Meteorological Siting Study

Ludeman Project
Glenrock, Wyoming

Prepared for:

Uranium One

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Brief Description

The proposed project is located in Converse County approximately 15 miles northwest of Douglas, Wyoming. The project area contains nearly 30 square miles, with elevations ranging from 4,900 to 5,400 feet. It is characterized by mildly rolling terrain with a few small drainages trending southward toward the North Platte River. The project area and proposed meteorological station location are overlain on aerial imagery in Figure 1. Also shown are two alternative meteorological station locations. Table 1 below provides the GPS coordinates of the preferred and alternative locations in UTM, Zone 13, NAD27.

Site Name	Easting (UTM)	Northing (UTM)	Latitude	Longitude
Met Option 1	444385.8	4752034.3	42.92	-105.68
Met Option 2	444018.3	4751087.8	42.91	-105.69
Met Option 3	449899.3	4752944.1	42.93	-105.61

Table 1. Meteorological Siting Location Coordinates

In order to comply with necessary conditions from the Nuclear Regulatory Commission (NRC), baseline meteorology will be monitored in accordance with Regulatory Guide 3.63 as well as EPA approved protocol. The following monitoring plan details the monitoring techniques, sensors, quality assurance methods, and data management procedures to be used in this meteorological monitoring program.

Meteorological Monitoring

The objective of meteorological baseline monitoring at the Ludeman Project is to support the locations of any future air quality monitoring stations and to enable the modeling of radioactive emission impacts using the MILDOS-AREA model. This monitoring will also support water related permitting activities. Baseline monitoring will be conducted for a minimum of one year.

Site Selection

Guidance for locating the meteorological monitoring station for the proposed mine was obtained from the U.S. NRC (NRC, 2008) and the U.S. EPA (EPA, 2000 and EPA, 2008). Accordingly, the following siting criteria were considered:

1. Representativeness – the chosen site should represent as closely as possible the long-term meteorological characteristics of the area of interest. The meteorological monitoring instruments should be located as close as possible to the emission sources for which monitoring is being conducted. The tower should be situated in the same meteorological regime as the emission sources. The wind sensors should be located on the monitoring tower at a height close to the emission source heights.

2. Terrain – if the overall terrain is simple, the monitoring site should be chosen to minimize local terrain effects. For complex terrain, the tower should be located at an aspect ratio of at least 10:1 from prominent terrain features.
3. Obstructions – the tower should be located as far as practical from obstructions such as trees and buildings, maintaining a minimum aspect ratio of 10:1 from such obstructions.

For the Ludeman Project, the terrain is relatively flat or rolling, mildly sloping to the south with a few ephemeral drainages. Therefore, the meteorological siting is more representative of a simple terrain location. “Simple terrain” means any site where terrain effects on meteorological measurements are minimal.

The nearest meteorological monitoring station providing hourly wind data is the Glenrock Mine, which was deactivated in 2009. The Glenrock Mine site is approximately 12 miles northwest of the Ludeman site. The dominant wind direction recorded at the Glenrock Mine for a 10-year period spanning from 1999 through 2008 was from the west-southwest sector, with westerly winds constituting the next most prominent direction (Figure 2). The proposed monitoring site at Ludeman (Met Option 1) is therefore downwind from the proposed satellite plant and evaporation pond facilities. Met Option 1 is also located on a high, unobstructed plain which will minimize local topographic influences and will closely represent regional weather patterns (Figure 3).

Several alternative locations were inspected as potential sites for the meteorological station. Many of these locations were eliminated from consideration due to poor accessibility, land ownership constraints, low elevation, or the presence of localized topographic features. Met Option #2 remained a viable alternative, although not as flat or accessible as Met Option #1. Met Option #3 is also a possibility, but this location is several miles from the proposed Ludeman facilities and could be inaccessible in the winter.

Met Option 1 was chosen as the preferred site due to its proximity and similar elevation to the proposed satellite plant, evaporation pond, and two of the six proposed well fields. All of these could be sources of radioactive emissions. The other four well fields are dispersed throughout the project region, such that no single tower location would be close to all six well fields. Met Option 1 is also preferred for its relatively flat terrain and high elevation, conducive to measuring regional wind conditions. This option is believed to be the most representative of the project area in general, and of the proposed satellite plant location in particular.

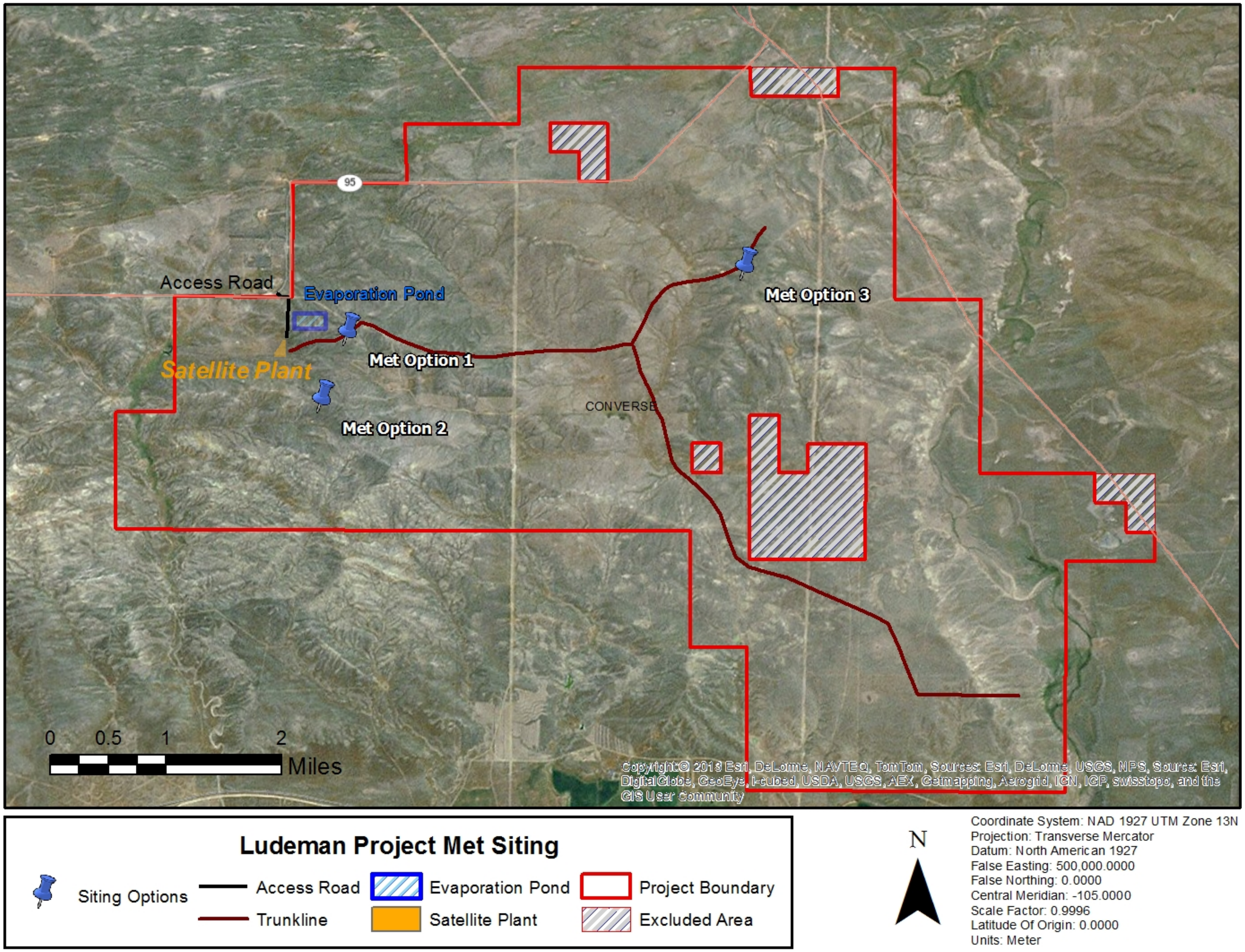

Figure 1. Project Location

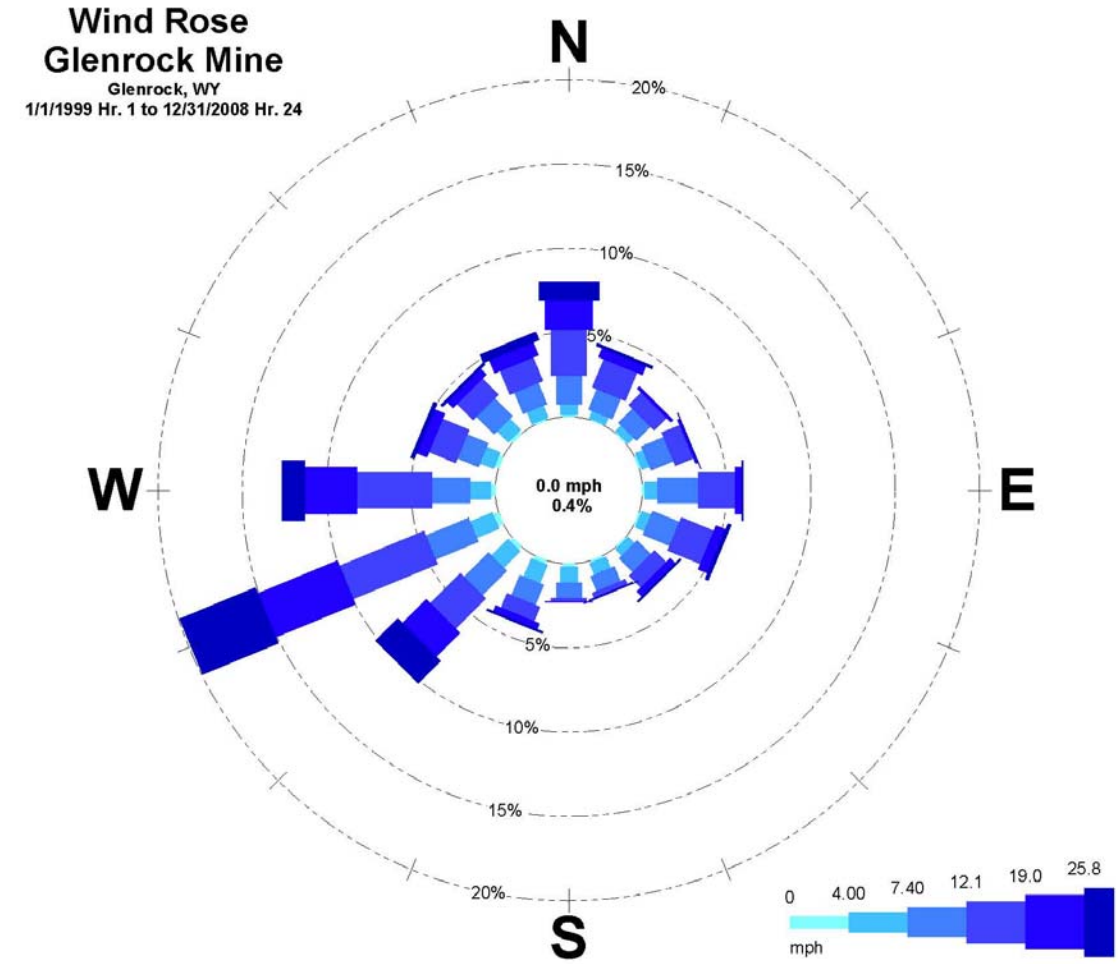

Figure 2. Project Area 20-Year Wind Rose

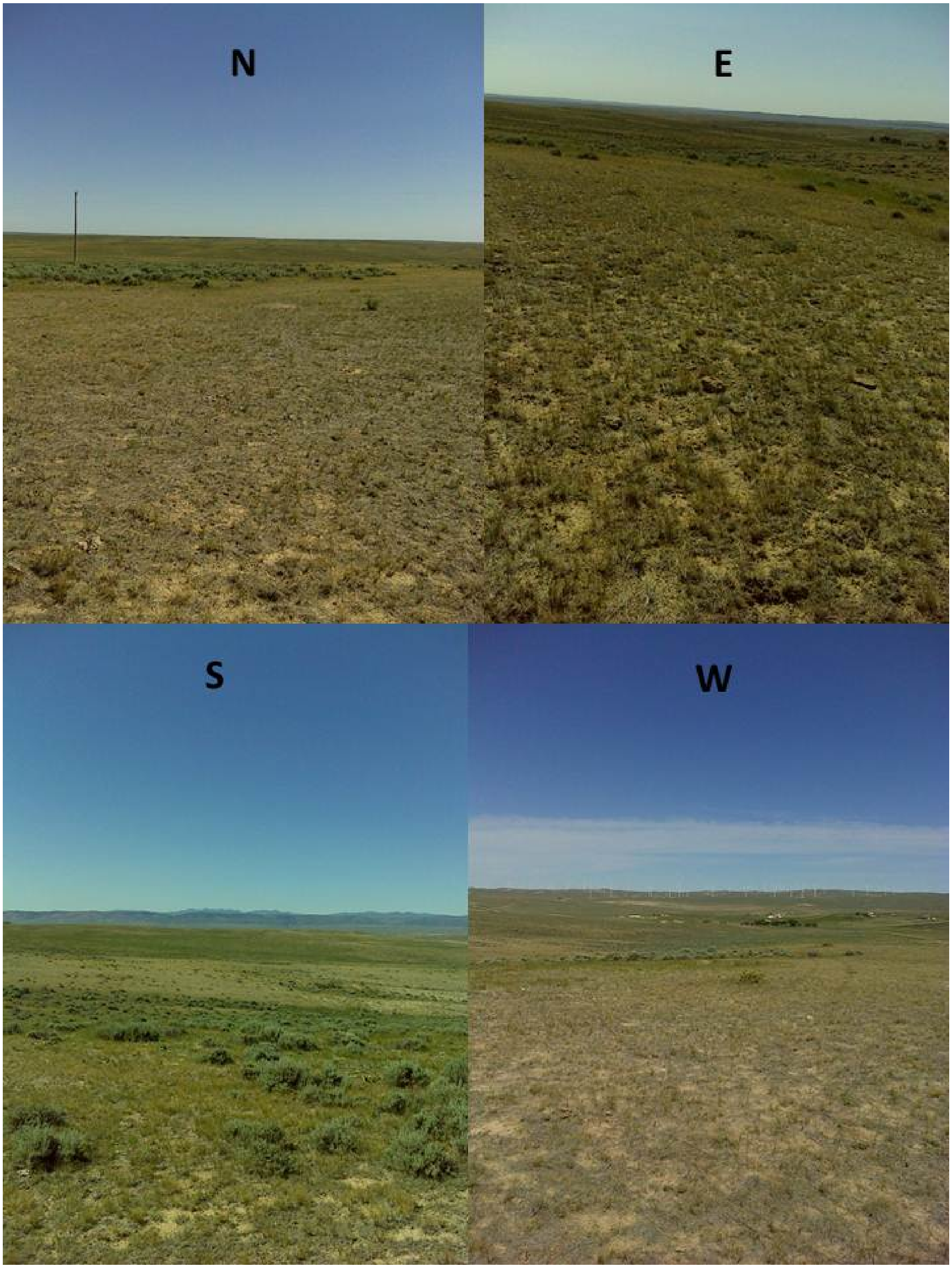

Figure 3. Met Option 1 As Viewed from Cardinal Directions

Monitoring Tower

Both EPA and NRC guidance recommend 10 meters as a standard height for meteorological monitoring towers. The AERMOD dispersion model requires 10 meters at minimum. Tower heights should also match source heights. Therefore, the proposed meteorological monitoring system will consist of a set of sensors mounted on a 10 meter tower. Details of the tower and base installation are provided in Appendix A of this document.

Parameters Monitored

Uranium One may choose to move an existing meteorological monitoring station from the Moore Ranch site to the Ludeman site. This meteorological monitoring station is configured to fully support dispersion modeling in accordance with both MILDOS and AERMOD requirements. The temperature measurements will consist of a set of matched probes at 2 and 10 meters high. The anemometer, wind vane, and pyronometer (solar radiation) will also meet the AERMOD criteria for their respective parameters. The solar radiation and vertical temperature gradient measurements provide a source for calculating atmospheric stability class, which both the AERMOD and MILDOS models require. NRC Regulatory Guide 3.63 also recommends relative humidity, precipitation and evaporation gauges.

The Moore Ranch station does not measure evaporation, so this would need to be added. Barometric pressure would be considered optional based on both EPA and NRC guidance.

Hourly and Sub-hourly values will be recorded for:

- Average horizontal wind speed at 10 meters
- Peak horizontal wind speed (5-second wind gust) at 10 meters
- Average horizontal wind direction at 10 meters
- Average standard deviation of horizontal wind direction
- Average ambient temperature at 2 meters
- Average ambient temperature at 10 meters
- Average difference in ambient temperature between 2 meters and 10 meters (calculated temperature lapse rate or delta-T)
- Average relative humidity
- Sample barometric pressure
- Total precipitation
- Average solar radiation
- Total evaporation (proposed to be added)

All sensors will be connected to a data logger, which will sample the electronic signals from the individual sensors once each second. The data logger will be connected to a phone modem, allowing access to the system from a remote PC equipped with a similar modem. The one-second measurements will be averaged

by the data logger once every 15 minutes and every hour to provide the recorded averages. The data will be stored in battery backed final storage in the data logger.

Meteorological Instrument Specifications

Table 2 lists the instruments to be employed, along with associated performance specifications.

Proposed Ludeman Project Meteorological Station					
Parameter	**Instrument**	**Range**	**Accuracy**	**Threshold**	**Instrument Height**
Wind Speed	RM Young 05305 Wind Monitor AQ	0 to 112 mph	±0.4 mph or 1% of reading	0.9 mph	10 meters
Wind Direction	RM Young 05305 Wind Monitor AQ	0 to 360º	±3º	1.0 mph	10 meters
Temperature	RM Young RTD Temperature Probe Assembly	-25º to 50º C	±0.2º C @ given range	-- º C	2 meters
Temperature	RM Young RTD Temperature Probe Assembly	-25º to 50º C	±0.2º C @ given range	-- º C	10 meters
Temperature Lapse Rate	RM Young RTD Temperature Probe Assembly	Difference Calculation	±0.1º C	-- º C	2 meters
Relative Humidity	CS 215 Temp and RH Probe	0 to 100%	±2% at 23º C	--	2 meters
Barometric Pressure	Vaisala CS106 Barometer	0 to 944" Hg	0.25%	--	2 meters
Precipitation	Texas Electronics 8" Heated Tipping Bucket Precipitation Gauge	0 to 10 in/hr	±0.5% @ 0.5 in/hr rate	0.01"	1 meter
Solar Radiation	Apogee CS300 Pyranometer	0 to 2,000 w/m^2	±5%	--	2 meters
Evaporation	Novalynx 255-100 Evaporation Gauge	0 to 944"	0.25%	0.01"	1 meter
				-- º C	1 meter
Data Logger	Campbell Scientific CR1000 Data Logger	--	--	--	--

Table 2. Meteorological Instrument Specifications.

Meteorological Measurement System Quality Assurance

The accuracy of meteorological measurements at the project will be assessed by auditing the performance of the system for each measured parameter. Traceable reference standards will be used to provide known conditions with which to evaluate system response. Independent audits will be conducted using a different set of traceable reference standards and by different personnel from those used to perform system adjustments and/or calibrations.

Instrument audits are required to be performed within 30 days of installation and on a semi-annual basis thereafter to ensure data quality. In the event of repairs, alterations, or calibrations to any or all portions of the system, an audit will be performed before returning the system online. Before decommissioning of the system, a shut-down audit will be performed to ensure accurate data collection.

Temperature accuracy will be assessed at a minimum of three points using either wet or dry thermal mass devices and a traceable temperature reference standard. Wind speed will be assessed by rotating the anemometer shaft at a minimum of five known rotation rates with a quartz drive motor. Using the transfer equation for the anemometer, known wind speeds will be determined and compared with the system response.

Cross arm mount or landmark alignment will be checked with a transit. The anemometer/wind vane will be aligned perpendicular and parallel to the cross arm. The wind vane will be pointed toward and 180° away from a landmark or set of landmarks if a cross arm is not present. The system response will be compared to transit readings taken from prominent landmarks. Ideally, landmarks will also be identified that are approximately 90° apart from the station alignment. Wind direction linearity will also be checked by evaluating system response at the four cardinal directions with a clockwise and counter clockwise rotation.

Precipitation gauge accuracy will be checked by introducing water into the gauge with a burette and recording the volume which corresponds to a defined number of tips. The number of tips at the gauge must match the number of tips recorded by the data acquisition system. The volume of water necessary to tip the bucket will be within 10% of the accuracy criteria as defined by the manufacturer's specification. Barometric pressure and relative humidity will each undergo a one-point comparison to a traceable reference standard particular to each parameter. Solar radiation will undergo at least one daytime and one dark (zero) instantaneous or time averaged comparison to a traceable reference standard.

System audits and calibrations will be recorded in the field and reported at the end of the appropriate calendar quarter. Appendix B provides a sample meteorological audit/calibration report.

Meteorological Data Acquisition, Data Quality Assurance and Reporting

The system will utilize Campbell Scientific LoggerNet software to operate the data logger and to interface with a remote PC(s). Programming and control logic for the CR1000 data logger will be created specifically for the project baseline monitoring. Recorded hourly and sub-hourly data will be downloaded to a PC every fifteen minutes by means of cellular phone modem.

Data validation will entail a combination of ensuring that data processing operations have been carried out correctly and of monitoring the quality of the internal QC assessments. Data validation can identify problems in either of these areas. Once problems are identified, the data will be corrected or invalidated, and corrective actions will be taken.

Data validation will be performed through both automated and interactive procedures. Software tools will perform a preliminary check of hourly data to find anomalies (unreasonable values, instrument fault status, etc.). A meteorologist will review the results of these checks, along with site inspection records, field data sheets, and any other available information, to make validation determinations.

Following preliminary checks, meteorological data are evaluated for reasonableness for the season and may be checked with other data collected at nearby sites. Data are considered invalid when either their value or their rate of change is unreasonable, when observations or audit results indicate a sensor is not operating properly, and when the system was being audited or serviced. All invalidated data and the reason for the invalidation, including invalidation code and qualifier, will be documented in the quarterly reports.

Data recovery goals will conform to NRC and EPA guidelines. These guidelines specify at least 90% recovery for any single meteorological parameter. Furthermore, they specify at least 75% joint (simultaneous) recovery of wind speed, wind direction, and all parameters used to determine atmospheric stability class (e.g., solar radiation and delta temperature).

Reports of all quality-related activities, including assessments, validation or invalidation, and corrective actions will be included in quarterly reports. Quarterly reports will be submitted to the owner and designated agency within 60 days following the end of the calendar quarter. Quarterly reports will include meteorological summaries, wind roses, and hourly record lists that have undergone quality assurance.

References

U.S. NRC, Regulatory Guide 3.63*, Onsite Meteorological Measurement Program for Uranium Recovery Facilities – Data Acquisition and Reporting*, March 2008.

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U.S. EPA, *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*, February 2000.

U.S. EPA, *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements Version 2.0;* March, 2008

APPENDIX A

Meteorological Tower Installation Details

18 Base Installation

1. Dig a hole 36" square and 48" deep where the tower base will be located (Figure 2.1-3).

2. Optional—construct a concrete form out of 2" x 4" lumber 36" square (inside dimensions). Center the form over the hole and drive two stakes along the outside edge of each side. Level the form by driving nails through the stakes and into the form while holding the form level.

3. Attach the bottom section of the tower to the B18 base using one bolt per leg, making sure that the hinge direction is common for all legs.

4. Center the bottom tower section with the base attached in the hole. Orient the tower/base for the proper hinge direction. Make sure that the top of the legs will be at least 1/2" above the finished height of the concrete (Figure 2.1-4).

5. Fill the hole with concrete. Getting the bottom tower section plumb is very important. As concrete is poured into the hole, periodically check the tower for plumb using a carpenter's level and make adjustments as necessary. Allow three to four days for the concrete to cure.

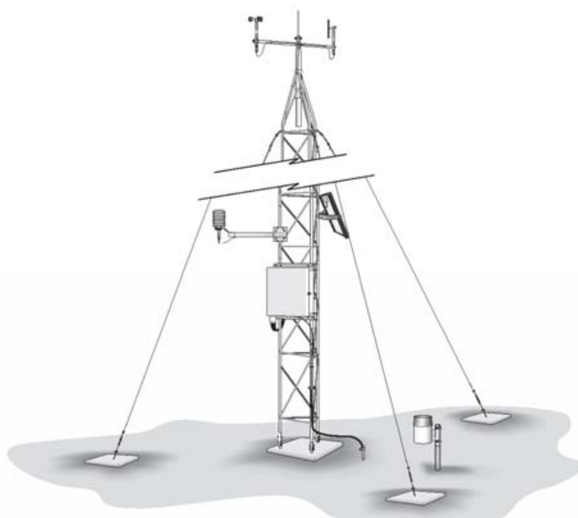

FIGURE 2.1-1. UT30 Tower-Based Weather Station

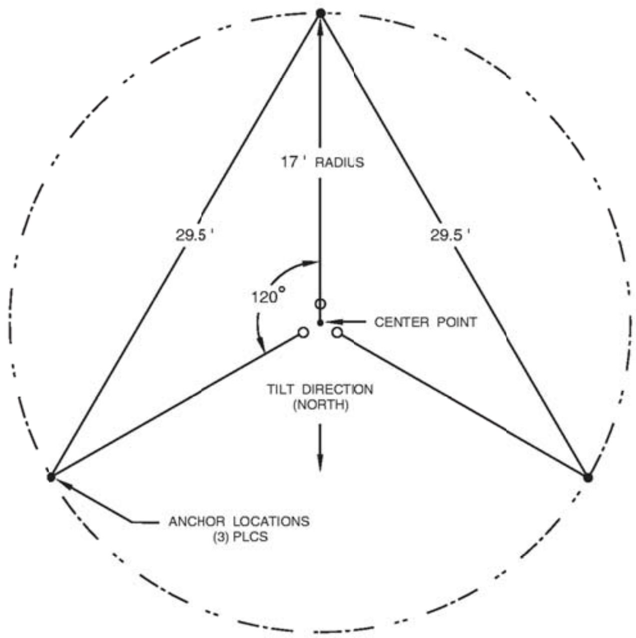

FIGURE 2.1-2. Top View of Base and Guy Anchor Layout

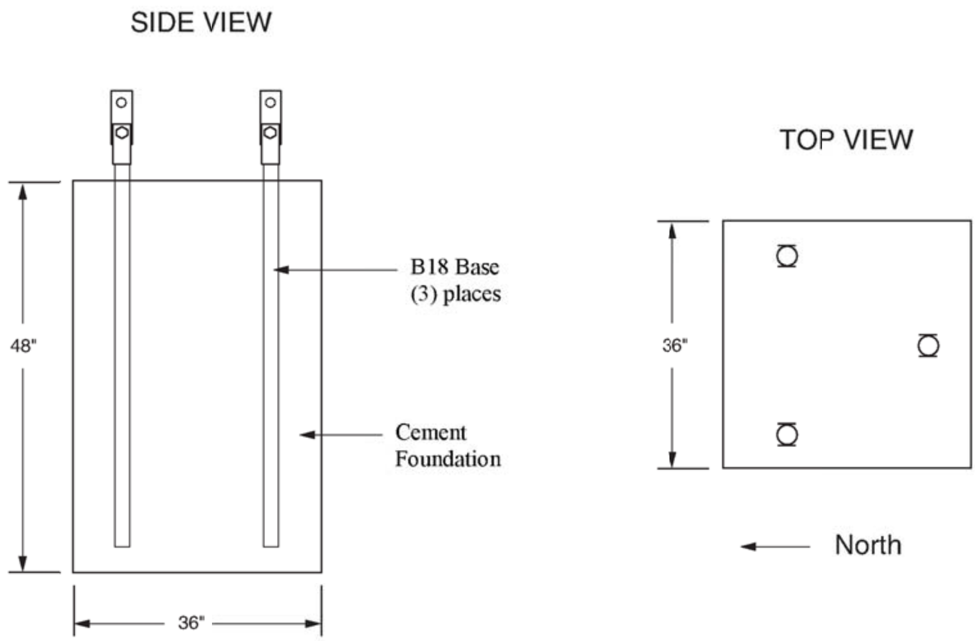

FIGURE 2.1-3. Foundation for B18 Base

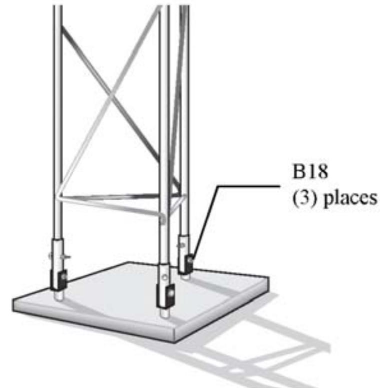

FIGURE 2.1-4. B18 Concrete Mounting Base

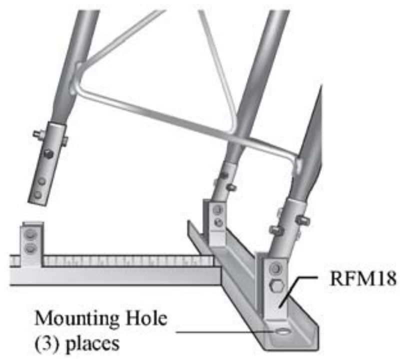

FIGURE 2.1-5. RFM18 Flat Roof Mounting Base

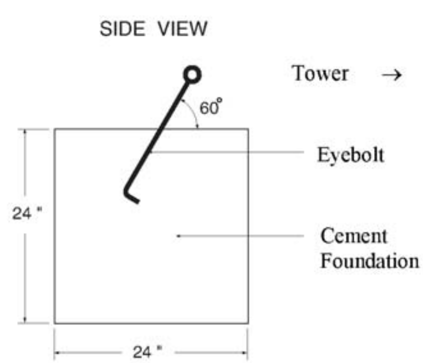

FIGURE 2.1-6. UTEYE Eyebolt Guy Anchor

APPENDIX B

Sample Meteorological System Audit/Calibration Report

METEOROLOGICAL STATION AUDIT SUMMARY

Met Station: Moore Ranch
Audit Date: 8-Dec-11
Audit Performed By: K. Hansen, Z. Heid -- IML Air Science

Sensor	Mfr./Model	Serial Number	Reference Device	Serial/ID Number
Vert. Wind Speed 10m:	RM Young Vertical Anemometer	N/A	quartz referenced drive motor	IML 0896
Wind Speed (WS):	RM Young Wind Monitor AQ	79704	quartz referenced drive motor	IML 0896
Wind Direction (WD):	RM Young Wind Monitor AQ	79704	transit, compass	IML 0900
Temperature @ 2 Meters:	RM Young 41342		digital thermistor	IML 1411
Temperature @ 10 Meters:	RM Young 41342	7740001	digital thermistor	IML 1411
Relative Humidity:	CS215	E2335	digital hygrometer	IML 0899
Barometric Pressure:	Vaisala PTB101B	C4740017	digital barometer	IML 0918
Solar Radiation:	Apogee	6734	collocated sensor	PY68877
Precipitation	8" Texas Electronic		lab grade burette	N/A
Data acquisition system:	CSI CR1000 datalogger	14183	N/A	N/A

Audit Results

		RPM	MPH	DAS Value	|Difference|	Specification	
WS (mph)		0	0.00	0.00	0.00	below threshold	
		300	3.44	3.44	0.00	0.56	(2)
		800	9.16	9.16	0.00	0.56	(2)
		3000	34.35	34.35	0.00	0.56	(2)
		8000	91.60	91.60	0.00	0.56	(2)
WS start torque (gm-cm)			1.0	t<1.0	N/A	1.0	(3)
Crossarm Alignment			354.5	355.0	0.5	5.0	(3)
WD (degrees)		Clockwise	0.0	0.4	0.4	5.0	(2)
			90.0	90.4	0.4	5.0	(2)
			180.0	179.9	0.1	5.0	(2)
			270.0	270.0	0.0	5.0	(2)
		Counter Clockwise	0.0	0.4	0.4	5.0	(2)
			90.0	90.2	0.2	5.0	(2)
			180.0	180.6	0.6	5.0	(2)
			270.0	269.9	0.1	5.0	(2)
			Reference	DAS Value	|Difference|	Specification	
Temp. 2 meter (°C):			-0.2	0.0	0.2	0.5	(2)
			17.5	17.4	0.1	0.5	(2)
			41.5	41.4	0.1	0.5	(2)
Temp. 10 meter (°C):			-0.2	0.0	0.2	0.5	(2)
			17.5	17.4	0.1	0.5	(2)
			41.5	41.4	0.1	0.5	(2)
Relative Humidity (%)			72.0	76.3	4.3	7.0	(2)
Solar Radiation (W/m^2)			143.7	137.7	6.0	25.0	(3)
Barometric Pressure ("Hg)			24.64	24.64	0.00	0.09	(2)
		DAS Value (in)	Reference (ml)	DAS Equivalent	|Difference|	Specification	
Precipitation (0.1" equiv.)		0.10	86.5	82.4	4.1	8.2	(1)
		0.10	90.0	82.4	7.6	8.2	(1)
		0.10	92.4	82.4	10.0	8.2	(1)

		Reference RPM	Reference cm/s	DAS Value	|Difference|	Specification	
Vert WS 10 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
(CW)		20	10.00	10.00	0.00	20.00	(2)
	U:	60	30.00	30.00	0.00	20.00	(2)
		200	50.00	50.00	0.00	20.00	(2)
		500	250.00	250.00	0.00	20.00	(2)
		RPM	cm/s	DAS Value	|Difference|	Specification	
Vert WS 10 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
(CCW)		20	-10.00	-10.00	0.00	20.00	(2)
	U:	60	-30.00	-30.00	0.00	20.00	(2)
		200	-50.00	-50.00	0.00	20.00	(2)
		500	-250.00	-250.00	0.00	20.00	(2)

BOLD difference values exceed performance specifications
(1)= Performance specification listed in facilities' Quality Assurance Project Plan
(2)= Performance specification listed In EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorlogical Measurements Version 2.0, 2008
(3)= Manufacturer's Specifications

Notes, Recommendations

System taken off-line at 14:40 MST and returned on-line 15:26 MST.