REPORT

# REVISED

# SAMPLING AND ANALYSIS PLAN

## FOR THE LA JARA MESA PROJECT

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# 1.0 INTRODUCTION

In the United States, nuclear sources provide about 21 percent of our electrical energy supply compared to 70 percent for carbon-based (oil, coal, and natural gas) and 9 percent for renewable sources (wind, solar, hydropower). As concerns related to carbon emissions increase, greater emphasis is being given to nuclear and renewable sources. Laramide Resources (USA) Inc. (Laramide) proposes to develop an underground uranium mine in northwestern New Mexico. The La Jara Mesa Project is located in the Ambrosia Lake Mining District approximately 10 miles northwest of Grants, NM (Figure 1-1).

As part of the New Mexico Mining Act (NMMA) permit application process (Subsection D.12 of 19.10.6.602), the New Mexico Mining and Minerals Division (MMD) requires the development of a sampling and analysis plan (SAP) detailing the methods proposed for the collection of baseline data specified in Subsection D.13 of 19.10.6.602. Laramide retained Golder Associates (Golder) to prepare a SAP to collected pertinent baseline data for the La Jara Mesa Project. This ***revision to the original*** plan ***submitted June 8, 2009 incorporates changes to address agency comments concerning administrative completeness in their letter to Laramide dated August 11, 2009. The changes between documents are shown in bold italics. This submittal*** complements additional information that is required in the NMMA permit application process.

## 1.1 Project Overview

Laramide submitted a Plan of Operations for the La Jara Mesa Project to the USDA-Forest Service and the MMD. The plan of operations provides a detailed description of the proposed mine operations and reclamation plan. A summary of the operational and reclamation plans is provided below.

The proposed mine portal and surface facilities are located on Forest Service lands at the base of La Jara Mesa (Plate 1). The mine portal and miner change house (dry), administration office, maintenance facility, and fuel and explosives storage areas will be located at about 7,300 feet in the NE¼ of Section 15, T12N, R9W. An escape raise will be about one mile east of the portal on top of the mesa in Section 11, T12N, R9W (Figure 1-2). The ore zones are located about 600 feet below the surface of mesa in the portions of Sections 1, 2, 11, 12, 13 and 14, T12N, R9W.

A total of about 16 acres of surface disturbance is anticipated in association with the portal, mine facilities, and escape raise (Plate 2). An existing road that crosses private, Bureau of Land Management and Forest Service land will be upgraded and used to access State Highway 605. Water and electric power utility lines will parallel the road in the MMD Permit Area on Forest Service lands. Because the ore will be hauled to a licensed mill, no ore processing (milling) or mill tailing disposal areas are associated with this project.

The La Jara Mesa Project will develop two parallel, low-angle inclines for access to the ore while providing for ventilation. The inclines will be about 12 feet wide and 15 feet high and 5,000 feet long.

The main incline will be for mining access and second incline will be used primarily for ventilation and as a contingency access and escape route. Once the inclines are complete, the escape raise (an approx. 8 foot in diameter borehole) will be developed from the underground mining area to surface of the mesa. Waste rock from the escape raise boring will fall into the underground working and will then be hauled out the main incline to the waste rock stockpile. Other than drill cuttings from a small diameter pilot hole, no waste rock is anticipated to be produced or stored on the top of the mesa.

The La Jara Mesa Project will be developed using a room and pillar mining technique. The overburden and barren (un-mineralized) rock produced during construction of the inclines, escape raise, and mine development will be placed just west of the portal. A flat pad area will be constructed from overburden and waste rock that will be used as a foundation for the mine buildings and facilities. Storm water diversions and sediment ponds will be constructed to control and contain surface water. A compacted clay-lined area with internal drainage controls will be constructed for temporary ore storage.

During the first phase of mining, an estimated 40,000 to 50,000 tons of ore will be removed for bulk mill testing. Under full production, the mine is anticipated to yield an average of 500 tons per day. The ore will be transported to the surface in mine trucks and placed on a compacted clay liner to prevent mixing of the waste rock and ore. The ore will be periodically loaded and transported in 40-ton highway trucks to a licensed mill for processing.

After the cessation of operations, Laramide will reclaim the site to meet the requirements of NMAC 19.10.6.603. The major components of the reclamation involve permanently closing the mine workings (inclines) and escape raise, demolishing and removing the buildings, reestablishing hydrologic balance of the surface water system, and covering and revegetating the overburden and waste rock piles. The access road on Forest Service land will be decommissioned and revegetated. The overall purpose of the reclamation is to return surface disturbed areas to a stabilized and self-sustaining condition that is consistent with the post-mining land use and surrounding ecosystem.

### *1.1.1 Proposed Permit Area*

The proposed MMD Permit boundaries for the La Jara Mesa Project are shown on Plate 1. The main mine facilities Permit Area occupies about 77 acres with a projected disturbance area of 16 acres. The disturbance area will be associated with surface water diversions and sedimentation controls, topsoil and waste rock storage areas, buildings, and roads. The access road right-of-way and utility corridor occupies about 30 acres, which will include about 6 acres of disturbance associated with the upgrading the existing road. The escape raise portion of the permit area is 0.25 acre with the actual disturbance area of about 0.10 acre. Thus, the proposed Permit Area for the La Jara Project is 107 acres with a projected disturbance area of about 22 acres, including the existing access road and utility corridor.

### *1.1.2 SAP Objectives and Structure*

The objective for assembling the baseline data is to describe the Permit Area and potential affected area to the extent practicable. The requirements for the collection of baseline data are broadly defined under 19.10.6.602.D.13 NMAC, with the level of detail determined by the location, size, scope, and type of mining operation at the discretion of the MMD Director. The NMMA allows the use of existing data where appropriate, but requires a minimum of 12 months of site-specific data associated with the evaluation of water quality and quantity, wildlife, and vegetation.

The SAP developed herein is predicated on providing a comprehensive description of the critical environmental factors considering the limited size and scope of the activities and disturbance that will be associated with the La Jara Mesa Project. The plan is structured in sections that address the major baseline parameters required by the MMD including, climate (Section 2), topography (Section 3), vegetation (Section 4), wildlife (Section 5), soils (Section 6), ore body and geology (Section 7), surface water (Section 8), groundwater (Section 9), background radiation (Section 10), prior mining operations (Section 11), historic and cultural properties (Section 12), and land use (Section 13).

The individual sections of this document provide the type of data/information to be collected/obtained and the numbers and frequency of samples to be collected. Quality assurance protocols for data collection and management are discussed in the attached Quality Assurance Project Plan (Appendix A).

## 2.0 CLIMATE

Climate is an important determinant of site ecological potential and a major consideration in operational and reclamation engineering designs. The climate of the La Jara Project area is broadly categorized as cool and dry. Mean annual temperature is near 50°F and precipitation averages about 10 inches per year in the portal area. Because of the elevation difference, the climate conditions at the escape raise are likely to be somewhat cooler and wetter than the lower elevation mine facilities.

### 2.1 Objective

The objective for collecting baseline climatic data is to provide a representation of the conditions that may occur in the Permit Area. The data will include an assessment of the normal and extreme conditions, which are important for assessing reclamation and engineering designs.

### 2.2 Sampling Design and Methods

In the southwestern United States, weather conditions are highly variable from year to year. Because of the wide range in seasonal and annual conditions in this region, the collection of site-specific data during the baseline period (e.g., 12 months) is expected to have limited value. Thus, Laramide proposes to compile historic data from the ***four*** stations to describe the climate of the site.

The ***Homestake Mill***, Grants, San Mateo, and McGaffey stations were selected to represent the project site from a geographic and elevation perspective (Figure 2-1). The La Jara Mesa Project is about 10 miles from the Grants and San Mateo Stations and occurs at a similar elevation. The McGaffey Station is about 40 miles northwest of the La Jara Mesa Project, but was selected because it is similar in elevation (8,000 feet) to the escape raise portion of the Permit Area. Table 2-1 lists summary information about the proposed stations. The sampling frequency for the data collected from the Homestake station, during the one year baseline period, is expected to be daily. The historic records from the other stations are expected to be monthly. If available, daily records will be compiled for the baseline period.

Data from these stations will be compiled and summarized to provide an understanding of the distribution, probable ranges, and extremes in precipitation and temperature that might be expected in the mine area. In addition, we will compile data relevant for engineering purposes (e.g., 100-year 24 hour distributions). ***The measurements at the Homestake Mill meteorological station include the following:***

**TABLE 2-1**
**HOMESTAKE MILL METEOROLOGICAL STATION EQUIPMENT**

| Parameter | Equipment | Serial Number |
|---|---|---|
| Wind Direction | Brunton 5008 Pocket Transit | 5060803362 |
| | Met One Model 040 Direction Template | NA |
| | Waters Torque Watch 366-1M | 3950 |
| Wind Speed | RM Young Model 18811 Anemometer Drive | CA01889 |
| | Waters Torque Watch 366-3M | 3618 |
| Temperature | Brooklyn Digital Model 6661 | C404690 |
| Precipitation | Pyrex 100 ml graduated cylinder | 3024 |
| | Kimax 50 ml graduated cylinder | NA |
| Relative Humidity | Vaisala Model HMP45AC | W1630084 |
| Barometric Pressure | Vaisala Model PTB101B | A1950021 |
| Solar Radiation | LiCor Model 200x | PY56373 |

**Notes:**
NA – Not applicable

***The meteorological tower at the Homestake Mill is owned and operated by Homestake Mining Company in Grants, New Mexico to meet U.S. Environmental Protection Agency Prevention of Significant Deterioration (PSD) quality assurance requirements. Homestake conducts at least annual meteorological instrument performance audits at the meteorological monitoring station in accordance with: 1) EPA's Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), 1987; and 2) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, March 2008. An example of the Quality Assurance Performance Audit that is conducted on the Homestake Mill station in included in Appendix C.***

**TABLE 2-2**
**LA JARA MESA PROJECT AREA CLIMATE STATIONS AND SUMMARY**

| Weather Station | Distance and direction from Portal (mi) | Elevation (ft) | Period of Record | | Mean Annual Temperature (°F) | Mean Annual Precipitation (inches) |
|---|---|---|---|---|---|---|
| Grants Airport | 10 SW | 6,530 | 5/1/1953 | 12/31/2005 | 50.3 | 10.34 |
| San Mateo | 10 NE | 7,300 | 4/1/1918 | 2/29/1988 | 48.1 | 8.66 |
| McGaffey 5SE | 40 NW | 8,000 | 1/1/1923 | 12/31/2005 | 43.1 | 18.72 |
| ***Homestake Mill*** | ***4*** | ***6,600*** | ***1997*** | ***present*** | ***TBD*** | ***TBD*** |

## 3.0 TOPOGRAPHY

Topographic considerations are important in the mine planning process for assessing engineering and drainage related issues. Plate 1 provides an overview of the Permit Area and surrounding topography. The main mine facilities occur near the base of the La Jara Mesa escarpment (Plate 2). This area is characterized as a gently to steeply sloping, dissected, pediment that ranges in elevation from about 6,800 to 7,600 ft above mean sea level (AMSL). An access road and utility corridor will extend south from the portal to the Forest Service boundary. The road crosses gently sloping dissected pediment and alluvial fan surfaces that parallel the escarpment. The escape raise and associated generator housing will be sited on the surface of the nearly level mesa top at an elevation of about 8,060 feet AMSL.

### 3.1 Objective

The objective for collecting topographic data is to provide a basis for establishing permitting boundaries and the locations of mine facilities and surrounding structures. Topographic considerations also figure prominently in the development of operational and reclamation plans and the development of costs associated with these activities.

### 3.2 Sampling Design and Methods

Laramide recently procured aerial photography and developed site-specific topography for the main mine facilities area. The air photos were interpreted to provide contour maps with intervals of 5 feet. United States Geological Survey (USGS) quadrangle data are available outside the permit area. The available topographic information is considered adequate for this phase of mine and reclamation planning and no additional topographic information is contemplated as part of the baseline data collection. ***The Laboratory and Field Quality Assurance Plan are not applicable for developing the baseline Topography.***

# 4.0 VEGETATION

Vegetation conditions in the Permit Area prior to mining are important for establishing expectations for revegetation success for post-mining land uses. In addition, it is important to determine whether Federal or State status threatened and endangered plants occur at the site.

The distribution of vegetation surrounding the La Jara Mesa Project reflects the combined influences of environmental gradients (soils and climate), disturbance history (mineral development, fire, grazing) and other management practices. The major structural characteristics of vegetation are controlled primarily by the prevailing environment gradients. The vegetation in the La Jara Mesa Project Permit Area is broadly classified as Pinyon-Juniper woodland. Within the project area, the specific composition of the vegetation and amount of ground cover vary as a function of the topography and soils. Plant species that are likely to occur in the Permit Area are listed in Table 4-1.

## 4.1 Objective

Baseline vegetation data is intended to support revegetation success analyses and to determine if sensitive or threatened and endangered plants are present within the disturbance area.

## 4.2 Sampling Design and Methods

The following sections detail the methods for determining baseline vegetation information including the type and frequency of data collection. The plant inventory is discussed in Section 4.21. The methods of vegetation classification are discussed in Section 4.2.2. The proposed approach to determining cover, density and production is outlined in Section 4.2.3. Section 4.2.4 deals with T&E species. ***The sampling frequency is discussed in Section 4.2.1.***

### *4.2.1 Plant Inventory*

An ecologist will conduct a ground survey of the entire permit area including the road/utility corridor and escape raise ***(Plate 1)***. This effort will allow the development of a comprehensive plant list for the project. The survey will be conducted in the late-summer and spring to facilitate recognition of the short-lived annuals. ***Therefore, the sampling frequency will be twice during the one year baseline period. All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

### *4.2.2 Vegetation Mapping*

The vegetation communities will be differentiated on the basis of species dominance and structure. Abrupt changes in environmental gradients have resulted in distinct types of vegetation with clear boundaries. The field investigations and mapping of the vegetation will be complemented by the interpretation of color aerial photographs.

The vegetation will be classified using the nomenclature and hierarchical classification of the United States National Vegetation Classification (USNVC) system (Grossman et al., 1998). The vegetation will be classified and mapped at the Alliance level, which represents the sixth tier in a seven-tiered hierarchy. The Alliance category is roughly equivalent to the series level used by the Forest Service (Pfister and Arno, 1980; USDA, 1997), except that it tends to emphasize existing dominants rather than end-member climax species (Grossman et al., 1998). ***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

### 4.2.3 Canopy Cover, Shrub Density, and Production

Canopy cover, shrub density, and production data are typically used to establish revegetation success criteria, particularly if a site-specific reference area approach is adopted. Alternatively, under a grazing post-mining land use (PMLU), information from the U.S. Department of Agriculture may be used to establish vegetation success standards. Pending concurrence from the Forest Service, grazing is the most likely PMLU that will be designated for the Permit Area.

Because of the small size of the Permit Area, lack of grazing capacity in portions of the permit area (e.g., talus and steep slopes), and the vegetation disturbance associated with existing roads within the main Permit Area, canopy cover, shrub density and production will be obtained from existing information available from the Forest Service. Because the Forest Service data has been collected from a broader area and longer periods of time, they are expected to provide better estimates of cover and productivity than data collected from the Permit Area alone. The long-term nature of the Forest Service data makes it desirable with respect to accounting for the climatic variability that is inherent in this region. In other words, the collection of data from one growing season may have limited value for future comparison.

Thus, data will be compiled from the Forest Service and/or Natural Resource Conservation Service to establish baseline vegetation conditions for cover and production. This assessment will be coupled with semi-quantitative field confirmation of the cover and production targets. ***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

### 4.2.4 Floral T&E Surveys

The Forest Service biologist for the Mt. Taylor Ranger District indicated that T&E plant species are unlikely to occur in the project area. Nonetheless, a ground survey and database search will be conducted. The T&E evaluation will involve assessing the State and Federal databases and comparing them to the plant inventory data collected from the site. Field work will be conducted in association with the inventory described in Section 4.2.1. ***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

## TABLE 4-1
## PLANT SPECIES LIST FOR THE LA JARA MESA PROJECT AREA

| Common Name | Scientific Name |
|---|---|
| **Grasses** | |
| Spike Dropseed | *Sporobolus contractus* |
| Little Bluestem | *Schizachyrium scoparium* |
| Bluegrass | *Poa* |
| Sand Dropseed | *Sporobolus cryptandrus* |
| Prairie Junegrass | *Koeleria macrantha* |
| James' Galleta | *Pleuraphis jamesii* |
| Pinyon Ricegrass | *Piptochaetium fimbriatum* |
| Western Wheatgrass | *Pascopyrum smithii* |
| Spike Muhly | *Muhlenbergia wrightii* |
| Ring Muhly | *Muhlenbergia torreyi* |
| Common Wolfstail | *Lycurus phleoides* |
| Muttongrass | *Poa fendleriana* |
| Sleepygrass | *Achnatherum robustum* |
| Cutleaf Coneflower | *Rudbeckia laciniata* |
| New Mexico Feathergrass | *Hesperostipa neomexicana* |
| Indian Ricegrass | *Achnatherum hymenoides* |
| Threeawn | *Aristida* |
| Poverty Threeawn | *Aristida divaricata* |
| Purple Threeawn | *Aristida purpurea* |
| Cane Bluestem | *Bothriochloa barbinodis* |
| Sideoats Grama | *Bouteloua curtipendula* |
| Blue Grama | *Bouteloua gracilis* |
| Sedge | *Carex* |
| Pine Dropseed | *Blepharoneuron tricholepis* |
| Needle And Thread | *Hesperostipa comata* |
| Squirreltail | *Elymus elymoides* |
| **Forbes** | |
| Rough Menodora | *Menodora scabra* |
| Sunflower | *Helianthus* |
| Hoary False Goldenaster | *Heterotheca canescens* |
| Red Bluet | *Houstonia rubra* |
| Fineleaf Hymenopappus | *Hymenopappus filifolius* |
| Pingue Rubberweed | *Hymenoxys richardsonii* |
| Flaxflowered Ipomopsis | *Ipomopsis longiflora* |
| Flatspine Stickseed | *Lappula occidentalis* |
| Gordon'S Bladderpod | *Lesquerella gordonii* |
| Plains Flax | *Linum puberulum* |
| Hoary Tansyaster | *Machaeranthera canescens* |

**TABLE 4-1**
**PLANT SPECIES LIST FOR THE LA JARA MESA PROJECT AREA**

| Common Name | Scientific Name |
|---|---|
| Rockcress | *Arabis* |
| Lacy Tansyaster | *Machaeranthera pinnatifida* |
| Spurge | *Euphorbia* |
| Four O'Clock | *Mirabilis* |
| Colorado Four O'Clock | *Mirabilis multiflora* |
| Pony Beebalm | *Monarda pectinata* |
| Bristly Nama | *Nama hispidum* |
| Clustered Broomrape | *Orobanche fasciculata* |
| Lemonscent | *Pectis angustifolia* |
| Beardtongue | *Penstemon* |
| Beardlip Penstemon | *Penstemon barbatus* |
| Toadflax Penstemon | *Penstemon linarioides* |
| Upright Blue Beardtongue | *Penstemon virgatus* |
| Varileaf Phacelia | *Phacelia heterophylla* |
| Slender Goldenweed | *Machaeranthera gracilis* |
| Woolly Prairie Clover | *Dalea lanata var. terminalis* |
| Carruth'S Sagewort | *Artemisia carruthii* |
| Tarragon | *Artemisia dracunculus* |
| White Sagebrush | *Artemisia ludoviciana* |
| Milkvetch | *Astragalus* |
| Ragleaf Bahia | *Bahia dissecta* |
| Mustard | *Brassica* |
| Wholeleaf Indian Paintbrush | *Castilleja integra* |
| Rose Heath | *Chaetopappa ericoides* |
| Goosefoot | *Chenopodium* |
| Fetid Goosefoot | *Chenopodium graveolens* |
| Birdbill Dayflower | *Commelina dianthifolia* |
| Dakota Mock Vervain | *Glandularia bipinnatifida* |
| Thicksepal Cryptantha | *Cryptantha crassisepala* |
| Firewheel | *Gaillardia pulchella* |
| Purple Prairie Clover | *Dalea purpurea* |
| Tansymustard | *Descurainia* |
| Touristplant | *Dimorphocarpa wislizeni* |
| Shieldpod | *Dithyrea* |
| Fleabane | *Erigeron* |
| Spreading Fleabane | *Erigeron divergens* |
| Trailing Fleabane | *Erigeron flagellaris* |
| Annual Buckwheat | *Eriogonum annuum* |
| James' Buckwheat | *Eriogonum jamesii* |

## TABLE 4-1
## PLANT SPECIES LIST FOR THE LA JARA MESA PROJECT AREA

| Common Name | Scientific Name |
|---|---|
| Sanddune Wallflower | *Erysimum capitatum* |
| Slimleaf Plainsmustard | *Schoenocrambe linearifolia* |
| Canadian Horseweed | *Conyza canadensis* |
| White Milkwort | *Polygala alba* |
| Prickly Russian Thistle | *Salsola tragus* |
| Rocky Mountain Zinnia | *Zinnia grandiflora* |
| Juniper Globemallow | *Sphaeralcea digitata* |
| Globemallow | *Sphaeralcea* |
| Ragwort | *Senecio* |
| **Shrubs** | |
| Banana Yucca | *Yucca baccata* |
| Pricklypear | *Opuntia* |
| Tree Cholla | *Opuntia imbricata* |
| Plains Pricklypear | *Opuntia polyacantha* |
| Wavyleaf Oak | *Quercus pauciloba* |
| Soapweed Yucca | *Yucca glauca* |
| Spineless Horsebrush | *Tetradymia canescens* |
| Red Barberry | *Mahonia haematocarpa* |
| Alderleaf Mountain Mahogany | *Cercocarpus montanus* |
| Skunkbush Sumac | *Rhus trilobata* |
| Pale Desert-Thorn | *Lycium pallidum* |
| Winterfat | *Kraschenínnikovia lanata* |
| Pingue Rubberweed | *Hymenoxys richardsonii* |
| Broom Snakeweed | *Gutierrezia sarothrae* |
| Spinystar | *Escobaria vivipara* |
| Echinocactus | *Echinocactus* |
| Fourwing Saltbush | *Atriplex canescens* |
| Prairie Sagewort | *Artemisia frigid* |
| Sand Sagebrush | *Artemisia filifolia* |
| **Trees** | |
| Rubber Rabbitbrush | *Ericameria nauseosa* |
| Twoneedle Pinyon | *Pinus edulis* |
| Oneseed Juniper | *Juniperus monosperma* |

**Source:**
USDA Forest Service- Terrestrial Ecosystem Survey of Mt. Taylor Ranger District

# 5.0 WILDLIFE

The La Jara Mesa Project occurs within the Arizona-New Mexico Mountains Ecoregion (REF-NMGF). The Permit Area is broadly classified as Pinyon-Juniper woodland and does not display any unique habitat features, such as permanent water sources or riparian ecosystems. Outside the Permit Area, cliffs occur below the rim of La Jara Mesa that may provide nest sites for raptors. Thus, the wildlife cohort in the Permit Area is expected to be consistent with species that normally inhabit Pinyon-Juniper woodlands in northwestern New Mexico.

## 5.1 Objective

The sampling objectives are to map and describe habitat types within the proposed permit area and assess the potential value for calving/fawning, nesting, foraging, and wintering areas. ***At a minimum the data collected will be shown for the Permit Area (Plate 1).*** The data collection effort is intended to support a determination of the potential direct and indirect impacts from the proposed operation from both a short- and long-term perspective. The area will be further evaluated to assess the potential for occurrence of Federal Threatened, Endangered, or Candidate wildlife species and State Threatened, Endangered, and Sensitive wildlife species.

## 5.2 Sampling Design and Methods

This section provides the methods for conducting the deer pellet group count (Section 5.2.1) and bird diversity surveys (Section 5.2.2). ***The sampling frequency will be twice within the one year baseline period as discussed in Section 5.2.1 and 5.2.2.***

### *5.2.1 Pellet Group Count Survey*

Pellet group counts are a standard, cost-effective way to determine relative abundance estimates and distribution of ungulates (Anderson et al., 1972; Eberhardt and Van Etten, 1956; Freddy and Bowden, 1983a and 1983b; Fuller, 1991 and 1992; Neff, 1968; White, 1992). This method will be used to assess deer and elk activity in the Main Facilities Permit Area.

The pellet counts will coincide with the spring bird surveys proposed in Section 3.2. To account for variability in pellet distribution, three transects will be assessed in the Main Facilities Permit Area (Plate 1). The location and compass direction of transects will be surveyed and plotted. Once established, the transect origin will be marked in the field to eliminate the need to re-establish transects for subsequent sample periods. The individual transects will be 202-meters (m) long and 2-m wide for a total sample area of 404 square meters (approximately 0.1 acre). ***Proposed transects are shown in Figure 5-1.***

A topographic map that shows the transect locations and major land features will be used during the field surveys. Standard datasheets will be used to record the survey information. At a minimum, the forms record the date; weather; start time; finish time; names of the observers; transect number; GPS locations for the start and end points; habitat type; species four letter codes (e.g., mule deer = MUDE); and location of the pellet groups. In addition, information will be collected concerning incidental wildlife sightings, tracks, scat, nests, burrows, and other signs of wildlife. Supplies that may be used during the survey include a map of suitable scale, GPS unit, compass, 2-m rod or stick, clip board, and camera.

The surveyors will be familiar with what constitutes a pellet group and how to distinguish between recent versus older pellet groups (only pellet groups from the current year are of interest). Pellet count surveys may be conducted during any part of the day. Surveyors will walk each transect with a 2-m rod held perpendicular to the direction of the transects and level with the ground surface. All pellet groups found within 1 m on either side of the center line will be counted as a pellet group. Pellet groups falling partly or wholly within the transect area will also be counted. As each pellet group is encountered, the survey information is recorded (transect number, habitat type, species, and any wildlife sightings). After the count has been recorded, the pellets will be cleared from the transect area to avoid recounting in subsequent years. At completion of the field survey, the total number of pellet groups per transect and the total pellet groups for all transects in the reclamation unit will be tallied.

Pellet group density will be calculated for each transect within each area to provide a mean and variance for the area. Pellet group density is the number of pellet groups divided by the area of the transects. The pellet locations provide an indication of use patterns. Ultimately, the relative abundance estimates can be compared to wildlife trends following reclamation in the Permit Area. ***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

### *5.2.2 Bird Diversity Surveys*

The purpose of this study is to provide an estimate of bird species diversity and relative abundance prior to mining. A combination of standard point count and transect count techniques are recommended as they provide accurate information using methods that are repeatable, unbiased, and simple to execute (Ralph et al., 1995 and Verner, 1985). ***Proposed transects are shown in Figure 5-1.***

Survey sessions will be scheduled twice per year: once in January for overwintering species and once during the peak breeding season of late-May to early June. Two survey periods each year are sufficient to assess species diversity and relative abundance changes over time. The transects will be monitored over 3 consecutive days during both the winter and spring survey periods.

The transect locations will be the same as for the pellet group surveys. Experienced biologists will perform the surveys. A topographic map that shows the transect locations and major land features will be used during the field surveys. At a minimum, the field survey forms will be used to record the date, weather, start time, finish time, names of the observers, species encountered, and distance of the bird from the observer. Additional information concerning wildlife sightings (e.g., scat, tracks, and burrows) will be recorded. Supplies that may be used during the survey include a compass, clipboard, field glasses, camera, and tape recorder.

Each daily survey will be started 30 minutes before dawn and completed by mid-morning (approximately 9:30 or 10:00 AM). Survey teams may start on either end of the transect line, but each transect should be located as far as possible from the next transect that is to be surveyed to reduce the chances of affecting the results at other survey sites if birds were flushed during the previous survey.

At the start of the transect, a fixed-distance circular point count will be completed before walking through the transect and flushing the birds. Standard point counts are 5-minute counts within a 100-m radius, where all birds are identified by sight and/or sound (Ralph et al., 1995). Distance of the bird from the observer and the time of the observation will be recorded. Counts will not be conducted in rain or high winds, as inclement weather could affect detection of birds.

Once the point count is completed, the transect line will be walked at a normal pace and all birds that can be seen or heard will be recorded. Species, sex (if known), distance from observer, behavior, and location will be recorded. If the birds cannot be identified immediately, an accurate description of the bird's physical features and characteristics will be used to identify the birds at a later time. ***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

### *5.2.3 Wildlife Sightings*

Wildlife sighting surveys will be made in the 2-hour period before sunset on the days that bird diversity surveys are conducted. Wildlife sightings and observations of sign (e.g., scat and tracks) made during the pellets and bird diversity surveys will be recorded in the daily notes***. All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

### *5.2.4 Faunal T&E Survey*

Based on preliminary discussions with the Forest Service biologist on the Mt. Taylor Ranger District, the Permit Area does not support Federal Threatened and Endangered wildlife species or State of New Mexico Threatened, Endangered, and Sensitive wildlife species. Nonetheless, a list of USFS Management Indicator Species (MIS) and species protected by the Migratory Bird Treaty Act (MBTA) will be developed. Surveys will be conducted to evaluate habitat conditions relative to the listings. Surveys for protected wildlife species will be conducted over 100% of the Permits Area in association with the winter and spring bird diversity surveys. ***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

## 6.0 SOILS

Reclamation of the waste rock pile and disturbed areas will be completed once the facilities are no longer needed or following closure of the mine. Laramide proposes to salvage and stockpile soils that will ultimately be used as a soil cover to reclaim the waste rock pile.

The Forest Service mapped the soils in the area around the La Jara Mesa Project using the Southwestern Region Terrestrial Ecosystem Survey (TES) approach. The distribution of TES units in the Permit Area and surrounding lands is shown on Figure 6-1. The soils in the main disturbance area are formed in eolian deposits (dunes) and are sandy and excessively well drained.

The TES data provides important information on the soil qualities, but lacks some of the chemical and physical data needed for evaluating soil suitability for reclamation purposes. Thus, additional testing of the soils is proposed.

### 6.1 Objective

The objective for collecting baseline soils data is to provide a basis for determining the suitability of the materials as reclamation substrates. This information will be used to develop salvaging strategies to determine if sufficient volumes of suitable material will be available at closure.

The MMD's reclamation performance standards require that native soils and other soil resources be characterized to determine their suitability for vegetation establishment. Mine operators are also required to salvage, store, and redistribute suitable soil materials for revegetation of mine-related disturbances. The soils investigation will document and quantify soil resources in support of mine permitting and reclamation planning in accordance with the MMD guidelines.

### 6.2 Methods

Soils in the proposed disturbance area will be characterized with the objective of determining the suitability of the soils for reclamation. All soil data will be collected in compliance with applicable guidance including the MMD Closeout Guidelines and the U.S. Department of Agriculture (USDA) National Cooperative Soil Survey (NCSS). Conforming to these widely recognized standards will ensure that the soil survey is defensible and data utility is maximized.

Samples will be collected from three locations to characterize the chemical and physical properties of soils in the projected disturbance areas. The proposed location of sample sites are provided on Figure 6.2, but test pit locations will ultimately be determined at the discretion of the field soil scientist. Three to five samples will be collected at each sampling location.

Soil profiles (pedons) will be described in the field using standard soil morphological terminology (Soil Survey Staff, 1993). Field descriptions will include horizon designations, depth interval, soil texture, color, structure, consistence, roots, reaction with weak acid, rock fragment content and other important accessory characteristics (e.g. slope, aspect, general vegetation). Soils will be classified to the family level according to Soil Taxonomy (Soil Survey Staff, 2006). All sampling sites will be photographed. Soil pedons will be sampled by genetic horizon and samples will generally be collected from horizons greater than three inches thick. Horizons less than three inches thick may be sampled with a similar adjacent horizon unless the horizon is the only A-horizon present.

Soil samples collected for fine-earth characterization (particles < 2mm in diameter) will be 5 to 10 kg placed in 1-gallon plastic bags and the larger rock fragments (>75 mm) will be removed. The soil analyses will be conducted using standard methods that are consistent with the 1996 MMD Draft Closeout Plan Guidelines (MMD, 1996). All samples will be stored in a suitable container as soon as practicable following collection. Samples will be shipped to Energy Laboratories in Billings, MT for laboratory analyses. The bulk soil samples collected for fine-earth analysis will be air-dried and passed through a 2 mm sieve at the laboratory. The less than 2 mm soil fraction will be analyzed for the parameters listed in Table 6-1. The primary references for the analytical techniques include Agricultural Handbook No. 60 (Salinity Laboratory Staff [SLS], 1954) and Methods of Soil Analysis (Agron 9, 1982).

## TABLE 6-1
## ANALYTICAL METHODS FOR CHEMICAL AND PHYSICAL SOIL CHARACTERIZATION

| Analysis | Source-Method |
|---|---|
| Saturated Paste pH | SLS, Method 2 and 21a |
| Electrical Conductivity | SLS, Method 3a and 4b |
| $CaCO_3$ equivalent percent (lime) | SLS, Method 23c |
| Saturation percentage | SLS, Method 27a |
| Ca, Mg and Na extracts and Sodium adsorption ratio | SLS, Method 3a and 20b |
| Particle Size Distribution, including very fine sand | Gee and Bauder (1986) |
| Rock Fragment | Dry sieve/gravimetric |
| Nitrogen (as Nitrate) | Agron 9, Method 10-2.3.2 |
| Extractable Potassium | Agron. 9, Method 13-3.5 |
| Available Phosphorus | Agron. 9, Method 24-5.4 |
| Selenium (hot water soluble) | Agron. 9, Method 80/3.2.1 |
| Boron (hot water soluble) | Agron. 9, Method 75-4 |
| AB-DTPA extraction | Agron. 9: Method 3-5.2 |
| AB-DTPA extractable metals (As, Cd, Cu, Hg, Pb, Mn, Mo and Ni) | EPA Method 6010/6020 |
| Acid-Base Account, Total sulfur* | Sobek et al., 1978 |
| Neutralization potential | Sobek et al., 1978 |

**Note:**
* Phased to include sulfur forms if needed

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# 7.0 OREBODY AND GEOLOGY

The geochemical nature and reactivity of the overburden, waste rock, and ore are important considerations with respect to development of reclamation plans. Understanding the structure and character of the rocks and configuration of the mine workings relative to groundwater are important for assessing mining activities relative to potential environmental impacts.

The La Jara Mesa Project is located in the Ambrosia Lake mining district, which has been extensively described (Rautman, 1980; Kelley, 1963). The geologic units of interest in the La Jara Mesa area range in age from Permian to Quaternary, and are dominated by Jurassic and Cretaceous rocks that are exposed in the slopes of the mesa. The mesa is capped by Tertiary volcanic rocks. A geologic map and stratigraphic section are shown in Figure 7-1.

The uranium mineralization is restricted to unnamed sandstone units in the in the Poison Canyon tongue of the Brushy Basin Member of the Morrison Formation (Laramide, 2008). The uranium-enriched zone is similar to many other sandstone-hosted uranium deposits in the Grants area. The average depth to the uranium mineralized sandstone zone is about 650 to 700 feet below the surface of the mesa.

## 7.1 Objective

The objectives for characterizing the overburden, waste rock, and ore are twofold: 1) to determine if the materials exposed as part of the mining process have the potential to generate excess acidity and/or react with water to produce conditions that could degrade surface or groundwater quality or hinder reclamation; and 2) to allow tailoring of waste management strategies, if necessary.

## 7.2 Sampling Design and Methods

Representative samples of the geologic units will be selected from existing drill core and outcrop to adequately represent the range of materials that will be associated with the waste rock and ore piles at the mine. The various geologic units that are expected to comprise the significant portions of the waste rock are identified along with their relative volume percentages in Table 7-1. Representative number of samples of these units will be collected for analytical testing; as indicated, most of these samples will come from existing drill core, with the exception of the Bluff Sandstone. The number of samples of each unit is proportional to the expected volumes in the piles.

### *7.2.1 Geology and Stratigraphy*

The geology and stratigraphy of La Jara Mesa will be described relative to springs and groundwater. Descriptions of the geologic units will developed from published sources complemented by data from the exploration activities and ground surveys within the Permit Area. Maps and cross-section will be presented to show the relationship of the mining area to the groundwater and springs system.

### *7.2.2 Geochemistry and Reactivity*

The mining process at the La Jara Mesa Project is expected to result in increased exposure of the waste rock to surface weathering conditions. Leachate may be produced from the infiltration of direct natural precipitation falling on these disturbed natural materials. Samples of key geologic materials will be tested to assess the interaction of the waste rock under surface conditions. During operations, water from direct natural precipitation will enter waste rock pile, which will be composed of disturbed geologic materials. The Synthetic Precipitation Leaching Procedure (SPLP; extraction by EPA Method 1312) will be used to evaluate the potential for generating leachate that could degrade surface or ground water. Acid generation potential will be evaluated through the use of static testing methods (Sobek et al, 1978).

Based on the current mine plan the waste rock pile will be composed primarily of Bluff Sandstone and the Westwater Canyon Member of the Morrison Formation (Table 7-1). The Recapture (shale) and Brushy Basin (shale and sandy shale) Members of the Morrison Formation will represent lesser components of the waste rock pile. Also included are minor volumes of Dakota Sandstone, Mancos Shale, and Tertiary volcanics (tuff, and basalt), which will be generated in the development of the escape raise. As indicated earlier, the uranium-bearing Poison Canyon unit will be segregated from the waste rock and hauled to a licensed mill for processing.

Subsamples from existing exploration core will be obtained for geochemical and acid generation potential testing based on availability and prevalence in the waste rock pile. Representative samples of the uranium-mineralized Poison Canyon unit will also be sampled and analyzed by the same methods. Core samples from Laramide’s recent exploration activities are available for the Brushy Basin, Poison Canyon, Westwater Canyon, and Recapture units. Limited quantities of the Recapture shale are available because the exploration drilling did not consistently extend into the unit. Core from the Dakota Sandstone, Mancos Shale, Tertiary volcanic were not retained because they lacked mineralization. Table 7-1 lists the number of samples that will be tested for the dominant components of the waste rock pile. Samples of the Bluff Sandstone will be collected from surface exposures.

A geologist will evaluate the core samples for uniformity and select sections that are representative of the formation. The core will be split and composited at the discretion of geologist after evaluation of the core. Bluff Sandstone is exposed in several areas on the mesa escarpment near the proposed portal location. Bluff Sandstone outcrops will be excavated to remove surface weathered material and to expose fresh rock. A composite section of the face will be sampled at each exposure. The exposures will be described and photographed.

The core and surface samples will be shipped to the laboratory in either one-gallon plastic bags or sealed in 5-gallon buckets, depending on the size of the sample. The samples will be crushed and homogenized in the laboratory prior to analyses. The samples will be analyzed as summarized in Table 7-2. ***All field***

***work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

## TABLE 7-1
## PREDICTED WASTE ROCK/ORE VOLUMES BY GEOLOGIC UNIT - LA JARA MESA PROJECT

| Geologic Unit | Dominant Lithology | Volume ($yd^3$) | Vol % of Total | Number of Samples | Sample Source |
|---|---|---|---|---|---|
| Basalt | Basalt | 140 | <1% | - | NA |
| Ash | Tuff | 660 | <1% | - | NA |
| Mancos Shale | Shale | 510 | <1% | - | NA |
| Dakota Sandstone | Sandstone | 200 | <1% | - | NA |
| Upper Brushy Basin | Shale/ Sandy Shale | 170 | <1% | 3 | Core |
| Poison Canyon waste rock | Sandstone | 140 | <1% | 3 | Core |
| Poison Canyon ore | | NS | | 3 | |
| Lower Brushy Basin | Shale | 12,300 | 5% | 3 | Core |
| Westwater Canyon | Sandstone | 151,900 | 56% | 5 | Core |
| Recapture Shale | Shale | 17,380 | 6% | 3 | Core |
| Bluff Sandstone | Sandstone | 86,600 | 32% | 5 | Surface |
| **Total** | | **270,000** | **100%** | **25** | |

**Notes:**
NA = Not available
NS = Not specified

## TABLE 7-2
## WASTE ROCK SYNTHETIC PRECIPITATION LEACHING PROCEDURE* ANALYTICAL SUITE

| Analyte | Method | Detection Limit, mg/L |
|---|---|---|
| Aluminum | EPA 200.8 | 0.1 |
| Arsenic | EPA 200.8 | 0.005 |
| Barium | EPA 200.8 | 0.1 |
| Boron | EPA 200.7 | 0.1 |
| Cadmium | EPA 200.7 | 0.001 |
| Chromium | EPA 300 | 1.0 |
| Chloride | EPA 200.8 | 0.01 |
| Cobalt | EPA 200.8 | 0.01 |
| Copper | EPA 200.8 | 0.01 |
| Fluoride | EPA 300.0 | 0.1 |
| Iron | EPA 6010 | 0.03 |
| Lead | EPA 200.8 | 0.002 |
| Manganese | EPA 200.8 | 0.01 |
| Mercury | EPA 200.8 | 0.0001 |
| Molybdenum | EPA 200.8 | 0.005 |
| Nickel | EPA 200.8 | 0.01 |
| Selenium | EPA 200.8 | 0.005 |
| Silver | EPA 200.8 | 0.01 |
| Uranium | EPA 200.8 | 0.0005 |
| Vanadium | EPA 200.8 | 0.1 |
| Zinc | EPA 6010C | 0.01 |
| Adjusted Gross Alpha | EPA 900.0 | 2.0 pCi/L |
| Radium 226 & 228 | EPA 904.0 | 1.0 pCi/L |

**Note:**
* Extraction procedure - EPA Method 1312

## 8.0 SURFACE WATER

The main mine facilities, portal, and escape raise occur in a poorly integrated, ephemeral watershed that terminates in a dune field about 3 miles west of La Jara Mesa. The access road and utility corridor drain areas that are tributary to Lobo Creek, which flows to San Mateo Creek. The surface water regime surrounding the site is influenced by the arid-to-semiarid climate of the region, the relatively medium-to-high permeability of the soils, and the exposed bedrock units within the watersheds. San Mateo Creek is an ephemeral stream throughout much of its length, flowing in direct response to precipitation or snow melt events. San Mateo Creek is a tributary of the Rio San Jose, which discharges to the Rio Puerco, and ultimately the Rio Grande.

Surface water in La Jara Mesa Project area is limited to ephemeral drainages that flow episodically during late-spring and summer storm events. The ephemeral drainages in the vicinity of the site originate on top of La Jara Mesa and flow to the southwest, past the proposed mine facility area (Figure 8-1). These drainages ultimately terminate in the valley, approximately 3 to 4 miles west of the top of the mesa without contributing to other surface-water bodies. Additional minor surface water features are located in the vicinity of the proposed mine site, including potential ponding areas on top of La Jara Mesa, water tanks west of the site, and springs south/southeast of the site that would not be affected by the proposed mine development and subsequent operational activities.

Preliminary delineation of the drainage basin boundary associated with the La Jara Mesa Project was developed from USGS 7.5 minute topographic maps (Dos Lomas and San Mateo Quadrangles) and from recent digital topographic maps of the proposed main mine facility area provided by Laramide. The drainage basin covers an area of approximately 2,600 acres and extends from the top of La Jara Mesa to approximately 3 to 4 miles southwest of the crest of the mesa (Figure 8-1). Because some uncertainty exists on the surface water flow patterns on top of La Jara Mesa (associated with the 20-foot contour USGS topographic maps), a field reconnaissance will be conducted to further refine or confirm the drainage basin boundary conditions for this particular area.

### 8.1 Objectives

The primary objectives of the surface water sampling and analysis program are to establish baseline data for surface water quality and channel sediment characteristics within the ephemeral channel that drain the proposed Permit Area. Additionally, as part of the surface water sampling and analysis program, the drainage basin encompassing the project area site will be further refined. The data and proposed sampling program are presented in Table 8-1. The information obtained in this effort will supplement existing information and will provide the information necessary to assess the baseline conditions in the area and the potential affects of mining on the surface water features in the area.

The primary requirements for characterizing the ephemeral drainages crossing the proposed mine permit area and any other surface water features that may exist in the area are identified NMAC 19.10.6.602

which describes the requirements for sampling and analysis plans and baseline data requirements, and in NMAC 20.6.4 which establishes water quality standards for all surface waters of the state and an anti-degradation policy for these waters.

## 8.2 Sampling Designs and Methods

Specific details of the sampling design and methods for the critical baseline requirements required by the MMD are provided below. The nature and extent of surface water in the project area is discussed in Section 8.2.1. The methods for assessing surface water quality are detailed in Section 8.2.2. Stream channel sediment characterization is discussed in Section 8.2.3. The methods and procedures for identifying springs and other surface water feature is presented in Section 8.2.4.

### *8.2.1 Nature and Extent of Flows within Ephemeral Drainages*

Determining the nature and extent of historical flows in the ephemeral channels draining the proposed mine area is important because the channels are apparently not integrated with the regional surface system. Confirming the termination point(s) of the ephemeral drainages will help to define the extent of potential affected surface water or channel sediments downgradient of the proposed mine area. The nature and extent of flow will be determined using available historical aerial photographs and subsequent field reconnaissance of the drainages. The analysis will determine the presence or absence of water or distinct channels associated with the individual drainages, degree of channel incision, identification of sediment deposition areas, and the nature of the channel bed materials. Additionally, as part of the field reconnaissance, potential historic mining features that could potentially contribute sediment to the identified surface water features in the area and the potential pathways of stormwater runoff from these facilities (if any) will be identified. Downgradient surface water and streambed sample locations described below may be adjusted based on the information obtained from this analysis.

### *8.2.2 Baseline Surface Water Quality*

Diversions and stormwater controls are planned in and around the main mine facilities. The planned surface water control systems are intended to limit interactions of the stormwater and ore and to retain the water and sediment on site. Surface water quality monitoring will be conducted in representative channels that could, force majeure or upset conditions, receive stormwater discharges from the main mine facilities area. These downstream channels constitute potential affected areas. Surface water quality monitoring will be conducted quarterly for a period of one year at four surface water monitoring points located within the ephemeral drainages crossing the proposed main mine facility area (Figure 8-1). Four surface water monitoring points were identified based on preliminary analysis of topographic maps and the current proposed mine facility layout provided by Laramide. The proposed sampling locations include: (1) an ephemeral drainage running west of the facility area immediately downgradient of the proposed main mine facility area (LJM-2009-01); (2) an ephemeral drainage immediately upgradient of the proposed stormwater containment basin (LJM-2009-02); (3) at the downgradient confluence of the three primary ephemeral drainages crossing the proposed mine permit area (LJM-2009-03); and (4) upgradient of the main mine facility area near the crest of La Jara Mesa (LJM-2009-04).

Quarterly surface water monitoring will be conducted for a 12 month period. To the extent practical, the monitoring will be performed during periods of storm activity to increase the probability of the presence of surface water. However, it is anticipated that surface water may not be present at each sample location during the quarterly monitoring events. If flow is not present at proposed sampling points, scheduled dates for quarterly sampling events may be adjusted to attempt to collect samples during rainfall and runoff events. As a contingency, siphon samplers will be installed at each of the sample locations that will allow for the collection of stormwater (Appendix B).

The siphon samplers will be checked for the presence of water during each quarterly monitoring event or after significant storm events. If water has collected in the sample container at a particular sample location, and there is no surface water present during the quarterly monitoring event, field parameter measurements will be obtained from the sample and it will be submitted for laboratory analyses. If surface water is present at a particular sample location during a quarterly monitoring event, the field parameter measurements and individual samples for laboratory analysis would be collected directly from the surface water source. In any event, excess water within the siphon sampler (if present) would be emptied back into the drainage following the collection of the samples. The container will be rinsed with de-ionized water between sampling events.

Water sampling, field parameter measurements and laboratory analyses will be performed on all source-distinct surface waters to establish the baseline quality in and around the proposed mine permit area. Water samples will be analyzed for total dissolved and suspended solids, pH, and dissolved metals, and primary anions and cations (Table 8-1). Field parameter measurements will include temperature, conductance, pH and turbidity. Water quality samples will be collected in containers supplied by a certified analytical laboratory using preservation techniques set forth in EPA protocols prescribed for analytical method. Samples collected for analysis of metals will be field filtered and placed in nitric acid-stabilized bottles and analyzed for dissolved metals (Appendix A). All samples will be placed on ice immediately after collection and chilled to maximum $4^{o}$C during transport to the laboratory under proper chain of custody documentation and protocol.

### *8.2.3 Stream Sediment Characteristics*

Because the alluvium downstream of the Permit Area was derived from potentially mineralized materials from natural sources and past mining activities, it is important to understand the geochemical characteristics of the sediments prior to the initiation of mining by Laramide. To address this data need, stream sediment samples will be collected at a minimum of eight (8) locations downstream from the Permit Area.

A minimum of four (4) samples will be collected from the surface water quality monitoring stations during the installation of the siphon samplers. Four (4) additional samples will be collected from areas that are representative of the drainages downstream of the proposed mine area. The approximate locations of the siphon samplers are shown on Figure 8-1. The location of the additional samples will be determined during the field reconnaissance (see Section 8.2.1). The sediment characterization will be coordinated with the background radiological investigation discussed in Section 10. Streambed sediment sample points will be surveyed with a portable GPS unit during sample collection.

Streambed surface sediment samples will be collected (surface to 12 inches deep) within the ordinary high water mark of the channels. The samples will be described using standard methods (Soil Survey Staff, 1993). The samples will be directly placed in 1-gallon plastic bags and shipped to a certified analytical laboratory under proper chain of custody documentation and protocols. All sampling equipment will be decontaminated prior to sample collection with an Alconox™ solution followed by a rinse with distilled water. Alternatively, disposable sampling trowels may be used for sample collection. The sediment samples will be analyzed for paste pH, paste EC and the total metals listed in Table 8-4.

### *8.2.4 Springs and Surface Water Features*

Any springs or other surface water features located within the La Jara Mesa site drainage basin that are identified on USGS topographic maps, Laramide maps, and/or aerial photographs will be cross checked in the field. The nearest springs currently identified in the vicinity of the site are Pumice Spring and Cliff Spring located approximately 3 miles southeast of the site. Other surface water features currently identified in the area include a pond/tank located approximately 1.4 miles northwest of the site, Roundy Stock Tank located approximately 3 miles south of the site, and Lobo Creek located approximately 2.1 miles south of the site. All of the springs and surface water features are located outside of the La Jara Mesa site drainage basin (Figure 8-1). This information will be further verified through additional analysis of the available maps and aerial photographs, and field verification of these data.

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## TABLE 8-1
## SURFACE WATER AND GROUNDWATER SAMPLE ANALYTICAL SUITE, METHODS AND DETECTIONS LIMITS

| Analyte | WQCC Standard Groundwater * (mg/L or as noted) | WQCC Standard Surface Water – Livestock (mg/L or as noted) | WQCC Standard Surface Water - Irrigation (mg/L) | U.S. EPA MCL (mg/L or as noted) | Analytical Methods | Detection Limits (mg/L or as noted) |
|---|---|---|---|---|---|---|
| Alkalinity | N.A. | N.A. | N.A. | N.A. | EPA 310 | 10.0 |
| Aluminum | 5.0 | N.A. | 5.0 | N.A. | EPA 200.8 | 0.1 |
| Antimony | N.A. | N.A. | N.A. | 0.006 | EPA 200.8 | 0.003 |
| Arsenic | 0.1 | 0.200 | 0.10 | 0.01 | EPA 200.8 | 0.005 |
| Barium | 1.0 | N.A. | N.A. | 2.0 | EPA 200.8 | 0.1 |
| Boron | 0.75 | 5.0 | 0.75 | N.A. | EPA 200.7 | 0.1 |
| Cadmium | 0.01 | 0.050 | 0.01 | 0.005 | EPA 200.7 | 0.001 |
| Calcium | N.A. | N.A. | N.A. | N.A. | I-3485 | 1.0 |
| Chloride | 250.0 | N.A. | N.A. | N.A. | EPA 300 | 1.0 |
| Chromium | 0.05 | 1.0 | 0.10 | 0.1 | EPA 200.8 | 0.01 |
| Cobalt | 0.05 | 1.0 | 0.050 | N.A. | EPA 200.8 | 0.01 |
| Copper | 1.0 | 0.50 | 0.20 | 1.3 | EPA 200.8 | 0.01 |
| Cyanide | 0.2 | N.A. | N.A. | 0.2 | ASTM D2036 | 0.005 |
| Fluoride | N.A. | N.A. | N.A. | 4.0 | EPA 300.0 | 0.1 |
| Iron | 1.0 | N.A. | N.A. | 0.3 | EPA 6010 | 0.03 |
| Lead | 0.05 | 0.10 | 5.0 | 0.015 | EPA 200.8 | 0.002 |
| Magnesium | N.A. | N.A. | N.A. | N.A. | EPA 6010C | 1.0 |
| Manganese | 0.2 | N.A. | N.A. | 0.05 | EPA 200.8 | 0.01 |
| Mercury | 0.002 | 0.010 | N.A. | 0.002 | EPA 200.8 | 0.0001 |
| Molybdenum | 1.0 | N.A. | 1.0 | N.A. | EPA 200.8 | 0.005 |
| Nickel | 0.2 | N.A. | N.A. | 0.1 | EPA 200.8 | 0.01 |
| Nitrate, as N | 10.0 | N.A. | N.A. | 10.0 | EPA 300.0 | 0.05 |
| Nitrite, as N | N.A. | N.A. | N.A. | 1 | EPA 300.0 | 0.05 |
| Nitrate+Nitrite | N.A. | 132 | N.A. | N.A. | EPA 300.0 | 0.01 |

## TABLE 8-1
## SURFACE WATER AND GROUNDWATER SAMPLE ANALYTICAL SUITE, METHODS AND DETECTIONS LIMITS

| Analyte | WQCC Standard Groundwater * (mg/L or as noted) | WQCC Standard Surface Water – Livestock (mg/L or as noted) | WQCC Standard Surface Water - Irrigation (mg/L) | U.S. EPA MCL (mg/L or as noted) | Analytical Methods | Detection Limits (mg/L or as noted) |
|---|---|---|---|---|---|---|
| Potassium | N.A. | N.A. | N.A. | N.A. | I-3631 | 1.0 |
| Selenium | 0.05 | 0.05 | 0.13 – 0.25 | 0.05 | EPA 200.8 | 0.005 |
| Silicon | N.A. | N.A. | N.A. | N.A | EPA 6010C | 0.1 |
| Sodium | N.A. | N. A. | N.A. | N.A | EPA 6010C | 1.0 |
| Sulfate | 600.0 | N.A. | N.A. | 250.0 | EPA 300 | 1.0 |
| TDS | 1000.0 | N.A. | N.A. | N.A. | EPA 160.1 | 10.0 |
| Zinc | 10.0 | 25.0 | 2.0 | 5.0 | EPA 6010C | 0.01 |
| pH | 6.0-9.0 s.u. | 6.0-9.0 s.u. | 6.0-9.0 s.u. | 6.5-8.5 s.u. | EPA 150.1 | 0.1 s.u. |
| Uranium | 0.03 | N.A. | N.A. | 0.03 | EPA 200.8 | 0.0005 |
| Vanadium | N.A. | 0.10 | 0.10 | N.A. | EPA 200.8 | 0.1 |
| Gross Alpha | N.A. | 15 pCi/L | N.A. | 15 pCi/L | EPA 900.0 | 1.0 pCi/L |
| Gross Beta & Photon | N.A. | N.A. | N.A. | 4 mrem/yr | EPA 900.0 | 4.0 piC/L |
| Radium-226 + 228 | 30.0 pCi/L | 30.0 pCi/L | N.A. | 5.0 pCi/L | EPA 904.0 | 1.0 pCi/L |
| Radon-222* | N.A. | N.A. | N.A. | 300 pCi/L | ASTM D5072-92 | 200.0 pCi/L |
| TSS | N.A. | N.A. | N.A. | N.A. | E160.2 | 10 |

**Notes:**
s.u. = standard units
* analysis in groundwater samples only

## TABLE 8-2
## SEDIMENT SAMPLE ANALYTICAL SUITE, ANALYTICAL METHODS AND DETECTION LIMITS

| Analysis | Standard-Method | Detection Limit |
|---|---|---|
| Saturated Paste pH | SLS, Method 2 and 21a | 0.01 standard units |
| Electrical Conductivity | SLS, Method 3a and 4b | 0.01 mmhos/cm |
| Saturation percentage | SLS, Method 27a | 0.1 wt % |
| Particle Size Distribution | Gee and Bauder (1986) | 0.1 wt % |
| Rock Fragment | Dry sieve/gravimetric | 2 wt % |
| Arsenic | SW3050, EPA200.8 | 5 mg/kg |
| Barium | SW3050, EPA200.8 | 5 mg/kg |
| Cadmium | SW3050, EPA200.7 | 1 mg/kg |
| Chromium | SW3050, EPA200.8 | 5 mg/kg |
| Cobalt | SW3050, EPA200.8 | 5 mg/kg |
| Copper | SW3050, EPA200.8 | 5 mg/kg |
| Lead | SW3050, EPA200.8 | 5 mg/kg |
| Manganese | SW3050, EPA200.8 | 5 mg/kg |
| Mercury | SW7471, EPA200.8 | 1 mg/kg |
| Molybdenum | SW3050, EPA200.8 | 5 mg/kg |
| Nickel | SW3050, EPA200.8 | 5 mg/kg |
| Selenium | SW3050, EPA200.8 | 5 mg/kg |
| Silver | SW3050, EPA200.8 | 5 mg/kg |
| Uranium | SW3050, EPA200.8 | 5 mg/kg |
| Vanadium | SW3050, EPA200.8 | 5 mg/kg |
| Zinc | SW3050, EPA6010C | 5 mg/kg |
| Gross Alpha | SW3050, EPA 900.0 | pCi/L |
| Gross Beta | SW3050, EPA 900.0 | pCi/L |
| Radium 226 + 228 | SW3050, EPA 904.0 | pCi/L |

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# 9.0 GROUNDWATER

Understanding groundwater conditions in relation to the mining operation are important for determining the probable hydrologic consequences of the mining activity in the Permit Area and potential affected area. The proposed La Jara Mesa mining operations are in unsaturated rocks situated nearly 600 feet above the shallowest regional aquifers in the area. The portal and waste rock pile will be more than 300 feet above these saturated zones.

The mining operation is not expected to have any water quality impacts to aquifers in the Permit Area because the mine workings will be entirely in unsaturated rocks, no processing solutions will be used and the ore will be segregated and contained on-site before being hauled offsite to licensed mill. Water supply for the mine will come from an offsite production well (Plate 1) and the use of water at the mine will be restricted to drilling uses for cooling and lubricating, underground and surface dust control and for sanitary uses by the mine workers.

## 9.1 Objective

The objectives of the groundwater baseline assessment include 1) describing the groundwater regime in the Permit Area and potential affected area with emphasis on identifying the character and location of water bearing units and the direction of groundwater flow; and 2) developing a baseline inventory of wells, springs and groundwater uses within a one-mile radius of the mine facilities portion of the Permit Area.

### *9.1.1 Hydrogeologic Regime*

The hydrogeologic regime of the aquifers in the Permit Area and potential affected area will be described from published sources, well data, and State of New Mexico and U.S. Geological Survey and other available records. The lithology and thickness of the geologic units in the permit area will be described using geologic maps, well records, geologic cross-sections and other available data. Wells and water bearing units will be evaluated relative to groundwater flow directions, aquifer recharge and discharge areas. Cross sections will be developed to illustrate the relationship between the proposed mining facilities and the overall hydrogeologic regime.

### *9.1.2 Aquifer Characteristics and Water Quality*

Pertinent characteristics of the aquifers and groundwater quality will be determined and described. Transmissivity, storativity, depth to the water table, and water quality data will be collected or compiled from existing sources.

***One (1)*** water sample will be collected from the proposed water supply well ***during the one year baseline period. The location of the existing well is shown in Plate 1.*** The well is equipped with a pump that will be used to evacuate a minimum of three well volumes of water prior to sample collection. The water sampling, field parameter measurements and laboratory analyses will be performed to establish the baseline quality of the water supply. The sample will be analyzed for total dissolved solids, pH, and dissolved metals, and primary anions and cations (Table 8-1). Field parameter measurements will include temperature, conductance and pH. Water quality samples will be collected in containers supplied by the certified analytical laboratory using preservation techniques set forth in EPA protocols prescribed for analytical method. Samples collected for analysis of metals will be field filtered and placed in nitric acid-stabilized bottles and analyzed for dissolved metals (Appendix A). All samples will be placed on ice immediately after collection and chilled to maximum 4$^{o}$C during transport to the laboratory under proper chain of custody documentation and protocol. ***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

### *9.1.3 Inventory of Wells and Springs*

An inventory will be performed of all known wells and springs within a one-mile radius of the main facilities in the Permit Area ***shown in Plate 1.*** This information will be obtained from existing information in the Office of the State Engineer, USGS, other records and site reconnaissance. An attempt will be made to locate the documented features in the field and describe and photograph them. Efforts will be made to determine current water levels in existing wells and compile any available historical water-level data for the features.

## 10.0 SOIL RADIOLOGICAL SURVEY

Ionizing radiation from natural sources including terrestrial radiation from radionuclides in the soil and cosmic radiation that originates in outer space constitutes background radiation. Radionuclides found in natural soils in significant quantities are Carbon-14 ($^{14}C$), Pottassium-40 ($^{40}K$), Rubidium-87 ($^{87}Rb$) and some members of the uranium ($^{238}U$, $^{230}Th$, $^{226}Ra$, $^{222}Rn$, and $^{210}Pb$), actinium ($^{235}U$ and $^{231}Pa$), and thorium ($^{232}Th$) series. Because the La Jara Mesa Project is in a region that may contain naturally elevated levels of uranium and its progeny, the background concentrations of radionuclides are expected to be higher than in un-mineralized terrains. The distribution of surface radionuclides in project area soils and sediment are expected to be a function of the contributions from parent rocks and post-depositional weathering.

### 10.1 Objective

The objective of the gamma-ray surveys and soil radiochemical characterization is to provide baseline information for the proposed La Jara Mesa Project and potentially affected areas. It is important to develop an understanding of the background and pre-project radiological conditions at the site to establish appropriate reclamation requirements.

### 10.2 Sampling Design and Methods

A combination of real-time gamma-ray surveys, soil sampling and conventional laboratory analysis will be used to establish surface background radionuclide levels. The gamma surveys will be used to assess the general variations in gross activity in the Permit Area and the potential downstream affected areas. The conventional laboratory analysis will be used to establish the site-specific range of selected radionuclide's in the soils. Archive soil samples will be collected to allow for future laboratory characterization, if needed.

The gamma-ray surveys methods are described in following sections. The radiological surveys will focused in the four areas listed below with approach specified in subsequent sections.

- Main Facilities Permit Area
- Road and utility corridor
- Potential downstream affected area, and
- Discretionary Analysis of Disturbed and Anomalous Areas.

#### *10.2.1 Gamma-Ray Surveys*

Gamma-ray measurements will be made with a GPS-enabled sodium iodide (NaI) scintillation detector (e.g., Ludlum 44-10 coupled with a Ludlum 2221 rate meter) held approximately 1 m above the soil surface. Data from the NaI detector will be automatically downloaded to the Trimble data logger as integrated 2-second counts and linked to corresponding X, Y, Z and time parameters. The survey will be conducted in accordance with standard protocols (NUREG/CR 5849, 1992; Whicker et al, 2008; Johnson et al., 2006) and will consist of traversing the study areas and collecting a continuous gamma-ray scan. Terrain permitting, a walking rate of about 0.5 meters per second will be maintained. The data will be used to determine the general conditions on the site and locations of anomalous areas. If anomalous areas are identified, they will be flagged and mapped on field sheets for further investigation.

The Ludlum 44-10 will be used to make point counts at the soil surface at discrete locations. The probe will be shielded to reduce complicating effects from surrounding areas. This approach is intended to improve the relationship between the gamma-ray measurements and soil radiochemical concentrations determined by conventional analysis recognizing that contributions from vertical anisotropies cannot be explicitly accounted for in the gamma-ray measurements. Triplicate six-second (0.1 min) gamma rate counts will be obtained using the lead-shielded NaI detector placed directly in contact with the soil. Surface vegetation and debris will removed for the measurement point to reduce potential interferences.

### 10.2.2 Soil Sampling Methods

Soil samples will be collected at each site where point count gamma-ray measurements are taken. Bulk samples will be collected by mixing the soil excavated from a 30 $cm^2$ area, 15 cm deep, in a stainless steel container and then placing the subsample in a 1-gallon zipper sealed bags. An archive sample will be collected and placed in a glass jar with lid sealed with tape. A signed and dated custody seal will be fixed across the lid of jar. The storage protocols for the archive samples will be further defined in consultation with regulatory agencies. The intent in collecting the archive samples is that they would be available for future chemical analysis if necessary. The stainless steel container compositing container will be cleaned using a wet-wipe to remove any soil.

The bulk samples will be taken to a controlled indoor environment to make gamma-ray readings to complement the field gamma-ray measurements. The results of the indoor gamma readings will be evaluated to select samples for conventional laboratory radiochemical analysis. The samples to be analyzed will be selected to represent the range field and controlled gamma-ray readings. The samples will be shipped to a qualified laboratory at ambient temperature for analyses (Appendix A). The analytical methods are summarized in Table 10-2.

### 10.2.3 Main Facilities Permit Areas

The Main Facilities Permit Area consists of a dissected pediment overlain by a sand sheet and dunes at the base of a steep escarpment. The escarpment is armored by a nearly continuous cover of basalt fragments with occasional outcrops of the bedrock. The nearly continuous cover of basalt fragments complicates the measurement of soil radionuclides with the gamma-ray survey equipment. Furthermore, terrain constraints limit the use of real-time gamma surveys in the escarpment portion of the main facilities Permit Area. For these reasons and because the majority of the disturbance and reclamation will occur in the lower elevation sand dune section, comprehensive gamma-ray surveys will be limited to the western half of the Permit Area (Figure 10-1).

An unbiased random approach will be used to select sampling sites in the Main Facilities Permit Area. A map of the investigation area will be overlain with a 3 m by 3 m grid and 30 sampling locations will be selected at random. The center of the gird (measurement point) will be located in the field using a GPS. Sampling grids may be changed in the field the pending results of the archeological investigations.

Vegetation and woody debris will be cleared from the measuring point and the shielded NaI detector will be placed in direct contact with the soil. Data collection at the site will include exposure rates and replicate (n = 3) six-second gamma rate counts, GPS X, Y coordinates, elevation, time, date, and weather conditions. A soil sample will be collected from upper 15 cm of soil.

### *10.2.4 Road and Utility Corridor*

Gamma emissions will be measured along the road and utility corridor portion of the Permit Area (Figure 10-1). This will be accomplished initially by performing a walkover survey using the GPS-enabled sodium iodide (NaI) scintillation detector to assess the general conditions along the corridor. The corridor will be surveyed down the centerline of the existing road and walking the opposing sides of the road. An offset of 20 feet from the road centerline will followed for the corridor survey.

Point measurements will be made in the western offset (west side of the road) at 1,200 intervals. Bulk and archive soil samples will be collected at each point measurement site. About 11 point measurements and soil samples will be collected in the road and utility corridor.

### *10.2.5 Potential Downstream Affected Areas*

During operations, surface water controls will be constructed to retain all sediment from the ore storage area, which will contain elevated uranium concentrations. However, in the event of force majeure or upset conditions, surface water discharges could enter the ephemeral stream channels that terminate about 3 miles from the base of the escarpment. These channels and floodplains represent the most likely areas that could be considered affected areas. Walkover surveys of the channels and surrounding floodplains the GPS-enabled NaI detector to assess general background conditions and the occurrence of anomalous areas. The surveys will be made down the center line of the channel and on the opposing stream terrace treads bounding the channel. Additional surveys will be made in the obvious sediment deposition areas outside of the channel. The general range of readings will be noted and anomalous areas will be flagged for further investigation.

A systematic sampling approach will be used to assess the background conditions downstream of the Main Facilities Permit Area. Point measurements with the shielded NaI detector will be spaced roughly 1,200 feet apart down the major channels leaving the Main Facilities Permit Area (Figure 10-1).

Sediment samples will be collected at specified points along drainages. About 14 measurements will be made in the main downstream drainages (Figure 10-1). Samples will be collected and analyzed in a similar manner as the samples collected for the proposed Permit Area including obtaining replicate (n = 3) six-second gamma rate counts for both the surface and subgrade at each location The radiological testing will be coordinated with the sediment sampling and analysis discussed in Section 8.

### *10.2.6 Discretionary Analysis of Disturbed and Anomalous Areas*

Disturbances associated with pre-existing roads, prospects, and mining activities will be evaluated using a judgmental approach whereby, surveys and sampling are conducted in disturbed areas at the discretion of the investigators in the field. The walkover surveys will provide a general understanding of the activity in the disturbed areas. Selected samples of materials associated with previous exploration, prospecting and mining activities will be sampled (n =5). Samples will be collected and analyzed in the same manner as the other soil samples. Discretionary sampling may be used in areas noted as anomalous during the walkover surveys.

### *10.2.7 Soil Radiochemical Analyses*

Twenty percent of all samples collected will be analyzed for total uranium, total thorium, isotopic radium (Ra-226 and Ra-228) and gross beta/alpha. In the laboratory, the samples will air-dried and, crushed to pass a 2 mm sieve prior to extraction and analysis. Table 10-2 provides the analytical methods and extraction procedure for the soil radionuclides.

**TABLE 10-1**
**NUMBER AND FREQUENCY OF GAMMA-RAY MEASUREMENTS AND SOIL SAMPLES**

| Location | Gamma –Ray Survey | Point Gamma-Ray Readings | Soil Samples | Soil Samples Analyzed |
|---|---|---|---|---|
| Main Facilities Permit Area | Complete- terrain permitting | 30 | 30 | 6 |
| Road and Utility Corridor | Complete- 3 Passes | 11 | 11 | 3 |
| Downstream Sediment | Complete- 3 Passes | 14 | 14 | 3 |
| Disturbed Areas | TBD | TBD | TBD | TBD |

**TABLE 10-2**
**ANALYTICAL METHODS FOR RADIONUCLIDE CHEMISTRY OF SOILS AND SEDIMENT**

| Radionuclide Analyte | Analytical Method Hot Digest* | Detection Limit |
|---|---|---|
| Uranium, total-238 | EPA 6020, ICP-MS | 0.01 mg $kg^{-1}$ |
| Radium 226 | EPA 903.1 | 0.5 pCi $g^{-1}$ |
| Radium 228 | EPA 9320 | 3.0 pCi $g^{-1}$ |
| Thorium, total-232 | EPA 6020, ICP-MS | 0.1 mg $kg^{-1}$ |
| Gross alpha/beta | EPA 9310 | 4.0 pCi $g^{-1}$ |

**Notes:**
* Extraction = US EPA Method 3050B (hot acid digestion for soils, wastes and sediments).

## 11.0 PRIOR MINING OPERATIONS

Uranium was discovered in the Grants mining in the early 1950s. Exploration and prospecting commenced on La Jara Mesa and other parts of the Ambrosia Lake mining district during this time, although no mining was undertaken within the Permit Area. There are historic disturbances associated with exploration (drill pads, holes and prospect pits) and access roads in and around the Permit Area and the potential affected area. There has also been considerable historical exploration, prospecting and development of mine workings associated with uranium mineralization immediately north, west and south of the Permit Area (Plate 1). Some of the known mining impacts include:

- *Uranium Mineralization in Poison Canyon Units* - In the early 1950s, about 110 tons of ore were produced from outcrops of uranium mineralization in the Poison Canyon sands exposed on the west side of the La Jara Mesa, just north of the Permit Area (Laramide); and
- *Uranium Mineralization in Todilto Limestone* – In the 1950s, exploration and development of uranium deposits occurred in the Todilto Limestone near the Permit Area and within the potential affected area. This includes numerous mine workings of various size and level of development in Sections 4, 9, 15 and 21 of T12N, R9W (McLaughlin, 1963).

### 11.1 Objective

Describe and delineate any prior exploration and mining operations that may have affected the Permit Area. ***Compile information from available references and reports.***

### 11.2 Sampling Design and Methods

Aerial photographs, topographic maps, and ground surveys will be used to delineate disturbances associated with prior mining and exploration within the Permit Area. ***Information collected during the ground surveys will include available records and information from the New Mexico Bureau of Geology and Mineral Resources.*** The disturbances will be delineated on topographic maps. Documentation will include descriptions of the nature of the disturbance and estimates of the amount of area involved. The report will be complemented by photographs ***and descriptions*** of representative features. ***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

## 12.0 HISTORIC AND CULTURAL PROPERTIES

Federal Section 106 of the National Historic Preservation Act and New Mexico Administrative Code Title 4, Chapter 10.4.10.15 require that cultural resource inventories to be conducted in association with the La Jara Mesa Project. The intent of the inventories is to determine if cultural or historic resources could be adversely impacted by the mining operation ***within the Permit Area shown in Plate 1.***

## 12.1 Objective

Cultural resources inventories are required to comply with Federal Section 106 requirements and New Mexico Administrative Code Title 4, Chapter 10.4.10.15.

## 12.2 Sample Design and Methods

The cultural resource inventories will be conducted in consultation with the Forest Service and New Mexico State Historic Preservation Office (SHPO) ***for the Permit Area shown in Plate 1.*** Data collection will involve records review and pedestrian field surveys. Prior to conducting the fieldwork, a records search will be conducted to review all available publications, manuscripts, site records, state files, NMCRIS files, and files available at the Cibola National Forest Supervisor's Office. In particular, the records associated with previous Forest Service fieldwork in the vicinity of the project area.

A 100 percent sampling would be conducted with a records review (Class I) and intensive cultural heritage resources survey (Class III) to identify all archaeological sites and historic structures within the Permit Area. The sampling procedure will include the Class I study records review and the results of previously conducted cultural studies within one mile of the project area. This would be followed by a Class III intensive cultural resources pedestrian field survey of the Permit Area.

The Class I and III studies would inventory all archaeological sites within the project area, as per directives from the USFS and SHPO to comply with Federal Section 106 and New Mexico Administrative Code Title 4, Chapter 10.4.10.15. All sites will be recorded on New Mexico Cultural Resources Information System (NMCRIS) forms.

### *12.2.1 Field Investigation*

Sites that have previously been recorded will be revisited and an update site form will be completed noting any changes to the site. All archaeological sites within the project area will be fully recorded or updated. Surveys along roads will be surveyed 110 feet (30 m) from the center line or as required by USFS and SHPO and the surveys will cover an area of approximately 110 feet on each side of the center line of the road, with the exception of areas of 40% (2 1/2:1 ratio) or greater slope on land adjacent to the road.

The surveys will locate, identify, describe, and document heritage resource sites and isolated occurrences observed as ground surface manifestations for any newly identified cultural resources. All sites requiring updated information will be documented using the Laboratory of Anthropology site inventory update form. Sites already determined not eligible for NRHP listing will not be re-evaluated, nor will update site forms be completed. Heritage resource sites will be recorded in 100 percent compliance with the USFS, Region 3, Cultural Resources Handbook; and according to New Mexico HPD-ARMS guidelines and standards, particularly Chapters 4 and 5 and procedures of the NMCRIS for submitting archaeological records.

Site location(s) will be recorded on USGS 7.5' maps. Sites larger than one (1) acre will be represented/documented by polygons that reflect the site boundaries. Sites less than one (1) acre will be represented/documented by a GPS point taken at the site datum or represented by polygons that reflect the site boundaries. For all sites a GPS point will be taken at the site datum. Sketch maps will accurately depict and label all the recorded features keying them to site form descriptions, as well as identification of artifact concentrations and the locations of key diagnostic artifacts. All diagnostic formal tools and features will be drawn and/or photographed, and keyed to the sketch map. The site datum and corresponding Universal Transverse Mercator (UTM) location will be shown on the map. The site boundary will be marked with pink or white flagging tape clearly identifying the location of the site including flagging trees on the perimeter of the site so the site is inter-visible and not obscured by branches or foliage. Site boundaries marked on the ground will represent the mapped boundary. A datum will be placed on a tree or other convenient, fairly permanent object as near to the center of the site as possible or next to a prominent feature of the site. An aluminum tag with the site number will be attached to the datum at head height with an aluminum nail on the north side of the tree. The site datum will also be identified by placing two bands of white flagging tape around the tree. Photographs of all sites (overviews) and features at a minimum will be taken.

Isolated occurrences (IO) will be GPS-point located and will be taken and accurately plotted on the appropriate 7.5 minute USGS map with locations, descriptions of artifacts, distributions of artifacts, number of artifacts, and photographs and drawing of diagnostic artifacts provided on the IO form. IOs will be documented using the Cibola National Forest IO form or a form otherwise identified by the USFS.

Parameters: For the survey, an archaeological site is defined as a locus of purposeful prehistoric or historic human activity. An activity is considered to have been purposeful if it resulted in a deposit of cultural material beyond the level of one or a few accidentally lost artifacts. Loci of human activity not classifiable as sites by this definition should be considered an IO.

Heritage resources, which include at least one of the following, are hereby defined as sites: one or more features; one formal tool, if associated with other cultural material or more than one formal tool; an occurrence of cultural material (e.g., shards, lithic debris, historic artifacts) that contain one of the following: a.) three or more types of artifacts or material; b.) two types of artifacts or material in a density of, at least 10 items per 100 square meters; and c.) a single type of artifact or material in a density of, at least 25 items per 100 square meters.

Historic remains are those at least 50 years old.

Evaluations of each heritage resource site and recommendations regarding its eligibility will be provided according to the NRHP criteria listed in 36 CFR 60.6, U.S. Department of the Interior (USDOI), National Register Bulletin 15, including all appropriate site, feature, and artifact documentation as required by SHPO and as justification for a determination of eligibility. Unevaluated recommendations will be justified, when eligibility is inconclusive based on surface observations.

NRHP eligibility recommendations, methods closely following the guidelines established by the USDOI will be used. Of particular importance are National Register Bulletins 15 and 16 (National Park Service [NPS] 1991a and 1991b). According to these bulletins, a property (or site) must possess historic significance and integrity to be listed on the NRHP. According to National Register Bulletin 15 (NPS 1991a:2), the criteria by which sites are determined significant are as follows:

- *Criterion A:* Properties, associated with events that have made a significant contribution to the broad patterns of our history.
- *Criterion B:* Properties, associated with the lives of persons significant in our past.
- *Criterion C:* Properties that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.
- *Criterion D:* Properties that have yielded, or may be likely to yield, information important to prehistory or history.

The property must also retain integrity of those features necessary to convey its significance (NPS 1991a:3). Seven qualities of integrity are defined: location, design, setting, materials, workmanship, feeling, and association (NPS 1991a:44-45). For archaeological sites, integrity is “based on the degree to which remaining evidence can provide important information. All seven qualities do not need to be present…” (NPS 1991a:4).

Sampling Locations/Maps: Sampling Frequency: 100 percent sample

Supplies will include 7.5 minute maps showing project boundaries, Form R3-FS-2300-4, Inventory Standards and Accounting Form, Isolated Occurrence recording form, aluminum site tags to be stamped by contractor and attached to datum tree and flagging to delineate site boundaries.

***All field work will be completed consistent with the Laboratory and Field Quality Assurance Plan in Appendix A.***

## 13.0 LAND USE

The Lara Mesa Project Permit Area ***shown in Plate 1*** is located entirely on Forest Service land. Land uses in the vicinity of the project area include grazing, mining, watershed, and recreation.

## 13.1 Objective

The objective for collecting baseline land use data is to provide information on post-mining land uses and to evaluate potential productivity and planned reclamation activities.

## 13.2 Sampling Design and Methods

Forest Service records will be evaluated to determine the primary land use designations for the Permit Area and surrounding areas. The Natural Resource Conservation Service (NRCS) and New Mexico Bureau of Mines will be consulted to determine land use on the surrounding private lands. Soil Survey information will accessed to determine the land capability classification. ***The Laboratory and Field Quality Assurance Plan are not applicable for developing the baseline Land Use.***

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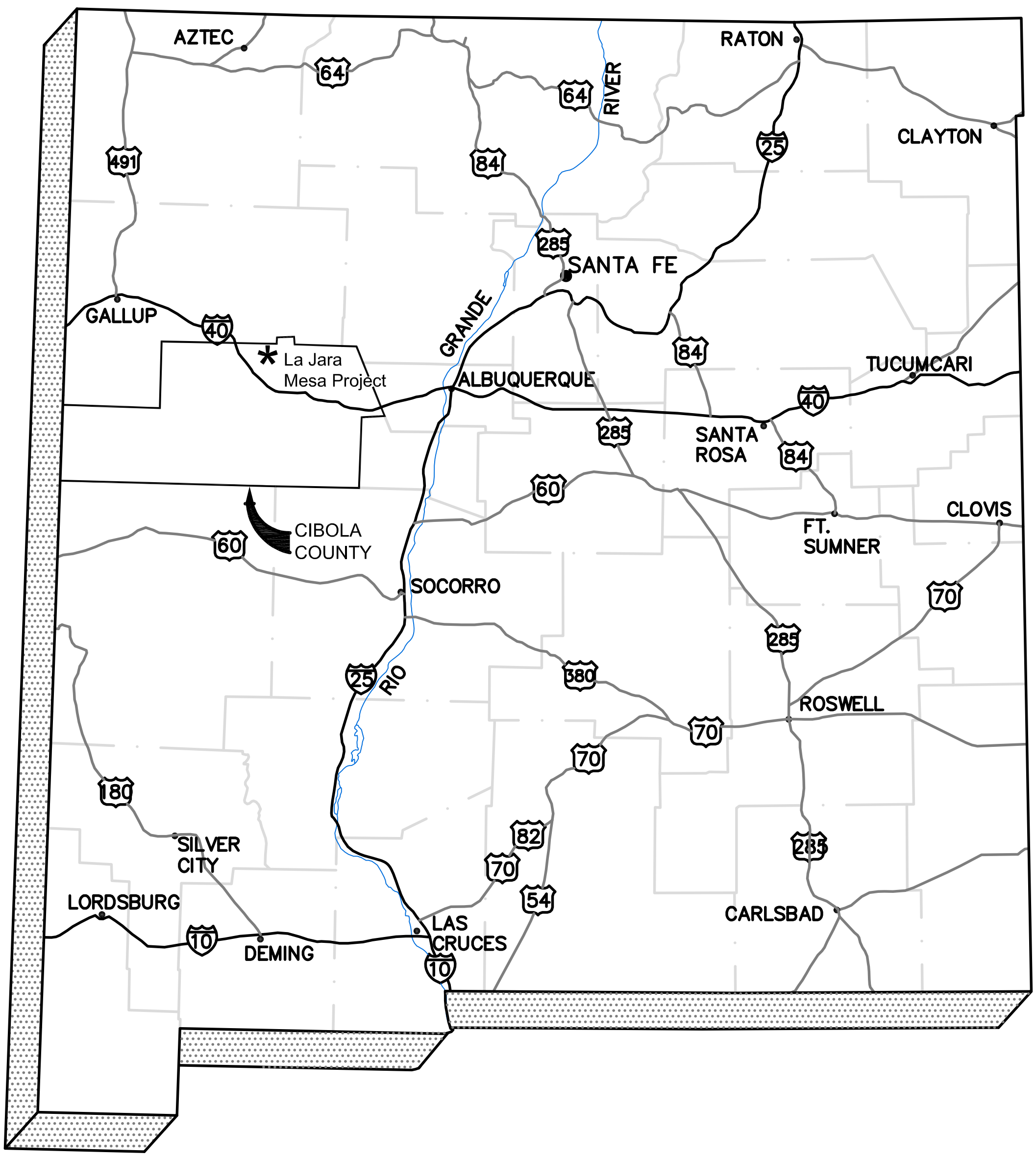
# FIGURES

# STATE OF NEW MEXICO

NOT TO SCALE






PROJECT
LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO

TITLE

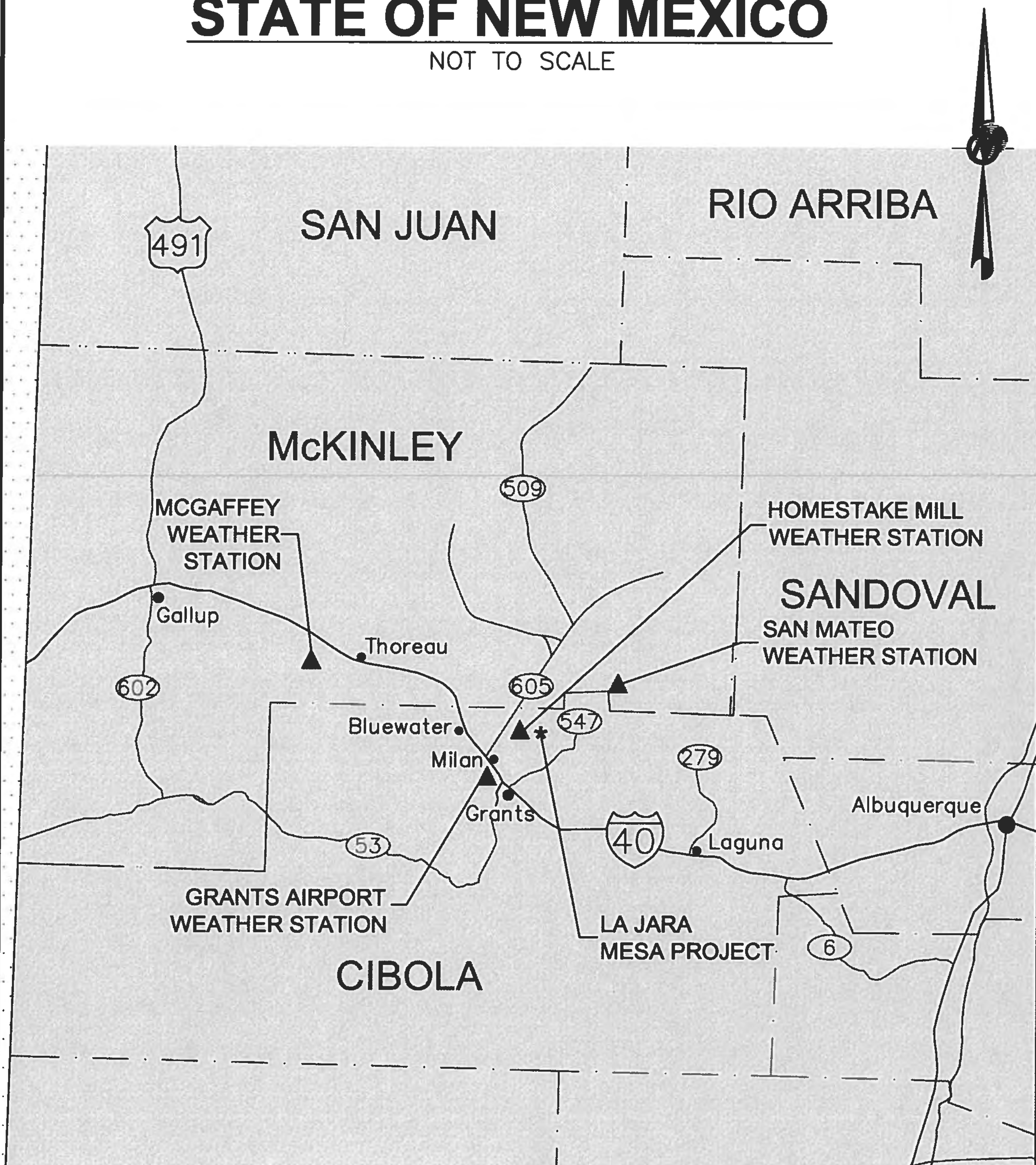
## SITE LOCATION MAP

Golder Associates
Albuquerque, New Mexico

| | | | | |
|---|---|---|---|---|
| PROJECT No. | 08393385-SA | | FILE No. | New Mexico |
| DESIGN | CM | 05/11/09 | SCALE AS SHOWN | REV. 0 |
| CADD | CM | 05/11/09 | **FIGURE 1-1** | |
| CHECK | EC | 05/11/09 | | |
| REVIEW | LM | 05/11/09 | | |

# STATE OF NEW MEXICO

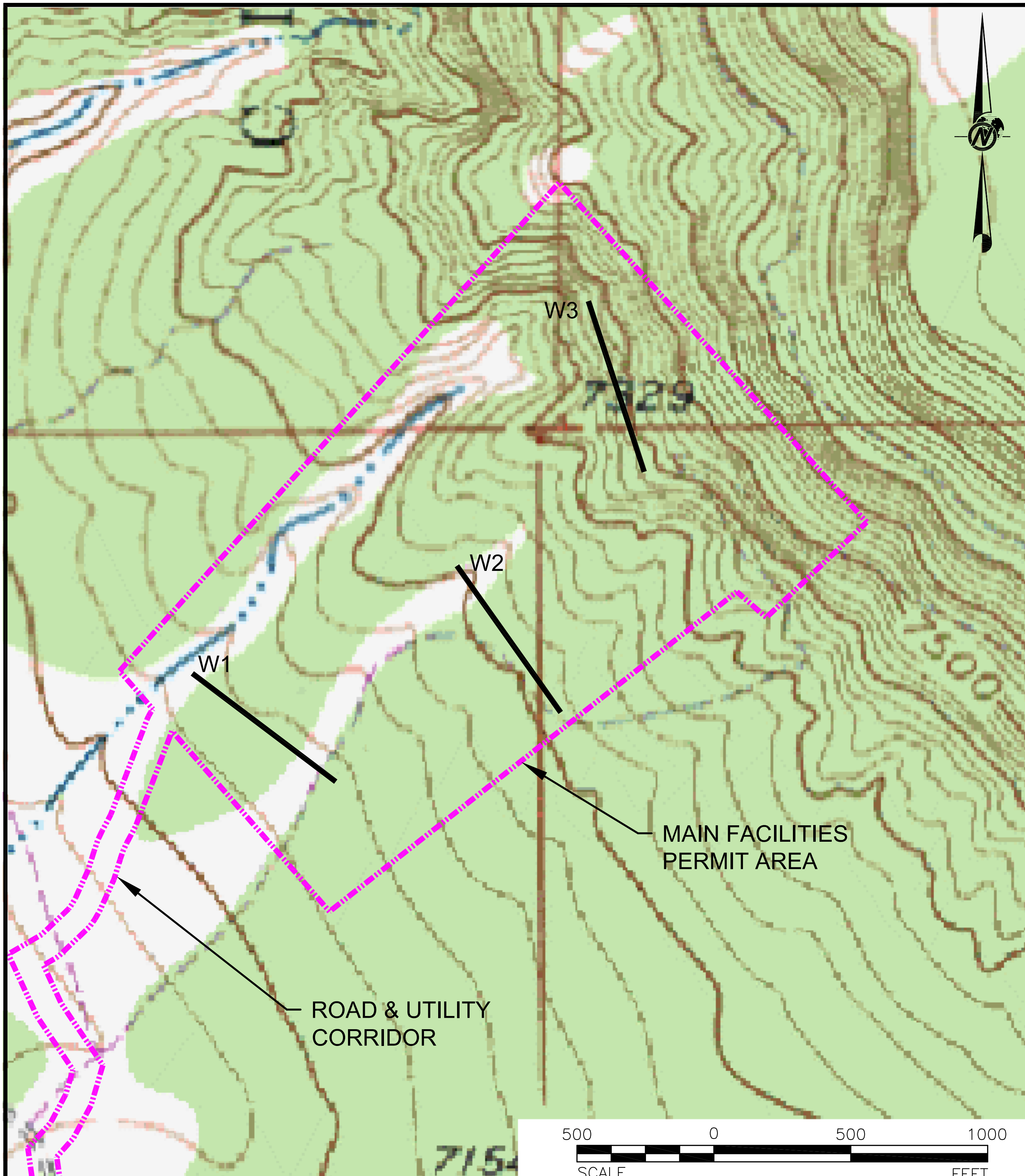
NOT TO SCALE




▲ PROPOSED WEATHER STATION

* LA JARA MESA PROJECT

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT | LARAMIDE RESOURCES (USA) INC.<br>LA JARA MESA PROJECT<br>CIBOLA COUNTY, NEW MEXICO | | | | | |
| TITLE | WEATHER STATION LOCATION MAP | | | | | |
| Golder Associates<br>Albuquerque, New Mexico | PROJECT No. | 08393385-SA | | FILE No. | New Mexico | |
| | DESIGN | CM | 05/11/09 | SCALE AS SHOWN | REV. | 0 |
| | CADD | CM | 05/11/09 | FIGURE 2-1 | | |
| | CHECK | EC | 05/11/09 | | | |
| | REVIEW | LM | 05/11/09 | | | |




LEGEND

W1 PROPOSED WILDLIFE TRANSECT

PERMIT BOUNDARY

PROJECT

LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO

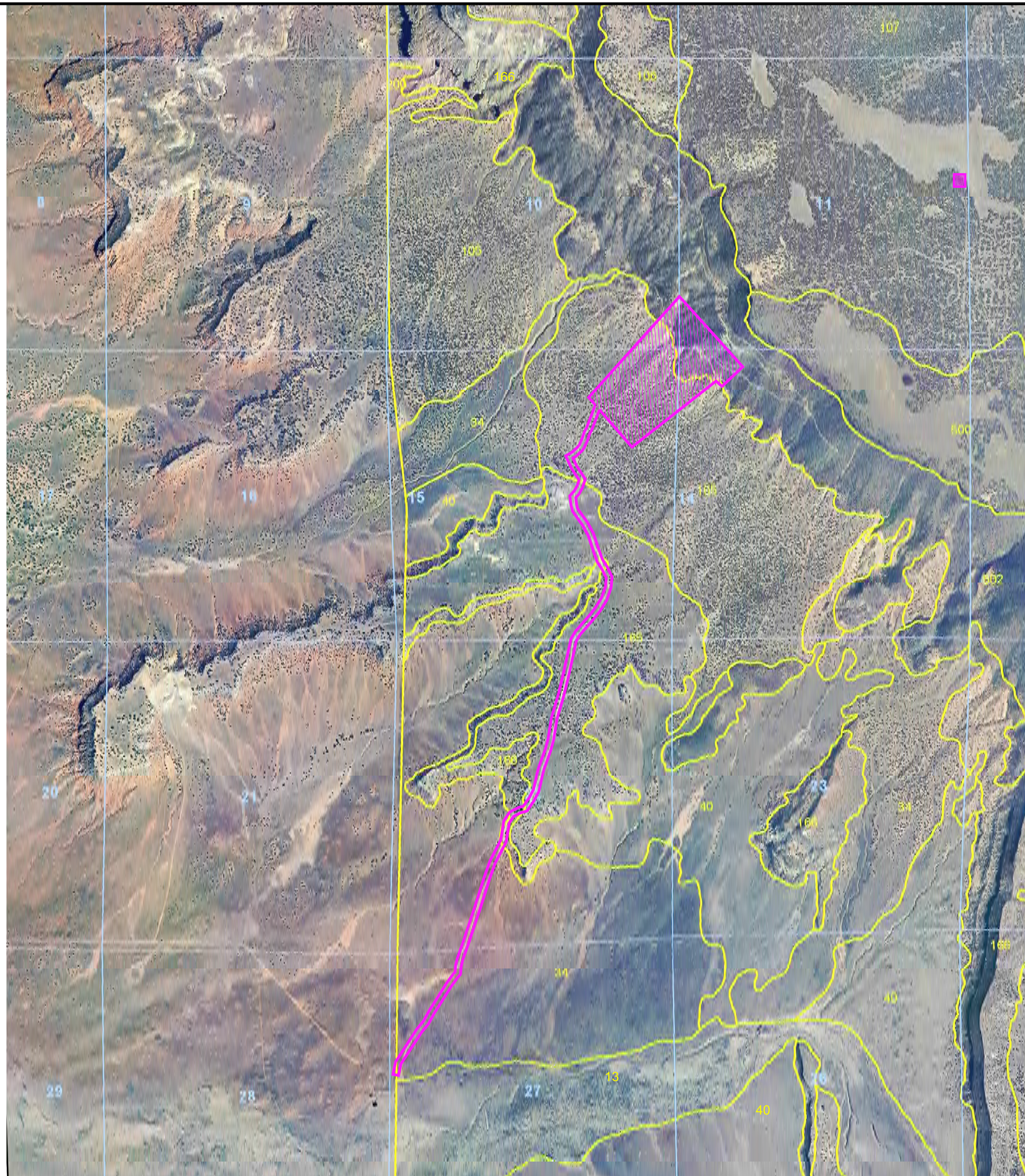
TITLE

**PROPOSED WILDLIFE TRANSECTS LOCATIONS**

Golder Associates
Albuquerque, New Mexico

| | | | | |
|---|---|---|---|---|
| PROJECT No. | | 08393385-SA | FILE No. | Figure5-1 |
| DESIGN | DR | 10/05/09 | SCALE AS SHOWN | REV. 0 |
| CADD | CM | 10/05/09 | **FIGURE 5-1** | |
| CHECK | DR | 10/05/09 | | |
| REVIEW | BN | 10/05/09 | | |

Drawing file: Figure5-1.dwg Oct 05, 2009 - 11:50am



1000 0 1000 2000
SCALE FEET

## LEGEND

SOIL MAP UNIT BOUNDARY

PROPOSED PERMIT AREA

ROAD & UTILITY CORRIDOR PORTION OF PERMIT AREA

ESCAPE RAISE PORTION OF PERMIT AREA (NOT TO SCALE)

| Map Unit | Soils |
|---|---|
| 13 | Pachic Argiustolls, Fluventic Haplustepts, and Typic Haplustalfs |
| 34 | Inceptic and Lithic Haplustalfs and Typic Haplustepts |
| 40 | Calcic Haplustalfs, Typic Calciustepts, and Typic Argiustolls |
| 105 | Calcic and Typic Haplustepts, Typic Haplustalfs, Typic Ustipsamments |
| 106 | Typic Ustipsamments, Calcic and Typic Haplustepts |
| 107 | Calcic and Typic Haplustalfs and Calcic Hplustepts |
| 165 | Typic and Lithic Haplustalfs, Typic Haplustepts, and Rock Outcrop |
| 166 | Typic and Lithic Haplustepts and Rock Outcrop |
| 500 | Typic Argiustolls and Calciustolls |
| 502 | Calcic Haplustalfs, Typic Argiustolls, Rock Outcrop, and Rubble Land |

SOURCE: SOIL DATA - USDA-FOREST SERVICE

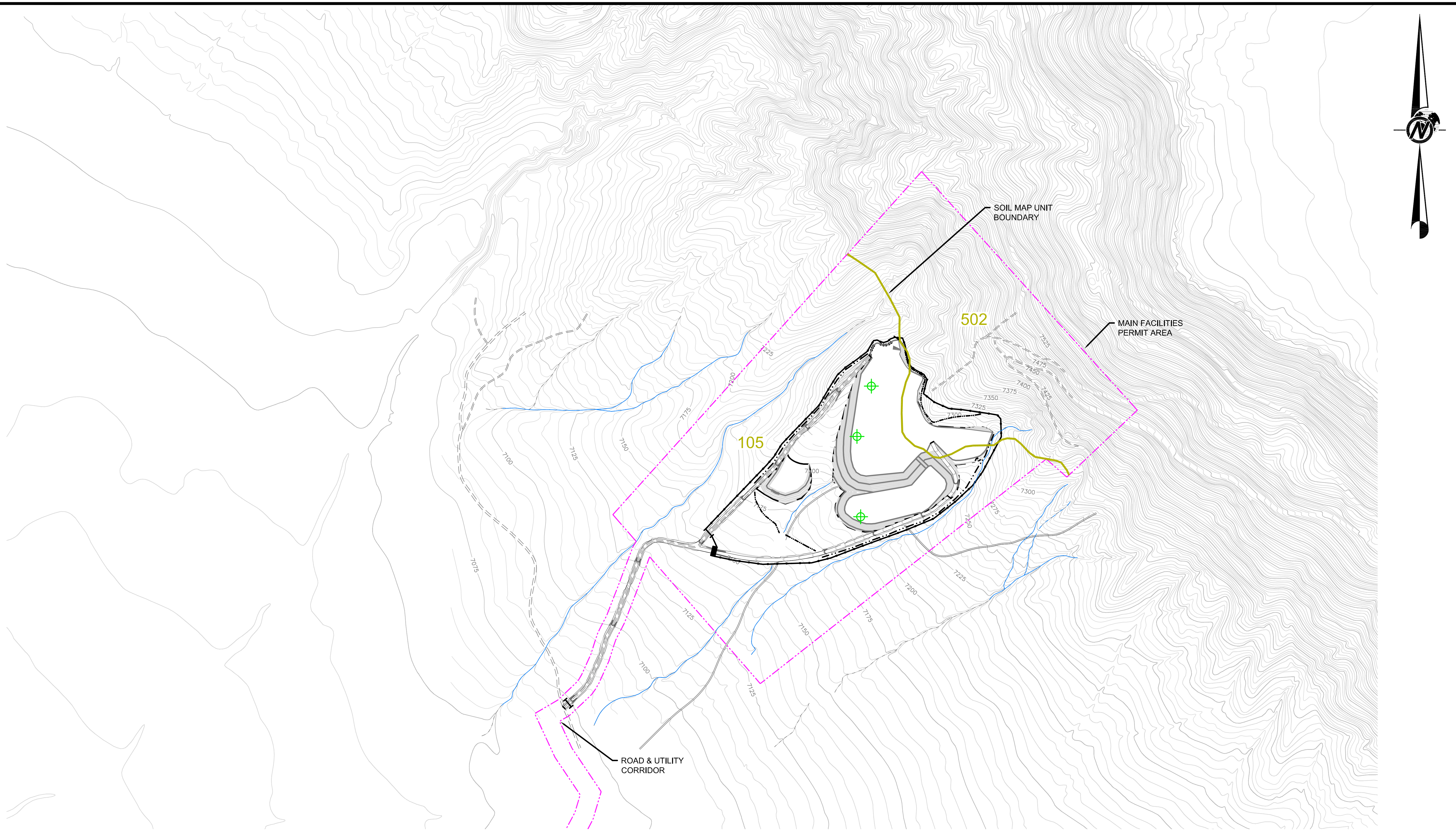
PROJECT
LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO

TITLE
# DISTRIBUTION OF TERRESTRIAL ECOSYSTEM SURVEY UNITS

Golder Associates
Albuquerque, New Mexico

| | | | | |
|---|---|---|---|---|
| PROJECT No. 08393385-SA | | | FILE No. Laramide Soils Map | |
| DESIGN | EC | 05/06/09 | SCALE AS SHOWN | REV. 0 |
| CADD | CM | 05/06/09 | | |
| CHECK | EC | 05/07/09 | FIGURE 6-1 | |
| REVIEW | LM | 05/07/09 | | |

Drawing file: Figure6-1_Soils.dwg Jun 08, 2009 - 8:19am




## LEGEND

- PROPOSED SOIL SAMPLING LOCATION
- 502 SOIL UNIT IDENTIFICATION

SCALE 500 0 500 1000 FEET

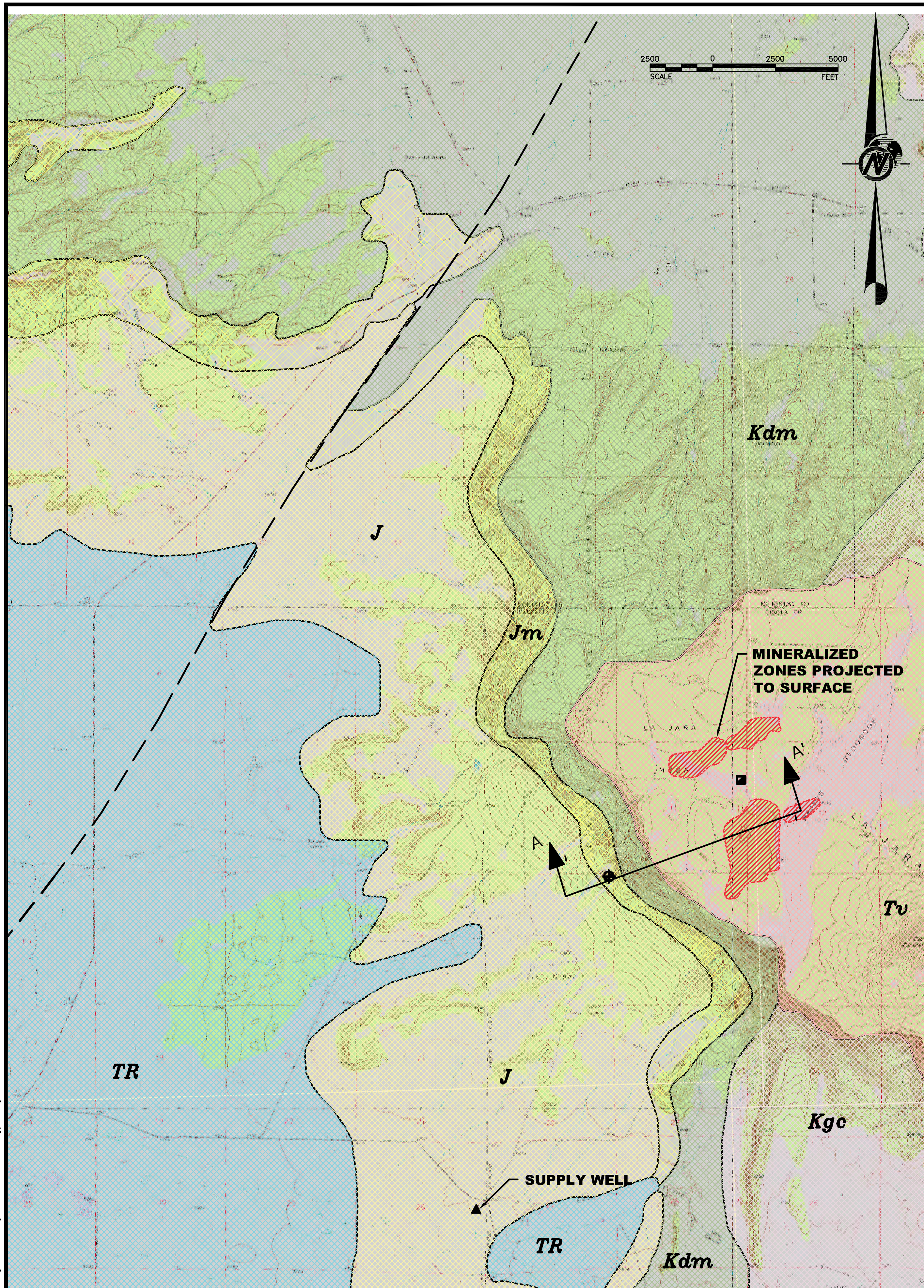
PROJECT
LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO

TITLE
**PROPOSED SOIL SAMPLE LOCATIONS**

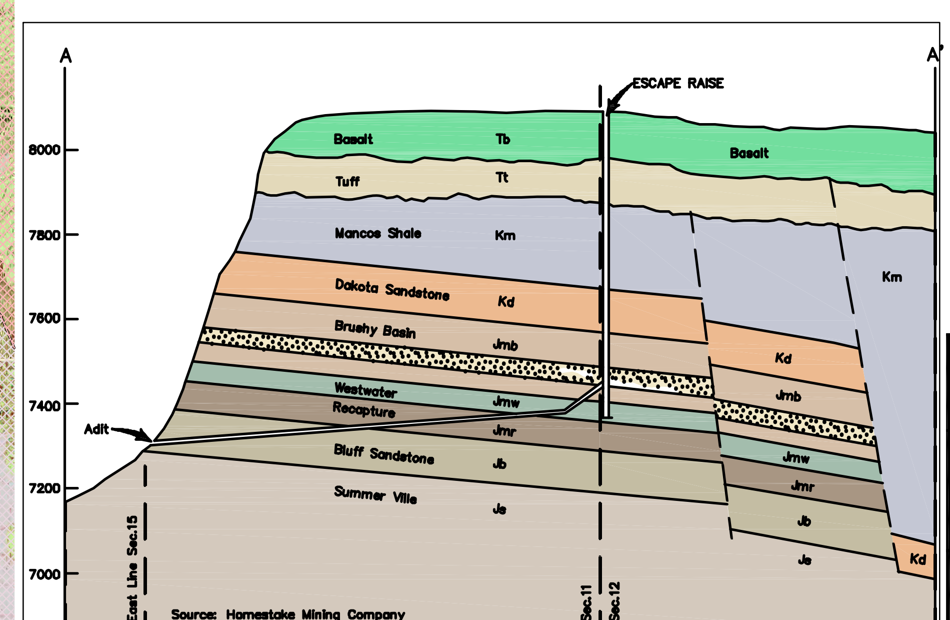
Golder Associates
Albuquerque, New Mexico

| | | | | |
|---|---|---|---|---|
| PROJECT No. | 08393385-SA | | FILE No. | Base Site Map |
| DESIGN | LM | 04/30/09 | SCALE AS SHOWN | REV. 0 |
| CADD | CM | 04/30/09 | | |
| CHECK | LM | 04/30/09 | **FIGURE 6-2** | |
| REVIEW | BN | 05/30/09 | | |

Drawing file: Figure6-2_Soil Samp.dwg Jun 08, 2009 - 8:20am




| MAP UNITS | AGE | FORMATION | MEMBER | LITHOLOGY | THICKNESS | DESCRIPTION |
|---|---|---|---|---|---|---|
| Tv | TERTIARY | MT. TAYLOR VOLCANIC (Tv) | EXTRUSIVE FLOW | | 85-110 FEET | Black Basalt |
| Kgc | CRETACEOUS | MESA VERDE GROUP | EXTRUSIVE FLOW | | 190-230 FEET | Pumice fragments, abundant quartz phenocrysts cemented with fine light colored ash. |
| Kdm | CRETACEOUS | MANCOS SHALE Km | | | 150-200 FEET | Black marine shale |
| | | DAKOTA SANDSTONE (Kd) | | | 40-90 FEET | Lt. brown, coarse to medium grained sandstone, limited black shale partings |
| Jm | JURASSIC | MORRISON FORMATION (Jm) | BRUSHY BASIN (Jmb) | | 100-180 FEET | Green shale with interbeds sandy shale |
| | | | POSION CANYON (Jmbp) | | 30-85 FEET | Lt. Brown to grayish-brown, fine to very coarse-grained arkosic-to sub arksoic sandstone, interbeds of grayish green mudstone, up to five sand units. |
| | | | WESTWATER CANYON (Jmw) SAND | | 80-100 FEET | Lt. gray to bleached, medium to coarse grained sandstone. |
| | | | RECAPTURE SHALE (Jmr) SHALE | | 50 FEET | grayish red and gray |
| J | | BLUFF SANDSTONE (Jb) | | | 235 370 FEET | pale-red to a pale brown, fine to medium-grained eolian sandstone |
| | | SUMMERVILLE FORMATION (Js) | | | 160-270 FEET | Interbedded verigated mudstone siltstone to very fine grained sandstone |
| | | TODILTO LIMESTONE (Jt) | | | 25-35 FEET | Pale olive gray, dark gray and pale yellow, thick bedded limestone |
| | | ENTRADA SANDSTONE (Je) | | | 150-185 FEET | Medium brown to reddish eolian Sandstone |
| TR | TRIASSIC | CHINLE GROUP (Tc) | | | 1000-1600 FEET | Grayish to pale reddish mudstone, siltstone and fine grained sandstone |
| | PERMIAN | SAN ANDRES LIMESTONE | | | 95-115 FEET | Dense gray and yellowish brown to red limestone with interbedded yellow, fine to medium grained, crossbedded sandstone, upper surface karst. |




NOT TO SCALE

## LEGEND

- MINERALIZED ZONE
- FAULT
- LA JARA MESA PROJECT PORTAL FACILITY AREA
- SUPPLY WELL
- ESCAPE RAISE

SOURCE: LARAMIDE RESOURCES (USA) INC.

PROJECT

LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO

TITLE

# GENERALIZED SITE GEOLOGY

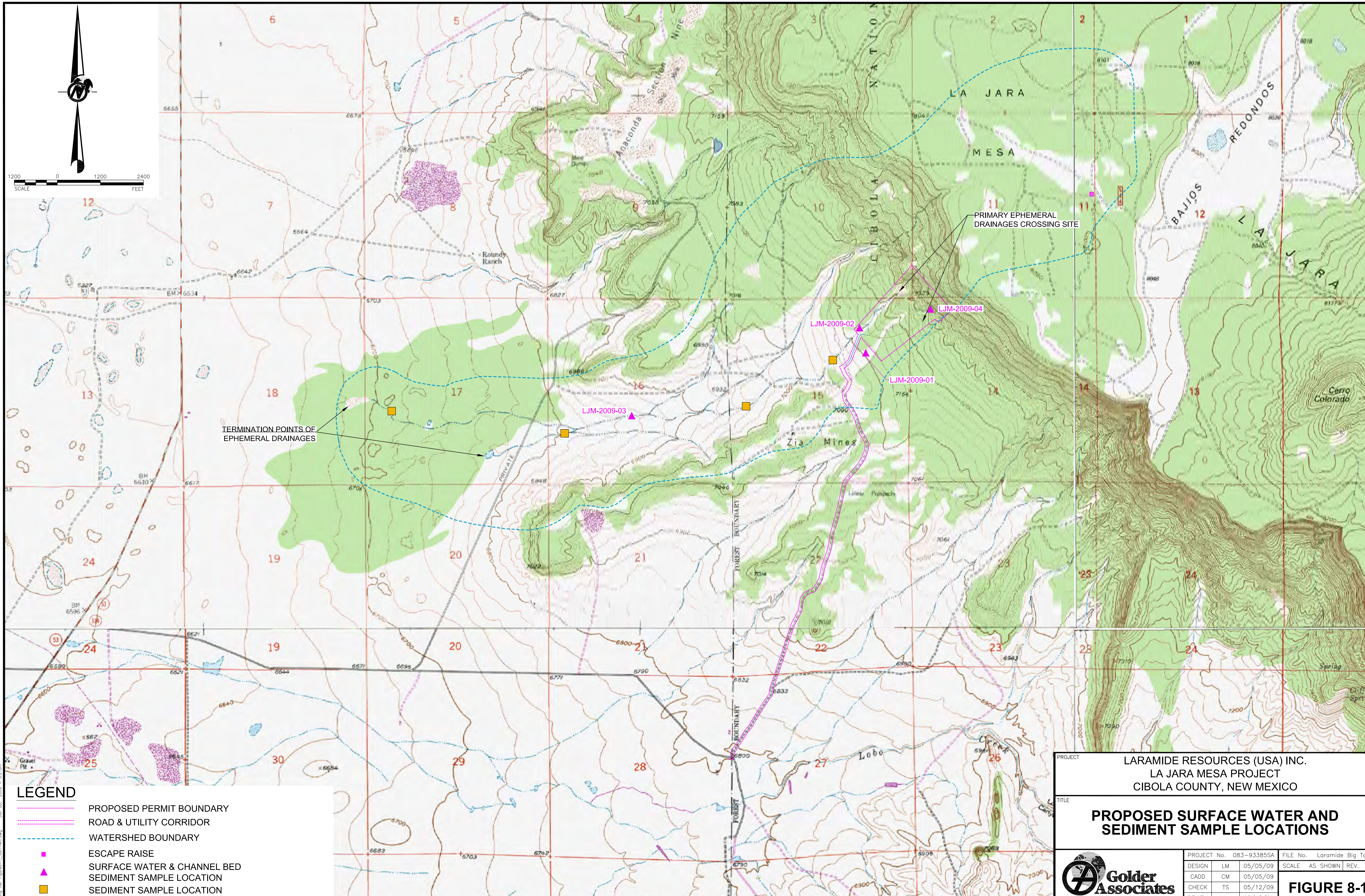
Golder Associates
Albuquerque, New Mexico

| | | |
|---|---|---|
| PROJECT No. | 08393385-SA | |
| DESIGN | LM | 04/30/09 |
| CADD | CM | 04/30/09 |
| CHECK | LM | 04/30/09 |
| REVIEW | BN | 05/30/09 |

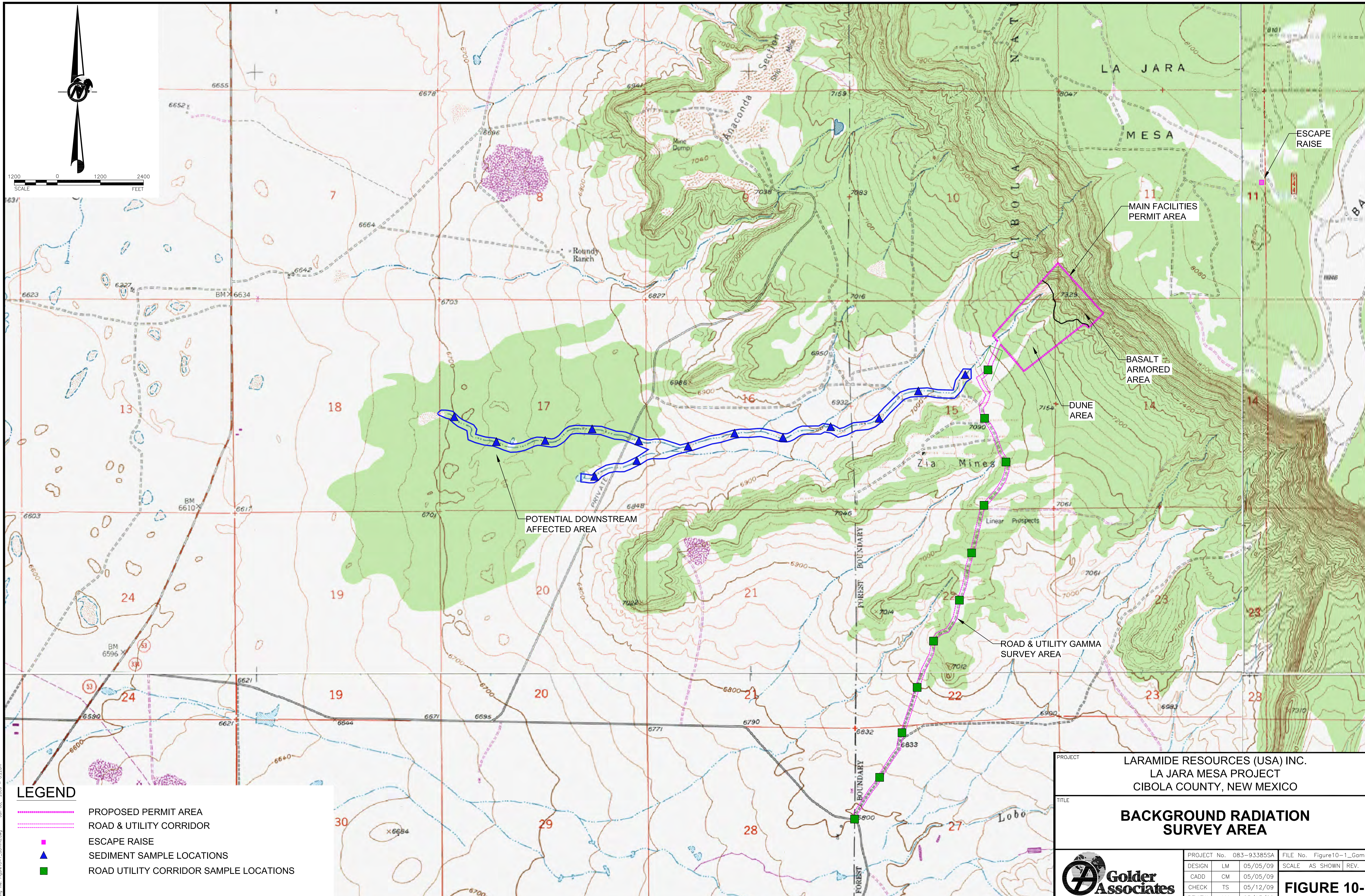
FILE No. Figure7-1_Geology
SCALE AS SHOWN
REV. 0

**FIGURE 7-1**

Drawing file: Figure7-1_Geology.dwg Jun 08, 2009 - 8:15am



SCALE
1200 0 1200 2400
FEET
LA JARA MESA
BAJIOS LA JARA
REDONDOS
CIBOLA NATIONAL
Round Ranch
Zia Mines
Cerro Colorado
Lobo
PRIMARY EPHEMERAL DRAINAGES CROSSING SITE
TERMINATION POINTS OF EPHEMERAL DRAINAGES
LJM-2009-01
LJM-2009-02
LJM-2009-03
LJM-2009-04
FOREST BOUNDARY
PRIVATE
LEGEND
PROPOSED PERMIT BOUNDARY
ROAD & UTILITY CORRIDOR
WATERSHED BOUNDARY
ESCAPE RAISE
SURFACE WATER & CHANNEL BED SEDIMENT SAMPLE LOCATION
SEDIMENT SAMPLE LOCATION
PROJECT
LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO
TITLE
PROPOSED SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS
Golder Associates
Albuquerque, New Mexico
PROJECT No. 083-93385SA
FILE No. Laramide Big Topo
DESIGN LM 05/05/09
SCALE AS SHOWN REV. 0
CADD CM 05/05/09
CHECK TS 05/12/09
REVIEW LM 05/13/09
FIGURE 8-1




PROJECT
LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO

TITLE
BACKGROUND RADIATION SURVEY AREA

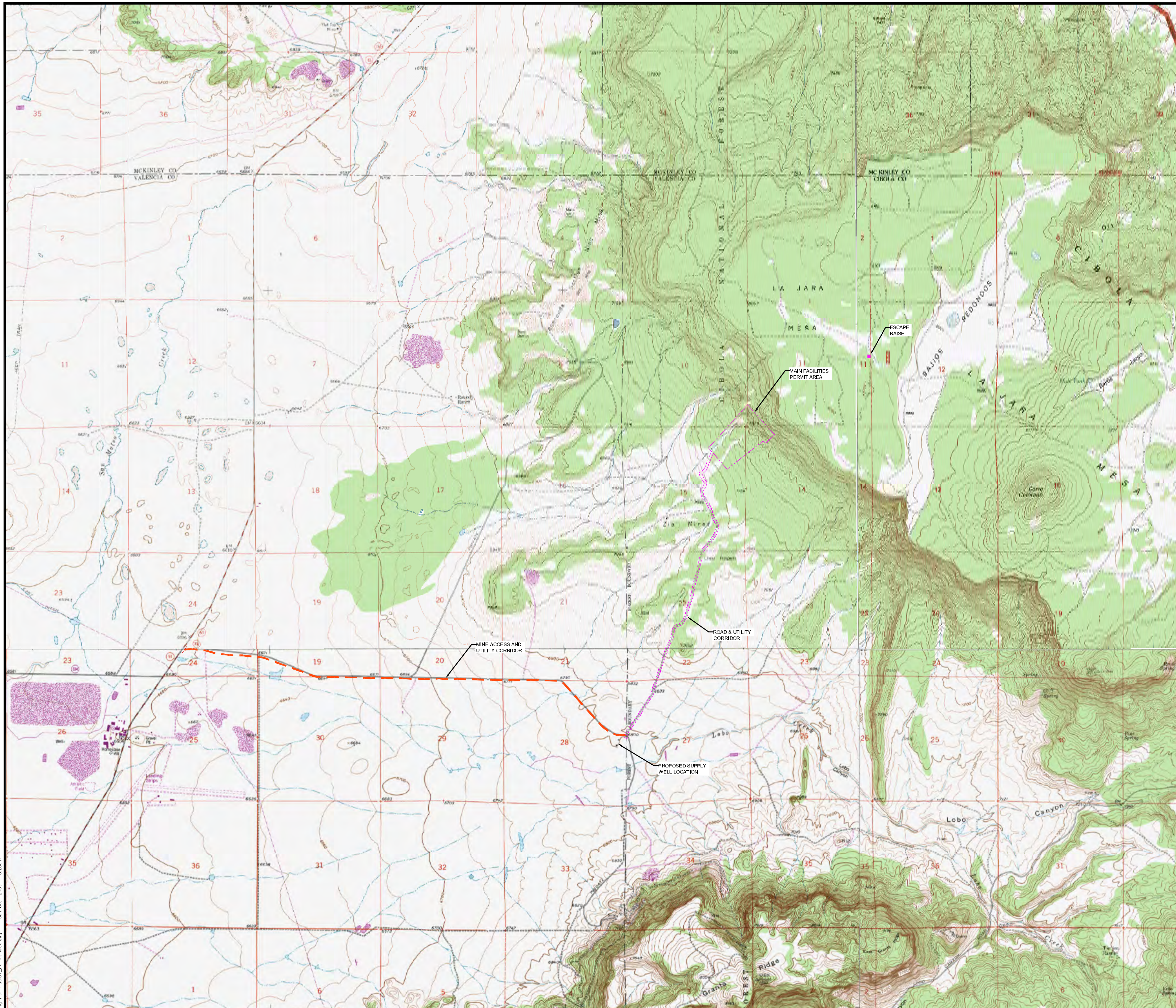
Golder Associates
Albuquerque, New Mexico

| | | |
|---|---|---|
| PROJECT No. | 083-93385SA | |
| DESIGN | LM | 05/05/09 |
| CADD | CM | 05/05/09 |
| CHECK | TS | 05/12/09 |
| REVIEW | LM | 05/13/09 |

FILE No. Figure10-1_Gamma
SCALE AS SHOWN REV. 0

FIGURE 10-1

# PLATES




## LEGEND

- PROPOSED PERMIT AREA
- ROAD & UTILITY CORRIDOR
- ESCAPE RAISE
- MINE ACCESS AND UTILITY CORRIDOR

MAP SCALE: 1:24,000

PROJECT

LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO

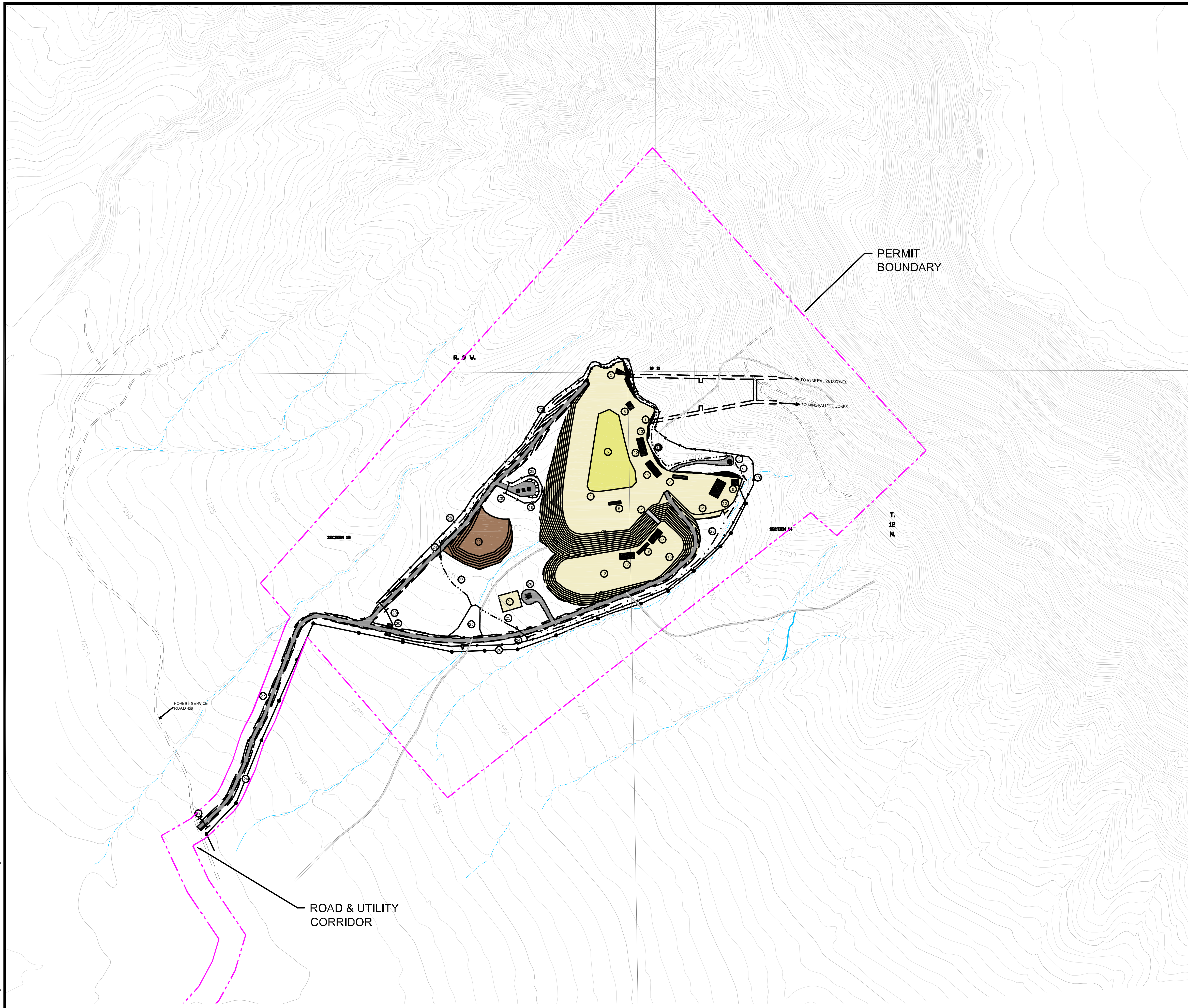
TITLE

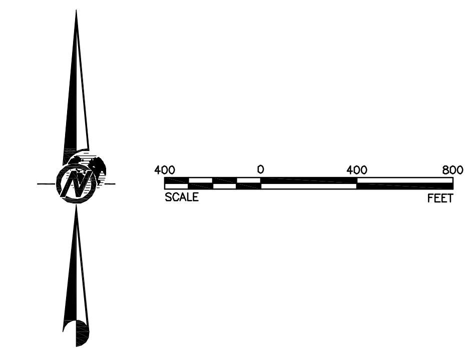
# PROPOSED PERMIT AREA

Golder Associates
Albuquerque, New Mexico

| PROJECT No. | 083-93385SA | | FILE No. Permit Area | |
|---|---|---|---|---|
| DESIGN | LM | 05/05/09 | SCALE AS SHOWN | REV. 0 |
| CADD | CM | 05/05/09 | PLATE 1 | |
| CHECK | TS | 05/12/09 | | |
| REVIEW | LM | 05/13/09 | | |

Drawing File: Plate01_Permit Area.dwg Jun 08, 2009 - 8:25am




## LEGEND

- EXISTING ROAD
- EXISTING FENCE
- EXISTING POWER LINE

NOTE: 5' CONTOUR INTERVALS

## EXPLANATION

1. MAIN PORTAL ENTRANCE
2. VENTILATION FAN / SECONDARY ACCESS
3. WATER STORAGE TANK / PUMPING STATION
4. WASTE ROCK PILE
5. STORAGE AREA
6. PORTABLE SCALE
7. SAFETY & SHIFTER TRAILER
8. COMPRESSOR
9. SUBSTATION
10. EXPLOSIVE STORAGE W/ GATE BERM & SECURITY FENCING
11. FUEL STORAGE
12. MAINTENANCE SHOP
13. OUTSIDE STORAGE & CONEX TRAILERS
14. EQUIPMENT PARKING
15. MENS CHANGE TRAILER (DRY)
16. WOMEN'S CHANGE TRAILER (DRY)
17. OFFICE TRAILER
18. EMPLOYEE & VISITOR PARKING (25-30 SPACES)
19. STAIRCASE TO PORTAL BENCH
20. SEPTIC TANK
21. SEPTIC LEACH FIELD
22. GROWTH MEDIUM STOCKPILE
23. STORMWATER DITCH
24. CULVERT
25. STORMWATER CONTAINMENT BASIN
26. POWERLINE
27. SITE ACCESS ROAD - 18 FOOT RUNNING SURFACE
28. GATE
29. PERIMETER FENCE (4 - STRAND BARBED WIRE)
30. CATTLE GUARD
31. "CLEAN" WATER DIVERSION
32. GENERATORS

PROJECT

LARAMIDE RESOURCES (USA) INC.
LA JARA MESA PROJECT
CIBOLA COUNTY, NEW MEXICO

TITLE

# CONCEPTUAL MINE LAYOUT PLAN

Golder Associates
Albuquerque, New Mexico

| | | |
|---|---|---|
| PROJECT No. | 08393385-SA | |
| DESIGN | LM | 04/30/09 |
| CADD | CM | 04/30/09 |
| CHECK | LM | 04/30/09 |
| REVIEW | BN | 05/30/09 |

FILE No. Base Site Map
SCALE AS SHOWN REV. 0

PLATE 2

Drawing file: Plate02_Site Plan.dwg Jun 08, 2009 - 8:26am

# APPENDIX A

# QUALITY ASSURANCE PROJECT PLAN

# 1.0 QUALITY ASSURANCE PROJECT PLAN (QAPP)

A quality assurance project plan (QAPP) is an integral part of the implementation of the Sampling and Analysis Plan (SAP). It specifies the data quality and quantity requirements needed as well as the procedures that will be used to collect, analyze, and report those data. The goal of SAP/QAPP is to collect representative samples which yield results that meet the projects data quality objectives and needs. The goal of quality assurance (QA) and quality control (QC) is to limit errors and bias in sampling and analysis process through an integrated implementation of management, assessment and control measures, thus facilitating the generation of data that is useful for decision making.

The QAPP can include one or more of the following:

- project management, organization and project personnel responsibilities;
- sampling, analysis, and measurement procedures;
- instrument calibration procedures;
- procedures for recording, reducing, validating, and reporting data;
- procedures for performing quality assurance verification and internal quality control checks;
- preventive maintenance schedules;
- specific routine procedures to evaluate;
- precision, accuracy, and completeness;
- steps for addressing deviations from plans and appropriate corrective actions; and
- information on appropriate staff training.

## 1.1 Project Management

Project organization, roles and responsibilities, training, record keeping, and documentation are discussed in the subsections that follow.

### *1.1.1 Project Organization Roles*

- Project Manager and Technical Lead,
- Quality Assurance/Quality Control (QA/QC) Manager,
- Hydrogeologist/Hydrogeologist,
- Field Operations Manager,
- Soil Scientist,
- Field Engineer,
- Radiation Safety Officer,
- Health and Safety Coordinator,

- Field Crew

### *1.1.2 Responsibilities*

A generalized description of the roles and responsibilities of the staff supporting the implementation on the Plan is as follows:

*Project Manage and Technical Lead* – provides project oversight, communicate with clients and regulatory representative/personnel, evaluate employee experience by certifying individuals qualified to work at the site and manage personnel.

*QA/QC Manager* – provides technical review of report(s) including QA/QC of technical data and verify data usability,

*Hydrologist/Hydrogeologist* –review surface water data and develop sampling plan, coordinate sampling and field activities, communicate with analytical laboratories, evaluate data usability and quality, analyze and interpret data, prepare report(s),

*Soil Scientist* – provides site materials characterization oversight (including sample plan development for soil characterization, vegetation densities and inventory, and habitat identification), communicate with analytical laboratories, evaluate data usability, data quality, analyze and interpret data, prepare report(s).

*Field Operations Manager and Engineer* – direct field activities and field sampling procedures, verify sample handling and field measurement procedures follow the SAP, report on status of field activities.

*Health and Safety Coordinator* – review, approve and implement Health and Safety Plan,

*Radiation Safety Officer*– provides oversight of field radiological survey, provide radiation safety and survey equipment training,

*Field Sampling Crew* – conduct field sampling and measurement activities in accordance with approved SAP and implement proper sampling and sample handling procedures.

## 1.2 Training Requirements

### *1.2.1 Health and Safety Training*

It is recommended that personnel who work on-site have one or more forms of health and safety training. This may include formal Occupational Safety and Health Administration (OSHA) or Mine Safety and Health Administration training as defined in Title 29 of the Code of Federal Regulations (CFR) Part 1910.120(e) and Title 30 CFR Part 46, respectively. Additional training may include: three (3) days of actual on-site field experience under the supervision of a trained and experienced field supervisor; ten (10) hours OSHA construction worker training and radiation safety training. Field personnel who directly supervise employees will go over the health and safety program requirements, training requirements, PPE requirements, and appropriate health-hazard monitoring procedures and techniques. Site-specific training covers the following areas:

- Names of personnel and alternates responsible for health and safety at the site;
- Health and safety hazards that may be present on site;
- Selection of the appropriate personal protection levels;
- Correct use of PPE;
- Work practices to minimize risks from hazards;
- Safe use of equipment on site; and
- The contents of the site-specific health and safety plan.

## 1.3 Documentation and Records

Documentation is critical for evaluating the success of any environmental data collection activity. The following section discusses the requirements for documenting field activities. Field personnel would use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook would list the contract name and number, the project number, the site name, and the names of subcontractors, the client, and the project manager. At a minimum, the following information would be recorded in the field logbook:

- Names and affiliations of all on-site personnel or visitors;
- Weather conditions during the field activity;
- Summary of daily activities and significant events;
- Sample locations, types, depths, GPS coordinates, and identifiers;
- Notes of conversations with coordinating officials;
- References to other field logbooks or forms that contain specific information;
- Discussions of problems encountered and their resolution;
- Discussions of deviations from the QAPP or other governing documents; and
- Descriptions of all photographs taken.

## 1.4 Data Acquisition

This section describes the requirements for the following:

- Sampling Design and Data Collection
- Field Activities
- Sample Handling and Custody
- Analytical Methods
- Quality Control Sampling
- Equipment Testing, Inspection, and Maintenance
- Instrument Calibration Procedures
- Inspection and Acceptance Requirements for Supplies and Consumables
- Management of Work Plan Deviations

### *1.4.1 Sample Design and Data Collection*

The sampling design is described in detail in the previous Section entitled "Sampling and Analysis Plan". Global Positioning System (GPS) data will be collected using a Geoexplorer II (Trimble ®) or equivalent and maintained in a database specified for the site. In addition, to logging the data on the GPS unit, GPS coordinates, date, time, and other relevant information (e.g. sample ID, type, etc) will be hand recorded in hard-bound field notebooks or worksheets.

### *1.4.2 Sampling Method Requirements*

Sampling techniques including standard methods, sampling containers and preservation are described in the Section entitled "Sampling and Analysis Plan."

### *1.4.3 Sample Handling and Custody Requirements*

The following subsections describe sample handling procedures, including sample identification, labeling, documentation, Chain of Custody (COC), and shipping.

#### 1.4.3.1 Sample Identification

Each sample collected during site assessment activities will be identified using a unique sample identification (ID) number and cross-referenced to the description of the sample type (water, soil, sediment, waste, etc.), sample collection location and the depth of sample collection in the field notes. The sample ID would be recorded on the COC forms. Field duplicates for aqueous samples would be collected at a frequency of 10 percent for individual sampling events. The duplicate sample would be given an ID similar to the one for the normal sample but with a distinct extension. This way, the sample association would be blind to the laboratory. The association between normal and duplicate sample would be noted in the log book and/or sampling forms.

#### 1.4.3.2 Sample Labels

Labels would be affixed to each sample container. The label would be completed with the following information written in indelible ink:

- Project name and location
- Sample identification number
- Date and time of sample collection
- Preservative used (if any)
- Sample collector's initials
- Analysis required
- And refrigerated (if necessary) by placing on ice in a cooler.

#### 1.4.3.3 Sample Documentation

Documentation during sampling is essential to promote proper sample identification. Field personnel would adhere to the following general guidelines for maintaining field documentation:

- Documentation would be completed in permanent black or blue ink.
- All entries would be legible.
- Errors would be corrected by crossing out the entry with a single line and then dating and initialing the lineout.
- Any serialized documents would be maintained and referenced in the site logbook.
- Unused portions of pages would be crossed out, and each page would be signed and dated.

#### 1.4.3.4 Chain of Custody (COC)

Field personnel would use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis. COC procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The COC form would be used to document all samples collected and the analyses requested. Information that the field personnel would record on the COC form includes:

- Project name and number
- Sampling location
- Name and signature of sampler
- Destination of sample (laboratory name)

- Sample ID
- Date and time of collection
- Number and type of containers filled
- Analyses requested
- Preservatives used (if applicable)
- Filtering (if applicable)
- Signatures of individuals involved in custody transfer, including the date and time of transfer
- Airbill number (if applicable) or courier information
- Project contact and phone number

Unused lines on the COC form would be crossed out and field personnel would sign COC forms and the airbill number would be recorded. It is expected that samples would be hand-carried to a local analytical laboratory for analysis. In the eventuality that samples would be shipped by courier or air carrier, the COC form would be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed airbills would serve as evidence of custody transfer between field personnel and the courier, and between the courier and the laboratory. Copies of the COC form and the airbill would be retained and filed by field personnel before the containers are shipped.

The laboratory sample custodian would receive all incoming samples, sign the accompanying COC forms, and retain copies of the forms as permanent records. The laboratory sample custodian would record all pertinent information concerning the samples, including the persons delivering the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample IDs, and any unique laboratory identification numbers for the samples. When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory would provide a secure storage area for all samples. Access to this area would be restricted to authorized personnel. The custodian would ensure that samples requiring special handling, including samples that are heat- or light-sensitive, radioactive, or have other unusual physical characteristics, would be properly stored and maintained prior to analysis.

#### 1.4.3.5 Analytical Methods

Analytical methods for the project are specified in Tables A-1, A-2 and A-3.

#### 1.4.3.6 Quality Control Sampling

The subsections below specify QA/QC protocols for field and laboratory samples. Duplicate samples would be collected during the investigation at a frequency of 10% the total number of samples collected.

#### 1.4.3.7 Instrument/Equipment Testing, Inspection and Maintenance

All equipment used during the site assessment would be properly tested, inspected, maintained, and calibrated. Samples collected during this investigation would be analyzed only by laboratory equipment. The laboratory's QA plan and written operating procedures describing specific testing, inspection, maintenance, and calibration procedures for equipment would be followed. Operation of the GPS unit and subsequent differential data corrections will be performed in accordance with the operator's manual. Daily GPS checks will include battery life, position dilution of precision, known point and data acquisition checks. Daily quality control checks for gamma survey meters will include battery life, high voltage and threshold, background, and known radioactive source checks.

#### 1.4.3.8 Field Instrument Calibration Procedures

All field equipment utilized for this project (ie: water quality meters, soil pH kit, etc.) would be calibrated regularly according to the associated manufacturer's Operation Manuals. Gamma survey meters employed will be calibrated by the manufacturer. The minimum detectable activity (MDA) level will be defined for all gamma survey meters using the calculations suggested in the literature NUREG-1507 and NUREG/CR-5849 Section 5. Additionally, the meters will be tested periodically at the Calibration Pad facility outside of Grants, NM and in accordance with the literature (Leino, et al., 1994; George, et al., 1985).

#### 1.4.3.9 Inspection and Acceptance Requirements for Supplies and Consumables

The field operations manager has the primary responsibility for identifying the types and quantities of supplies and consumables needed to complete the project and is responsible for identifying acceptance criteria for these items.

Supplies and consumables can be received either at the office or at the work site. When supplies are received at an office, the project manager or field personnel would sort them according to vendor, check packing slips against purchase orders, and inspect the condition of all supplies before they are accepted for use on a project. If an item does not meet the acceptance criteria, deficiencies would be noted on the packing slip and purchase order and the item would then be returned to the vendor for replacement or repair.

Procedures for receiving supplies and consumables in the field are similar. When supplies are received, the project manager or field personnel would inspect all items against the acceptance criteria. Any deficiencies or problems would be noted in the field logbook, and deficient items would be returned for immediate replacement.

With respect to surface water samples, the analytical laboratory would provide certified clean containers for all analyses.

### 1.4.4 Plan Deviations

Minor deviations, including field instrument malfunction (pH meter, etc.) would be addressed by field crew and the project manager using professional judgment. Any deviation from the SAP would be detailed in the field notebook and included in the final report to the client and regulatory agency representative. Any deviation considered significant would be addressed by the field crew, project manager, the client and the regulatory representative. A consensus on correcting the deviation would be achieved prior to executing any work plan changes. If a situation arises that requires work plan deviation and attempts to contact the client and regulatory representative are unsuccessful and the need for a decision is time critical, the project manager would use professional judgment to adjust work plan specifications as needed.

## 1.5 Data Validation and Usability

This section describes the procedures that are planned to review and evaluate field and laboratory data. This section also discusses procedures for verifying that the data are sufficient to meet the data quality objectives.

### 1.5.1 Data Review, Validation and Verification Requirements

For this project, 100 percent of the laboratory results will be reviewed. No validation will be performed outside of those performed by the certified analytical laboratory. Data will be reviewed for holding times, handling and preservation procedures, chain of custody, acceptance within control limits, and to ensure data meet method control limits for project goals.

### 1.5.2 Data Evaluation and Usability

Laboratory personnel would verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any non-conformances to the requirements of the analytical method. Laboratory personnel would make a systematic effort to identify any outliers or errors before they report the data. Outliers that result from errors found during data verification would be identified and corrected; outliers that cannot be attributed to errors in analysis, transcription, or calculation would be clearly identified in the case narrative section of the analytical data package.

All laboratory and previously collected data would be reviewed to ensure usability. The data evaluation strategy would determine if the analytical results are within the QC limits set for the project and data usability would be assessed. Specifically, sample analytical methods, handling requirements, holding times, duplicate results, and QC control limits would be reviewed.

### *1.5.3 Data Management*

Field data would be recorded in logbooks and/or field forms and scanned copies would be included in the appendices of the Baseline Data Report. Analytical data would be received in electronic form and would be summarized, tabulated, analyzed, and provided in the body of the report. The original laboratory data would also be provided in the appendices. As appropriate, some data would be presented graphically. Environmental data collection will undergo an appropriate level of assessment and audit activities. Any problems encountered during an assessment of field investigation or laboratory activities would require appropriate corrective action to ensure that the problems are resolved.

## 1.6 Reporting

Quarterly progress reports will be prepared summarizing the results of the field investigation activities and monitoring results for the duration of the field investigation. The outcome of this investigation would be documented in a final baseline data report. This report would include a description of all field operations, any deviations from the original SAP, a review of previously collected data and data limitations, all raw and processed analytical data collected during this investigation, as well as graphical representations of all spatial data. The report would also include other related supporting information and recommendations for subsequent data collection if data gaps are identified upon completion of the current investigation.

**TABLE A-1**
**ANALYTICAL METHODS FOR RADIONUCLIDE CHEMISTRY OF SOILS AND SEDIMENT**

| Radionuclide Analyte | Analytical Method Hot Digest* | Detection Limit |
|---|---|---|
| Uranium, total-238 | EPA 6020, ICP-MS | 0.01 mg $kg^{-1}$ |
| Radium 226 | EPA 903.1 | 0.5 pCi $g^{-1}$ |
| Radium 228 | EPA 9320 | 3.0 pCi $g^{-1}$ |
| Thorium, total-232 | EPA 6020, ICP-MS | 0.1 mg $kg^{-1}$ |
| Gross alpha/beta | EPA 9310 | 4.0 pCi $g^{-1}$ |

* Extraction = US EPA Method 3050B (hot acid digestion for soils, wastes and sediments).

**TABLE A-2**
**ANALYTICAL METHODS FOR CHEMICAL AND PHYSICAL CHARACTERIZATION OF SOILS, SEDIMENTS AND OTHER MATERIALS**

| Analysis | Source-Method |
|---|---|
| Saturated Paste pH | SLS, 1954 - Method 2 and 21a |
| Electrical Conductivity | SLS, 1954 - Method 3a and 4b |
| Saturation percentage | SLS, 1954 - Method 27a |
| $CaCO_3$ equivalent percent (lime) | SLS, 1954- Method 23c |
| Particle Size Distribution | Gee and Bauder (1986) |
| Rock Fragments | Dry sieve/gravimetric |
| Total Sulfur and Sulfur Forms, ABA | Sobek et al., 1978 |
| Neutralization Potential | Sobek et al., 1978 |
| SPLP extracted metals (As, Ba, Cu, Co, Mn, Se, U ) | EPA Method 1312. |
| Selenium (hot water soluble) | Agron. 9 - Method 80/3.2.1 |
| Boron (hot water soluble) | Agron. 9 -Method 75-4 |

**TABLE A-3**
**ANALYTICAL METHODS FOR CHEMICAL ANALYSES OF WATER SAMPLES**

| Analyte | Standard Methods | Detection Limits (mg/L) |
|---|---|---|
| Alkalinity | EPA 310 | 10.0 |
| Aluminum | EPA 200.8 | 0.1 |
| Antimony | EPA 200.8 | 0.003 |
| Arsenic | EPA 200.8 | 0.005 |
| Barium | EPA 200.8 | 0.1 |
| Boron | EPA 200.7 | 0.1 |
| Cadmium | EPA 200.7 | 0.001 |
| Calcium | I-3485 | 1.0 |
| Chloride | EPA 300 | 1.0 |
| Chromium | EPA 200.8 | 0.01 |
| Cobalt | EPA 200.8 | 0.01 |
| Copper | EPA 200.8 | 0.01 |
| Cyanide | ASTM D2036 | 0.005 |
| Fluoride | EPA 300.0 | 0.1 |
| Gross Alpha | EPA 900.0 | 1.0 pCi/L |
| Gross Beta | EPA | 2.0 piC/L |
| Iron | EPA 6010 | 0.03 |
| Lead | EPA 200.8 | 0.002 |
| Magnesium | EPA 6010C | 1.0 |
| Manganese | EPA 200.8 | 0.01 |
| Mercury | EPA 200.8 | 0.0001 |
| Molybdenum | EPA 200.8 | 0.005 |
| Nickel | EPA 200.8 | 0.01 |
| Nitrate, as N | EPA 300.0 | 0.05 |
| Nitrite, as N | EPA 300.0 | 0.05 |
| Nitrate+Nitrite | EPA 300.0 | 0.01 |

| Analyte | Standard Methods | Detection Limits (mg/L) |
|---|---|---|
| Potassium | I-3631 | 1.0 |
| Radium-226 + 228 | EPA 904.0 | 1.0 pCi/L |
| Radon-222 | ASTM D5072-92 | 100.0 pCi/L |
| Selenium | EPA 200.8 | 0.005 |
| Silicon | EPA 6010C | 0.1 |
| Sodium | EPA 6010C | 1.0 |
| Sulfate | EPA 300 | 1.0 |
| TDS | EPA 160.1 | 10.0 |
| Uranium | EPA 200.8 | 0.0003 |
| Vanadium | EPA 200.8 | 0.1 |
| Zinc | EPA 6010C | 0.01 |
| Ph | EPA 150.1 | 0.1 |

# APPENDIX B

# SIPHON SURFACE WATER SAMPLER

**USGS**
***science for a changing world***

# Comparison of Water-Quality Samples Collected by Siphon Samplers and Automatic Samplers in Wisconsin

## Introduction

In small streams, flow and water-quality concentrations often change quickly in response to meteorological events. Hydrologists, field technicians, or locally hired stream observers involved in water-data collection are often unable to reach streams quickly enough to observe or measure these rapid changes. Therefore, in hydrologic studies designed to describe changes in water quality, a combination of manual and automated sampling methods have commonly been used-manual methods when flow is relatively stable and automated methods when flow is rapidly changing. Automated sampling, which makes use of equipment programmed to collect samples in response to changes in stage and flow of a stream, has been shown to he an effective method of sampling to describe the rapid changes in water quality (Graczyk and others, 1993). Because of the high cost of automated sampling, however, especially for studies examining a large number of sites, alternative methods have been considered for collecting samples during rapidly changing stream conditions. One such method employs the siphon sampler (fig. 1), also referred to as the "single-stage sampler." Siphon samplers are inexpensive to build (about $25-$50 per sampler), operate, and maintain, so they are cost effective to use at a large number of sites. Their ability to collect samples representing the average quality of water passing though the entire cross section of a stream, however, has not been fully demonstrated for many types of stream sites.

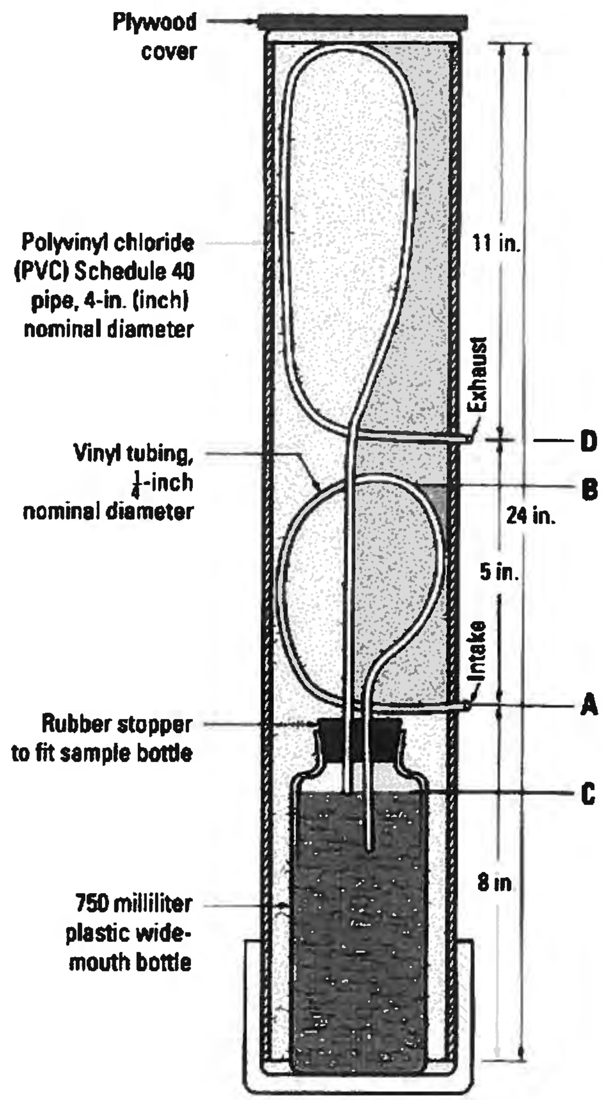



**Figure 1.** Typical siphon sampler.

The Inter-Agency Committee on Water Resources, Subcommittee on Sedimentation

(ICWR-SS) developed and tested siphon samplers under laboratory conditions and concluded that siphon samplers are able to collect a sample representative of near-surface water quality during rising stages. ICWR-SS (1961) developed several models of samplers to collect representative samples for distinct ranges of stream velocity, water-surface surge, water temperature, and sediment size. The study concluded that siphon samplers are useful when sediment concentrations near the water surface are of value and sampling by other, possibly more accurate methods is not practical or feasible. Edwards and Glysson (1988) outlined some of the limitations of siphon samplers. The primary limitation was that, because samples are collected near the water surface at one point in the stream, adjustments may be needed to describe the vertical and horizontal distributions in water quality, especially if the stream transports large sand-size particles. This is also a limitation for automatic samplers because automatic samplers collect a sample at a fixed horizontal and vertical location in the stream cross section.

The U.S. Geological Survey (USGS) and Wisconsin Department of Natural Resources (WDNR) are currently monitoring the water quality of several streams with a combination of manual and automated sampling methods. Future studies are aimed at describing changes in water quality at many sites; therefore, siphon samplers are being considered as a means to augment manual sampling and minimize sampling costs. Siphon samplers have had limited use in Wisconsin but have not been thoroughly tested to determine their ability to collect representative samples in Wisconsin streams. This fact sheet describes how successfully siphon samplers can be used to collect representative samples at selected stream sites in Wisconsin. Concentrations of suspended sediment, total phosphorus, and ammonia nitrogen in samples collected by siphon samplers in three streams in southwestern Wisconsin are compared with those collected with the more thoroughly investigated stage-change-activated automated samplers (Krug and Goddard, 1986).

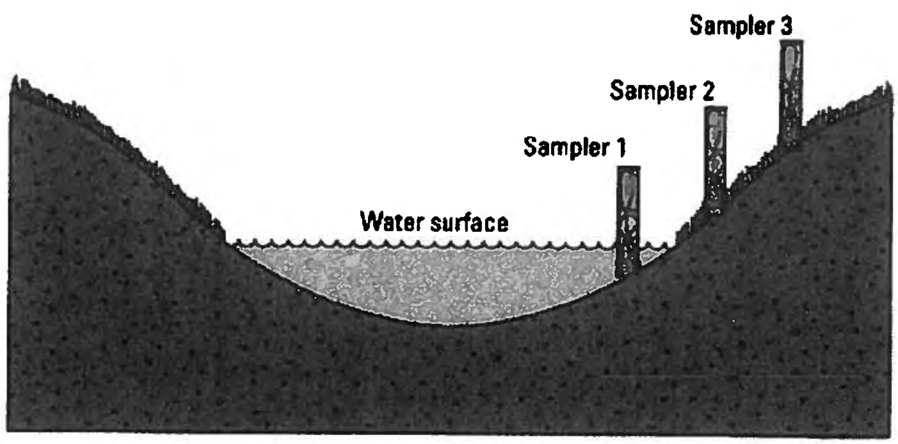



**Figure 2.** Typical stream-site installation of siphon samplers.

## Siphon-Sampler Design and Operation

The design of the siphon sampler used in this study is similar to that described by the ICWR-SS (1961) and by Edwards and Glysson (1988) and shown in figure 1. The operation of a siphon sampler during an event with increased stage and flow is simple. As the stream stage rises to the elevation of the intake level A (fig. 1), water enters the 1/4-inch-diameter plastic tube. As the stream continues to rise, water continues to move up the intake tube until the stream and the water in the tube reach level B. When the water levels rise past level B, a siphon is created and the sample bottle starts to fill. The sample bottle fills rapidly because the flow rate is driven by the hydraulic head, which is approximately the height difference between the stream stage (level B) and the discharge end of the intake tube (level C). As the water level in the sample bottle reaches the bottom end of the exhaust port (level C), filling is substantially completed; however, a small amount of additional water, equal to the water volume in the exhaust tube between levels C and D, enters the bottle after the water level rises past level C. After the stream stage reaches level D, an airlock is established in the loop of the exhaust tube, which precludes further filling of the bottle. Changes in the water level after this point do not significantly affect the contents in the bottle. After the event, the bottles are collected and the contents analyzed. Siphon samplers are unrefrigerated; therefore, analytical results may have to be qualified for certain constituents that are unstable at temperatures above about 40 Celsius. Several samplers can be installed at different levels at each site to collect samples throughout the anticipated range in water levels (fig. 2).

**Table 1.** Comparison of water-quality data from siphon samplers with those from automated (ISCO) samplers. [Statistics are based on 47paired samples for total phosphorus and ammonia nitrogen and 41 paired samples for suspended sediment]

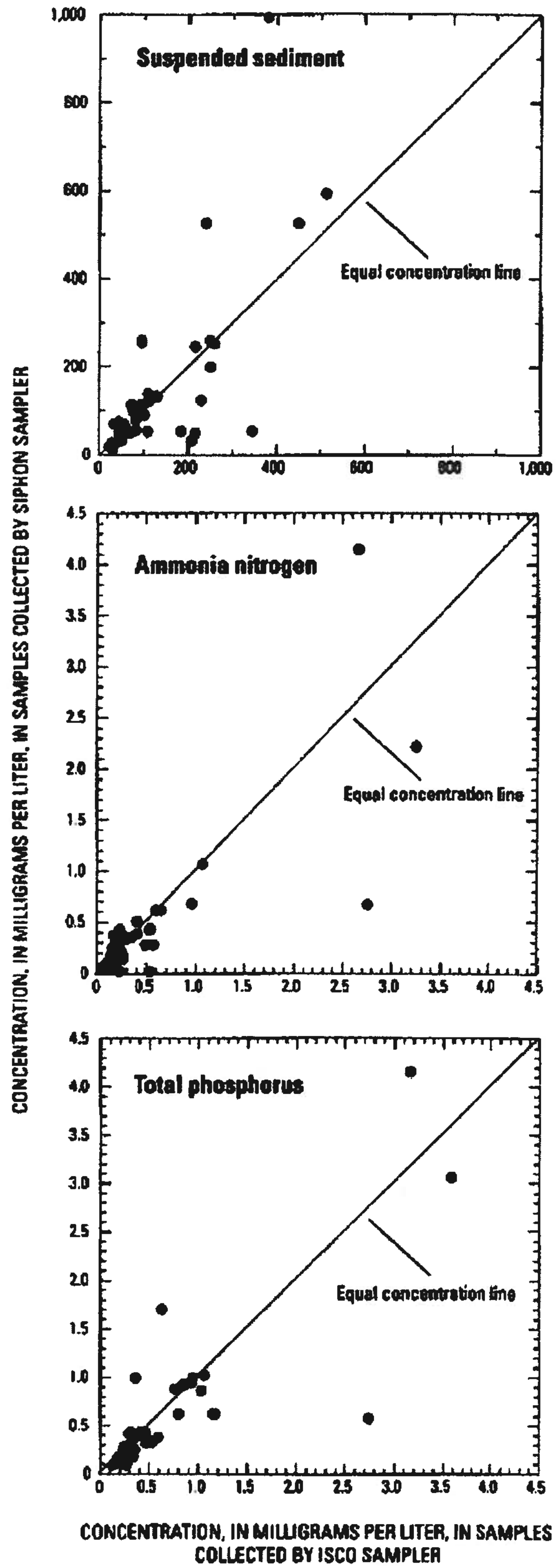
| Constituent and method | Concentration, in milligrams per liter | | | | | Difference in concentration (Siphon – ISCO), in milligrams per liter (and percent) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | Standard deviation | Mean | Median | Maximum negative difference | Maximum positive difference | Standard deviation | Mean difference | Median difference |
| **Total phosphorus** | | | | | | | | | | |
| Siphon sampler | 0.10 | 4.16 | 0.73 | 0.60 | 0.41 | -2.16 | 1.08 | 0.43 | -0.05 (-23%) | -0.03 (-7%) |
| ISCO sampler | 0.13 | 3.58 | 0.73 | 0.65 | 0.41 | | | | | |
| **Ammonia nitrogen** | | | | | | | | | | |
| Siphon sampler | 0.02 | 4.15 | 0.67 | 0.39 | 0.22 | -2.09 | 1.49 | 0.43 | -0.07 (-7%) | -0.02 (-8%) |
| ISCO sampler | 0.05 | 3.25 | 0.68 | 0.46 | 0.22 | | | | | |
| **Suspended sediment** | | | | | | | | | | |
| Siphon sampler | 12 | 995 | 193 | 155 | 75 | -291 | 617 | 133 | 14 (-41%) | 5 (4%) |
| ISCO sampler | 23 | 512 | 120 | 141 | 95 | | | | | |

## Sampling Sites

Siphon samplers were installed at three sites near USGS offices in Middleton, Wis.: North Fork of Pheasant Branch Creek (North Fork) and Pheasant Branch Creek at Highway 12 (Pheasant Branch), which are perennial streams; and South Fork of Pheasant Branch Creek (South Fork), an ephemeral stream. A USGS streamflow-gaging station was operational at each site, along with an automated water-quality sampler (ISCO) programmed to collect samples during runoff events. The drainage area above the North Fork site, 9.8 $mi^2$ (square miles), is primarily agricultural, whereas the drainage area above the South Fork site (5.7 $mi^2$) is predominantly urban. The drainage area above Pheasant Branch (18.3 $mi^2$), which is downstream from both the North and South Forks, encom-passes

**Figure 3.** Concentrations of suspended sediment and chemical constituents in samples collected by the siphon sampler and ISCO sampler.

both agriculture and urban development. Historical data from samples collected at Pheasant Branch indicate that most suspended-sediment particles were silt- and clay-sized (particles<0.062 millimeters).




At each site, siphon samplers were installed at three distinct elevations to sample different stages and times during an episode of increasing streamflow (fig. 2). The samplers were placed so that the first sample would be collected when the water stage rose approximately 0.2 feet. The second sample would be collected approximately 0.3-0.5 feet above where the first sample was collected, and the third sample would be collected 0.4-0.6 feet above where the second was collected. A fence post was driven into the stream bottom, and each siphon sampler was attached to the post by a large hose clamp. The intake nozzles of the samplers were oriented perpendicular to the direction of streamflow to minimize the likelihood of the nozzles being clogged with sediment or debris. The automated ISCO samplers at each site were programmed to collect discrete samples at the stages and times similar to those for the siphon samplers.

Samples were removed from both the automated refrigerated samplers and siphon samplers as soon as possible after each runoff event and preserved by either chilling (for suspended-sediment analyses) or chilling and acidifying (for total phosphorus and ammonia nitrogen analyses). After sample removal, each sampler was cleaned by flushing the intakes with streamwater and distilled water. Suspended-sediment analyses were done by the USGS sediment laboratory in Iowa City, Iowa, and total phosphorus and ammonia nitrogen analyses were done by the Wisconsin State Laboratory of Hygiene in Madison, Wis. All samples were analyzed by use of standard methods (American Public Health Association, 1995; Guy, 1969).

### Water-Quality Comparison

Pairs of samples (IS CO and siphon) were collected from the three sites over a range of flows and water-quality conditions and were aggregated into one data set for the statistical analyses. Forty-seven pairs of samples were analyzed for total phosphorus and ammonia nitrogen and 41 pairs for suspended sediment. As is evident from table 1, constituent concentrations in the paired samples were similar, but the ranges in values were slightly smaller in the samples collected with the ISCO samplers than in those collected with the siphon samplers.

No systematic biases are evident in the distribution of data points about the 1:1 line (the line of equal concentrations) in the graphs shown in figure 3. The mean concentrations of the total phosphorus and ammonia nitrogen in the 47 sample pairs were within 0.07 mg/L (milligrams per liter) of each other, although the mean percentage difference for total phosphorus was almost 23 percent. The mean concentrations of suspended sediment were within 14 mg/L of each other, with a mean percentage difference of 41 percent. Differences between medians were even smaller. The median total phosphorus and ammonia nitrogen concentrations were identical, with the median percentage difference about 8 percent. The median difference in suspended-sediment concentrations was 5 mg/L and the median percentage difference was 4 percent.

A nonparametric Wilcoxon signed-rank test (Conover, 1980) applied to the data indicated no statistically significant differences in the constituent concentrations between the samples collected by the two types of samplers. The null hypotheses of the tests performed were that there were no differences between the constituent concentrations using either sampler. At the 5-percent significance level ($P < 0.05$), there were no statistically significant differences found in concentrations between the sampling methods for any of the constituents. Therefore the null hypotheses were not rejected.

In general, the constituent concentrations of samples collected with automated samplers (ISCO) have been shown to be similar to those of manually collected, cross-section-ally integrated water-quality samples (Krug and Goddard, 1986). Therefore, the similarity found in the means and medians for each of the three water-quality constituents indicates that siphon samplers also collect representative water samples over the range of sampled flow conditions for the type of streams examined. It follows that samples collected with siphon samplers typically should have about the same accuracy (bias) as automated samplers; however, individual measurements may be less precise (as seen in the variance around the 1:1 lines in fig. 3). Part of the scatter around the 1:1 line of equal concentrations may have resulted from the pair of samples not being collected exactly at the same time and, therefore, may have been samples of water of different concentrations. Additional work is needed to determine if this variability between data sets is caused by sampler performance or by slight differences in sample-collection timing.

* Use of trade names in this report is for identification purposes only and does not constitute endorsement by the US Geological Survey.

## Conclusions

Siphon samplers are low-cost alternatives to automatic samplers that have been traditionally used to collect representative water-quality samples. Siphon samplers can be used to augment manual sampling of "flashy" streams and remote streams by collecting samples during rapidly increasing stream stage-a generally impractical condition to be sampled adequately with a manual sampling program. Siphon samplers would also be a cost-effective alternative to automatic samplers if samples need to be collected at numerous sites. Siphon samplers do not collect water samples when the stream stage is decreasing; therefore, manual samples still need to be collected during this period. Decreases in stage, however, are generally more protracted than increases in stage and commonly can be manually sampled by a field person dispatched at the beginning of the event. Additional studies may help to determine the reason for the variability between individual constituent concentrations of samples collected with an automated sampler and the siphon sampler as demonstrated by the scatter around the 1:1 lines in figure 3.

Authors: David J. Graczyk, Dale M. Robertson,
Layout and illustrations: Michelle Greenwood and Aaron Konkol

**References**

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**Information**

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USGS Fact Sheet FS-067-00
July 2000

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US Geological Survey

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# APPENDIX C

# QUALITY ASSURANCE PERFORMANCE AUDIT OF METEOROLOCIAL TOWER

# QUALITY ASSURANCE PERFORMANCE AUDIT OF METEOROLOGICAL TOWER HOMESTAKE MINING COMPANY GRANTS, NEW MEXICO MAY 2008

Prepared for:

Homestake Mining Company
Grants Project
P.O. Box 98
Grants, New Mexico 87020-0011

By

Meteorological Solutions Inc.
Project No. 05080728

August 2008

Meteorological Solutions Inc.

**QUALITY ASSURANCE PERFORMANCE AUDIT**
**OF METEOROLOGICAL TOWER**
**BARRICK/HOMESTAKE MINING COMPANY**
**GRANTS, NEW MEXICO**
**MAY 2008**

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**QUALITY ASSURANCE PERFORMANCE AUDIT**
**OF METEOROLOGICAL TOWER**
**BARRICK/HOMESTAKE MINING COMPANY**
**GRANTS, NEW MEXICO**
**MAY 2008**
MSI Project No. 05080728

## 1.0 INTRODUCTION

On May 28, 2008, MSI conducted quality assurance performance audits of instrumentation on a meteorological tower owned and operated by Barrick/Homestake Mining Company in Grants, New Mexico to meet US EPA Prevention of Significant Deterioration (PSD) quality assurance requirements. This report summarizes the performance audit activities conducted during that site visit.

Meteorological instrument performance audits at Barrick/Homestakes' meteorological monitoring station was conducted in accordance with the following guidelines:

- EPA's Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), 1987; and

- Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, March 2008.

## 2.0 PERFORMANCE AUDIT EQUIPMENT

The following MSI reference standard instruments, presented in Table 2-1 were used to conduct sensor performance audits.

**Table 2-1**

**MSI Quality Assurance Performance Audit Equipment**

| Parameter | Audit Reference Equipment | Serial Number |
|---|---|---|
| Wind Direction | Brunton 5008 Pocket Transit<br>Met One Model 040 Direction Template<br>Waters Torque Watch 366-1M | 5060803362<br>NA<br>3950 |
| Wind Speed | RM Young Model 18811 Anemometer Drive<br>Waters Torque Watch 366-3M | CA01889<br>3618 |
| Temperature | Brooklyn Digital Model 6661 | C404690 |
| Precipitation | Pyrex 100 ml graduated cylinder<br>Kimax 50 ml graduated cylinder | 3024<br>NA |
| Relative Humidity | Vaisala Model HMP45AC | W1630084 |
| Barometric Pressure | Vaisala PTB101B | A1950021 |
| Solar Radiation | LiCor Model 200x | PY56373 |

NA = Not Available.

Copies of the audit equipment certifications are presented in Appendix A.

## 3.0 SENSOR PERFORMANCE AUDITS

This section describes the meteorological instrument performance checks conducted by MSI at the Barrick/Homestake Mining Company, Grants, New Mexico meteorological monitoring station.

### 3.1 Description of Meteorological Station

Barrick/Homestake's meteorological station is located approximately at:

Latitude: 35° 14' N

Longitude: 107° 51' W

The station is equipped to measure horizontal wind speed and wind direction at 10 meters, temperature at 9.5 meters, solar radiation at 2 meters, relative humidity at 9.4 meters, precipitation at 0.4 meters, and barometric pressure at 8.8 meters. Table 3-1 lists the meteorological sensors installed at the meteorological station. Figure 3.1 presents a photograph of the meteorological station.

**Table 3-1**
**Homestake Mining Meteorological Station Sensors**

| Parameter | Meteorological Equipment | Serial Number |
|---|---|---|
| Wind Direction | Qualimetrics Model 2020 | 2881 |
| Wind Speed | Qualimetrics Model 2030 | NA |
| Temperature | Vaisala Model HMP45AC | NA |
| Precipitation | Weathertronics Model 6011 | 374 |
| Relative Humidity | Vaisala Model HMP45AC<br>Vaisala Model HMP45AC | NA[1]<br>C5110079 [2] |
| Barometric Pressure | Weathertronics | 7112 |
| Solar Radiation | LiCor 200X | PY31168 |

1 - As found

2 - Replacement sensor

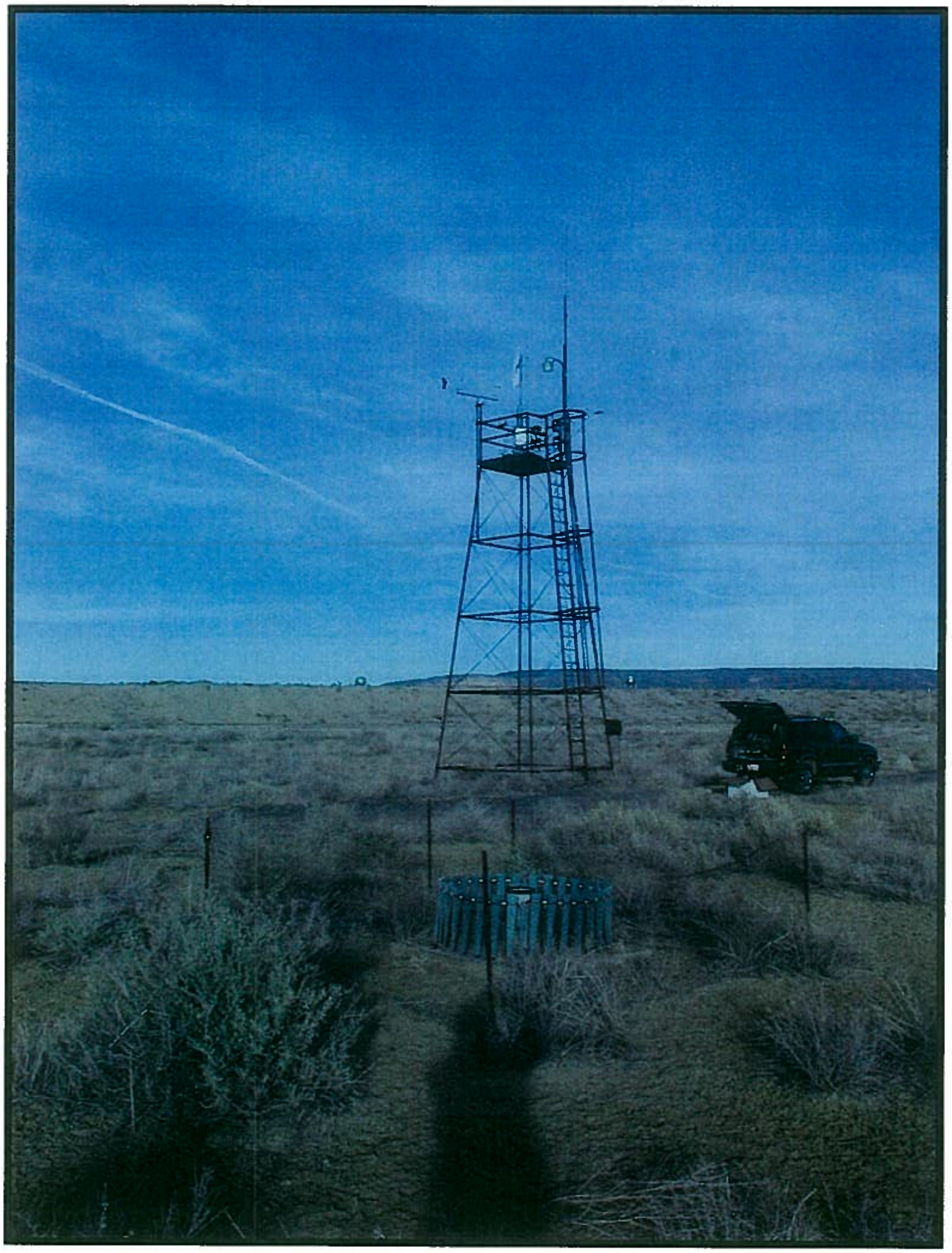

**Figure 3.1 Photograph of Meteorological Monitoring Station**

## 3.2 Performance Audit Methods

This section describes the audit methods used to verify the performance of the meteorological equipment. A summary of the audit methods and the acceptable tolerances for each method is presented in Table 3-2.

**Table 3-2**
**Performance Audit Methods and Acceptable Tolerances**

| Parameter | Audit Method | Acceptable Tolerances |
|---|---|---|
| Wind Direction | Orientation plus Linearity<br>Starting Threshold | ±5°<br><0.5 m/s |
| Wind Speed | Synchronous Motor<br><br>Starting Threshold | ±0.25 m/s @ <5 m/s<br>or ±5% @ >5 m/s<br><0.5 m/s |
| Temperature | Reference Thermometer Comparison | ±1.0°C |
| Relative Humidity | Collocated Reference Comparison | ±10% |
| Solar Radiation | Certified Reference Collocation | ±5% |
| Barometric Pressure | Collocated Reference Comparison | ±3 mbar |
| Precipitation | Calibrated Volumetric Addition | ±10% |

### 3.2.1 Wind Direction

The orientation of the wind direction sensor was checked using a professional magnetic compass. The compass was set using a magnetic declination of 10 degrees east of north.

In addition, the wind direction sensor linearity was verified by checking the sensor output at 90 degree increments throughout the entire 0 to 360 degree range in both clockwise and counterclockwise directions. The sensor starting torques were determined by measuring shaft rotational torque.

### 3.2.2 Wind Speed

The performance of the wind speed sensor was verified by applying known revolutions per minute using a variable speed motor drive. The shaft of the synchronous motor was attached to the bearing shaft of the anemometer with the cups removed. Synchronous motor speeds were translated into calculated wind speeds in miles per hour using manufacturer's specifications. Sensor responses were compared to the calculated wind speeds. Wind speed sensor shaft rotational torques were measured with a torque gauge to evaluate starting threshold.

### 3.2.3 Temperature

The calibration of the temperature sensor was verified by direct comparison of the sensor outputs to a collocated calibrated reference standard thermometer at ambient temperature.

### 3.2.4 Relative Humidity

The relative humidity sensor was checked by collocating a certified reference sensor with the station sensor.

### 3.2.5 Solar Radiation

The solar radiation pyranometer outputs were verified by collocation of a calibrated pyranometer adjacent to the system sensor. The MSI reference pyranometer was interfaced to a Campbell datalogger for signal processing and averaging. A 4-hour period was recorded and the readings from the reference pyranometer were compared directly to the site's pyranometer readings.

### 3.2.6 Barometric Pressure

The barometric pressure sensor was audited by collocating a calibrated reference barometer and comparing outputs with sensor outputs recorded on the data acquisition system.

### 3.2.7 Precipitation

Precipitation sensor outputs were audited using a standard graduated volumetric cylinder and syringe to add water to the gauge to simulate rainfall. The volume of water required to produce ten tips was recorded for each of the three runs. This volume was compared with the calculated calibration value and the amount of precipitation recorded by the data acquisition systems.

## 4.0 PERFORMANCE AUDIT RESULTS

The following sections present the quality assurance performance audit results for the meteorological sensors located at Barrick/Homestake's meteorological monitoring site. Performance audits of the meteorological sensors were conducted on May 28, 2008.

### 4.1 Wind Direction

As found, the wind direction sensor orientation checks indicated that the cross arm alignment was 270 degrees in reference to true west. When the wind vane was positioned parallel to the cross arm at 90 and 270 degrees, the sensor output was 400 and 120 degrees, respectively. The wind direction sensor orientation was not within the acceptable tolerance of ±5 degrees. Sensor linearity, when checked at 90 degree increments over the entire 0 to 360 degree range both clockwise and counterclockwise, was within 536 degrees. The wind direction sensor orientation plus linearity was not within the recommended tolerance of ±5 degrees. Sensor shaft rotational torque was <4.0 gram-centimeters (gm-cm) clockwise and counterclockwise. The rotational torque was within the starting threshold of ≤0.5 meters per second (m/s). Further investigation revealed that the datalogger did not have the correct programming for this wind sensor. The correct program was uploaded, the bearings were replaced and the wind direction sensor was re-audited.

After program upload and bearing replacement, the orientation checks indicated that the cross arm alignment was 270 degrees in reference to true west. When the wind vane was positioned parallel to the cross arm at 90 and 270 degrees, the sensor output was 90 and 269 degrees, respectively. Sensor linearity, when checked at 90 degree increments over the entire 0 to 360 degree range both clockwise and counterclockwise, was within 2.8 degrees. The wind direction sensor orientation plus linearity was within the recommended tolerance of ±5 degrees. Sensor shaft rotational torque was <3.0 gm-cm clockwise and counterclockwise. The rotational torque was within the starting threshold of ≤0.5 m/s.

### 4.2 Wind Speed

The wind speed sensor responses were checked over the range of 0 to 100 miles per hour (mph). As found, the shaft rotational torque was 1.2 gm-cm clockwise and counterclockwise translating to a starting threshold greater than 0.5 mps. Sensor response to anemometer drive inputs was unexpectedly an order of magnitude too high. Investigation revealed incorrect datalogger programming for this sensor.

The correct program was uploaded to the datalogger and sensor bearings were changed. Following bearing replacement and program change, the wind speed sensor was re-audited. The shaft rotational torque was less than 0.1 gm-cm clockwise and counterclockwise translating to a starting threshold less than 0.5 m/s. Sensor responses were nearly identical with the rpm audit input references that were checked.

### 4.3 Temperature

A certified digital thermometer was collocated with the station sensor simultaneously at ambient temperature for intercomparison. The temperature sensor output was within 0.7°C of the reference standard which exceeds the acceptable tolerance of ±0.5°C.

The temperature sensor was replaced and was re-audited. The digital reference thermometer was collocated with the station sensor at ambient temperature for intercomparison. The temperature sensor output was within an absolute average of 0.3°C of the reference standard which is within the acceptable tolerance of ±0.5°C.

### 4.4 Precipitation

Three runs of ten tips indicated that the precipitation gauge required an average of 3 percent more water to produce ten tips than the amounts recorded by the data acquisition system. The gauge output is within the ±10.0 percent tolerance.

## 4.5 Relative Humidity

A reference standard relative humidity sensor was collocated with the station sensor at ambient conditions for intercomparison. Sensor output was within 0.1 percent of the reference standard which is within the acceptable tolerance of ±10.0 percent.

The relative humidity sensor was replaced and re-audited. Sensor output was within an absolute average of 0.25 percent of the reference standard which is within the acceptable tolerance of ±10.0 percent.

## 4.6 Barometric Pressure

A certified reference barometer was used for intercomparison with the sensor at ambient conditions in inches of mercury (in. Hg). The audit input and responses were then converted to millibars (mb) from in. Hg. The sensor was found to be an average of 15.5 mb different than the reference standard which exceeds the allowable tolerance of ±3 mb.

## 4.7 Solar Radiation

A calibrated reference pyranometer was collocated with the station sensor for approximately 4 hours. Instantaneous manual readings taken at 6 different times during this period showed an average difference of 1.8 percent. Hourly averages during this period showed an average difference of 2.3%. This is within the recommended ±5 percent tolerance.

An intercomparison plot showing one-hour reference standard data versus one-hour Homestake data is shown in Figure 4.1. Figure 4.2 presents the linear regression results of the hourly paired solar radiation values. Tabular Data from the Homestake sensor and the MSI reference standard during the audit period are presented in Table 4-1.

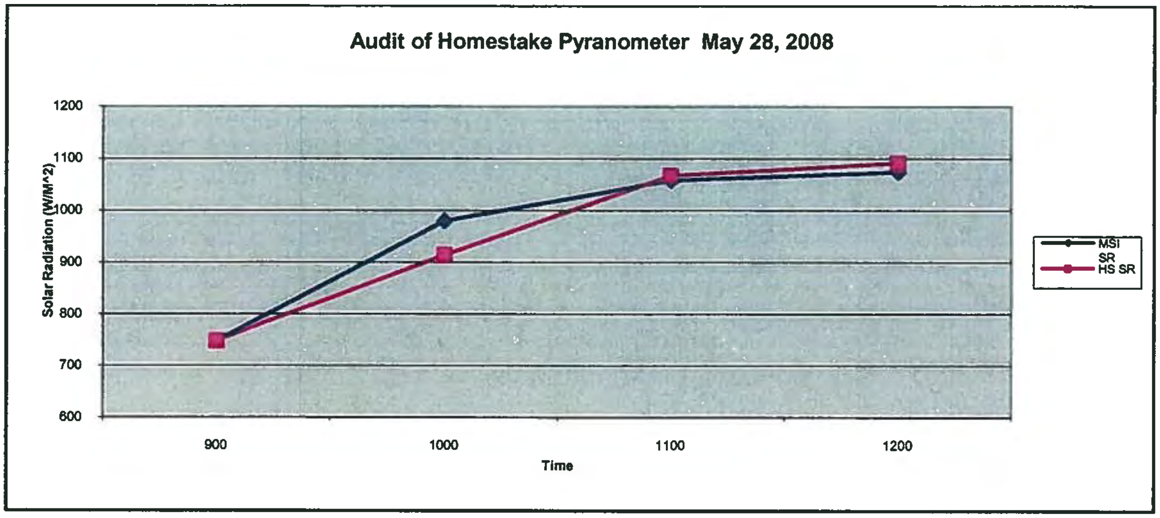


**Figure 4.1 Intercomparison Plot - MSI Reference Standard Versus Homestake Mining Company's Solar Radiation Sensor**

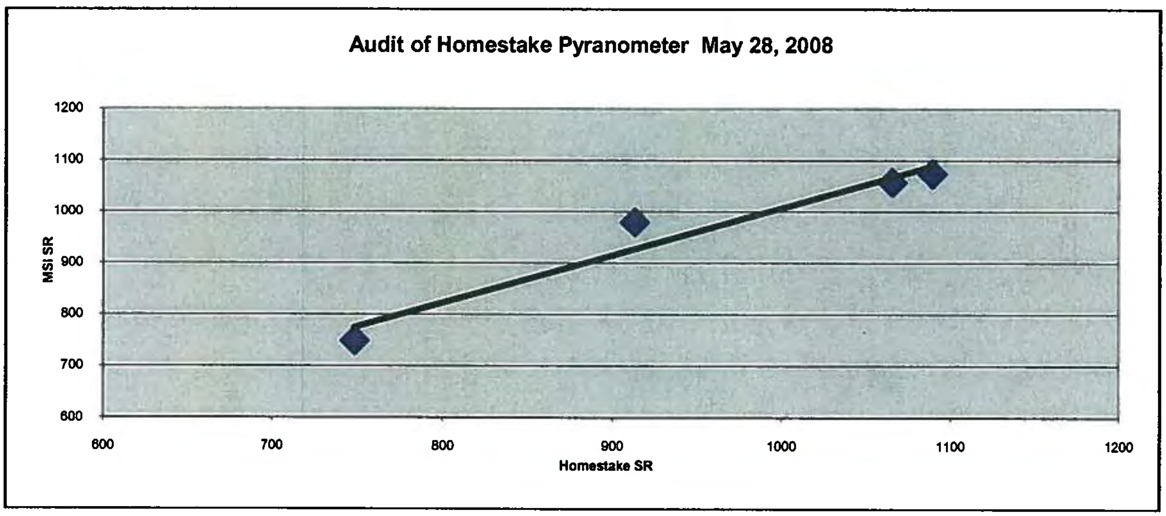


**Figure 4.2 Linear Regression Results of Paired Solar Radiation Values**

**Table 4-1**

**Tabular Data from Homestake Mining Company's Solar Radiation Sensor and MSI Reference Standard**

| Time | MSI Pyranometer Watts/$m^2$ | Homestake Pyranometer Watts/$m^2$ | Percent Difference |
|---|---|---|---|
| 900 | 748 | 748 | 0.0 |
| 1000 | 979 | 913 | -6.7 |
| 1100 | 1057 | 1065 | 0.8 |
| 1200 | 1073 | 1089 | 1.5 |
| Percent Difference = 2.3 | | | |

Copies of the performance audit field data sheets for the meteorological station are found in Appendix B.

## 5.0 SUMMARY

On May 28, 2008, MSI conducted quality assurance performance audits of meteorological instrumentation at Homestake Mining's Grants, New Mexico meteorological station.

As found, wind sensor speed and direction outputs were nowhere near reference inputs. Further investigation revealed that an extended power outage on June 23, 2007 caused the datalogger to shut down completely since the backup battery was depleted. Once power was restored and the battery re-charged, the datalogger apparently automatically retrieved an older no longer used program resident in the attached storage module used for datalogger backup. It contained different wind sensor programming from what is currently used and caused wind sensor outputs to be incorrect. In addition, the wind speed sensor starting threshold exceeded recommended tolerances because of bad bearings. Once the proper datalogger program was installed and wind sensor bearings were replaced, wind sensor performance was within US EPA recommended specifications.

Temperature sensor checks indicated that the site sensor was reporting ambient temperatures slightly lower than the reference. This sensor was scheduled for replacement during this visit and audit checks on the replacement sensor showed agreement with the reference within recommended tolerance.

Barometric pressure sensor output, when checked against a certified reference was not within recommended tolerance. This sensor is no longer supported by the manufacturer due to its age. Barometric pressure data should be scrutinized and unreasonable values should be invalidated. MSI recommends replacement of the barometric pressure sensor.

Solar radiation, relative humidity, and precipitation sensors were all operating with recommended tolerances.

The wind, temperature, and barometric pressure sensors failed the May 28, 2008 audit. All other sensors at the meteorological site were found to be operating normally and reporting data accurately within manufacturer's recommended tolerances and EPA-approved quality assurance guidelines for meteorological measurements. Table 5-1 summarizes the results of this audit.

**Table 5-1**

**Summary of May 28, 2008 Audit Results**

| Sensor Parameter | Result |
|---|---|
| Wind Direction | Fail |
| Wind Speed | Fail |
| Temperature | Fail |
| Precipitation | Pass |
| Relative Humidity | Pass |
| Barometric Pressure | Fail |
| Solar Radiation | Pass |

**Appendix A**
**Audit Equipment Certifications**

# THE BRUNTON COMPANY
## Certificate Of Calibration

Equipment Owner: METEOROLOGICAL SOLUTIONS
Name: ______

Address: 2257 SOUTH 1100 EAST SUITE 203

City, State, Zip: SALT LAKE CITY UT 84106

Calibration traceable to the National Institute of Standards and Technology in accordance with Mil-STD-45662A has been accomplished on the instrument listed below by comparison with standards maintained by The Brunton Co. The accuracy and stability of all standards maintained by The Brunton Co. are traceable to national standards maintained by the National Institute of Standards and Technology in Washington, D.C. and Boulder, CO. Complete record of all work performed is maintained by The Brunton Co. and is available for inspection upon request.

This Unit has been calibrated to Lietz TM10E serial number 30937 traceable to N.B.S. no. 738 227675 this 29TH Day of APRIL 2008

DESCRIPTION: POCKET TRANSIT

PURCHASE ORDER: RA 123319

ORDER NUMBER: 1727835

LOT NUMBER: ______

MODEL NUMBER: 5006

SERIAL NUMBER: 5060863362

CALIBRATION DATE: 4-29-08

RECALIBRATION DUE DATE: 4-29-09

Signed: Linda Kenyon
QUALITY CONTROL MANAGER

# Houston Precision, Inc.

## Calibration Report

8729 Gulf Freeway
Houston, TX 77017-6504

| | | | |
|---|---|---|---|
| **Company:** | Meteorological Solutions, Inc. | **Doc #:** | 41467 |
| **Address:** | 2257 South 1100 East Suite 203<br>Salt Lake City, UT 84106 | **Date:** | 8/22/2007 |
| | | **PO#:** | CREDIT CARD |
| **Contact:** | Mike Peterson | **Page:** | 1 |
| **Dept:** | QC | | |
| **Gage:** | 366-1M Torque Watch | **Control:** | 3950 |
| **Mfg:** | Waters | **Model:** | 366-1M Torque Watch |
| **Location:** | | **Serial #:** | 3950 |

## Parameters:

## Text:

## Comments:

Calibration Completed by: Caltech
Original Certificate (attached) #: 5450

Reference HPI S/O # 15322

*We certify the equipment used for this calibration is traceable to NIST through one or more of the following numbers:*
Vendor Master:
Last / Next Cal Dates: -->

**Gage Status: PASS** **Next Calibration Due: 8/22/2008**

Certified By: Denice V. Mills Signature: Denice Mills

This certificate is not valid unless all 1 page(s) are present.
*Laboratory Environmental Conditions: Temperature: 68°F +/- 3.6°F and/or 20C +/- 2C, Relative Humidity: between 40% and 60%.
*Calibration measurements are performed in accordance with guidelines set forth in ANSI/NCSL Z540-1-1994 and Houston Precision's Quality manual.
*The measurement of uncertainity has not been taken into account when reporting readings "in" or "out of tolerance" on this calibration report.
*If additional information regarding this calibration is required, please contact this laboratory.
*All calibrations have been performed under the supervision and authority of Jacob Bradley , Lab Manager.
*Any number of factors may cause the subject of this calibration to drift out of calibration before the recommended interval has expired.
HPI will not be held responsible for the calibration status of an item whose calibration interval exceeds the actual validity of the calibration.
*This Report shall not be reproduced expect in full, or with the expressed written permission of Houston Precision, Inc.
End of document.

# *Certificate of Calibration*

The instrument listed below meets or exceeds published specifications and has been calibrated under controlled conditions and is traceable to the National Institute of Standards and Technology(N.I.S.T.), or to accepted intrinsic standards of measurement, or by the ratio type of self-calibration techniques. Cal-Tech Calibration conforms to the following. ISO/IEC 25/17025.

---

Customer: Houston Precision
Certificate Number: 5450
Instrument Make: Waters
Model: 366-1M
S/N: 3950
ID: n/a

Date: 8-22-07
Temp: 73 Deg F
Humidity: 43%
Rec. In Tol.
Due Date: 8-22-08

This report may not be reproduced, except in full without written permission from Cal-Tec Calibration.

Certification by:

**Accuracy:** +\- n/a

Comments:

| Standards Used | Model | Certification Number | Due Date |
|---|---|---|---|
| Acculab | VIC-300 | 19453469 | 11-30-07 |
| Troemner | Weight Set | 822/266607-02 | 03-08 |

| In.Oz. Range | As Found | After Adjust | Final Reading |
|---|---|---|---|
| 3.01 | 3.00 | none | 3.00 |
| 6.02 | 6.01 | none | 6.01 |
| 12.0 | 12.0 | none | 12.0 |
| 18.0 | 18.0 | none | 18.0 |
| 21.0 | 21.1 | none | 21.1 |

**Cal-Tech Calibration, Inc.**
1314 FM 646 West /Ste. 15 / Dickinson, Texas 77539 /Phone 281-614-0050 / Fax 281-614-0046

# Houston Precision, Inc.

# Calibration Report

**8729 Gulf Freeway**
**Houston, TX 77017-6504**

| | | | |
|---|---|---|---|
| **Company:** | Meteorological Solutions, Inc. | **Doc #:** | 41468 |
| **Address:** | 2257 South 1100 East Suite 203 | **Date:** | 8/22/2007 |
| | Salt Lake City, UT 84106 | **PO#:** | CREDIT CARD |
| **Contact:** | Mike Peterson | **Page:** | 1 |
| **Dept:** | QC | | |
| **Gage:** | 366-3M Torque Watch | **Control:** | 3618 |
| **Mfg:** | Waters | **Model:** | 366-3M Torque Watch |
| **Location:** | | **Serial #:** | 3618 |

## Parameters:

## Text:

## Comments:

Calibration Completed by: Caltech
Original Certificate (attached) #: 5449

Reference HPI S/O # 15322

*We certify the equipment used for this calibration is traceable to NIST through one or more of the following numbers:*
Vendor Master:
Last / Next Cal Dates: ->

**Gage Status: PASS** **Next Calibration Due: 8/22/2008**

Certified By: Denice V. Mills Signature: Denice Mills

This certificate is not valid unless all 1 page(s) are present.
*Laboratory Environmental Conditions: Temperature 68°F +/- 3.6°F and/or 20C +/- 2C. Relative Humidity: between 40% and 60%.
*Calibration measurements are performed in accordance with guidelines set forth in ANSI/NCSL Z540-1-1994 and Houston Precision's Quality manual.
*The measurement of uncertainity has not been taken into account when reporting readings "in" or "out of tolerance" on this calibration report.
*If additional information regarding this calibration is required, please contact this laboratory.
*All calibrations have been performed under the supervision and authority of Jacob Bradley , Lab Manager
*Any number of factors may cause the subject of this calibration to drift out of calibration before the recommended interval has expired.
HPI will not be held responsible for the calibration status of an item whose calibration interval exceeds the actual validity of the calibration.
*This Report shall not be reproduced expect in full, or with the expressed written permission of Houston Precision, Inc
End of document.

# *Certificate of Calibration*

The instrument listed below meets or exceeds published specifications and has been calibrated under controlled conditions and is traceable to the National Institute of Standards and Technology(N.I.S.T.), or to accepted intrinsic standards of measurement, or by the ratio type of self-calibration techniques. Cal-Tech Calibration conforms to the following, ISO/IEC 25/17025.

---

Customer: Houston Precision
Certificate Number: 5449
Instrument Make: Waters
Model: 366-3M
S/N: 3618
ID: n/a

Date: 8-22-07
Temp: 73 Deg f
Humidity: 43%
Rec. In Tol.
Due Date: 8-22-08

This report may not be reproduced, except in full without written permission from Cal-Tec Calibration.

Certification by:______________________

**Accuracy**: +\- n/a

Comments:

| Standards Used | Model | Certification Number | Due Date |
|---|---|---|---|
| Acculab | VIC-300 | 19453469 | 11-30-07 |
| Troemner | Weight Set | 822/266607-02 | 03-08 |

| In.Oz. Range | As Found | After Adjust | Final Reading |
|---|---|---|---|
| .40 | .42 | none | .42 |
| .80 | .81 | none | .81 |
| 1.20 | 1.20 | none | 1.2 |
| 1.60 | 1.61 | none | 1.61 |
| 1.80 | 1.80 | none | 1.80 |

**Cal-Tech Calibration, Inc.**
1314 FM 646 West /Ste. 15 / Dickinson, Texas 77539 /Phone 281-614-0050 / Fax 281-614-0046

SIMCO electronics

6537 CECILIA CIRCLE
BLOOMINGTON, MN 55439

Certificate No. **3697178**

A2LA ACCREDITED CERT 1395.14

# CERTIFICATE OF CALIBRATION FOR METEOROLOGICAL SOLUTIONS INC

Description: **BROOKLYN, 6661, Digital Thermometer/Probe**

Serial No: **CT071007015-TM9** Asset No: Simco ID: **43762-1**

Dept: **NONE** PO No: **1562**

| Calibration Date: **11/08/07** | Calibration Interval: **12 Months** | Recall Date: **11/08/08** |
|---|---|---|
| Arrival Condition: **MEETS MANUFACTURER'S SPEC'S.** | Service: **CALIBRATED TO MFR SPEC,& CLEAN** | |

Procedure: **NAV17-20ST-10 2/95**
Temperature: **69°F** Relative Humidity: **36%**

Standards Used:

| Type | Simco ID | Due Date | Intvl Mos | Acc/Unc | Trace No. |
|---|---|---|---|---|---|
| **Digital Thermometer** | **39051*130** | **12/29/08** | **24** | **TEMPERATURE** | **269872-04** |
| **RTD PROBE** | **39051*127** | **12/18/08** | **12** | **TEMP C** | **SEE FILE** |
| **RTD PROBE** | **39051*127** | **12/18/08** | **12** | **0to-197 +/-25mK** | **A4715016** |
| **RTD PROBE** | **39051*127** | **12/18/08** | **12** | **1to232 +/-30mK** | **A4715016** |
| **Liquid Bath** | **39051*460** | **06/12/08** | **12** | **TEMP STABILITY** | |
| **Liquid Bath** | **39051*460** | **06/12/08** | **12** | **+/-0.025 DEG C** | **CINA 31274** |

Detail Of Work Performed:
The Expanded Measurement Uncertainty listed on the data sheet applies only at the time of calibration and no allowance has been made for handling or time related effects. Expanded uncertainty computed at 95% confidence level, coverage factor K = 2.
MEASUREMENT UNCERTAINTY: 0.03 DEG C

FULL SN IS CT071007015-TM99A-E, FOR
6661 BROOKLYN DIGITAL THERMOMETER.

Continued on next Page

SIMCO electronics

Certificate No. **3697178**

6537 CECILIA CIRCLE
BLOOMINGTON, MN 55439

A2LA ACCREDITED CERT. 1395.14

# CERTIFICATE OF CALIBRATION
# FOR
# METEOROLOGICAL SOLUTIONS INC

Continued from Page 1

Parts Replaced:

| | | |
|---|---|---|
| **EN22** | **9V BATTERY/NO CHARGE** | **( 1 )** |

Calibration Data:

| Parameter | Nominal | Measured Before | Measured After | Tolerance |
|---|---|---|---|---|
| **TEMPERATURE** | | | | |
| **SYSTEM CAL** | | | | |
| **METER/PROBE** | **-20.7 DEG C** | **-20.8** | **-20.8** | **+/-0.1 DEG C** |
| **METER/PROBE** | **-10.1 DEG C** | **-10.1** | **-10.1** | **+/-0.1 DEG C** |
| **METER/PROBE** | **0.0 DEG C** | **0.0** | **0.0** | **+/-0.1 DEG C** |
| **METER/PROBE** | **20.0 DEG C** | **20.0** | **20.0** | **+/-0.1 DEG C** |
| **METER/PROBE** | **40.0 DEG C** | **40.0** | **40.0** | **+/-0.1 DEG C** |

Work performed by:
**Diane Carmon**
Electronic Technician B ( 13192 )

Reviewed by:
**Ken Wyckoff**
Electronic Tech Lead/ QA Rep



Dated: **11/08/07**

Duplicate Certificate

# Temperature Sensor Calibration Record

2557 S 1100 E
Suite 203
SLC UT 84106
MSI
Meteorological Solutions Inc
P 801.474.3636 F 801.474.0766

Sensor Type: Brooklyn Digital with utility probe
Sensor ID: C404690
Sensor Range: -40.0 to +150.0 C

CALIBRATION:
Calibrated on 11/21/2007
Next calibration due 11/21/2008
Time: 9:45
Location: MSI Lab
Reference Device Brooklyn Digital with utility probe
Reference Device ID: CT071007015-TM9
Technician: Scott Adamson

Procedure:
Water baths used for temp medium. Each point stirred 3-5 minutes until stabil.
Values should be within +/- 0.5 degrees C.

| Calibration Temperature Point | Calibration Reference Temperature ( C ) Tr | Observed Sensor Temperature ( C ) Ts | Difference in Degrees ( C ) | Percent Error (dT) [dT=((Ts-Tr)*100)/Tr] |
|---|---|---|---|---|
| 1 | 47.80 | 47.70 | -0.1 | -0.21% |
| 2 | 22.40 | 22.30 | -0.1 | -0.45% |
| 3 | 0.00 | 0.00 | 0.0 | 0.00% |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# RELATIVE HUMIDITY SENSOR CALIBRATION RECORD

**Sensor Manufacturer:** VAISALA HMP45AC
**Sensor ID:** W1630084
**Sensor Range:** 0 - 100%
**Calibrated on** 12/31/07
**Next calibration due** 12/31/08
**Time:** 10:00 - 13:30
**Location:** MSI lab
**Reference Device:** Vaisala HMK 15 Salt Chambers
**Reference Device ID:** (LiCL C435) (MgCL12 C413) (NaCL C471)
Brooklyn digital thermometer s/n CT071007015-TM9
**Technician:** MRP
**Comments** Lab temperature = 24.3 C

| Time From | Time To | Reference Salt Solution NaCL / LiCL | Reference Relative Humidity % | Observed Sensor Output | Difference |
|---|---|---|---|---|---|
| 10.00 | 11.00 | LiCL | 11.3% | 10.9% | 0.4% |
| 11:00 | 12.00 | MgCL12 | 33.0% | 31.1% | 2.0% |
| 12:00 | 13:00 | NaCL | 75.4% | 74.6% | 0.8% |
| | | | Reference Temperature | Sensor Response | Difference |
| 13:00 | 13:30 | | 24.3 C | 24.3 C | 0.0 C |

Procedure.
Remove sensor cap and insert probe into salt chamber.
After one hour record value.
Record lab temperature and comparison with HMP sensor using reference thermometer.

**VAISALA**

MEASUREMENT STANDARDS LABORATORY
ACCREDITED CALIBRATION LABORATORY

**FINAS**
Finnish Accreditation Service
K008 (EN ISO/IEC 17025)

# CERTIFICATE OF CALIBRATION no K008-Q02193

**Customer** VAISALA Oyj
PO Box 26
FI-00421 Helsinki, Finland

**Item** NaCl Saturated Salt Solutions

**Manufacturer** Vaisala Oyj

**Model** 19731HM

**Batch** NaClC471, 100 pcs

**Description** Sample calibration of 19731HM Saturated Salt Solutions.
From salt batch no NaClC471 six ( 6) randomly selected salts were prepared to HMK 15 Salt Solution Calibrators according to the instruction manual of HMK 15 using water 19767HM.
The humidity values of these salts were compared to Vaisala Measurement Standards Laboratory Salt Solution Generator UG 8195. Traceability of the Salt Solution Generator is based on the physical phenomenon in which the equilibrium relative humidity values associated with certain saturated salt solutions are known. Measurements were made more than 16 h after preparation of the salts using Vaisala HMP41 Humidity Probes and Agilent 34970 A Digital Multimeter on November 21, 2007 by Lasse Mäki.

**Uncertainty** The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02.

**Results**

| Salt | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Reference | 75,4 %RH | 75,4 %RH | 75,4 %RH | 75,4 %RH | 75,4 %RH | 75,4 %RH |
| Reading | 75,5 %RH | 75,5 %RH | 75,6 %RH | 75,4 %RH | 75,4 %RH | 75,5 %RH |
| Temperature | + 23,0 °C | + 23,0 °C | + 23,0 °C | + 23,0 °C | + 23,0 °C | + 23,0 °C |
| Correction | - 0,1 %RH | - 0,1 %RH | - 0,2 %RH | 0,0 %RH | 0,0 %RH | - 0,1 %RH |
| Uncertainty | ± 0,4 %RH | ± 0,4 %RH | ± 0,4 %RH | ± 0,4 %RH | ± 0,4 %RH | ± 0,4 %RH |

All the measured values extended by the estimated uncertainty were within the specification (± 1,5 %RH) of the NaCl Saturated Salt Solutions 19731HM at the measurement temperature.

**Conditions** Temperature + 24,1 °C ± 0,3 °C
Humidity 36 %RH ± 3 %RH

**Date** November 21, 2007

**Signature** Lasse Mäki
Calibration Engineer

**Page 1 ( 1)**

**Documents attached -**

Checked by: ____________



*Vaisala Oyj*, PO Box 26, FI-00421 Helsinki, Finland
Telephone +358 9 894 91 • Fax +358 9 8949 2227
Email MeasStdLab@vaisala.com • www.vaisala.com
Domicile Vantaa, Finland • VAT FI01244612 • Business ID 0124416-2

**VAISALA**

MEASUREMENT STANDARDS LABORATORY
ACCREDITED CALIBRATION LABORATORY

FINAS
Finnish Accreditation Service
K008 (EN ISO/IEC 17025)

# CERTIFICATE OF CALIBRATION no K008-Q01988

**Customer** VAISALA Oyj
PO Box 26
FI-00421 Helsinki, Finland

**Item** MgCl2 Saturated Salt Solutions
**Manufacturer** Vaisala Oyj
**Model** 19730HM
**Batch** MgCl2C413, 100 pcs

**Description** Sample calibration of 19730HM Saturated Salt Solutions.
From salt batch no MgCl2C413 six ( 6) randomly selected salts were prepared to HMK 15 Salt Solution Calibrators according to the instruction manual of HMK 15 using water 19767HM.
The humidity values of these salts were compared to Vaisala Measurement Standards Laboratory Salt Solution Generator UG 8195. Traceability of the Salt Solution Generator is based on the physical phenomenon in which the equilibrium relative humidity values associated with certain saturated salt solutions are known. Measurements were made more than 16 h after preparation of the salts using Vaisala HMP41 Humidity Probes and Agilent 34970 A Digital Multimeter on October 18, 2007 by Lasse Mäki.

**Uncertainty** The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02.

**Results**

| Salt | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Reference | 32,9 %RH | 32,9 %RH | 32,9 %RH | 32,9 %RH | 32,9 %RH | 32,9 %RH |
| Reading | 32,9 %RH | 32,9 %RH | 32,8 %RH | 32,9 %RH | 32,9 %RH | 32,9 %RH |
| Temperature | + 22,9 °C | + 22,9 °C | + 22,9 °C | + 22,9 °C | + 22,9 °C | + 22,9 °C |
| Correction | 0,0 %RH | 0,0 %RH | + 0,1 %RH | 0,0 %RH | 0,0 %RH | 0,0 %RH |
| Uncertainty | ± 0,5 %RH | ± 0,5 %RH | ± 0,5 %RH | ± 0,5 %RH | ± 0,5 %RH | ± 0,5 %RH |

All the measured values extended by the estimated uncertainty were within the specification (± 1,2 %RH) of the MgCl2 Saturated Salt Solutions 19730HM at the measurement temperature.

**Conditions** Temperature + 23,4 °C ± 0,3 °C
Humidity 40 %RH ± 3 %RH

**Date** October 18, 2007

**Signature** [signature]
Lasse Maki
**Page 1 ( 1)** Calibration Engineer

**Documents attached -**

Checked by: HTD



*Vaisala Oyj*, PO Box 26, FI-00421 Helsinki, Finland
Telephone +358 9 894 91 • Fax +358 9 8949 2227
Email MeasStdLab@vaisala.com • www.vaisala.com
Domicile Vantaa, Finland • VAT FI01244612 • Business ID 0124416-2

VAISALA

MEASUREMENT STANDARDS LABORATORY
ACCREDITED CALIBRATION LABORATORY

FINAS
Finnish Accreditation Service
K008 (EN ISO/IEC 17025)

# CERTIFICATE OF CALIBRATION no K008-Q02049

**Customer** VAISALA Oyj
PO Box 26
FI-00421 Helsinki, Finland

**Item** LiCl Saturated Salt Solutions

**Manufacturer** Vaisala Oyj

**Model** 19729HM

**Batch** LICIC435, 156 pcs

**Description** Sample calibration of 19729HM Saturated Salt Solutions.
From salt batch no LICIC435 six ( 6) randomly selected salts were prepared to HMK 15 Salt Solution Calibrators according to the instruction manual of HMK 15 using water 19767HM.
The humidity values of these salts were compared to Vaisala Measurement Standards Laboratory Salt Solution Generator UG 8195. Traceability of the Salt Solution Generator is based on the physical phenomenon in which the equilibrium relative humidity values associated with certain saturated salt solutions are known. Measurements were made more then 48 h after preparation of the salts using Vaisala HMP41 Humidity Probes and Agilent 34970 A Digital Multimeter on November 1, 2007 by Heli Tonteri.

**Uncertainty** The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02.

**Results**

| Salt | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Reference | 11,3 %RH | 11,3 %RH | 11,3 %RH | 11,3 %RH | 11,3 %RH | 11,3 %RH |
| Reading | 11,2 %RH | 11,1 %RH | 11,2 %RH | 11,3 %RH | 11,3 %RH | 11,3 %RH |
| Temperature | + 23,0 °C | + 23,1 °C | + 23,1 °C | + 23,0 °C | + 23,0 °C | + 23,0 °C |
| Correction | + 0,1 %RH | + 0,2 %RH | + 0,1 %RH | 0,0 %RH | 0,0 %RH | 0,0 %RH |
| Uncertainty | ± 0,7 %RH | ± 0,7 %RH | ± 0,7 %RH | ± 0,7 %RH | ± 0,7 %RH | ± 0,7 %RH |

All the measured values extended by the estimated uncertainty were within the specification (± 1,3 %RH) of the LiCl Saturated Salt Solutions 19729HM at the measurement temperature.

**Conditions** Temperature + 23,5 °C ± 0,3 °C
Humidity 40 %RH ± 3 %RH

**Date** November 1, 2007

**Signature** [signature]
Heli Tonteri
Calibration Engineer

**Page 1 ( 1)**

**Documents attached -**

Checked by: [signature]



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Domicile Vantaa, Finland • VAT FI01244612 • Business ID 0124416-2

# PRESSURE
## Calibration Record

MSi
Meteorological Solutions Inc
P 801.474.3826 F 801.474.0766

Start Date 12/7/2007
Sensor Type Vaisala PTB101B
Sensor ID A1950021
Next calibration due 12/7/2008

Reference Device Novalynx Digital Barometer (MSI REF)
Reference Device ID 930690-Y4
Location MSI Lab
Comments Lab Temp checked with Brooklyn Digital Thermometer s/n CT071007015-TM9
Technician Scott Adamson

Procedure:
Three readings taken side by side with MSI reference in ambient conditions. Then averaged.

| Date | Time | Lab Temp C | Reference inches Hg | Pressure Sensor inches Hg | Diff mb |
|---|---|---|---|---|---|
| 12/7/07 | 1355 | 24 | 853.5 | 853.6 | 0.10 |
| 12/7/07 | 1423 | 23.2 | 853.5 | 853.6 | 0.10 |
| 12/7/07 | 1550 | 23.4 | 854.3 | 854.50 | 0.20 |
| Average | | 23.5 | 853.77 | 853.90 | 0.13 |

Calibration Critieria = +/- 3 mb

Adjustment required ? No

Kipp & Zonen

**Kipp & Zonen (USA), Inc.**
125 Wilbur Place
Bohemia, New York 11716
USA
*T* +1(800) 645-1025
*F* +1 (631) 589-2068
*E* kipp.usa@kippzonen.com

# CALIBRATION CERTIFICATE
# PYRANOMETER

PYRANOMETER MODEL : LI-COR LI-200

SERIAL NUMBER : PY56373

SENSITIVITY : 5.01 mV / 1KWm$^{-2}$
derived indoors at normal incidence
in accordance with ISO-9847 standard

CALIBRATION PROCEDURE : The indoor calibration procedure is based upon comparison to a LI-COR LI-200 calibration transfer reference pyranometer under a voltage stabilized artificial sun/lamp source (150W metal-halide gas discharge lamp). The lamp reflector and lens assembly under illumination conditions produces a vertical beam irradiance of approximately 575 Wm$^2$ at the pyranometer transfer reference and test pyranometer detector level. Both LI-COR LI-200 transfer reference and test pyranometer to be calibrated are illuminated simultaneously side-by-side for a period of 1-minute and the voltage output signals recorded. Both pyranometers are then shaded for 1-minute and the respective dark noise offset signals of each are either added or subtracted from the recorded illumination signals. The position of the pyranometers are then reversed 180° and the above process is repeated. A lamp stability check is conducted after the second lamp illumination cycle; if the lamp test is successful the sensitivity of the LI-COR LI-200 test pyranometer is calculated from the established ratio; test signal / mean reference signal. Because the LI-COR LI-200 transfer reference and test pyranometers are of identical model type, the indoors calibration condition in principle has no adverse bias on the sensitivity transfer from the reference pyranometer to the test pyranometer.

REFERENCE PYRANOMETER : LI-COR LI-200 S/N: PY55910

The above LI-COR LI-200 calibration transfer reference pyranometer has been calibrated outdoors in New York on Nov. 28, 2007 under clear sky conditions against a collocated Kipp & Zonen CM21 pyranometer. s/n 990631, in the horizontal global hemispheric mode.

The CM21 reference pyranometer was calibrated on June 8, 2007 outdoors by National Renewable Energy Laboratory, Golden CO, against a WRR traceable Primary Standard HF Cavity Radiometer via component summation technique (normal incidence SW direct + global SW diffuse). The derived sensitivity of the CM21 reference pyranometer is normalized for 45° direct beam response.

OTHER TEST EQUIPMENT : Keithley 2000 Multi-Meter, Calibrated: April 4, 2007

IN CHARGE OF TEST : Robert Dolce, Nov. 29, 2007, Bohemia, NY

**Notice:**
This calibration certificate is valid for one year upon customer receipt, or instrument deployment. Although the date of calibration and customer receipt/deployment date may differ, the instrument does not suffer from any sensitivity drift effect while packaged and shielded from solar or visible radiation; also refer to the 'non-stability' performance (max. sensitivity / year drift) in the radiometer specifications list.

## CERTIFICATE OF CALIBRATION AND TESTING

MODEL: **18801** (Comprised of Models 18820 Control Unit & 18830 Motor Assembly)
SERIAL NUMBER: CA01889

R. M. Young Company certifies that the above equipment was inspected and calibrated prior to shipment in accordance with established manufacturing and testing procedures. Standards established by R.M. Young Company for calibrating the measuring and test equipment used in controlling product quality are traceable to the National Institute of Standards and Technology.

| Nominal Motor Rpm | Output Frequency Hz (1) | Calculated Rpm (2) | Indicated Rpm (3) |
|---|---|---|---|
| 600 | 320 | 600 | 600 |
| 1200 | 640 | 1200 | 1200 |
| 2400 | 1280 | 2400 | 2400 |
| 4200 | 2240 | 4200 | 4200 |
| 6,000 | 3200 | 6000 | 6000 |
| 8,100 | 4320 | 8100 | 8100 |
| 9,900 | 5280 | 9900 | 9900 |
| [X] Clockwise and Counterclockwise rotation verified | | | |

(1) Measured at the optical encoder output.
(2) Frequency output produces 32 pulses per revolution of motor shaft.
(3) Indicated on the Control Unit LCD display.

* Indicates out of tolerance

[X] No Calibration Adjustments Required [ ] As Found [ ] As Left

Traceable frequency meter used in calibration Model: DP5740 SN: 4863

Date of inspection 16 JAN 2008
Inspection Interval One Year

Tested By EC

# Appendix B
# Performance Audit Field Data Sheets

# HORIZONTAL WIND DIRECTION AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining
Start Time: 0845 DAS
Stop Time: 1530 DAS

Sensor Mfg: Qualimetrics
Serial No.: 2881
Crossarm Alignment: 270/90
Site Declination (degrees): 10°
Last Calibration Date:

WD Sensor Model: 2020
WD Sensor Ht (m): 10 (33')
WD Sensor Range 0- 360 degrees
Vane parallel to crossarm= 400/120
WD Shaft Rotational Torque: <4 gm-ccm
Starting Threshold: NA

| AUDIT INPUT (deg) | AUDIT INPUT (deg) | CLOCKWISE DAS RESPONSE DAS (v) | CLOCKWISE DAS (deg) | CLOCKWISE DIFF (deg) | COUNTERCLOCKWISE DAS RESPONSE DAS (v) | COUNTERCLOCKWISE DAS (deg) | COUNTERCLOCKWISE DIFF (deg) |
|---|---|---|---|---|---|---|---|
| North | 0/360 | | 536.0 | 536.0 | | 533.0 | 533.0 |
| East | 90/450 | | 117.0 | 27.0 | | 118.0 | 28.0 |
| South | 180/540 | | 255.0 | 75.0 | | 255 | 75.0 |
| West | 270 | | 397.0 | 127.0 | | 395.0 | 125.0 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria:
Alignment with true North: ± 5 degrees
Linearity Test: ± 3 degrees
Starting Threshold: <= .5 m/s

WD Audit Device: Met One
WD Audit Model: 040 Template
WD Audit Serial #: NA

Comments:
Brunton 5008 Pocket Transit # 5060803362
Waters Torque 366-1M #3950

Audited By: W. Hauze

# HORIZONTAL WIND DIRECTION AUDIT SHEET

After Datalogger Programming Change and Bearing Replacement

2257 S 1100 E
Suite 203
SLC, UT 84106
MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

| | | | |
|---|---|---|---|
| Operator | Homestake Mining | Date | 5/28/2008 |
| Site Name | Grants, New Mexico | Stn ID | |
| Project | AQ07-28 | Client | Homestake Mining |
| | | Start Time | 0845 DAS |
| | | Stop Time | 1530 DAS |

| | | | |
|---|---|---|---|
| Sensor Mfg | Qualimetrics | WD Sensor Model | 2020 |
| Serial No. | 2881 | WD Sensor Ht (m) | 10 (33') |
| Crossarm Alignment | 270/90 | WD Sensor Range 0- | 360 degrees |
| Site Declination (degrees) | 10° | Vane parallel to crossarm= | 90/269 |
| Last Calibration Date | | WD Shaft Rotational Torque | <3 gm-cm |
| | | Starting Threshold | NA |

| AUDIT INPUT | | CLOCKWISE DAS RESPONSE | | | COUNTERCLOCKWISE DAS RESPONSE | | |
|---|---|---|---|---|---|---|---|
| (deg) | (deg) | DAS (v) | DAS (deg) | DIFF (deg) | DAS (v) | DAS (deg) | DIFF (deg) |
| North | 0/360 | | 0.2 | 0.2 | | 0.2 | 0.2 |
| East | 90/450 | | 87.2 | -2.8 | | 87.5 | -2.5 |
| South | 180/540 | | 177.5 | -2.5 | | 178.2 | -1.8 |
| West | 270 | | 271.0 | 1.0 | | 269.0 | -1.0 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria:
Alignment with true North: ± 5 degrees
Linearity Test: ± 3 degrees
Starting Threshold: <= .5 m/s

WD Audit Device: Met One
WD Audit Model: 040 Template
WD Audit Serial #: NA

Comments: Brunton 5008 Pocket Transit # 5060803362
Waters Torque 366-1M #3950
New bearings installed.
Datalogger programming change due to power failure June 23, 2007.

Audited By W. Hauze

# HORIZONTAL WIND SPEED AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

| | | | |
|---|---|---|---|
| Operator | Homestake Mining | Date | 5/28/2008 |
| Site Name | Grants, New Mexico | Stn ID | |
| Project | AQ07-28 | Client | Homestake Mining |
| | | Start Time | 0845 DAS |
| | | Stop Time | 1530 DAS |

| | | | |
|---|---|---|---|
| Sensor Mfg | Qualimetrics | WS Sensor Model | 2030 |
| Serial No. | Not readable | WS Sensor Ht (m) | 10 (33') |
| Last Calibration Date | | WS Range 0- | 100 mph |
| WS Shaft Rotational Torque | 1.2 gm-cm | Sensor Starting Threshold | >0.5 m/s |

| AUDIT INPUT (rpm) | AUDIT INPUT (mph) | PRIMARY DAS RESPONSE DAS (v) | DAS (mph) | DIFF (mph) | BACKUP DAS RESPONSE DAS (v) | DAS (mps) | DIFF (mps) |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.0 | | 0.0 | 0.0 | | | |
| 300 | 15.9 | | 227 | 211.1 | | | |
| 600 | 31.1 | | 450 | 418.9 | | | |
| 900 | 46.2 | | 675 | 628.8 | | | |
| 1500 | 76.5 | | 1125 | 1048.5 | | | |
| 1800 | 91.65 | | 1345 | 1253.4 | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria: ± 0.25 m/s when wind speed <= 5 m/s
± 5% when ws >5 m/s

| | |
|---|---|
| WS Audit Device | R M Young |
| WS Audit Model | 18811 |
| WS Audit SER # | CA01889 |

Comments: Waters Torque 366-3M #3618
Incorrect datalogger program

Audited By W. Hauze

# HORIZONTAL WIND SPEED AUDIT SHEET

After Datalogger Programming Change and Bearing Replacement

2257 S 1100 E
Suite 203
SLC, UT 84106

Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Start Time: 0845 DAS
Stn ID:
Stop Time: 1530 DAS
Client: Homestake Mining

Sensor Mfg: Qualimetrics
Serial No.: Not readable
Last Calibration Date:

WS Sensor Model: 2030
WS Sensor Ht (m): 10 (33')
WS Range 0-: 100 mph

WS Shaft Rotational Torque: <0.1 gm-cm
Sensor Starting Threshold: <0.5 m/s

| AUDIT INPUT | | PRIMARY DAS RESPONSE | | | BACKUP DAS RESPONSE | | |
|---|---|---|---|---|---|---|---|
| (rpm) | (mph) | DAS (v) | DAS (mph) | DIFF (mph) | DAS (v) | DAS (mps) | DIFF (mps) |
| 0.0 | 0.0 | | 0.0 | 0.0 | | | |
| 300 | 5.8 | | 5.89 | 0.09 | | | |
| 600 | 15.9 | | 15.9 | 0.0 | | | |
| 900 | 31.1 | | 31.1 | 0.0 | | | |
| 1200 | 46.2 | | 46.2 | 0.0 | | | |
| 1500 | 76.5 | | 76.5 | 0.0 | | | |
| 1800 | 91.65 | | 91.65 | 0.0 | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria: ± 0.25 m/s when wind speed <= 5 m/s
± 5% when ws >5 m/s

WS Audit Device: R M Young
WS Audit Model: 18811
WS Audit SER #: CA01889

Comments: Waters Torque 366-3M #3618
New bearings installed. Correct datalogger program uploaded.

Audited By: W. Hauze

# BAROMETRIC PRESSURE AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008  Start Time: 1147 DAS
Stn ID:  Stop Time: 1445 DAS
Client: Homestake Mining

Sensor Mfg: Weathertronics
Serial No.: 7112
Recording Resolution:

Sensor Ht (m): 8.8 (29')

Last Calibration Date: 12/7/2007

| AUDIT INPUT | | PRIMARY DAS RESPONSE | | | BACKUP DAS RESPONSE | | |
|---|---|---|---|---|---|---|---|
| Time | (in. Hg) | DAS (v) | DAS (in. Hg) | % DIFF | DAS (v) | DAS (in. Hg) | % DIFF |
| 1147 | 23.63 | | 23.46 | -0.72 | | | |
| 1340 | 23.58 | | 22.85 | -3.10 | | | |
| 1401 | 23.57 | | 22.85 | -3.05 | | | |
| 1445 | 23.56 | | 23.35 | -0.89 | | | |
| | | | | | | | |
| | | | Abs. Avg. = | 1.94 | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria: 3 mbar

Gauge Audit Device: Vaisala
Gauge Audit Model: PTB101B
Gauge Audit SER #: A1950021

Comments: Sensor failed audit.

Audited By: W. Hauze

# BAROMETRIC PRESSURE
# AUDIT SHEET

As Found Millibar Conversion

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining
Start Time: 1147 DAS
Stop Time: 1445 DAS

Sensor Mfg: Weathertronics
Serial No.: 7112
Recording Resolution:

Sensor Ht (m): 8.8 (29')

Last Calibration Date: 12/7/2007

| AUDIT INPUT | | PRIMARY DAS RESPONSE | | | BACKUP DAS RESPONSE | | |
|---|---|---|---|---|---|---|---|
| Time | (mb) | DAS (v) | DAS (mb) | DIFF (mb) | DAS (v) | DAS (mb) | DIFF (mb) |
| 1147 | 800.2 | | 794.4 | 5.80 | | | |
| 1340 | 798.5 | | 773.8 | 24.70 | | | |
| 1401 | 798.2 | | 773.8 | 24.40 | | | |
| 1445 | 797.8 | | 790.7 | 7.10 | | | |
| | | | | | | | |
| | | | Abs. Avg. = | 15.5 | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria: ± 3 mb

Gauge Audit Device: Vaisala
Gauge Audit Model: PTB101B
Gauge Audit SER #: A1950021

Comments: Sensor failed audit.

Audited By: W. Hauze

**RELATIVE HUMIDITY**
**AUDIT SHEET**
As Found

2257 S 1100 E
Suite 203
SLC, UT 84106
MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 9/26/2007
Start Time: 15:09
Stn ID:
Stop Time: 17:05
Client: Homestake Mining

Sensor Mfg: Vaisala
Sensor Model: HMP45AC
Serial No.: NA
Range: 0-100%

Sensor Ht. (m): 9.4 (31' AGL)

Last Calibration Date:

| AUDIT INPUT | | PRIMARY DAS RESPONSE | | | BACKUP DAS RESPONSE | | |
|---|---|---|---|---|---|---|---|
| DAS (Time) | (%) | DAS (v) | DAS (%) | DIFF (%) | DAS (v) | DAS (%) | DIFF (%) |
| 925 | 39.3 | | 39.1 | -0.2 | | | |
| 1145 | 22.2 | | 22.2 | 0.0 | | | |
| 1341 | 9.3 | | 9.3 | 0.0 | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria: ± 10% RH

Rel. Humidity Audit Device: Vaisala
Rel. Humidity Audit Model: HMP45AC
Rel. Humidity Audit SER #: W1630084

Comments:

Audited By: W. Hauze

2257 S 1100 E
Suite 203
SLC, UT 84106

Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

# RELATIVE HUMIDITY AUDIT SHEET

After Sensor Replacement

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 9/26/2007
Start Time: 15:09
Stn ID:
Stop Time: 17:05
Client: Homestake Mining

Sensor Mfg: Vaisala
Sensor Model: HMP45AC
Serial No.: C5110079
Range: 0-100%

Sensor Ht. (m): 9.4 (31' AGL)

Last Calibration Date:

| AUDIT INPUT | | PRIMARY DAS RESPONSE | | | BACKUP DAS RESPONSE | | |
|---|---|---|---|---|---|---|---|
| DAS (Time) | (%) | DAS (v) | DAS (%) | DIFF (%) | DAS (v) | DAS (%) | DIFF (%) |
| 1402 | 7.4 | | 7.7 | 0.3 | | | |
| 1443 | 6.3 | | 6.5 | 0.2 | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
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| | | | | | | | |

Audit Criteri: ± 7% RH

Rel. Humidity Audit Device: Vaisala
Rel. Humidity Audit Model: HMP45AC
Rel. Humidity Audit SER #: W1630084

Comments: New sensor installed; Vaisala C5110079.

Audited By: W. Hauze

# SOLAR RADIATION AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

| | | | |
|---|---|---|---|
| Operator | Homestake Mining | Date | 5/28/2008 |
| Site Name | Grants, New Mexico | Stn ID | |
| Project | AQ07-28 | Client | Homestake Mining |
| Start Time | 0925 DAS | Stop Time | 1440 DAS |

| | | | |
|---|---|---|---|
| Sensor Mfg | Li-Cor | Sensor Model | LI200X |
| Serial No. | PY31168 | Sensor Ht. (m) | 2 (6.56') |
| Range | 0-1400 watts/$m^2$ | | |

Last Calibration Date 5/16/2007

| AUDIT INPUT | | | DAS RESPONSE (watts/m^2) | | | DAS RESPONSE (watts/m^2) | |
|---|---|---|---|---|---|---|---|
| Time | (watts/m^2) | (Ly/min) | (volts) | (watts/m^2) | (diff %) | (watts/m^2) | (diff) |
| 935 | 894 | | | 928 | 3.8% | | |
| 957 | 948 | | | 978 | 3.2% | | |
| 1146 | 1106 | | | 1126 | 1.8% | | |
| 1342 | 1042 | | | 1050 | 0.8% | | |
| 1400 | 1005 | | | 1012 | 0.7% | | |
| 1440 | 915 | | | 919.5 | 0.5% | | |
| | | | | | 1.8% | | |
| | | | | | | | |

Audit Criteri: ± 5%

Solar Radiation Audit Device Li Cor
Solar Radiation Audit Model Li200x
Solar Radiation Audit SER # PY56373

Comments

Audited By W. Hauze

# PRECIPITATION GAUGE AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining
Start Time: 1410 DAS
Stop Time: 1445 DAS

Sensor Mfg: Weathertronics
Serial No.: 374
Recording Resolution: 1 TIP = 0.01 in

Sensor Model: 6011
Sensor Ht (m): 0.43 (17"AGL)
Gauge Range 0 -: unlimited

Last Calibration Date:

Funnel size (cm): 20 cm

| AUDIT INPUT (in.) | PRIMARY DAS RESPONSE DAS (v) | DAS (in.) | % DIFF | BACKUP DAS RESPONSE DAS (v) | DAS (in.) | % DIFF |
|---|---|---|---|---|---|---|
| 80 ml | | 0.1 | | | | |
| 85 ml | | 0.1 | | | | |
| 82 ml | | 0.1 | | | | |
| Ave. = 82.3 ml = 0.1031 | | 0.1 | -3.0 | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Audit Criteria: ± 10% of input

Gauge Audit Device: Pyrex
Gauge Audit Model: 100 ml grad cyl
Gauge Audit SER #: 3024

Comments: Kimax 50 ml grad cyl

Audited By: W. Hauze

# TEMPERATURE AUDIT SHEET

As Found

2257 S 1100 E
Suite 203
SLC, UT 84106

MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining
Start Time: 1143 DAS
Stop Time: 1441 DAS

Sensor Mfg: Vaisala
Serial No.: NA
Range: -40 to 60 °C

Sensor Model: HMP45AC
Sensor Ht (m): 9.5 (31.17")

Last Calibration Date:

| AUDIT INPUT | | PRIMARY DAS RESPONSE | | | BACKUP DAS RESPONSE | | |
|---|---|---|---|---|---|---|---|
| (Time) | (°C) | DAS (v) | DAS (°C) | DIFF (°C) | DAS (v) | DAS (°C) | DIFF (°C) |
| 1143 | 23.9 | | 23.2 | 0.7 | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria: ± 0.5 °C

Temperature Audit Device: Brooklyn
Temperature Audit Model: 6661
Temperature Audit SER #: C404690

Comments:

Audited By: W. Hauze

# TEMPERATURE AUDIT SHEET

After Sensor Replacement

2257 S 1100 E
Suite 203
SLC, UT 84106
MSi
Meteorological Solutions Inc.
P: 801.474.3826 F: 801.474.0766

Operator: Homestake Mining
Site Name: Grants, New Mexico
Project: AQ07-28

Date: 5/28/2008
Stn ID:
Client: Homestake Mining
Start Time: 1143 DAS
Stop Time: 1441 DAS

Sensor Mfg: Vaisala
Serial No.: C5110079
Range: -40 to 60 °C

Sensor Model: HMP45AC
Sensor Ht (m): 9.5 (31.17")

Last Calibration Date:

| AUDIT INPUT | | PRIMARY DAS RESPONSE | | | BACKUP DAS RESPONSE | | |
|---|---|---|---|---|---|---|---|
| (Time) | (°C) | DAS (v) | DAS (°C) | DIFF (°C) | DAS (v) | DAS (°C) | DIFF (°C) |
| 1408 | 27.8 | | 27.4 | -0.4 | | | |
| 1441 | 28.8 | | 28.6 | -0.2 | | | |
| | | | Absolute Avg. | 0.3 | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Audit Criteria: ± 0.5 °C

Temperature Audit Device: Brooklyn
Temperature Audit Model: Digital 6661
Temperature Audit SER #: C404690

Comments: New temperature sensor installed; Vaisala C5110079

Audited By: W. Hauze