relevant, and useful information about the Earth and its processes.
Unregulated Contaminant Monitoring Rule (UCMR)	EPA program to monitor unregulated contaminants in drinking water.
Validation	DoD- The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
Verification	TNI- Confirmation by examination and objective evidence that specified requirements have been met. In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.
Voluntary Action Program (VAP)	A program of the Ohio EPA that gives individuals a way to investigate possible environmental contamination, clean it up if necessary and receive a promise from the State of Ohio that no more cleanup is needed.
Whole Effluent Toxicity (WET)	The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent).

7.4 Appendix D: Organization Chart(s)

7.4.1 PAS - Corporate December 2019



7.4.2 PAS-Pittsburgh



Last Revised – February 4, 2020
Last Reviewed – February 4, 2020

* holds safety responsibilities as well

7.5 Appendix E: Equipment Listing

The equipment listed represents equipment were held by each location on the effective date of this manual. This information is subject to change without notice. External parties should contact the location for the most current information.

7.5.1 PAS-Pittsburgh

Equipment List: PAS-Pittsburgh

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
EDON IC	Dionex	ISC 2000	8120223	03/04/2009	Working	213	7024	PDF on desktop
EDON Autosampler	Dionex	AS-AP	14092562	10/23/2014	Working	213	NA	CD
EDON IC	Dionex	ISC2100	14092120	10/23/2014	Working	213	7036	CD
EDON GC	Varian	3400	10272	Unknown	Not in service	220	NA	CD
Dissolved Gases GC	ThermoFisher	Trace Ultra	620120045	04/01/2012	Working	213	7025	CD
Autosampler	ThermoFisher	TriPlus RSH	241284	04/01/2012	Working	213	7026	PDF on desktop
VOC GC	Agilent	6890 GC	US00042429	09/2018	Working	221	7048	CD on data station
VOC Autosampler	Tekmar	7000/7050	91099014/91346016	1995	Working	221	NA	Rm 221 Bookshelf
VOC GC	Hewlett Packard	5890 SeriesII	3336A3505	Unknown	Working	220	NA	Rm 221 Bookshelf
VOC GC	Agilent	6890	NA	Unknown	Not in service	Storage	7049	Rm221 Bookshelf
Dissolved Gases GC	ThermoFisher	Trace Ultra	620120028	04/18/2012	Working	221	7019	Data station PDF
Dissolved Gases Autosampler	ThermoFisher	TriPlus Headspace	237682	04/18/2012	Working	221	7020	Data station PDF
RISK GC	GOW MAC	Series 580	580-200	1995	Working	220	NA	With GC
Dissolved Gases GC	Proprietary	GC	N/A	12/2005	Working	220	NA	Rm 221 Bookshelf
RISK Autosampler	Tekmar	7000/7050	92220011/92220006	04/2018	Not in service	220	7051	Rm 221 Bookshelf
VOC Autosampler	Tekmar	7000/7050	95025019/95025018	07/2016	Working	220	NA	Rm 221 Bookshelf
GC (4)	Proprietary	NA	NA	12/1998	3 In Service	220/221	NA	Bookshelf
Analytical Balance	Ohaus	DV215CD	1128122704	Unknown	Working	213	NA	Room 213

Anion Autosampler	Dionex	AS-40	97050241	01/16/2009	Working	213	NA	On-Line
IC	Dionex	ICS3000DC	08120559	01/16/2009	Working	213	7023	On-Line
Cation Autosampler	Dionex	AS-DV	160911290	10/17/2016	Working	213	NA	On-Line
IC	Dionex	ICS3000DP	08120254	01/16/2009	Working	213	7023	On-Line
TOC Analyzer	Aurora	1030	J025730751	02/01/2017	Working	213	7022	On Instrument
TOC Autosampler	Aurora	1088	E019788198	02/01/2017	Working	213	NA	On Instrument
CSIA Autosampler	Tekmar	AquaTek 70	US06151001	Unknown	Working	426-428	7014	J drive (CSIA/Manuals)
CSIA Autosampler	Tekmar	AquaTek 70	US07003004	Unknown	Working	424	7029	J drive (CSIA/Manuals)
CSIA Purge &Trap	Tekmar	Velocity XPT	6335001	Unknown	Working	424	NA	J drive (CSIA/Manuals)
CSIA Pre Concentrator	Entech	7100A	1304	Unknown	Working	424	NA	J drive (CSIA/Manuals)
CSIA GC	ThermoFisher	Trace Ultra	200510408	Unknown	Working	424	7030	J drive (CSIA/Manuals)
CSIA Combustion Interface	ThermoFisher	Combustion III	111201-175	Unknown	Working	424	NA	Room 426 drawer under chlorine autosampler
Reactor	ThermoFisher	TC Reactor OD	1085260-349	Unknown	Working	424	NA	Unknown
Mass Spectrometer	ThermoFisher	Delta V plus Isotope Ratio	8018	Unknown	Workiing	424	NA	Room 426 drawer under chlorine autosampler
Concentrator	Tekmar	Velocity	US6047001	Unknown	Working	426-428	7015	J drive (CSIA/Manuals)
Mass Spectrometer	ThermoFisher	Delta V plus Isotope Ratio	08607D	Unknown	Working	426-428	NA	Room 426 drawer under chlorine autosampler
Interface	Thermo	Conflo IV Interface	1222750-179	Unknown	Working	426-428	NA	Room 426 drawer under chlorine autosampler
Interface	Thermo	GC Isolink Interface	1229600-147	Unknown	Working	426-428	NA	Room 426 drawer under chlorine autosampler
Gas Chromatograph	Agilent	7890A	CN11311133	Unknown	Working	426-428	NA	Room 426 drawer under

								chlorine autosampler
Autosampler	Tekmar	Aquatek 100	US11305020	Unknown	Working	426-428	NA	J drive (CSIA/Manuals)
Autosampler	Tekmar	Stratum	US1130000	Unknown	Working	426-428	NA	Room 426 drawer under chlorine autosampler
Gas Chromatograph	Agilent	6890N	US10226064	Unknown	Working	424	7011	Room 426 drawer under chlorine autosampler
Gas Chromatograph	Agilent	5976N NSD	US63810430	Unknown	Working	424	NA	Room 426 drawer under chlorine autosampler
Autosampler	Agilent	G1888 Headspace Autosampler	IT40220036	Unknown	Working	426-428	NA	J drive (CSIA/Manuals)
Autosampler	Agilent	G4513A	CN12090144	Unknown	Working	426-428	NA	J drive (CSIA/Manuals)
Autosampler	Entech	7032AQ	1032	Unknown	Working	424	NA	J drive (CSIA/Manuals
Canister Cleaner	Entech	3100A	110	Unknown	Working	424	NA	J drive (CSIA/Manuals
Evacuation Chamber	Entech	B33ER-0118	B33ER-0118	Unknown	Working	424	7031	J drive (CSIA/Manuals
Gas Chromatograph	Agilent	7890A	CN12121090	Unknown	Working	426-428	7006	Room 426 drawer under chlorine autosampler
Mass Spectrometer	Agilent	5975C MSD	US12157802	Unknown	Working	426-428	NA	Room 426 drawer under chlorine autosampler
High Capacity Gas Purifier	Supelco	29541-U	1312955/1A-22	Unknown	Working	424	NA	J drive (CSIA/Manuals
Centrifuge	Eppendorf	5810R	581101849	Unknown	Not in Use	Cage	7002	J drive (CSIA/Manuals
GC/MS	Agilent	7890A/5975	CN12091092	Unknown	Working	126	7007	Online
GC/MS	Agilent	6890/5975	US00008852	Unknown	Working	126		Online
GC/MS	Agilent	6890/5975	US00006875	Unknown	Working	126		Online
Autosampler	Tekmar	AquaTek 100	US11348004	Unknown	Working	126	7012	Online
Purge and Trap	Tekmar	Stratum	US11327002	Unknown	Working	126	7013	Online

Gas Chromatograph	Agilent	6890N	US10347026	Unknown	Working	126	7018	Online
Gas Chromatograph	Agilent	6890	US00001417	Unknown	Working	126	7005	Online
Gas Chromatograph	Agilent	5890	Unknown	Unknown	Working	126	NA	Online
Concentrator	Zymark	TurboVap	04770	Unknown	Working	127	NA	Online
Concentrator	Zymark	TurboVap	04756	Unknown	Working	127	NA	Online
Evaporator	Zymark	TurboVap LV	04384	Unknown	Working	127	NA	Online
Balance	Sargent-Welsh	SWT-603D	T0121781	Unknown	Working	126	NA	Online
Oven	Fisher	550-126	1.51107E+12	Unknown	Working	126	NA	Online
GC	Agilent	7890A	CN10741050	Unknown	Working	126	7057	Online
MS	Agilent	5975	US10494609	Unknown	Working	126	7057	Online
Autosampler	Agilent	7693	CN18040069	Unknown	Working	126	7057	Online
Autosampler	Agilent	7683	CN50932285	Unknown	Working	126	7018	Online
Autosampler	Agilent	7683	US14907665	Unknown	Working	126	NA	Online
Autosampler	Agilent	7683	Unknown	Unknown	Working	126	7005	Online
Autosampler	Agilent	Unknown	CN12090158	Unknown	Working	126	7007	Online

wsp.com