THE MAKAH AIR QUALITY PROJECT

QUALITY ASSURANCE PROJECT PLAN

INDOOR AIR QUALITY ASSESSMENT

Prepared By:
Jim Woods
Air Quality Specialist
Makah Tribe

Acronyms and Abbreviations

AIRS	Aerometric Information Retrieval System
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CAA	Clean Air Act
CV	coefficient of variation, or sample standard deviation divided by the mean
CFR	Code of Federal Regulations
COC	chain of custody
DQA	data quality assessment
DQOs	data quality objectives
EPA	Environmental Protection Agency
FRM	Federal reference method
GIS	geographical information systems
IAQ	Indoor Air Quality
ITEP	Institute for Tribal Environmental Professionals, Northern Arizona University
LAN	local area network
MQOs	measurement quality objectives
NIST	National Institute of Standards and Technology
PD	percent difference
PE	performance evaluation
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RAIEL	Radiation and Indoor Environments National Laboratory
RPD	relative percent difference
SOP	standard operating procedure
TAMS	Tribal Air Monitoring Support Center
T_a	temperature, ambient or actual

ACKNOWLEDGEMENTS

A SPECIAL THANKS to Rich Prill, Building Science and Indoor Air Quality Specialist with the Washington State University Cooperative Extension's Energy Program. Rich has been instrumental in the planning of this study and has contributed his talent, expertise and professional support. Thanks Rich for all your help with this indoor air project on the Makah Reservation.

Melinda Ronca Battista, Thank you so much for all the time you spent working with me on this Q.A.P.P. Your direction has shown to be invaluable in the creation of this Model project plan. "KLAKO"

1.0 QA Project Plan Identification and Approval

Title: The Makah Air Quality Project *QA Project Plan for Indoor Air Quality Assessment*

This QAPP for the Indoor Air Program commits the Makah Air Quality Project-to follow the procedures described and referenced in this plan, and the following individuals agree to this plan and their responsibilities for ensuring that these requirements are met.

The Makah Air Quality Project Program Officials

1) Signature: _____ Date: _____
Nathan Tyler, Makah Tribal Chairman

2) Signature: _____ Date: _____
Bob Polasky, General Manager

3) Signature: _____ Date: _____
Lois Thadei, Makah S.H.E. Dept. Director

4) Signature: _____ Date:_____
Vincent Cooke, Environmental Health Specialist

5) Signature: _____ Date:_____
James Woods, Makah Air Quality Specialist

Washington State University - Cooperative Extension, Energy Program

6) Signature: _____ Date:_____
Rich Prill, Building Scientist, W.S.U Cooperative Extension, Energy Program,
Quality Assurance Consultant for this project

U.S. Environmental Protection Agency, Region 10

7) Signature: _____ Date:_____
Mary Manous, Project Officer
EPA, Office of Air Quality

8) Signature: _____ Date:_____
Chris Hall, Quality Assurance Specialist,
EPA, Office of Environmental Assessment

2.0 Table of Contents

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3.0 Distribution

Paper copies of this QAPP have been distributed to the people listed in Table 3-1.

Table 3-1 Distribution List

Name	Position	Division/Branch
The Makah Air Quality Project		
James Woods	Air Quality Specialist	Makah Air Quality Project
Vincent Cooke	Environmental Health Specialist	Environmental Health Program
Lois Thadie	S.H.E. Department Director	Makah Social Health & Education Department
Steve Pendleton	Environmental Manager	Makah Tribe
Bob Polasky	General Manager	Makah Tribe
Nathan Tyler	Tribal Chairman	Makah Tribal Council
Washington State University – Cooperative Extension		
Rich Prill	Building Science and Indoor Air Quality Specialist	Washington State University, cooperative - Energy Program
EPA Region 10		
Mary Manous	Project Officer	EPA Region 10, Office of Air Quality
Chris Hall	QA Specialist	EPA Region 10, Office of Environmental Assessment
Tribal Air Monitoring Support Center		
Annabelle Allison	Co- Director	T.A.M.S. Center
Melinda Ronca-Battista	QA/QC Specialist	T.A.M.S. Center

4.0 Project/Task Organization

4.1 The Role of the Makah Air Quality Project (a Tribal Air Program)

The Makah Air Quality Project incorporates quality assurance activities as an integral part of any program that gathers environmental data, from work in the field, from their own data analysis and reporting, and from any consulting and contractor laboratories which they may use.

The following sections list the responsibilities of each individual in the Makah Air Quality Project.

Environmental Health Specialist, Vince Cooke

The Environmental Health Specialist, Vince Cooke has overall responsibility for managing the Makah Air Quality Project tribal air program. Ultimately, the Environmental Health Specialist is responsible for establishing QA policy and for resolving QA issues identified through the QA program. Major QA-related responsibilities of the Environmental Health Specialist include:

- Reviewing acquisition packages (contracts, grants, cooperative agreements, inter-agency agreements) to determine the necessary QA requirements;
- Assuring that the tribal air office develops and maintains this QAPP for Indoor Air Quality Assessment and ensures adherence to the document by staff, and where appropriate, outside contractors and consultants;
- Maintaining regular communication with the Air Quality Specialist and other technical staff;
- Conducting management systems reviews;
- Developing QA documentation and providing answers to technical questions;
- Ensuring that all personnel involved in this program have access to any training or QA information needed to be knowledgeable in QA requirements, protocols, and technology of that activity;
- Reviewing and approving this QAPP;
- Ensuring that this program is covered by appropriate QA planning documentation (e.g., QA project plans and data quality objectives);

Air Quality Specialist, Jim Woods

The Air Quality Specialist is responsible for carrying out the work in the field and ensuring that the data gathered meet the requirements of this QAPP. Their responsibilities include:

- Ensuring that reviews, assessments and audits are scheduled and completed, and at times, conducting or participating in these QA activities;
- Recommending required management-level corrective actions; and
- Serving as the program QA liaison with EPA regional QA Managers or QA Officers and the EPA regional Project Officer.
- Providing comments and assistance in the development and implementation of the Indoor Air QAPP;
- Maintaining regular communication with the Environmental Specialist and other technical staff, Quality Assurance Coordinator and the Tribal Air Monitoring Support (TAMS) Center staff;
- Participating in training and certification activities;
- Writing and modifying standard operating procedures (SOPs);
- Verifying that all required QA activities are performed and that measurement quality standards are met as required in this QAPP;
- Following all manufacturer's specifications;
- Performing and documenting preventative maintenance;
- Documenting deviations from established procedures and methods;
- Reporting all problems and corrective actions to their supervisor;
- Assessing and reporting data quality;
- Preparing and delivering reports to their supervisor; and
- Flagging suspect data.

Quality Assurance Consultant, Rich Prill of Washington State University's cooperative extension - Energy Program

The Quality Assurance Consultant (QAC) will assist with the reviews of quality assurance, quality assessment, and participant in quality control activities. The QAC is responsible for certifying standards used in the field and assisting in generating QC reports.

4.2 EPA Radiation and Indoor Environments National Laboratory (RAIE Lab)

The RAIE Laboratory is responsible for the tasks associated with the analysis of the Radon Canister tests, coordinating data transfer and maintaining a database of the canister analysis results. This includes providing ongoing technical assistance regarding charcoal canister analysis.

- Maintaining and adhering to Standard Operating Procedures (SOPs) and a laboratory QAPP for laboratory operations which is consistent with EPA guidance and policies;
- Obtaining, storing, coding, shipping and analyzing canisters in accordance with good laboratory practices;
- Providing accessibility to the facility and documents to the tribal air offices for on-site laboratory inspections and audits;
- Maintaining a database of canister information and
- Furnishing QA, calibration, and canister reports to the Makah Air Quality Project on an as-requested and monthly basis.

4.3 The Role of the EPA Region 10 Office

EPA Regional Offices have been developed to address environmental issues related to the tribal air offices within their region. EPA's Region 10 Office is responsible for the following activities in support of this program:

- Reviewing, providing assistance with, and approving this QAPP;
- Responding to requests for technical and policy information and interpretations;
- Evaluating quality system performance through technical systems audits, performance evaluations and network reviews, as appropriate for each grant and the tribal air office; and
- Making available the technical and quality assurance information developed by EPA to the tribal agencies, and making the tribe aware of any unmet quality assurance needs of the tribal agencies.

5.0 Problem Definition/Background

Indoor Air Quality is of growing concern through out Indian Country due to in many cases; low income housing or housing that is poorly constructed and under maintained. On the Makah Indian Reservation in Neah Bay, Washington located at the very northwesterly tip of the Olympic Peninsula, (also referred to as Cape Flattery) and it is a very wet climate to say the least. This rainy, wet climate accompanied with sea salt air and the wide use of wood stoves has an effect on the indoor quality of air with in the villages and surrounding areas of the Makah Tribe. Due to the severity of the weather most of the population stays indoors most of the time.

The objective of the project is to obtain baseline data that can be used to develop an understanding of the representative indoor air quality in our buildings through assessment and measurements in (10) ten tribal government buildings and (20) twenty residential homes. This data may be used as part of educational projects to assist people in improving their indoor air quality, to focus mitigation efforts on particular parameters, such as makeup air to combustion appliances, or to serve as a baseline study of currant indoor air quality. Any use of the

data will be made in conjunction with the Makah Air Quality Project, so that the data are not misinterpreted. The baseline data from this study may help to influence building standard on Indian land by providing characterized reference to the Makah Tribes Housing Authority, Operations department, Realty office and the Planning department. A summary report will also be made available to the Makah Environmental Health office, Neah Bay Indian Health Services (BIA) Health Clinic, Makah Caregivers Program, Makah Senior Citizens Program, Clallam County Environmental Health Department and the Cape Flattery School District for informational and educational purposes.

This QAPP describes how this program controls and evaluates data quality so that the objective is met. The objective for overall accuracy (total error) is a relative percent difference between an external check of each measured parameter and the value measured with the hand held instruments used in this project of 10% or less. All activities will be documented including which instruments were used in which house, so that reconstruction of how the data were gathered will be possible.

6.0 Project/Task Description

6.1 Description of Work to be Performed

The project will monitor for key factors affecting indoor air quality: carbon monoxide, carbon dioxide, moisture, radon, and particulates from smoke and combustion appliances. Ventilation rates and ventilation systems will be evaluated. Indoor air instruments such as carbon monoxide, carbon dioxide, particle counter, blower door, temperature/relative humidity instrument, moisture meter, chemical smoke kits, and radon test kits will be used.

The data will be compiled into a report documenting the relative quality of indoor air in these buildings on the Makah Reservation according to building type, construction, and use. The report will also provide recommendations for practical improvements for the deficiencies that are identified in the assessments.

6.2 Field Activities

Tribal Air Quality Specialist will obtain field measurements at each site according to IAQ field assessment checklist.

Table 6.1 lists the field measurements.

Table 6.1: Parameters Measured

Parameter	Instrument Type	Instrument Manufacturer	Instrument Model	Location
Solid material (wood, wallboard) moisture content (percent water)	Resistance between two metal probes placed into the material	Delmhorst	BD-10	Indoors; at least two locations in each of 3 rooms
Air temperature (degrees Celsius)	Thermo-Hygrometer	Mannix	LAM 880D	Adjacent to the moisture content measurements, at least two feet from any wall, door, or window
Relative Humidity (% RH)	Thermo-Hygrometer	Mannix	LAM 880D	Same as above
Carbon monoxide (ppm)	Air pumped into chamber, UV absorption of CO detected by pm	Bacharach	Monoxor II	Same as above

	tube?			
Airborne particulates of sizes 2 microns and greater, and a second measurement in the same location of particles greater than 5 microns (number particles/m^3)	Air pumped into chamber, orifice limits particle sizes, and each particle passing through orifice is counted?	Met One	GT-321	Same as above
Carbon dioxide (ppm)	Infrared absorption of reference air and sample air drawn into unit with a pump	Telaire	7001	Same as above
Ventilation rate (cubic feet per minute)	Blower door	The Energy Conservatory	Minneapolis Model 3	Main building entrance, with all windows and doors and fireplace and stove vents sealed and shielded
Radon	Charcoal canister	EPA Radiation & Indoor Environments National Laboratory, Center for Indoor Environments. Provided by the Tribal Air Monitoring Support Center	Charcoal canister	Indoors; at least one location at the lowest floor of the building (see SOP)

6.3 Project Assessment Techniques

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. As used here, assessment can mean a performance evaluation (PE), management systems review (MSR), peer review, inspection, or internal audit. Section 20 will discuss the details of the Makah Air Quality Project assessments.

7.0 Quality Objectives and Criteria for Measurement Data

7.1 Data Quality Objectives (DQOs)

Obtain an understanding of the representative indoor air quality in buildings on the Makah Reservation through assessment and measurements in (10) ten tribal government buildings and (20) twenty residential homes.

Table 7.1 Data Quality Objectives for Indoor Air Measurements

Parameter	Range	Instrument Stability Checks	Location	Objective	Error limit
Moisture in wood	Wood: 0.06-0.40 as a proportion of water to solid; zero moisture is set using a Douglas fir standard at the factory	Internal check conducted prior to moving to a new room or at least every five measurements, whichever is most often	Two points (at least) within each room, including the suspected dampest and the suspected driest locations; the average value in each room will be used, although all values will be recorded and stored	An average value for moisture content in the walls of the room	Values are indications only that will be used as indicators of potential areas of improvement in indoor air quality
Moisture in non-wood materials	1-100 relative range, with 1 as no moisture; always using a known dry material as a reference	Internal check conducted prior to moving to a new room or at least every five measurements, whichever is most often, battery check	Two points (at least) within each room, including the dampest and the driest locations; the average value in each room will be used, although all values will be recorded and stored	An average value for moisture content in the walls of the room	Values are indications only that will be used as indicators of potential areas of improvement in indoor air quality
Air temperature	-20 to 50 degrees C	Battery check and /or side by side comparison	One location within each of the three rooms in each building	Information useful for determination of the ability of mold to grow; indoor/outdoor air exchange rates.	Temperature accurate to within 1 degree C within 60 seconds
Carbon monoxide	0-1999 ppm	Zero check of outside air before and after measurements. Battery check.	One location within each of the three rooms in each building	Information useful for health of occupants, low makeup air to combustion appliances	$\pm$ 10 ppm OR $\pm$ 5%, whichever is greater, after 40 seconds

Particulate matter of 3 microns and greater in diameter	0 – 100 million particles per cubic meter	Flow rate verification, battery check	One location within each of the three rooms in each building	Useful for baseline indoor air quality; possible high concentrations may be due to combustion	
Particulate matter of 5 microns and greater in diameter	0 – 100 million particles per cubic meter	Flow rate verification, battery check	One location within each of the three rooms in each building	Useful for baseline indoor air quality; possible high concentrations may be due to combustion	
Carbon dioxide	0-10,000 ppm	Zero check, battery check	One location within each of the three rooms in each building	Useful for air exchange rate determination?	$\pm$ 50 ppm OR $\pm$ 5%, whichever is greater, after 60 seconds
Radon	"Picocuries of radon per liter" (pCi/L)	EPA lab analysis	Indoors; at least one location at the lowest floor of the building (See SOP)	To determine the amount of "picocuries of radon per liter" (pCi/L) is at or above 4 pCi/L	EPA lab analysis

7.2 Measurement Quality Objectives (MQOs)

Measurement quality objectives are designed to evaluate and control various phases (sampling, preparation, analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. MQOs can be defined in terms of the following data quality indicators:

Precision - a measure of mutual agreement among individual measurements of the same property usually under prescribed similar conditions, or how well side-by-side measurements of the same thing agree with each other. Sometimes, as in the case of environmental measurements such as temperature in the weighing lab, precision can be estimated by repeated measurements of the same thing over time. It is important that the measurements be as similar as possible, using the same equipment or equipment as similar as possible, and that what they measure is as similar as possible. Precision represents the random component of uncertainty. This random component is what changes randomly high or low, and which, try as you might, you cannot control with the equipment and procedures you are using. Precision is estimated by various statistical techniques using the standard deviation or, if you only have two measurements, the percent difference between them.

Bias - the systematic or persistent distortion of a measurement process that causes uncertainty in one direction. This means that the result is generally higher than it should be, or lower than it should be. These types of systematic errors are caused by poor calibration, or doing the same thing "wrong" for each of the measurements that makes each result either always higher or always lower than it should be. Bias is estimated by evaluating your measurement results against some known standard that you use as the "true" value. It is generally expressed as a positive or negative percentage of the "true" value.

Representativeness - a measure of the degree which data really represent some characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. For example, if you were trying to estimate the population exposed to $PM_{2.5}$ within a tribal boundary, representative measurements would be those that measure what the people breathe, rather than emissions from an industry on the land.

Detectability- The determination of the low range critical value of a characteristic that a method specific procedure can reliably discern. In other words, that level below which the instrument (e.g., scale) cannot tell the difference from zero. Because there is always variation in any measurement process (precision uncertainty), even when

weighing the clean filters, for example, the level of detectability depends on how much precision error is in the process.

Completeness - a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions.

Comparability - a measure of confidence with which one data set can be compared to another. Good comparability is very important so that data sets from one part of the country can be compared to data from another part of the country, or so that your data from one year can be compared to data from another year.

Accuracy has been a term frequently used to represent closeness to truth and includes a combination of precision and bias uncertainty components.

7.2.1 Makah Indoor Air Quality Study Objectives

The purpose of this study is to provide baseline information on the indoor air quality in the buildings used and lived in on the Makah Reservation. The information obtained in the study may be used for a variety of purposes. The first is to document the existing air quality in a subset of homes, so people understand how their indoor air quality compares to the quality of most homes and office buildings. The baseline data from this study may help to influence building standards on Indian land by providing this information to the Makah Tribes Housing Authority, Operations department, Realty office and the Planning department. The summery report will also be made available to the Makah Environmental Health office, Neah Bay Indian Health Services (BIA) Health Clinic, Makah Caregivers Program, Makah Senior Citizens Program, Clallam County Environmental Health Department and the Cape Flattery School District for informational and educational purposes.

The summery information will be publicly available, and may be used by people interested in improving indoor air quality. For example, problems with high humidity can be mitigated by using vapor barrier or other techniques, or high radon concentrations may be decreased by installing sub-slab ventilation, or high carbon monoxide concentrations may be decreased by installing more adequate makeup air systems. The measurement results may be used by the Makah Air Quality Project to increase public awareness of the importance of the various air quality hazards and how to address remediation strategies.

There are four general factors that have been considered when planning this study. These are:

- Representativeness of the sample of homes / buildings, the location of the measurements within these structures, and the conditions at the time of the measurements;
- Comparability of the measurement types and methods to other studies conducted by EPA and possibly future studies on the Makah reservation;
- Accuracy (total error) of the instruments and methods, which includes bias (calibration or systematic) error and precision (random) errors and
- Measurement results outside the range of accuracy of each instrument will be recorded and flagged to indicate potential inaccuracies. Only measured values in the accuracy range will be used for data statistics.

The buildings selected will be approximately representative of their proportion of buildings in the general community. A set of five buildings will be included from each of the six major types of buildings in the Makah community, resulting in a total of 30 structures (20 houses & 10 buildings) included in the final report. Measurements will be conducted during the winter of 2002-2003, during a time when homes are generally kept closed and indoor air quality is expected to be at its worst. This season extends through May.

Measurement methods used will be those commonly used by the construction and health industry so that results are comparable to other studies. Guidelines on indoor air measurements are available from EPA (EPA/400/9-91/033) and the equipment and methods used will be consistent with EPA guidance. Information on how to conduct each specific measurement is included on the data sheet for that parameter (attach data sheets as appendices).

References

1. EPA Guidance for Quality Assurance Project Plans EPA QA/G-5, EPA/600/R-98/018, February 1998
2. NIST Technical Note 1297, Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results"
3. Introduction to Indoor Air Quality, EPA/400/3-91/002
4. Building Air Quality, EPA/400/9-91/033

8.0 Special Training Requirements/Certification

Personnel assigned to the Indoor Air Quality assessment activities will meet the educational, work experience, responsibility, personal attributes, and training requirements for their positions. Records on personnel qualifications and training are maintained in personnel files and are accessible for review during audit activities.

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. Training is aimed at increasing the effectiveness of employees at the Makah air office. Sufficient time (at least 16 hours) will be provided by management to the personnel directly involved in this project (including field technicians) to read and understand this QAPP and the referenced documents.

Appropriate training is available to employees supporting the Air Quality Program, commensurate with their duties. Such training may consist of classroom lectures, workshops, teleconferences, and on-the-job training.

9.0 Documentation and Records

The following information describes the Makah Air Quality Project's document and records procedures for the Indoor Air Quality Assessment Project. The assessment records are defined as all the information required to support the concentration data reported to the tribal government and entities outside the Makah Air Quality Project office, including the EPA, which includes all data required to be collected as well as other information deemed important by the Makah Air Quality office. Table 9-1 identifies these documents and records.

The Makah Air Quality Project has a structured records management retrieval system that allows for the efficient archive and retrieval of records. The Indoor Air Quality Assessment information is included in this system. Table 9-1 includes the documents and records that are filed according to the statute of limitations discussed in Section 9.3.

Table 9-1 IAQ Reporting Package Information USE WHATEVER IS APPLICABLE

Categories	Record/Document Types
Management and Organization	Tribal air office Work Plan Reporting agency information Organizational structure Personnel qualifications and training Training certification Document control plan
Site Information	Building descriptions Site characterization information Site maps Site pictures Building floor plan sketch
Environmental Data Operations	QA Project Plans Standard operating procedures (SOPs) Field notebooks
Raw Data	Indoor Air Quality Assessment Worksheet Any original data (routine and QC data) including data entry forms
Data Reporting	Air quality index report Annual tribal air quality information Data/summary reports Journal articles/papers/presentations
Data Management	Data algorithms Data management plans/flowcharts Data management systems
Quality Assurance	Project reviews Control charts Data quality assessments QA reports System audits Response/corrective action reports

9.1 Annual Summary Reports

The Makah Air Quality Project shall submit to the Region 10 Office, a final summary report of the indoor air quality monitoring data. This shall occur after review and approval by the Makah Tribal Council. The report will contain the following information:

- Site and Assessment information.
- Site location and or address's (when applicable),

Jim Woods, as the senior air pollution control official for the Makah Tribe, will certify that the completed summary is accurate to the best of his knowledge. This certification is based on the various assessments and reports performed by the organization, in particular, the Annual QA Report discussed in Section 21 that documents the quality of the Indoor air assessment data and the effectiveness of the quality system.

9.2 Data Reporting Package Format and Documentation Control

Table 9-1 represents the documents and records, at a minimum, that must be filed into the reporting package. Note that this information is kept as supporting information in the tribal office and is not necessary to report to EPA unless agreed to in the grant language. All hardcopy information is filled out in indelible ink. Corrections are made by inserting one line through the incorrect entry, initialing this correction, and placing the correct entry alongside the incorrect entry, if this can be accomplished legibly, or by providing the information on a new line.

9.2.1 Notebooks

The tribal air office will issue a notebook to the field technician. This notebook is uniquely numbered and associated with the assessment project. Although data entry forms are associated with all routine field activities, the notebook can be used to record additional information about these operations.

Field notebook - A notebooks is issued for the sampling sites. These are 3-ring binders that will contain the appropriate data forms for routine operations as well as inspection and maintenance forms and SOPs.

9.3 Data Reporting Package Archiving and Retrieval

All the information listed in 9-1 is kept for 3 years from the date the data were reported unless otherwise noted in the funding agreement. However, if any litigation, claim, negotiation, audit or other action involving the records has been started before the expiration of the 3-year period, the records are retained until completion of the action and resolution of all issues which arise from it, or until the end of the regular 3-year period, whichever is later. The tribal air office will extend this regulation in order to store records for three full years past the year of collection. For example, any data collected in calendar year 2001 (1/1/01 - 12/31/01) is retained until, at a minimum, January 1, 2005; unless the information is used for litigation purposes.

10.0 Sampling Design

10.0 Procedure for selecting sample of building

The population of all building types includes tribal government buildings and residential homes. There are two subcategories of office buildings and four subcategories of residences, and a sample of five of each type of residences will be assessed. This will result in a total of thirty building assessments.

There are a variety of types of tribal government buildings, and the air quality specialist will use judgmental sample selection to include that the range of ages and types of buildings in the selection. At least ten tribal government buildings will be selected, including the day care center and the senior center.

There are four categories of residences and five homes will be selected from each of the following categories:

- Mobile/modular homes,
- homes less than five years old,
- homes between six and 20 years old,
- homes greater than 20 years old.

A target list of buildings will be made using the air quality specialist's best judgment as to which buildings are (a) representative of their category, and (b) have cooperative occupants who are willing to provide access and information. In the case when it is impossible to obtain information about a building, the air quality specialist will select another building for assessment, so that a total of thirty buildings will be included in the final study. The air

quality specialist will work with the housing authority and the Makah Realty department to choose homes and contact homeowners. The Tribal Operations department may be consulted to select the tribal government buildings.

10.1 Procedure for Conducting Measurement Locations in each Subset of Buildings

Three rooms or locations within each building will be selected for indoor measurements. The objective is to make measurements where people spend most of their time. In residences, at least two of the rooms will be bedrooms and all will be living areas, such as living rooms. If the residence has only one bedroom, one room selected will be the bedroom, one the living room, and one another central location. Measurements of radon should not be made in an area with plumbing fixtures such as in a bathroom, kitchen or any high humidity areas. The rooms in the office buildings will be selected so that measurements are made where people spend most of their time, which is usually near workstations.

Measurements of CO will be made in areas where there are combustion appliances, such as kitchens, utility rooms or mechanical rooms. A specific checklist of locations to avoid and locations to measure is included as the footer in the relevant data sheet.

10.5 Classification of Measurements as Critical/Non-critical

The critical measurements in this study are those that are measured with the equipment. Supplementary information, such as the general condition of the house, is just used as an indicator of potential indoor air problems, such as moisture and mold.

10.6 Validation of Any Non-Standard Measurements

The only data that will be part of this study that is not gathered directly by the air quality specialist may be (1) the age of the building, and (2) the address or legal description of the building. These are important in terms of selecting the building for inclusion in the study and for contacting the occupants, but are not critical in terms of making measurements that indicate health effects.

Visual and odor observations will be considered in the evaluation of potential IAQ problems.

11.0 Sampling Methods Requirements

11.1 Data Collection

The following steps will be followed to collect data:

- An appointment with the owner, resident, or responsible person will be made, allowing sufficient time for the assessment;
- The appropriate data sheets will be printed and packed;
- The appropriate equipment will be checked and packed (see equipment list in table 11-1);
- The air quality specialist will notify the responsible official when he arrives at the site and obtain their written permission to conduct the assessment;
- Location (address) and weather information will be noted on the data sheet;
- Outdoor observations will be made and recorded on the data sheet;
- Three rooms or locations within the building will be selected for indoor measurements. The objective is to make measurements where people spend most of their time. In residences, at least two of the rooms will be bedrooms and all will be living areas, such as living rooms or TV rooms. If the residence has only one bedroom, one room selected will be the bedroom, one the TV room, and one other central location. The

rooms in the office buildings will be selected so that measurements are made where people spend most of their time, which is usually on or near desks.

- The equipment will be turned on (allowing appropriate time for warm-up and/or boot-up of instrument's) and set up in each of the three areas/rooms;
- Indoor measurements will begin;
- Charcoal canisters will be placed in at least one area (in residences) and on or near a desk (in offices);
- Air quality (including radon) measurements will not be made within three feet of doors, windows, vents, stoves, heat-producing appliances, or in direct sunlight;
- Observations and results will be carefully logged on the data sheets as they are conducted. Specific information on each measurement is in the site data sheet for that measurement type (attached);
- Information about the charcoal canister will be given to the responsible building person or resident and a schedule for returning to retrieve the canister will be agreed upon.

After returning to the office, the air quality specialist will conduct data entry and file the paper copy of the site data sheets in the file associated with that building and measurement type. After the results have been entered, the air quality specialist will send the responsible building official a letter of thanks and a summary of the measurement results. If any results are higher than relevant guidelines, information on health effects of that pollutant and how to lower concentrations will be brought to the building in person by the air quality specialist and the information will be explained to the occupants.

11.2.1 Canister Set-up

The Air Quality Specialist will place two radon test canisters at each site at the time of the assessment. Canisters will be placed at locations with in areas commonly occupied by people at a height that would be considered at or below the breathing zone (on a dresser, nightstand or table). The occupants will be made aware of locations. At least five duplicate (side by side) sets of canisters will be placed in a subset of buildings.

11.2.2 Canister Recovery

The Air Quality Specialist will retrieve the canisters from the site at the designated time frame (4 days). The canister will then be re-sealed and labeled. The canisters are to be returned to the Tribal air quality office and data recorded and made ready for shipping to the lab for analyses. Shipping to the lab must occur as soon as possible after recovery, ideally within 48 hours.

11.3 Support Facilities for Sampling Methods

Since there are other items that the field operator may need during a site visit that are not expected to be at each site, the operator is expected to bring these items with him/her. Table 11-1 lists those items each operator is expected to bring with her.

Table 11-1 Site Dependent Equipment and Consumables

Item	Minimum Quantity	Notes
Tools	1 box	*Screw drivers, fitted wrenches, etc...*
Digital Multi meter (DMM)	1	*For troubleshooting electrical components, if trained to do so.*
Flash light	1	
Drop light	1	

Plastic / poly sheeting or drop cloth	1 roll	4 mill plastic to protect interior flooring
Extension Cord	50’	Must be grounded, 14/3 (min)
First Aid Kit	1 box	
Latex Gloves	1 box	
Safety Glasses	2 pr.	.
Canvas Drop cloth	2	Runner Type 4”x12” or 15” long

11.4 Sampling/Measurement System Corrective Action

If any of the measurement equipment appears to malfunction, the Technician will contact the QA Coordinator and the manufacturer to have repaired or replaced

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12.0 Sample Custody

Charcoal canister custody only, See Appendix.

13.0 Analytical Methods Requirements

The requirements for the indoor air quality measurements are as specified in Tables 6.1 and 7.1. These requirements are consistent with EPA. The requirements for the analysis of the charcoal canisters are described in the QAPP for the Radon Laboratory of the Radiation and Indoor Environments National Laboratory.

14.0 Quality Control

Quality control (QC) is 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. In the case of this network, QC activities are used to ensure that measurement uncertainty can be estimated and is less than the measurement quality objectives so that the DQOs can be met.

14.1 Quality Control Requirements

There are three main components of field-related quality control for this project.

14.1.1 First, there is the day-to-day quality control made using the instrument reliability checks shown in table 14.1. These are intended to monitor the stability of the instruments and document that they are operating consistently from one measurement to the next.

14.1.2 Second, all of the methods used allow for an estimation of precision made in one of several ways. Radon measurements made with charcoal canisters will be made side-by-side in a subset of ten percent of the locations. Hand-held instruments produce real-time estimates of the remaining parameters. In order to

estimate precision error for these parameters (CO2, CO, particle concentration, moisture content, air temperature, and relative humidity), measurements will be immediately repeated (allowing for adequate time) and the results will be recorded. This will be conducted in at least ten percent of all measurement locations. The site data sheet will include a line for the results of this check, if it is made, and allow for the results to be incorporated into the database. The requirements for these precision estimates and how results are handled are discussed in section 14.2 and again in section 24.

14.1.3 Third, there is the intercomparison of measured results using a more reliable system (the TSI Q-Track, model 8550) that will be conducted in the field, under a variety of conditions. This intercomparison will be conducted at least three times during the project; at the beginning, sometime during the middle months, and again at the end of the project. The criteria for the intercomparison and a description of the planned conditions are described in section 14.3. Although it is not a rigorous method of assessing accuracy, the TSI instrument is kept in the laboratory when not in use and is considered to be more stable and accurate than the hand-held instruments used routinely in this study. The results of these three intercomparison will serve as a rough estimate of accuracy of each parameter at the beginning, middle, and end of the project.

Table 14.1 Instrument Reliability QC Checks

Requirement	Frequency	Acceptance	Reference	Recorded
Self test	Every site visit, at the beginning of each set of measurements	No error codes	owners manual for each instrument	On data sheet for that pollutant and site
Zero check of CO meter. (Allowing appropriate time for warm-up and/or boot-up of instrument)	Outdoors, prior to entering each building at the beginning of each set of measurements	Meter set to zero using a screwdriver and adjustment screw	Owners manual for each instrument	On data sheet for CO and site
Outdoor check of CO2 (Allowing appropriate time for warm-up and/or boot-up of instrument)	Outdoors, prior to entering each building at the beginning of each set of measurements	Verification that meter indicates concentration between 380 and 450 ppm CORRECT IF THIS IS WRONG	Average ambient air concentration range (is there a reference for avg outdoor ppm?)	On site data sheet for CO2 and that site
Battery check	Ongoing	Acceptable results shown on the screen	owners manual for each instrument	On data sheet for that pollutant and site
Flow rate check for particulate monitor (Allowing appropriate time for warm-up and/or boot-up of instrument)	At beginning and end of each sample period	The flow rate must be between 2.80 and 2.86 lpm, as shown on the screen SPECIFY IF YOU DISAGREE	Met One GT-321 owners manual	On data sheet for particulate matter for each site

14.2.1 Duplicate measurements with charcoal canisters

At least ten percent of locations where charcoal canisters are placed will receive duplicates. Canisters will be placed about 4 inches (10 cm) apart and opened and sealed at the same time. A record of the duplicates and canister number and locations will be make in the project logbook and on the site data sheets, as well as the charcoal canister data sheets. The air quality specialist, based on a rough estimate of every tenth location, will select locations.

Locations will be chosen where there is enough space for two canisters and where they are most likely to be undisturbed.

14.2 QC Assessments for Duplicate Radon Canisters

Results will be analyzed using equation 1 to calculate relative percent difference (RPD). Pairs where either of the results is 0.5 pCi/l or less will not be used in the precision calculations. The goal for each pair is a RPD of ten percent or less. If any result indicates a RPD greater than ten percent, the air quality specialist will investigate whether the canisters may have been moved during their exposure period. If possible, the duplicate measurements will be repeated.

The overall estimate of precision error for the radon measurements will be generated by the pooled coefficient of variation for all the pairs. This is calculated by:

(a) generating the coefficient of variation (COV) for each pair, by dividing the RPD by the square root of two (1.414).
(b) Then, add up all the COVs.
(c) Then, divide the sum by the number of pairs.

This is an estimate of the precision error associated with each charcoal canister result.

14.3 Precision Assessments with CO, CO2, Moisture Content, Temperature, Particle Count, and Relative Humidity

Approximately ten percent of the measurements will include a precision estimate made by repeating the measurement within the same hour or so. Measurements should be made in exactly the same location, under the same conditions. It is adequate to immediately repeat the measurement, if enough time is allowed for both measurements. Results of the repeated measurement will be recorded on the site data sheet for that pollutant. If the results of the initial measurement are greater than the range shown in Table 14.2, the handheld calculator will be used by the air quality specialist to allow an immediate calculation of whether the repeated measurement was within ten percent of the first measurement. This calculation will not be made if levels are below those shown in Table 14.2, because at low concentrations, the repeatability of measurements decreases. Note that this will limit the locations where the repeated measurements can be made.

Table 14.2 Range below which precision is not calculated

Parameter	Range below which 10% agreement between repeated measurements does not apply
Moisture in wood	0.10 as a proportion of water to solid
Moisture in non-wood materials	N/A—repeated measurements not conducted for non-wood materials
Air temperature	Repeated temperature measurements should be within 10% or 1 degree C
Relative humidity	10% RH
Carbon monoxide	10 ppm
Particulate matter of 3 microns and greater in diameter	1 million particles per cubic meter
Particulate matter of 5 microns and greater in diameter	0 – 100 million particles per cubic meter
Carbon dioxide	200 ppm
Radon	0.5 pCi/l

14.4 Evaluation of Measurement Error via Intercomparisons with the TSI Q-Track

At the beginning of the study, the QA Coordinator will bring a recently calibrated TSI model 8550 indoor air monitor (see section 14.1.3) to the Makah community to conduct an intercomparison exercise with the instruments used in this study. Measurements will be made in a stable environment, such as an office, and preferably where concentrations of most of the pollutants are greater than the limits listed in Table 14.2. The instruments measuring CO, CO2, temperature, and relative humidity will be set up with intakes within one meter but not closer than 10 cm to the intake of the Q-track. Measurements will be made over periods similar to those used in the buildings in the study. Results will be logged in the logbook on an intercomparison data sheet.

The objective for the bias between the Q-track and the field instruments will be ten percent. A relative percent difference between the Q-track and the field instrument will be calculated using the spreadsheet in Appendix B (Melinda will do—unless Rich already has?), using the Q-track as the "standard" results in the denominator.

If results are not within ten percent, the QA Coordinator and the air quality technician will consult on whether to adjust the field instrument or to replace it. All adjustments will be logged in the project logbook, after being approved by the QA Coordinator.

This intercomparison will be conducted at least three times during the project. The first intercomparison will be conducted during the first several days when measurements are being made. The second intercomparison will be conducted during the middle months of the project. The final intercomparison will be conducted during the final month of the project during the spring of 2003. Overall results will be evaluated and summarized in the project records and in a report to the Makah air quality management.

15.0 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

The equipment used in this project is self-contained and requires no maintenance. System checks are conducted as described in section 14, and if there appears to be any instrument malfunction the air quality technician will first consult the QA Consultant for the project, Richard Prill. He may suggest general troubleshooting activities such as checking the batteries of internal connections. If the equipment does not return to normal operation, replacements will be obtained.

15.3 Inspection of Field Items

All field items including tools, equipment and instruments shall be examined daily, before and after each site visit.

16.0 Instrument Calibration and Frequency

16.1 Calibration frequency

The Instruments used in this project are self-contained and pre-calibrated in the factory and require no maintenance. System checks are conducted three times during this project as described in section 14, and if there appears to be any instrument malfunction the air quality technician will first consult the QA Coordinator for the project, Richard Prill. He may suggest general troubleshooting activities such as checking the batteries or internal connections. The QA

Coordinator will check and make comparisons to a "Q-Trak™ IAQ Monitor, Model # 8551" and in most cases may use outside or fresh air as a comparable method of reference along with the gas calibrated Q-Trak™ IAQ Monitor.

Table 16.1 List of Instrument and their calibration frequencies.

Instrument	Frequency	Reference
Telaire® 7001 (CO2)	In Factory	In Factory calibration every 12 months
Monoxor® II (CO)	In Factory and by field Technician	Operation Manual, Operatio/4.2 zeroing the instrument.
GT-321 Aerosol Particulate Monitor	In Factory, pre-calibrated	Operation Manual
Delmhorst BD-10 Moisture Meter87	In Factory and self calibration check button	Operation Manual
Model LAM880D, 8703 Thermo - hygrometer. Temp/RH	In Factory	Operation Manual on 8700 Series

17.0 Inspection/Acceptance Requirements for Supplies and Consumables

Table 17.1 describes the critical supplies:

Table 17.1 Critical Supplies and Consumables

Area	Item	Description	Vendor	Model Number
Instrument	Battery	9 volt	Purchase local	
Instrument	Battery	AAA	Purchase local	
Instrument	Battery	AA	Purchase local	
All	Low-lint wipes			
ALL	Paper towels		Purchase local	
All	Latex Gloves	Latex Gloves	Global	

17.1 Acceptance Criteria

Acceptance criteria must be consistent with overall project technical requirements. In general, acceptance criteria such as observation of damage due to shipping can only be performed once the equip ment has arrived on site.

18.0 Data Acquisition Requirements for Outside Data

This section addresses data not obtained by direct measurements. This includes outside data, geographical locations, and historical. Any supplementary data acquired from other sources such as the National Weather Service, Tribal Departments (Realty, Operations or Housing Departments) will be considered valid. This data will only be used for the purposes of ownership, occupancy, locations and weather or other Information that is specific to the sites described in this project.

19.0 Data Management

This section describes the data management operations pertaining to indoor air measurements by the Makah Air Quality Project. It provides the requirements for how the data are transferred from the site into the database and how the data are reported. These operations include data recording, validations, calculations, transmittal, analysis, storage, and retrieval.

All sampling data will be entered into the tribal air database / file system through manual entry, electronic transfer from the field, or both. Data is organized and filed as shown in Table 9.1. The database runs on the office's desktop computer. Appropriate security (password) is assigned to each person who must use the database. Different privileges are given each authorized user depending on that person's need.

19.1 Data Recording

Chain of custody sheets will be used, along with the field notebook, to record all data transfer activities in the field. Verification of the data entered is discussed in the following section.

19.2 Data Validation

Data validation involves checking that data processing operations have been carried out correctly and monitoring the quality of the field operations. Condition flags never internally overwrite numerical data stored in the database. Flags denoting error conditions or QA status are saved as separate fields in the database, so that it is possible to recover the original data. A summary of data validation steps is in Table 19.1.

Table 19.1 Validation Check Summaries

Type of Data Check	Electronic Transmission and Storage	Checked "by hand," field by field
Data Parity and Transmission Protocol Checks	X	
Date and Time Consistency		X
Completeness of Required Fields		X
Range Checking		X
Correct data entry		X
Statistical Outlier Checking		X
Manual Inspection of Charts and Reports		X

19.3 Data Reduction

Examples of data summaries include:

- Average concentration of each pollutant in each location, and
- Average concentration of each pollutant in each building;

All backups will be retained so that any audit trail information can be retrieved for at least three years.

19.8 Data Storage and Retrieval

Data archive policies are shown in Table 19.3.

Table 19.3 Data Archive Policies

Data Type	Medium	Retention Time	Final Disposition
Field data sheets	Hardcopy	3 years	Discarded
Field Notebooks	Hardcopy	3 years	NA
reports	Electronic (on-line)	5 years	NA

19.9.1 Data Reporting

Measurement results outside the range of accuracy of each instrument will be recorded and flagged to indicate potential inaccuracies. Only measured values in the accuracy range will be used for data statistics.

20.0 Assessment and Response Actions

The results of assessments indicate whether the control efforts are adequate or need to be improved. Documentation of all quality assurance and quality control efforts implemented during the data collection, analysis, and reporting phases is important to data users, who can consider the impact of these control efforts on the data quality (see Section 21). Both qualitative and quantitative assessments of the effectiveness of these control efforts will identify those areas most likely to impact the data quality and to what extent.

In order to ensure the adequate performance of the quality system, the Makah Air Quality Project will perform the following assessments:

- Field Performance Evaluations
- Data Quality Assessments

20.1 Field Performance Evaluations

Field performance evaluations reveal how the data are handled, what judgments were made, and whether uncorrected mistakes were made. The field performance evaluations are completely described in section 14.3. Results will be interpreted as soon as possible, and before further measurements in homes are made, so that any corrective action can be taken. Results be interpreted in terms of the bias between the Q-track instrument and the hand-held instruments, and the Q-track will be assumed to be unbiased for the purpose of this assessment. Results will be in the form of a spreadsheet, listing the results of the Q-track and the results of the hand-held instruments, and the percent difference between them. After making any necessary adjustments to the hand-held instrument(s), the comparison will be repeated to verify that the instrument is now operating properly. An internal, informal report in the form of a memo to the Program Director will also describe any corrective actions that were taken and their effectiveness.

20.2 Data Quality Assessment

Measurement statistics and summaries will be calculated and reviewed for each quarter and year, as well as other time periods deemed relevant to the Makah Air Quality Project. For example, data summaries may be reviewed for each season, during periods of high winds, precipitation, or severe temperature differences between indoor and outdoor temperatures. In general, the data will be reviewed each month or more frequently. The statistics described in section 14 will be calculated as well as the average of each parameter during the time period at each location (room and building).

20.3 Documentation of Assessments

Assessment reports will be filed, reported to air office management, and available at all times in the case of an audit by the EPA regional office.

21.0 Reports to Management

This section describes the quality-related reports and communications to management necessary to support the program.

21.1 Quarterly Reports

Reports will be issued each quarter or more often as requested by the air office management.

21.2 Final Report

A report describing the study will be issued by the air office after appropriate review by the personnel involved and peer reviewers. A copy of the final report will be sent to all interested building occupants who participated in the study.

21.3 Information Provided to Building Occupants

At the inception of the study, a fact sheet will be given to interested building occupants describing the measurements that will be performed. This sheet will be provided when asked and/or when the responsible building official signs the agreement to participate in the study.

As the data from each building are gathered, building occupants will be interested in the results. In general, it is appropriate to provide occupants with information about the general range of the measurements made and the expected ranges in similar buildings as the data are obtained. For example, occupants may watch the measurements as they are gathered and ask the air quality technician what the results are and how they should be interpreted. Measurement results should not, however, be given out in report form until some review has occurred. At the least, this review must include the QA Coordinator.

A set of brochures and pamphlets containing information on the parameters measurement should be taken to each building. These brochures are those that are available from the EPA regional office and the EPA Internet site about indoor air quality.

22.0 Data Review, Validation and Verification Requirements

This section describes how the Makah Air Quality Project will verify and validate the data collection operations. Verification can be defined as confirmation by examination and provision of objective evidence that specified ***requirements*** have been fulfilled. Validation can be defined as confirmation by examination and provision of objective evidence that the particular requirements ***for a specified intended use*** are fulfilled. Although there are a number of possible uses for this data, the objective is for obtaining baseline information on the indoor air quality of the northwest coast and therefore, this will be identified as the intended use.

22.1 Sampling Design

The objective of the sampling design is to represent the population of buildings on the Makah land. When the final report is written, the air quality technician, the QA Consultant, and any peer reviewers will review the buildings chosen for the study and their representativeness of the population.

22.2 Data Collection Procedures

The review of QC data such as the performance evaluation, and the sampling equipment verification checks that are described in Sections 14 can be used to validate the data collection activities. Any data that indicates unacceptable levels of bias or precision will be investigated.

22.3 Quality Control

Section 14 of this QAPP specifies the QC checks that are to be performed during data collection. Validation of QC procedures includes a review of the documentation of the corrective actions that were taken when QC checks failed to meet the acceptance criteria, and the potential effect of the corrective actions on the validity of the routine data. The air quality specialist and the QA Consultant conduct this review on an ongoing basis.

22.4 Calibration

Routine instrument performance checks are performed to ensure the calibration remains stable. If a degradation of the calibration factor occurs, it will be obvious to the site operator because the routine instrument performance checks will indicate changes in the system. Any data that indicates unacceptable instrument response will be investigated. This investigation could lead to a discovery of inappropriate calibration procedures, or equipment problems requiring corrective action.

22.5 Data Reduction and Processing

At the time of the final report, a subset of raw data will be reviewed and the average concentrations by room and by building will be calculated by hand to determine if the final values submitted are the same as those produced by a second calculation.

23.0 Validation and Verification Methods

Exceptional field events may occur and field activities may negatively affect the integrity of data files. In addition, some of the QC checks will fail to meet the requirements. It is important to determine how these failures affect the routine data. This section describes the methods that will be used to evaluate the data.

A thorough review of the data will be conducted for completeness and data entry accuracy. All raw data that is hand entered from data sheets will be double-checked. The entries are compared to reduce the possibility of entry and transcription errors.

Records of all invalid data files will be filed, including the original results. Information noted with the result includes a brief summary of why the data file was invalidated along with the associated flags. This record will be available on the database. At least one flag will be associated with an invalid data file, that being the "INV" flag signifying invalid. Additional flags will usually be associated with an the INV flag that helps describe the reason for this flag, as well as notes from the site operator.

24.0 Reconciliation with Data Quality Objectives

Reconciliation with the data quality objectives (DQOs) involves reviewing both routine and QA/QC data to determine whether the DQOs have been attained and that the data is adequate for its intended use. This process is termed data quality assessment (DQA).

The measurement quality objectives (MQOs) listed in Table 14.1 are the goals for measurement uncertainty that, if met, will achieve the overall data quality objectives for this project. The following sections describe how the calculations will be made to determine if the MQOs have been met.

24.1 Calculations for Precision

24.1.1 Precision error of charcoal canister measurement results

The results of the collocated canisters as described in section 14.3 will be analyzed as follows.

Results will be analyzed using equation 1 to calculate relative percent difference (RPD). Pairs where either of the results is 0.5 pCi/l or less will not be used in the precision calculations. The goal for each pair is a RPD of ten percent or less. If any result indicates a RPD greater than ten percent, the air quality specialist will investigate whether the canisters may have been moved during their exposure period. If possible, the duplicate measurements will be repeated.

The overall estimate of precision error for the radon measurements will be generated by the pooled coefficient of variation for all the pairs. This is calculated by:

- generating the coefficient of variation (COV) for each pair, by dividing the RPD by the square root of two (1.414).
- Then, add up all the COVs.
- Then, divide the sum by the number of pairs.

This is an estimate of the precision error associated with each charcoal canister result.

24.1.2 Precision assessments with CO, CO2, moisture content, temperature, particle count, and relative humidity

Approximately ten percent of the measurements will include a precision estimate made by repeating the measurement within the same hour or so. If the results of the initial measurement are greater than the range shown in Table 14.2, the handheld calculator will be used by the air quality specialist to allow an immediate calculation of whether the repeated measurement was within ten percent of the first measurement. This calculation will not be made if levels are below those shown in Table 14.2, because at low concentrations, the repeatability of measurements decreases. Note that this will limit the locations where the repeated measurements can be made.

24.2 Evaluation of Measurement Error via Intercomparisons with the TSI Q-Track

The intercomparison conducted three times during the project is described in section 14.3. The results will be analyzed as follows.

The objective for the bias between the Q-track and the field instruments will be ten percent. A relative percent difference between the Q-track and the field instrument will be calculated using the spreadsheet in Appendix B (Melinda will do—unless Rich already has?), using the Q-track as the "standard" results in the denominator.

If results are not within ten percent, the QA Coordinator and the air quality technician will consult on whether to adjust the field instrument or to replace it. All adjustments will be logged in the project logbook, after being approved by the QA Coordinator.

25.0 APPENDICES

(Attachments)