Comprehensive Sampling Plan for Monitoring Sulfur Dioxide in Ambient Air

St. Louis County, Missouri

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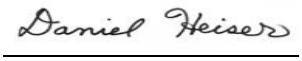
Independent Reviewed by  (signature)

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1.0 CHAPTER 1

1.1 BACKGROUND

Stantec Consulting Services, Inc. (Stantec) has prepared this comprehensive sampling plan (CSP) to install and operate ambient air monitors for sulfur dioxide (SO_2) on behalf of Bridgeton Landfill, LLC (Bridgeton Landfill). This CSP is a comprehensive document providing detail for the ambient air monitor work plan, Quality Assurance Project Plan (QAPP), sampling and analysis plan (SAP), and field sampling plan (FSP) specific to this monitoring program. Bridgeton Landfill is submitting this document as required in Section VIII, Item 35.d. of the Administrative Settlement Agreement and Order on Consent for Removal Actions, referred to as the Settlement (CERCLA Docket No. 07-2016-0005), between the United States Environmental Protection Agency (USEPA) Region 7 and Bridgeton, April 28, 2016. Specifically, the Settlement requires Bridgeton to:

> "*Within 30 days of the Effective Date, Respondent will submit a work plan to EPA and MDNR for approval for the installation and operation of two* ***SO_2 Ambient Air Monitors*** *for 1-hour SO_2 measurements for a monitoring period of one year. The monitors shall be operational within 30 days of EPA's approval of the work plan. The location and type of monitor will be determined in consultation with and approval from EPA.*"

Section VIII, Item 40 a. and b. of the Settlement state general requirements for the QAPP/SAP.

The Administrative Settlement Agreement and Order on Consent was executed under the Comprehensive Environmental Response, compensation, and Liability Act of 1980 (CERCLA) and primarily pertains to actions to be taken by Bridgeton Landfill relative to the North Quarry area of the Bridgeton Landfill which is adjacent to Operable Unit 1 of the West Lake Landfill Superfund Site.

The field activities that are proposed for this project consist of non-invasive work such as ambient air monitoring operations. This work plan has been developed to provide project personnel with a guidance document for performing the required environmental air monitoring operations. The CSP describes the monitoring equipment to be used; specifies data collection procedures, including data management, validation, and reporting; and describes general monitoring station operations to be followed by responsible parties throughout the duration of the monitoring project.

Project personnel will conduct the proposed activities under the direction of the Project Manager and EPA representatives as directed. Any deviations from the procedures addressed in this work plan will be recorded and appropriate notifications will be made to the EPA.

The monitoring equipment will be installed and field-certified by Inquest Environmental Inc. (Inquest). Onsite training by Inquest is anticipated for Bridgeton Landfill staff in the operation and maintenance of the monitoring equipment.

1.2 SITE DESCRIPTION

The Bridgeton Landfill lies within the boundary of the larger West Lake Landfill. The West Lake Landfill Site, referred to as the "Site", is an approximately 200-acre solid waste landfill that served as a solid waste landfill from the 1940s through 2004. Wastes accepted at the site included: municipal refuse, industrial solid wastes, and construction/demolition debris. Additionally, what is identified as the Bridgeton Landfill served as a limestone quarrying and crushing operation from 1939 through 1988 with portions of quarried areas repurposed for landfill use. The Site is located at 13570 St. Charles Rock Road in Bridgeton, Missouri, approximately one mile north of the intersection of Interstate 70 and Interstate 270. The approximate center of the Site is located at GPS coordinates 38°46'5.68"N, 90°26'38.73"W. Figure 1 shows a map of the Site. The West Lake Landfill was designated as a federal Superfund Site as a result of radiologically-impacted materials (RIM) disposed of in two separate areas of Operable Unit 1 (OU-1) at the site, identified as Area 1 and Area 2.

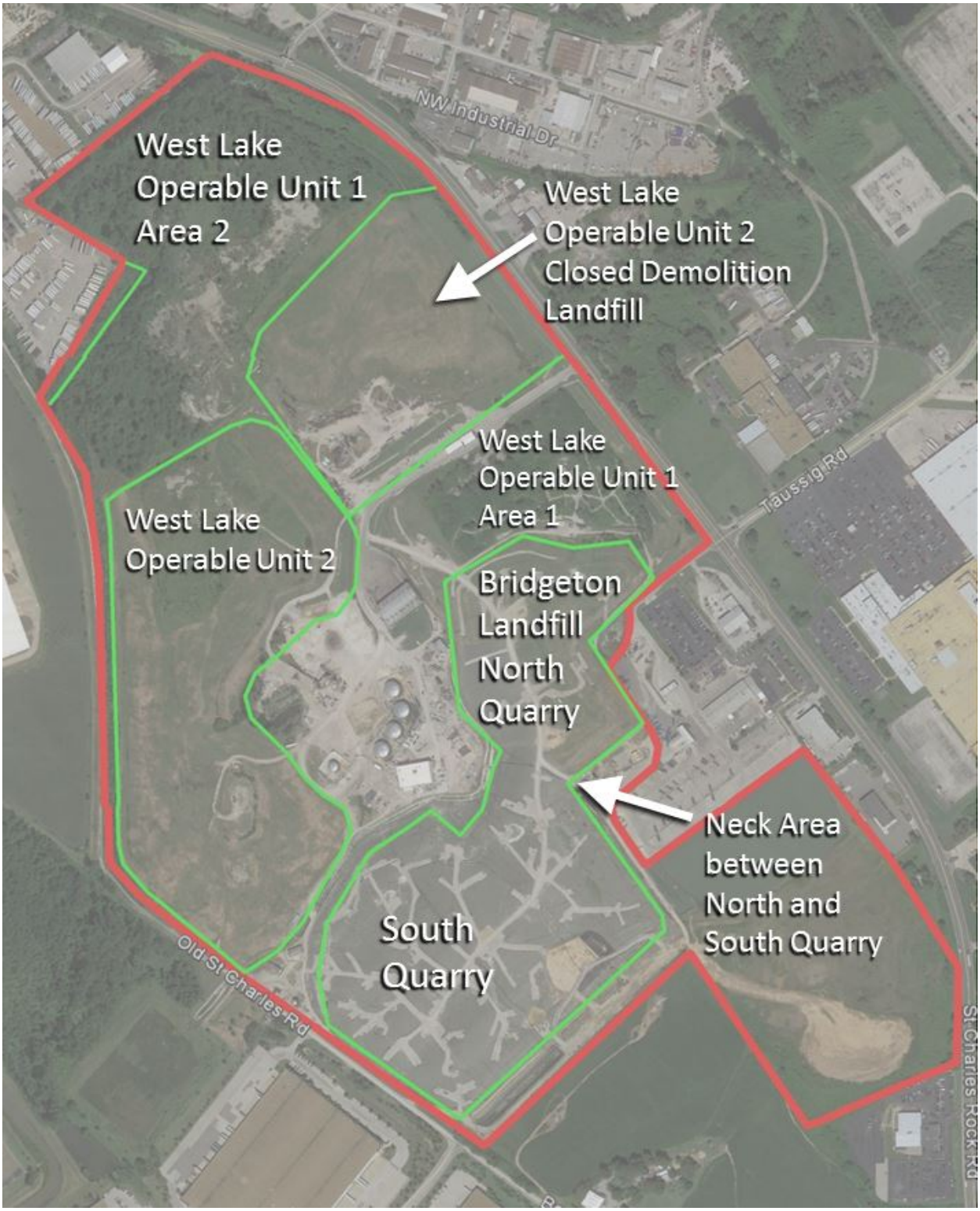
The limestone quarrying area, which lies within the boundaries of the West Lake Landfill, became the Bridgeton Landfill. Bridgeton Landfill began landfill activity in the North Quarry Pit in 1979. In 1985, the landfill underwent an expansion into the area identified as the South Quarry Pit. The Bridgeton Landfill stopped receiving waste in December 2004.

1.3 MONITORING OBJECTIVES

As defined by the Settlement, the objective of this monitoring is to install and operate two monitors to determine the 1-hour maximum SO_2 concentrations during a one year period at two locations determined by EPA. This SO_2 ambient air monitoring work plan addresses the following monitoring objective:

- Characterize concentrations of SO_2 in ambient air at multiple locations over a period of one year.

Figure 1 Site Map



2.0 PROJECT OVERVIEW

As discussed, the Settlement Agreement requires Bridgeton Landfill to install and operate two ambient SO_2 monitors for a one-year period. The monitor locations, as prescribed by USEPA and Missouri Department of Natural Resources (MDNR), will be located as follows: one near the water tower at Spanish Village and the second on the northern end of the West Lake Landfill site. The first of the two sites is in the vicinity of a modeled area of interest for SO_2 near the populated Spanish Village neighborhood and, the second site is uniquely positioned to evaluate ambient air relative to the Spanish Village neighborhood impacts near the fence line under southerly wind conditions and to determine upwind impacts from other nearby SO_2 sources under northerly wind conditions. The second site is not an ambient monitoring station; however both sites were approved by USEPA in the email correspondence dated Wednesday, May 25, 2016. In the event either monitoring station cannot be installed in the approved locations, new sites will be selected and approved in advance by the USEPA.

Bridgeton Landfill will secure a minimum 1 year lease agreement, power and other infrastructure required to site and operate the monitors consistent with 40 CFR Part 53, Part 58, and Volume II, Part I of the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems. The following sections provide additional detail regarding the monitoring locations and equipment installation and operation procedures.

2.1 PROJECT TEAM

Bridgeton Landfill is responsible for the installation and operation of the ambient air SO_2 monitoring program detailed in this CSP. Bridgeton Landfill will work closely with USEPA to develop and implement this program to satisfy the intent of the Settlement. Bridgeton Landfill has selected the following companies to support this program:

- Inquest Environmental, Inc. (Inquest) to install and operate the SO_2 monitoring stations associated with this CSP.
- Stantec will interpret the collected data and evaluate it relative to the NAAQS for SO_2.
- Trinity Consultants (Trinity) will assist Stantec and Inquest in finalizing the CSP, commencing monitoring, and evaluating results.
- Engineering Management Support Inc. (EMSI) will provide overall coordination of the work including oversight of the project plan preparation, coordination of the various contractors, preparation of monthly status reports, and coordination with USEPA.

Bridgeton Landfill staff and/or contractor will provide routine inspections, operation, and maintenance of each monitoring station as directed by Inquest.

Detail regarding the parties involved in this project, their roles, and key contact personnel are included in Appendix A of this document.

2.2 PROJECT TIMELINE

Table 1 provides a timeline for implementation of this monitoring program.

Table 1 Ambient SO_2 Monitoring System Project Timeline

Event	Date
Submittal of CSP to USEPA	May 31, 2016
Monitoring systems startup	30 days from EPA approval of the CSP
Initial performance audit at each sample system	Within 90-days from monitoring system startup
Submittal of sampling data	Monthly reports will be submitted within 30-days following the end of the reporting month. Quarterly reports will be submitted within 60-days following the end of each sampling quarter
Final sample report	Within 60-days following the end of the required 1-year sample period

2.3 MONITORING SYSTEM LOCATIONS

USEPA has approved the recommended locations for the two required monitoring systems. The water tower monitor location is off-site in the vicinity of the Spanish Village area, approximately 0.5 miles south of the southernmost point of the site. The northern onsite location, identified as the St. Charles Rock Road (SCRR) Monitor, will be located in the northernmost point of the area identified as the "Operable Unit 2, Closed Demolition Landfill" in Figure 1.

Table 2 provides additional detail regarding the location of each monitoring system. Figure 2 provides a visual representation of each monitoring system location as well as the location of the Bridgeton Landfill flares. Figure 3 details the wind rose data for the St Louis Regional Airport for all seasons for the 2010 through 2014 period.

Table 2 Ambient SO_2 Monitoring System Locations

Station	Latitude	Longitude	Ground Elevation
Water Tower on Forrester Road in Spanish Village	38.754635	-90.444151	596 ft.
St. Charles Rock Road Monitor	38.773566	-90.444907	470 ft.

Figure 2 SO_2 Ambient Air Monitoring Locations

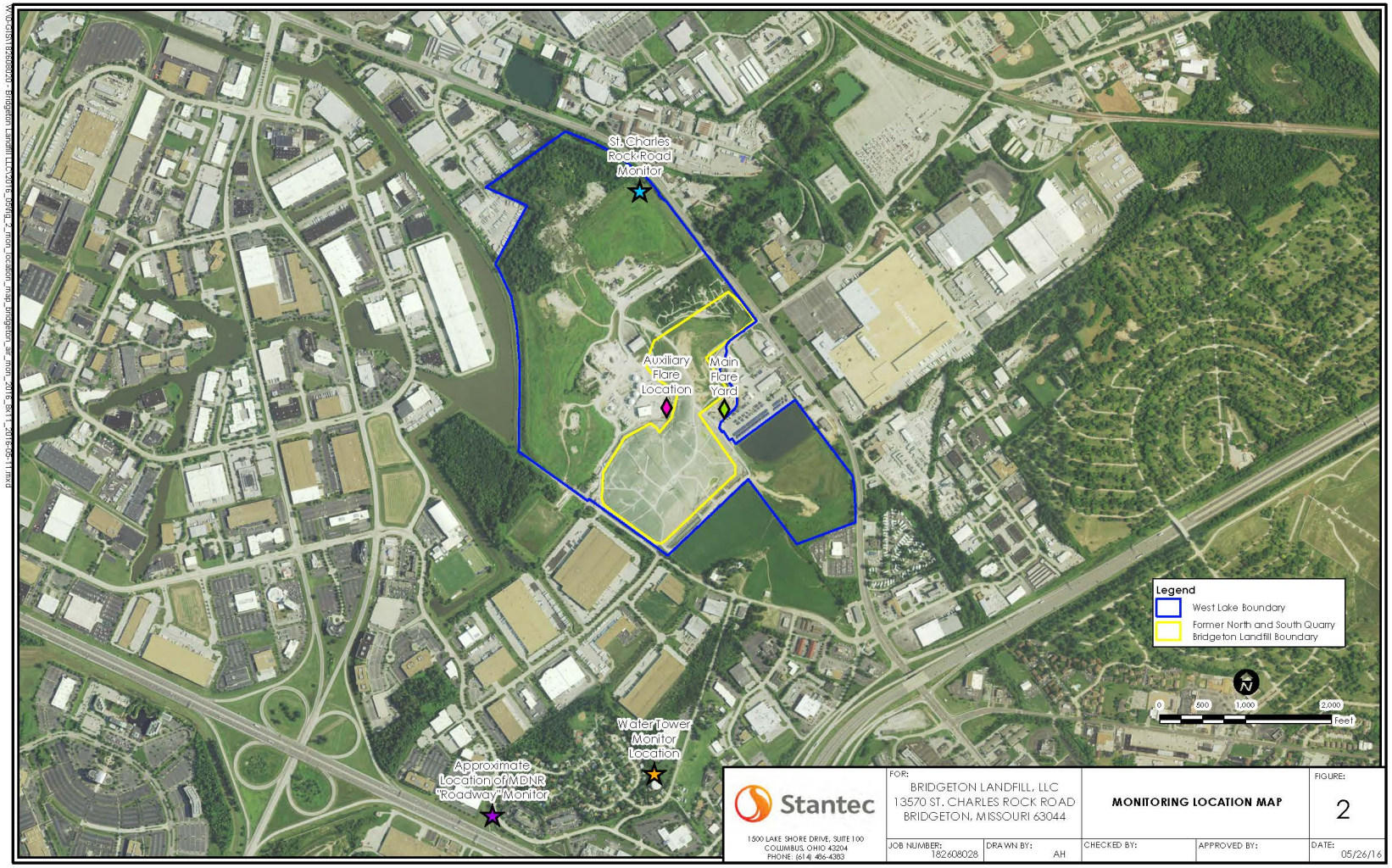
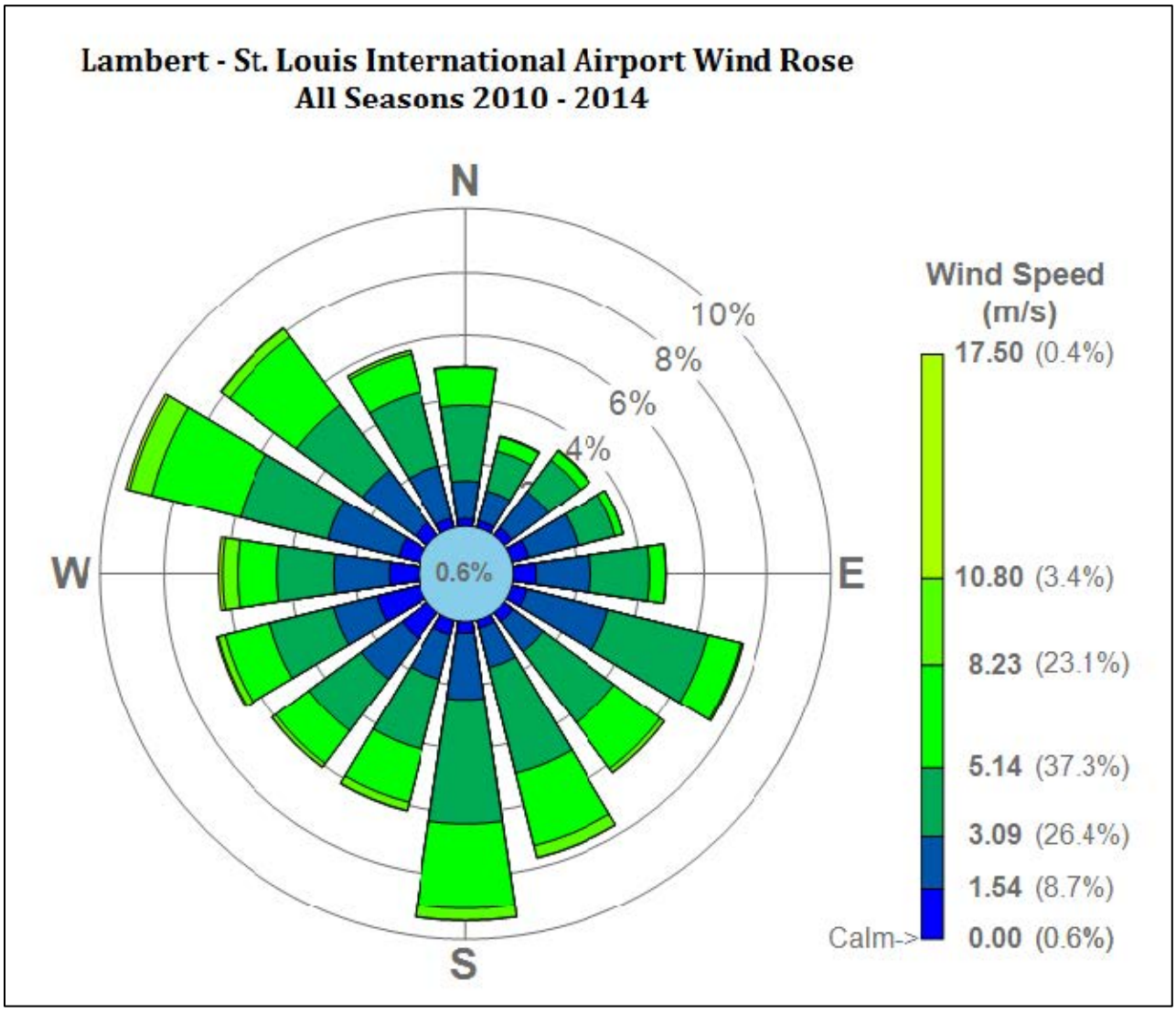


Figure 3 Lambert-St. Louis International Airport Wind Rose



2.4 MONITORING SYSTEM EQUIPMENT

The stations installed at each location will consist of a walk-in style, environmentally controlled shelter housing the SO_2 analyzer. Support equipment installed at each location will include a dilution calibrator system, data acquisition system (DAS), and digital cellular modem. Table 3 details the monitoring equipment to be installed at each location.

Table 3 Ambient SO_2 Monitoring System Equipment

Instrument	Make/Model	Quantity
ThermoFisher Scientific SO_2 Analyzer (or equivalent)	43C	1
ThermoFisher Scientific Multi-Gas Calibrator (or equivalent)	146i	1
Campbell Scientific CR10X Measurement and Control System	CR10X	1

The SCCR Location is in close enough proximity and at a similar elevation to existing meteorological towers in operation at Bridgeton's facility. The available meteorological tower data from the site will be used in the interpretation of the SO_2 concentration data from this location. The water tower location is located further from the site and at a higher elevation. As a result, Bridgeton Landfill plans to install a 10-meter meteorological tower and sensors for measuring wind speed and direction at the water tower location. Table 4 lists the make, model, and quantity of the meteorological instruments deployed at the water tower location.

Table 4 Water Tower Meteorological Monitoring System Equipment

Instrument	Make / Model	Quantity
Wind Direction	RM Young 05305	1
Wind Speed	RM Young 05305	1

The SO_2 monitor at each location and meteorological sensors at the water tower will direct signals to the DAS specific to the location. The DAS will store the data onsite. Additionally, data will be automatically retrieved on a daily basis using a digital cellular modem connected to the DAS and stored in a database at Inquest's office. All monitored parameters for this project will be collected continuously.

Each monitoring systems operation, data collection, and quality control procedures are consistent with *EPA Requirements for Quality Assurance Project Plans (QA/R5)* EPA/240/B-01/003 (March 2001, reissued May 2006), *Guidance for Quality Assurance Project Plans (QA/G-5)*

EPA/240/R-02/009 (December 2002), and *Uniform Federal Policy for Quality Assurance Project Plans,* Parts 1-3, EPA/505/B-04/900A-900C (March 2005).

2.4.1 SO_2 Monitor Overview

The air sample stream will be analyzed for SO_2 using a ThermoFisher Scientific Model 43C continuous SO_2 analyzer. The 43C is a pulsed fluorescence based analyzer and is based on the principle that SO_2 molecules absorb ultraviolet light and become excited at one wavelength, then decay to a lower energy state emitting UV light at a different wavelength.

The sample is drawn into the analyzer and flows through a hydrocarbon "kicker", which removes hydrocarbons from the sample by forcing the hydrocarbon molecules to permeate through the tube wall. The SO_2 molecules pass through the hydrocarbon "kicker" unaffected.

The sample flows into a fluorescence chamber, where pulsating UV light excites the SO_2 molecules. The condensing lens focuses the pulsating UV light into the mirror assembly. The mirror assembly contains four selective mirrors that reflect only the wavelengths that excite SO_2 molecules.

As the excited SO_2 molecules decay to lower energy states they emit UV light that is proportional to the SO_2 concentration. The bandpass filter allows only the wavelengths emitted by the excited SO_2 molecules to reach the photomultiplier tube (PMT). The PMT detects the UV light emission from the decaying SO_2 molecules. The photodetector, located at the back of the fluorescence chamber, continuously monitors the pulsating UV light source and is connected to a circuit that compensates for fluctuations in the UV light.

The sample then flows through a flow sensor, a capillary, and the shell side of the hydrocarbon "kicker". The Model 43C outputs the SO_2 concentrations to the front panel display and the analog outputs.

The Model 43C has received an USEPA designation as an equivalent method for the determination of sulfur dioxide concentrations in ambient air. Components or procedures that have received designation as an equivalent method must be operated as prescribed in its method number. Detail regarding the use of this model SO_2 analyzer can be found in USEPA document number EQSA-0486-060. The reference method for continuous SO_2 data collection can be found in 40 CFR, Part 50, Appendix A.

2.4.2 Meteorological Monitors Overview

Meteorological parameters at the water tower location will be measured with an RMYoung Model 05305 sensor measuring for wind speed and wind direction at ten-meters above the ground surface.

Wind direction is sensed by the orientation of the fuselage-shaped sensor body, which is connected to an internal potentiometer. The datalogger applies a known precision excitation voltage to the potentiometer element. The output is an analog voltage signal directly

proportional to the azimuth angle. Table 5 provides detail regarding the specifications for this measurement device.

Table 5 Model 05305 Wind Direction Sensor Specifications

Specification	Sensor Parameters	Acceptance Criteria
Accuracy	±3 degrees	±5 degrees
Starting Threshold	0.5 m/s @ 10 degrees	≤0.5 m/s @ 10 degrees
Damping Ratio	0.45	0.4 – 0.7 @ 1.2 kg/m^3
Operating Range	0-360 degrees	0-360 degrees
Delay Distance	1.2 m	≤ 5 m
Operating Temp	-50° to 50°C	
Signal Output	Analog DC voltage proportional to azimuth angle with regulated excitation voltage applied across potentiometer.	
Power Requirement	Regulated DC voltage, 15 VDC max	

Propeller rotation produces an AC sine wave signal with frequency proportional to wind speed. This AC signal is induced in a stationary coil by a six-pole magnet mounted on the propeller shaft. Three complete sine wave cycles are produced for each propeller revolution. Table 6 provides detail regarding the specifications for this measurement device.

Table 6 Model 05305 Wind Speed Sensor Specifications

Specification	Sensor Parameters	Acceptance Criteria
Accuracy	±0.2 m/s or 1% of reading	±0.2 m/s
Starting Threshold	0.4 m/s	≤0.5 m/s
Distance Constant	2.1 m	≤5 m
Operating Range	0 to 50 m/s	0.5-50 m/s
Operating Temp	-50° to 50°C	
Signal Output	AC voltage (three pulses per revolution); 90 hz (1800 rpm) = 9.2 m/s	
Power Requirement	NA	

All meteorological data collection will follow the procedures listed in *Inquest Environmental Standard Operating Procedures Manual, Revision 3.0, dated January 2006*.

2.5 MONITORING SYSTEM INSTALLATION AND OPERATION

Bridgeton Landfill will coordinate with offsite parties to secure access to each location and to provide the required utilities for each monitoring system. The monitor sites will be available and accessible to USEPA and MDNR and owned by a willing landowner. Bridgeton Landfill will notify Inquest upon completion of this step at each location. Upon receipt of this notification, Inquest will mobilize the required equipment to each monitoring location for system setup and startup. Data collection will begin upon completion of the startup routines at each location. The sample system will be secured and unattended excluding daily visual observation of operation by Bridgeton Landfill staff and routine operation and maintenance activities performed by Inquest personnel. Each SO_2 monitoring system will be setup to conduct automatic daily zero and span checks.

2.5.1 Calibration Procedures

The SO_2 analyzer will be calibrated on a quarterly basis. A ThermoFisher Scientific Model 146 Multi-Gas Calibrator, or equivalent, is used to mix the desired SO_2 calibration standards. The 146 uses calibrated mass flow controllers to measure the flow rate of zero air and a known SO_2 protocol gas standard to generate known calibration standards for the desired instrument span. The Model 146 calibration system will be certified against a National Institute of Standards and Technology (NIST) traceable standard on an annual basis.

Analyzer calibrations will include a zero concentration and not less than four upscale concentrations. The analyzer calibrations will be carried out under normal operating conditions at the monitoring station. The test concentrations of the SO_2 calibration gas will pass through all filters, scrubbers, conditioners, and other components that are used during normal sampling.

For the wind direction monitoring device, the instrument will be calibrated using a linearity test fixture prior to startup in the field. The accuracy of the wind direction and wind speed monitoring equipment will be verified on a semiannual basis. In the event of excessive calibration error, the equipment will be repaired or replaced.

2.5.2 System Maintenance

Bridgeton Landfill shall be responsible for monitor maintenance and quality assurance activities. To accomplish this, Bridgeton Landfill will contract with Inquest to perform systems maintenance, quality control checks, and instrument calibrations during scheduled site visits. Scheduled site visits will occur approximately once per week. Consumables will be replaced as needed. The technician performing the maintenance activities will document actions performed in the site checklist and site logbook. An example checklist is included in Appendix B.

Inquest technicians are trained in the routine maintenance procedures required for ambient monitoring systems. The manufacturer's operating manuals, which will be left onsite, can be

referenced for maintenance and troubleshooting procedures and provide additional information on the operation of the instrumentation. A copy of this CSP will be maintained at each monitoring station. Preventive maintenance will be conducted on the monitoring equipment during routine site visits. Table 7 details the routine maintenance conducted on the monitoring equipment and shelters.

Table 7 Monitoring System Routine Maintenance Procedures

Equipment/Parameter	Maintenance Check	Frequency	Corrective Action
SO_2 Analyzer	Check sample system flow	Each scheduled visit	Check sample pump, check sample lines for leaks
	Confirm analyzer range is set to 0.50 ppm	Each scheduled visit	Set to 0.50 ppm range
	Inspect for moisture in sample line	Each scheduled visit	Dry lines
	Inspect sample inlet filter	Each scheduled visit	Replace filter
Wind Direction	Replace bearings if the starting threshold exceeds acceptable limits of 11 gram-cm, or the bearings exhibit tightness, binding, or noise	Each scheduled visit	Replace bearings and/or resolver
Wind Speed	Replace bearings if the starting threshold exceeds acceptable limits of 1.0 gram-cm, or the bearings exhibit tightness, binding, or noise	Each scheduled visit	Replace bearings
Tower	Inspect to ensure that it is straight and secure	Each scheduled visit	Straighten/secure as needed
DAS	Check battery to ensure that it holds a charge	Each scheduled visit	Replace battery
Shelter	Inspect for moisture leaks	Each scheduled visit	Seal opening(s)
	Verify temperature in range of 20 to 30°C	Each scheduled visit	Adjust climate control
	Inspect AC filter for dirt	Each scheduled visit	Clean/replace

The instrumentation and procedures are field proven and reliable. In the event of equipment malfunction, Inquest personnel will refer to manufacturer's operating manuals and the Inquest Environmental SOP if necessary to make repairs as needed.

The Project Coordinator will be notified of any equipment problems should they occur and will become responsible for any repairs or corrective actions that are necessary to correct the situation. All problems requiring corrective action will be recorded in the Field Logbook maintained at each monitoring location.

2.5.3 Consumables and Spare Parts

Consumable parts used by the SO_2 analyzer consist of 5 micron, 47mm inlet filters. A sufficient supply of these consumables will be kept at each monitoring station in order to prevent an interruption in sample collection. Consumables for the SO_2 monitors will be purchased from ThermoFisher Scientific. The contact number for Fisher Scientific is (800) 766-7000. Table 8 details the recommended onsite spare parts inventory for this monitoring program.

Table 8 Spare Parts Inventory

Instrument	Part No.	Description	Quantity
SO_2	NC9737152	5µm, 47mm inlet filters	3
Wind Direction/ Wind Speed	05324	Vertical shaft bearings	2
	05363	Flange bearings	2
	05190	Bearing gap gauge	1
	05191	Hex wrench, 1/16"	1

Additionally, Inquest will have the responsibility of maintaining redundant components of the sample system. These components include an SO_2 analyzer, wind direction/wind speed equipment, DAS, and modem in inventory at the Inquest offices. All spare systems have been purchased from the same manufacturer as those installed at the monitoring stations. Should any breakdowns or equipment failures take place, Inquest monitoring personnel are equipped to repair or replace malfunctioning equipment and resuming data collection in a timely fashion.

3.0 DATA MANAGEMENT

The Campbell Scientific software package LoggerNet is used for data logger communications, programming, and data retrieval. The signal outputs associated with the monitor(s) installed at each location will be measured and recorded by the data logger. This data logger features extensive data storage capability (approximately five weeks of historical data at any time). The data logger will take measurements from the outputs once each second. These readings are then used to calculate 15-minute and 1-hour data, which are stored in non-volatile memory for later collection. The records are indexed according to the time stamp associated with each data string. The data are reported in Central Time using an ending time convention; that is, the first hour of the day is labeled 1:00, meaning the hour beginning at 00:00:01 and ending at 1:00:00 A.M. The second hour is labeled 02, meaning the values collected from 01:00:01 A.M. to 02:00:00 A.M., etc. The data acquisition systems will automatically adjust for daylight savings time. Each data logger will have a battery back-up system capable of retaining the

programming and stored data for an extended period of time. Data will be collected manually using the LoggerNet program during weekly site visits.

In addition to the raw electronic data discussed above, each monitoring station will include additional documentation. This includes a Site Logbook, Quality Control worksheets (flow checks, leak checks, calibrations, etc.), and Quality Assurance audit reports. The Site Logbook will be kept onsite throughout the project and will contain entries noting all site activities and visits. The Logbook will be filed with the project paperwork at the Inquest offices at the end of the project for a minimum of five years.

3.1 DATA COLLECTION AND STORAGE

Daily data collection will be accomplished by retrieving the data using the digital cellular modem. This automated process will occur seven days per week and will collect all data recorded following the most recent data collection. Additionally, Inquest personnel will perform manual remote call-ins three to five times per week.

The collected data, whether from the automatic retrieval or a manual session, is stored on the central computer database in comma-separated text files. These raw data files are not edited or changed in any way. A new data file is created for each station on a monthly basis to maintain reasonably sized data files. This database is automatically backed-up once per day to a large auxiliary hard drive at the Inquest offices. Primary data storage redundancy will include the site data logger, the laptop computer used for manual retrieval, the central computer database and the auxiliary hard drive located at the Inquest offices. Auxiliary backup of data stored on the central computer database includes the use of electronic media (e.g., CD, flash drive, etc.) no less than once per month. The primary data and the back-up data copies will be stored at the Inquest offices for a minimum of five years after the completion of the project.

3.2 DATA VALIDATION

Specific measures are implemented to aid in generating reliable data as a result of the sampling and analytical activities of every field program. The objective of this phase of the program is to follow the proper collection of representative and quality assured field and analytical data with approved data reduction methods and equations.

Upon completion of remote data retrieval, the data is validated per the criteria in *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final). March, 2008. EPA/454/B-08-002. U.S. Environmental Protection Agency, Research Triangle Park, NC*. Data validation will occur after the data have been downloaded to the central computer database maintained by Inquest. The data will be analyzed as they are scanned for high and/or unusual looking readings. Every incidence of high or unusual looking readings will be investigated and it will be determined if the data appear to be correct or if the data should be invalidated. Decisions to validate data will be based primarily on successful precision and accuracy checks; however, other information will assist with the validation process. Other information might include comparisons to similar measured

parameters in the area, equipment performance records, local meteorological records, and current weather conditions such as excessive heat and dry conditions. Any data that are invalidated will be documented by the Data Reporting Officer as to the reasons for invalidation.

Level I Checks: Quality checks will be performed by Inquest's Data Reporting Officer by manually reviewing data for problems and outliers. Quality control flags will be assigned. Documentation of Level I checks will be kept in a chronological format. Documentation will include the date of the check, the operator's initials, and the unadjusted data.

Level II Checks: Involve checking measurements with independent data sets such as local meteorological records at nearby airports. The closest National Weather Service meteorological data station to the Bridgeton facility is located at the Saint Louis International Airport.

Level III Check and Final Evaluation: Data flagged by the Level I and II checks will be further evaluated at this step. Data will also be graphed to visualize any unusual trends present in the data. Findings in the review will be documented. Additional detail regarding data review, validation, and verification is included in Section 4.0 of the CSP.

4.0 DATA QUALITY OBJECTIVES

A number of quality control procedures are incorporated into the monitoring program to ensure the accuracy and precision of the measured data. These procedures include:

- Daily zero and span checks at each SO_2 monitoring system.
- Zero, span, and precision checks at each SO_2 monitoring system no less than once every 14 days.
- Multi-point calibration checks at each SO_2 monitoring system no less than once per calendar quarter.
- Performance Audits at each SO_2 monitoring system at least once per calendar quarter. Additionally, Performance Audits will be performed at the meteorological sensors semiannually.
- Technical System Audits at each monitoring system.

In conjunction with these procedures, the measured data is subject to review, verification, and validation as prescribed in *EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final). March, 2008*.

4.1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

Data review, verification, and validation are techniques used to accept, reject or qualify data in an objective and consistent manner. Verification can be defined as confirmation, through provision of objective evidence that specified requirements have been fulfilled. Validation can

be defined as confirmation through provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

4.1.1 Data Verification Methods

The verification requirements for the data operation include the verification of sampling and analysis processes and operations like data entry, calculations, and data reporting. The data verification process involves the inspection, analysis, and acceptance of the field data. These inspections take the form of frequent inspections by field operators and data technicians. The following items should be confirmed during the verification process:

- The air monitoring data operations were performed according to the procedures governing those operations.
- The SO_2 ambient air monitoring sensor performed correctly. Individual checks such as meteorological influences, and all other assessments, audits, and performance checks have been acceptably performed and documented.
- The SO_2 ambient air monitoring data passed initial visual inspections for reasonableness.
- A manual review has been made of the data tabulations to spot unusually high or low values or other outliers that might indicate a gross error in the data collection.
- Manual calculations, manual data entry, or human adjustments to the software settings have been checked. Automated calculations should be verified and accepted prior to use, but at some frequencies these calculations should be reviewed to ensure that they have not changed.
- The SO_2 ambient air monitoring data operations have been performed to meet the data quality objectives and the operations are performs as specified.

Calibration of instruments and equipment are performed periodically as prescribed in the USEPA methodologies and by the equipment manufacturers. The associated data should be reviewed by station operators and data validation staff. The following items should be verified:

- The calibrations are performed within an acceptable time prior to generation of data.
- The proper number of calibration points is conducted.
- The calibrations are performed using standards that "bracketed" the range of reported measurement results.
- Acceptable linearity checks and other checks are made to ensure that the measurement system was stable when the calibration was performed.

4.1.2 Data Validation Methods

Data validation is a routine process designed to ensure that reported values meet the quality goals of the ambient air monitoring data operations. The purpose of data validation is to detect

and then verify any data values that may not represent actual ambient air conditions at the monitoring station.

Validation flags are used to signify data that may be suspect or invalid. Each value recorded in the database has a flag (QC code) associated with it. Readings that have been confirmed to be invalid, or are missing from the database, are replaced with a value of -999.

Table 9 details each QC code, a description of the code, and whether the code invalidates the data or not.

Table 9 Data Validation Codes

QC Code	Description	Valid / Invalid
0	Normal	Valid
1	Quality Assurance	Invalid
2	Monitor Malfunction	Invalid
3	Non-monitor Malfunction	Invalid
4	Other Known Cause	Invalid
5	Unknown Cause	Invalid
6	Data has been corrected or recalculated	Valid
7	Suspicious data or value exceeded alert limits	Valid
8	Reserved	
9	Data not available / Missing data	Invalid

Table 10 lists the parameters and the conditions that are evaluated when screening the data.

Table 10 Data Screening Criteria

Parameter	Condition
Wind Direction	<0 or >360° Varies < 1° over 3 hours Varies < 10° over 18 hours
Wind Speed	<0 or >25 m/s Varies < 0.1 m/s over 3 hours Varies < 0.5 m/s over 12 hours

Once the data have been imported into the database, the data technician manually invalidates data collected during quality control or quality assurance activities, and also any data recorded during periods of known monitor downtime.

Additionally, any data that can be readily identified as invalid is flagged. The data technician then investigates any data flagged by the automatic screening process and determines whether the data are acceptable or not.

Some parameters are associated with other parameters. Any related parameters must be validated or invalidated according to the validity of each parameter. For example; if a relative humidity reading is invalidated then the dew point data must be invalidated as well.

Graphs of the data are used extensively to reveal any unusual patterns, outliers, or anomalies in the data set, and as a method of visualizing the data relative to other parameters.

Another tool used for data validation is to compare the ambient air measurements with other nearby stations. Agreement with the other stations could help in validating the data, particularly during periods of unusual readings or conditions.

Data following an instrument condition resulting in the failure to collect data, outside of the prescribed system operating criteria, or extended period of non-operation should be regarded as invalid until the next subsequent acceptable check or calibration.

It is recommended that results from performance audits and evaluations not be used as the sole criteria for data invalidation because these checks (performance audits) are intended to assess the quality of the data.

Observations that do not meet each and every criterion should be invalidated unless there are compelling reason and justification for not doing so. The data for which one or more of these criteria are not met is invalid until proven otherwise.

Criteria that are important for maintaining and evaluating the quality of the data collection system are included in Tables 11 and 12. Violation of a criterion or a number of criteria may be cause for invalidation. The decision should consider other quality control information that may or may not indicate the data are acceptable for the parameter being controlled. Therefore, the data for which one or more of these criteria are not met is suspect unless other quality control information demonstrates otherwise.

Table 11 Data Quality Requirements and Assessments, Meteorological Measurements Specifications

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Wind Direction	Vane	Degrees	0 to 360	0.5	Hourly	1 minute	90%
Wind Speed	Propeller	m/sec	0.5 to 50	0.1	Hourly	1 minute	90%
SO_2	Pulse fluorescence analyzer	ppm	0.00 to 0.50	0.01	Hourly	1 minute	80%

Table 12 Meteorological Measurement Quality Objectives – Calibration and Accuracy Criteria

Measurement	Type	Acceptance Criteria	Frequency
Wind Direction	Solar noon, GPS, or magnetic compass	±5 degrees including orientation error	Quarterly
Wind Speed	NIST traceable synchronous motor	±0.2 m/s	Quarterly

4.1.3 Reconciliation with Data Quality Objectives

Once data results are compiled a review of the data to determine if they fall within the acceptable limits is undertaken. All quality control and quality assurance documents are inspected for unacceptable results or any deviation from standard operating procedures.

Basic statistics, such as minimums and maximums, and graphs of the data are generated and then scrutinized in order to uncover any unusual patterns, outliers, or anomalies in the data set. Any readings that have been flagged by the validation process are analyzed and either deemed valid or are invalidated as the case may be.

Completeness is also evaluated to determine if the completeness goal for this project has been met. The database is scanned for any missing data records and any unusual periods of monitor downtime are looked into.

If any of the data quality goals are not met then the suitability of the data for the intended purposes may be in question. Failure to meet the data quality goals does not necessarily mean the data is invalid or of no use. All the fact and evidence must be carefully weighed in order to make a determination of whether or not to use the data for the data quality objectives. Any corrective actions not yet taken must be implemented as soon as possible.

4.2 PERFORMANCE AND TECHNICAL SYSTEM AUDITS

Performance audits consist of evaluation of analysis results for samples to test the proficiency of a monitoring system. A Technical System audit is different from the Performance Audits in that the entire monitoring process will be evaluated. Technical Systems audits consist of an onsite review and inspection of a meteorological monitoring program to assess its compliance with established regulations governing the collection, analysis, validation and reporting of monitoring data.

The audits are conducted by personnel that are different from persons performing the on-site operation and quality control activities. Persons conducting the audits must have extensive knowledge and experience with the instruments being audited and the audit equipment.

The equipment used for the audits is different from any equipment used for routine sampling quality control activities. The audit devices must have certified traceability to primary standards. The audit standards are certified at least annually.

The preliminary results of either audit is discussed with the operating personnel and/or management at the time of the audit. Problem areas discovered must be addressed and the auditor will provide recommendations for corrective actions to be implemented.

4.2.1 Audit Schedule

Performance audits for each SO_2 monitoring system will be performed on a quarterly basis. Meteorological performance audits are performed every 6 months (every other quarter). A Technical Systems audit will be performed within 90 days of the startup of the monitoring systems. Technical systems audit will be performed on an annual basis after the initial audit is performed.

Inquest audit personnel will issue a Technical Systems Audit Report to the Project Coordinator no more than 30 days after the completion of the Technical Systems audit. The Project Coordinator will then have the responsibility of filing and forwarding the Technical Systems Audit Report to the USEPA on a quarterly basis, no more than 30 days following the end of the quarter the audit was performed.

The initial performance audit will be performed within 60-days following startup of each monitoring station. A Technical Systems audit will be performed by Inquest auditing personnel on each monitoring network no more than 90 days after commencement of sampling.

4.2.2 Wind Direction Audit Method

The wind direction audits are initiated by first determining the crossarm alignment in respect to True North. This is accomplished by aligning a tri-pod mounted certified Brunton Model F-5008, or equivalent, pocket transit along the length of each crossarm, then recording the direction indicated by the transit. The transit reading is corrected for magnetic declination in order to determine True North.

After the tower is lowered, the linearity of the wind direction sensor is audited by aligning the wind vane to an R M Young Model 18212, or equivalent, vane angle fixture. This is done in 90° increments or less, in both clockwise and counter-clockwise directions. The sensor's total error is then calculated by adding the linearity error to the crossarm alignment error.

Finally, the wind vane is visually aligned and held across the crossarm. A reading is taken from the datalogger to ensure that the sensor housing is correctly orientated with the crossarm.

The sensor bearings are inspected manually, by rotating the shaft and checking that it turns freely, without any tightness, binding, or noise. A torque measuring device may be used if there is any question about the condition of the sensor bearings. Bearings will be replaced if the torque exceeds 11 gram-cm.

Table 13 presents the wind direction audit criteria.

Table 13 Wind Direction Audit Criteria

Instrument	Audit Criteria
Wind Direction	±3° relative to the index of the audit test fixture ±5° absolute error, including orientation error

4.2.3 Horizontal Wind Speed Audit Method

The wind speed sensor calibration is verified using a certified R.M. Young Model 18801 variable-speed anemometer drive. The wind cups are removed from the sensor and the drive is connected using a flexible coupling. The sensor is then rotated in the appropriate direction at several different speeds.

The sensor bearings are inspected manually, by rotating the shaft and checking that it turns freely, without any tightness, binding, or noise. A torque measuring device may be used if there is any question about the condition of the sensor bearings. Bearings will be replaced if the torque exceeds 1 gram-cm.

Table 14 presents the wind speed audit criteria.

Table 14 Wind Speed Audit Criteria

Instrument	Audit Criteria
Wind Speed	(< 5 m/s ±0.2 m/s) (> 5 m/s ±0.2 m/s or 5%)

4.2.4 SO_2 Audit Method

The audits for the SO_2 monitoring systems will be accomplished by introducing known concentrations of SO_2 audit gases through the sample system to the analyzer. The analyzer response, as indicated by the DAS will be compared to each actual audit gas concentration. Table 15 details the audit gas ranges for this monitoring program.

Table 15 Audit Gas Ranges

Audit Point	Audit Gas Range (ppm)
1	Zero gas
2	0.03 to 0.08
3	0.15 to 0.20
4	0.40 to 0.45

The concentration ranges listed above assume the full scale operational range of each SO_2 analyzer will be 0.50 ppm. The difference between the actual concentration of the audit test gas and the concentration indicated by the analyzer will be used to assess the accuracy of the monitoring data. The percent difference for failing an audit will be greater than +/- 20% of the upper and lower 95% probability limits.

The audits will be conducted using certified standards that are different from those used during routine monitoring operations and will be conducted by Inquest personnel that are different from those conducting the routine monitoring operations.

Table 16 presents the performance criteria for each SO_2 monitoring system.

Table 16 SO_2 Performance Criteria

Instrument	Frequency	Audit Criteria
SO_2 – One-point QC	Once per 14-day period	Precision: 10% Bias: ±10%
SO_2 – Annual performance evaluation	Once per calendar quarter	≤ 15% for each audit concentration

5.0 REPORT AND RECORDKEEPING

Project data from each monitoring station will be placed into a single bound and electronic report format at the conclusion of each month of data collection. The report will include hourly average and maximum readings from the SO_2 analyzers and 15-minute and hourly averaged readings from the meteorological sensors.

Upon completion of each month of monitoring, the Inquest Project Coordinator will generate a data report. The data from the reporting month will be reviewed for accuracy and completeness. Missing data and/or data not meeting the prescribed performance criteria will be documented, reviewed, and reported accordingly. Table 17 provides detail regarding the reporting requirements for this monitoring project.

Table 17 Reporting Requirements

Type	Responsible Party	Frequency	Receiving Agency
Data Report	Inquest/Stantec	Monthly	USEPA
Performance Audit	Inquest/Stantec	Quarterly, Annual	USEPA
Technical System Audits (if required)	Inquest/Stantec	Within 90 days from startup. Anytime during the project, as required.	USEPA

5.1.1 Monthly Reports

Summary reports will be prepared on a monthly basis and submitted to Bridgeton Landfill and the project team for review and approval. Upon receipt of approval from Bridgeton, Stantec will submit the monthly reports to USEPA. The monthly reports will be submitted within 30-days following completion of the reporting month. The monthly data will be evaluated against one-hour National Ambient Air Quality Standards (NAAQS) standard for SO_2 of 75 parts per billion (ppb). In addition, the data will be included with the existing modeling database to provide more up to date information. These monthly reports will include:

- Cover Letter – This includes information about the month being reported including a summary of additional activities that occurred at each monitoring site during the reporting period.
- Data Summary Report – This includes the first and second highest reading captured each month by the SO_2 monitor at each station. Corresponding meteorological conditions will be included with these readings.
- Missing Data Report – Includes the time periods for any missing data and the reason the data is missing.

- Quality Assurance Reports – Includes all bi-weekly zero/span/precision check results and quarterly multi-point calibration results performed on each SO_2 analyzer.
- Performance Audit Reports – Includes quarterly performance audit results on the SO_2 analyzers and semiannual performance audit results on the meteorological sensors.

The monitoring data will also be output to a data file such as an Excel spreadsheet or a comma-delimited text file with units of measure.

5.1.2 Quarterly Reports

Comprehensive monitoring reports are compiled for each calendar quarter and submitted to USEPA within 60-days following completion of the calendar quarter. Quarterly reports will be submitted following the schedule in §58.16(b). The quarterly reporting periods are January 1 through March 31, April 1 through June 30, July1 through September 30, and October 1 through December 31. The first quarterly report will be submitted within 90 days following the end of the period during which system startup occurred. This report will contain data from the system startup data until the end of the period. Subsequent reports will be submitted within 90 days following the end of the reporting period.

The quarterly reports include the following sections:

- Cover letter that summarizes the report contents and explains any unusual conditions or occurrences
- Data summaries for each parameter that include statistics such as averages, minimums, maximums, or totals
- Chart reports for each parameter
- Wind rose for the quarter
- Data completeness and monitor downtime reports
- Equipment calibrations
- Equipment maintenance and site activity
- Quality Assurance Audit report

Quarterly reports will be submitted as a single bound copy and in Adobe PDF format. The validated monitoring data is provided in a Microsoft Excel file.

5.1.3 Audit Reports

A summary report detailing the results of any performance audits will be prepared and submitted to Bridgeton and the designated appointees within 30 days following the audit date. At a minimum, the audit report should include the following sections:

- Background information for the monitoring stations
- Description of the on-site instrumentation and audit equipment

- Summary of the audits results
- Recommendations for corrective actions, if any
- Detailed worksheets of the audit for each parameter
- Certification documents for the audit standards

The results of the Technical Systems Audit Report will be submitted to the Project Coordinator within 30 days following completion of the Technical Systems Audit. The Project Coordinator will then have the responsibility of filing and forwarding the Technical Systems Audit Report to Bridgeton on a quarterly basis, no more than 30 days following the end of the quarter the audit was performed.

5.1.4 Records Retention

Table 18 presents the categories and types of records and documents that are kept related to ambient air monitoring. Current copies of all documents will be maintained at the specified locations. Copies of past documents will be kept according to the retention time schedule. Any electronic records should be retained indefinitely.

Table 18 Records Retention

Categories	Record/Document Types	Location [Facility or Consultant (F/C), USEPA]	Minimum Retention Time (yrs)
Management and Organization	Quality Management Plan	USEPA	5
	Quality Assurance Project Plan (CSP)	F/C & USEPA	5
	Personnel qualification and training	F/C	5
Site Information	Site audits	USEPA & F/C	5
Environmental Data Operations	Standard operating procedures (SOP)	F/C & USEPA	5
	Field and laboratory notebooks	F/C	5
	Quality control records	F/C	5
	Sample handling/custody records	F/C	5
Raw Data	Any original data	F/C	5
Data Reporting and Data Management	Data Summary Reports	F/C & USEPA (as received)	5

Appendix A PROJECT ORGANIZATION

Table A-1 Plan Distribution List

Individual	Title	Agency Represented	No. of Copies
Nicholas Bauer, P.E.	Environmental Manager	Bridgeton Landfill	Control
Dan Feezor, P.E.	Project Engineer	Feezor Engineering, Inc.	1
Deborah L. Gray, PhD, DABT	Project Officer	Stantec Consulting Services, Inc.	1
Mike Liebert	Project Officer	Trinity Consultants	1
Mike Jay	Air Monitoring Unit Chief	USEPA	1

Table A-2 Key Personnel/Areas of Responsibility

Role	Personnel	Organization	Contact Information
Project Engineer	Dan Feezor, P.E.	Feezor Engineering, Inc.	(217) 483-3118 dfeezor@feezorengineering.com
Project Coordinator	Paul Rosasco	EMSI	(303) 940-3426 paulrosasco@emsidenver.com
Project Officer	Deborah L. Gray, PhD, DABT	Stantec Consulting Services, Inc.	(614) 643-4362 Deb.Gray@stantec.com
Sampling Operations	John Kunkel	Inquest Environmental Inc.	(573) 474-8110 jkunkel@inquestenv.com
Sampling QC	John Kunkel	Inquest Environmental Inc.	(573) 474-8110 jkunkel@inquestenv.com
Laboratory Operations	N/A	N/A	N/A
Data Processing Activities	Deborah L. Gray, PhD, DABT	Stantec Consulting Services, Inc.	(614) 643-4362 Deb.Gray@stantec.com
Data Process QC	Deborah L. Gray, PhD, DABT	Stantec Consulting Services, Inc.	(614) 643-4362 Deb.Gray@stantec.com

Role	Personnel	Organization	Contact Information
Data Quality Reviewer	David West, CESCO	Stantec Consulting Services, Inc.	(615) 829-5456 David.West@stantec.com
Data Assessment	Deborah L. Gray, PhD, DABT	Stantec Consulting Services, Inc.	(614) 643-4362 Deb.Gray@stantec.com
Modeler	Jeremias Szust	Trinity Consultants	JSzust@trinityconsultants.com
Performance Auditing	John Kunkel	Inquest Environmental Inc.	(573) 474-8110 jkunkel@inquestenv.com
Technical Systems Auditing	John Kunkel	Inquest Environmental Inc.	(573) 474-8110 jkunkel@inquestenv.com
Facility Project Manager	Nicholas Bauer, P.E.	Bridgeton Landfill	(314) 744-8139 nbauer@republicservices.com
Overall USEPA QA	Mike Jay	USEPA	(913) 551-7460 Jay.Michael@epa.gov
USEPA Project Coordination	Mike Jay	USEPA	(913) 551-7460 Jay.Michael@epa.gov
USEPA Quality Assurance Review	Mike Jay	USEPA	(913) 551-7460 Jay.Michael@epa.gov
USEPA External Technical Systems Auditing	Mike Jay	USEPA	(913) 551-7460 Jay.Michael@epa.gov

Appendix B EXAMPLE SITE CHECKLIST

Table B-1 Meteorological Checklist

Station _____

Date					
Technician					
Weekly Inspection - Readings consistent with observations. Wind speed propellers and wind direction vanes turning freely. No debris or obstructions.					
Wind Speed 10m	Y / N	Y / N	Y / N	Y / N	Y / N
Wind Direction 10m	Y / N	Y / N	Y / N	Y / N	Y / N
Temperature 10m	Y / N	Y / N	Y / N	Y / N	Y / N
Temperature 2m	Y / N	Y / N	Y / N	Y / N	Y / N
Relative Humidity	Y / N	Y / N	Y / N	Y / N	Y / N
Solar Radiation	Y / N	Y / N	Y / N	Y / N	Y / N
Barometric Pressure	Y / N	Y / N	Y / N	Y / N	Y / N
Precipitation gauge clean and level	Y / N	Y / N	Y / N	Y / N	Y / N
Quarterly Inspection					
Wind Speed bearings	Pass / Fail	Pass / Fail	Pass / Fail	Pass / Fail	Pass / Fail
Wind Direction bearings and potentiometers	Pass / Fail	Pass / Fail	Pass / Fail	Pass / Fail	Pass / Fail
Temperature aspirated shields clean and motors operating properly	Y / N	Y / N	Y / N	Y / N	Y / N
Relative Humidity sensor clean and unobstructed	Y / N	Y / N	Y / N	Y / N	Y / N
Solar Radiation sensor clean, level, and no condensation	Y / N	Y / N	Y / N	Y / N	Y / N
Barometric Pressure sensor port unobstructed	Y / N	Y / N	Y / N	Y / N	Y / N

Table B-2 SO_2 Monitoring System Checklist

Station _____

Date					
Technician					
Tank Pressure (>200)					
SO_2 Instrument PPB					
BKG					
COEF					
Flow					
UV Lamp					
Last Calibration					
Replace Inlet Filter					
Computer Log On					
SO_2 Reading					
Room Temp (68/86)					
Batt (>13V)					
Flow					
Collected Data					
Ports/Flags Off					
Time/Date OK					
Visual Observation					
Log Off					
Calibrator Remote Button In					
Manifold (Clean/Dry)					
Shelter					
Inside Clean/Trash Removed					
Outside Weeds/Trash Removed					
Site Operator ID>>					