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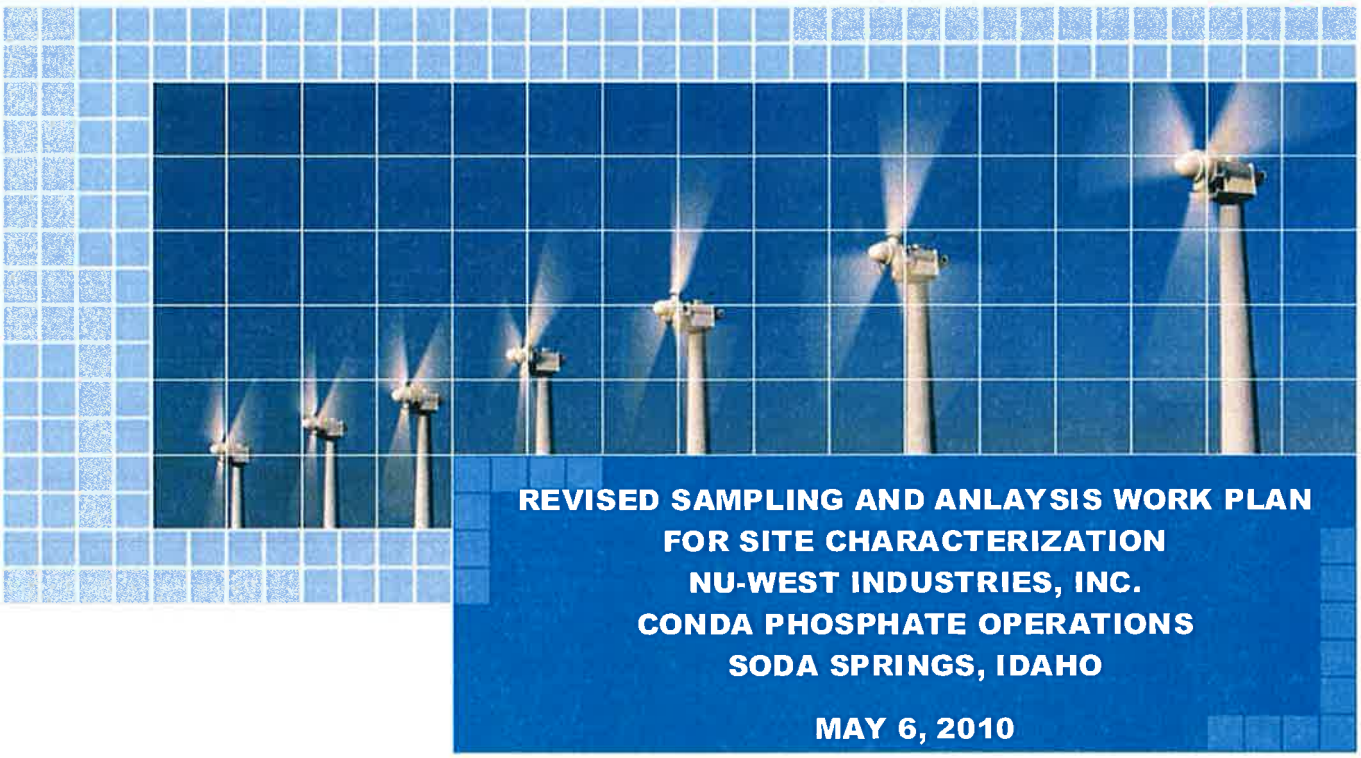

REVISED SAMPLING AND ANLAYSIS WORK PLAN FOR SITE CHARACTERIZATION NU-WEST INDUSTRIES, INC. CONDA PHOSPHATE OPERATIONS SODA SPRINGS, IDAHO

MAY 6, 2010

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1 Introduction

This document presents the Sampling and Analysis Work Plan for Site Characterization (Work Plan) of environmental conditions in the areas of potential interest at the Nu-West Industries, Inc. (Nu-West) Conda Phosphate Operations (CPO) Facility in Soda Springs, Idaho. The Facility is situated on a 1,012-acre site located approximately 5 miles north of Soda Springs, Idaho (Figure 1). The El Paso Natural Gas Products Company purchased the property in 1961 and constructed a phosphate ore processing plant which began operating in 1964. Beker Industries purchased the Facility in 1971 and operated it until 1985, when operations were shut down. Nu-West purchased the Facility in July 1987 and reactivated the operation following re-conditioning of the plant. The Facility currently produces granular mono ammonium phosphate (MAP) and liquid phosphate fertilizer products.

Operations at the Facility include unloading phosphate ore from rail cars, washing and crushing the ore, producing acid from crushed ore and elemental sulfur, producing MAP and liquid phosphate fertilizer for agricultural application, and loading bulk fertilizer on trucks and trains for shipment. Phosphate ore is delivered by train to the Facility from the Agrium Dry Valley Mine approximately 8 months per year, and is stockpiled to allow year-round processing. Phosphoric acid production creates phospho-gypsum (gyp), a gypsum byproduct, which is pumped to gyp stacks for storage. A series of tailing ponds and gyp stacks are located immediately to the west of the Main Processing Area.

Throughout this Work Plan, the term "Facility" is used to denote the entire Nu-West property where Nu-West conducts its operations. The term "Site" is an inclusive term referring to both the Facility and the adjacent properties that will be included in the characterization study. "Main Processing Area" is a term to denote the southeast portion of the Facility where most processing operations occur. This area includes most of the Facility buildings, tank farms, loading and unloading areas, etc. "The Main Processing Area" does not include the cooling ponds, gyp stacks, or tailings ponds.

This Work Plan was prepared in accordance with the requirements of the Administrative Order on Consent (Consent Order) that Nu-West Industries and the U.S. Environmental Protection Agency (EPA) formally executed on June 23, 2009. The objectives of this Work Plan and the Supplemental Work Plan to follow are to: (i) characterize Facility soil quality, focusing primarily on production and storage areas where past spills and releases have or may have occurred; (ii) characterize Site-wide surface water and sediment quality (within unlined water bodies); and (iii) characterize Site-wide groundwater quality. The scope of work presented in this Work Plan is designed to provide an overall assessment of soil and groundwater at the Facility including areas of potential interest within the Main Processing Area and the various ponds and an assessment of groundwater quality across the Site. Through the collection of soil, surface water, sediment, and groundwater samples, the investigation outlined in this Work Plan will allow Nu-West to assess the potential for impacts associated with plant operations, characterize the nature of any impacts, identify the sources of any impacts, and assess potential pathways of contaminant migration as well as any potential or actual human and ecological receptors.

The Site characterization activities described in this Work Plan will be sequenced such that initial baseline data is developed to focus the later activities on the appropriate areas.

Section 2 of this Work Plan provides background information on the Site including physical setting, main features, meteorology, water use, geology and hydrogeology, and the available groundwater sampling data. Section 3 presents the preliminary conceptual model for the Site. Section 4 summarizes quality assurance and data quality objectives (DQOs) for this Site characterization. Section 5 provides a description of the areas of potential interest that will be evaluated in accordance with this Work Plan.

Section 6 summarizes proposed ground survey and geophysical survey activities. Section 7 describes the investigation activities to be performed to further characterize soil, sediment, and surface water. Section 7 also summarizes the existing groundwater monitoring well network, a summary of the

monitoring results, and the proposed approach for further groundwater investigation. Sections 8 and 9 summarize the scope and objectives for a potable well survey and a wetland and surface water quality survey. Section 10 discusses the objectives of the Project Management Plan.

Section 11 summarizes the Data Management Plan, and Section 12 identifies the data and information that will be provided in the Site Assessment Report, which, if necessary, may identify data gaps and provide a preliminary understanding of the activities proposed to address any such gaps. Section 13 discusses the project schedule for the investigation activities detailed in this Work Plan.

2 Site Description

The physical characteristics of the Site are presented in Sections 2.1 through 2.4, with local geology and hydrogeology discussed in Section 2.5, and nearby surface waters discussed in Section 2.6. Section 2.7 describes the operations of the Facility. Section 2.8 provides a brief summary of previously conducted site assessments.

2.1 SITE SETTING

The Facility (Figure 2) occupies approximately 1,012 acres and is located at 3010 Conda Road approximately 5 miles north of Soda Springs, Caribou County, Idaho. The Facility is located in the west portion of Section 10, Township 8 South, Range 42 East. The gyp stacks and ponds are within the east portion of Section 9, Township 8 South, Range 42 East. The Facility is situated in a broad valley at the western base of the Aspen Range. Ground elevations generally range from approximately 6,200 feet above mean sea level (amsl) on the east portion of the Facility to approximately 6,150 feet amsl on the west portion.

The Facility is divided by the Union Pacific Railroad lines which run north and south, and are used for transporting phosphate ore, elemental sulfur, sulfuric acid, phosphoric acid, and bulk fertilizer products. The Main Processing Area occupies approximately 120 acres in the southeastern portion of the Facility and contains office buildings, production facilities, raw material and product storage areas, ore stockpiling areas, and maintenance buildings (Figure 3). The gyp stacks, tailings ponds, and cooling ponds are located west and north of the rail lines and occupy approximately 597 acres.

2.2 METEOROLOGY

The southeastern portion of Idaho is a high desert climate zone that is characterized by hot summers and cold winters. Climatological data are recorded for Soda Springs and are archived by the National Climatic Data Center for the years 1971 through 2000. According to these records, summer high temperatures are between 73° and 83° F and the average winter low temperatures range from 8° to 18° F. Average annual precipitation in the Soda Springs area is approximately 16 inches. May has the highest monthly precipitation. December has the lowest monthly precipitation (NCDC 2002). In the northern end of the Bear River Basin, which includes the Facility, the average annual precipitation ranges from approximately 15 to 20 inches. In higher elevations of southern Idaho, more than 15 miles south of the Facility, the average annual precipitation (which mostly falls as snow) ranges from 30 to 45 inches per year (USGS 1969).

2.3 ZONING AND LAND USE

The Facility is zoned for industrial use, and the area around the Facility is sparsely populated and used primarily for ranching and agriculture. The Facility is bordered to the north and east by undeveloped and agricultural properties (e.g., barley production and cattle grazing). The Torgesen Ranch, a residential and agricultural property currently in barley production, is located to the west. Conda Road is located to the south followed by land owned by J.R. Simplot, which was formerly used for mining. Industrial properties owned by Monsanto and Kerr-McGee are located further to the southwest. The Aspen Mountain Range is east of the Facility.

2.4 GROUNDWATER USE

Groundwater in the area of the Facility is used for industrial, domestic, and irrigation purposes. The Facility obtains water for industrial use from four wells, including NW-5, NW-7, NW-9 and NW-10 (Figure 4). NW-7 and NW-9 are south of the Main Processing Area, NW-10 is north of Tailings Pond #4, and NW-5 is southeast of Tailings Pond #2. A former well, NW-1, is located to the west of the quality control laboratory and is no longer in use. According to Idaho Department of Water Resources (IDWR) records, Nu-West's water rights allows for the withdrawal of volumes up to 1,500 gallons per minute (gpm) from a combination of three points of diversion. IDWR records were not available regarding the other Nu-West water rights. Average pumping rates are 231 gpm at NW-5, 158 gpm at NW-7, 68 gpm at NW-9, and 926 gpm at NW-10. Nu-West provides bottled water to employees for drinking purposes.

There are two registered domestic water wells,Torgesen Ranch and Lowry, and five production wells,JRS-7, JRS-8, JRS-10, JRS-11 (owned by J. R. Simplot) and Arr-Maz, downgradient and in proximity to the Facility (Figure 4). The Torgesen Ranch well is drilled to a depth of 225 feet while the depth of the Lowry well is not available. The depth of the J.R Simplot production wells range from 180 to 200 feet but the depth of the Arr-Maz well is unknown. JRS-8 and JRS-10 have had poor water quality (high levels of iron, sulfite, nitrate, and bacteria) according to the Site Inspection Report prepared by Ecology and Environment, Inc (March 1988). Each of these wells is sampled semiannually in accordance with a groundwater monitoring plan approved by the Idaho Department of Environmental Quality (IDEQ). A summary of the Facility's groundwater monitoring well network is provided in Section 7.4.

The City of Soda Springs obtains water from two springs located north and east of the city. These springs appear to be hydrologically cross-gradient from the Facility.

2.5 GEOLOGY AND HYDROGEOLOGY

This section summarizes information on regional and Site geology, groundwater, and surface water.

2.5.1 Regional and Site Geology

2.5.1.1 Regional Geology

The Site is situated in an area located at the east limit of a broad, north-south trending valley, approximately 4 miles wide, that has been filled by lava flows. The general geology of the valley region comprises alluvial deposits overlying basaltic and sandstone bedrock. The alluvium consists of silt and clay associated with erosion or windblown deposits and is typically less than 50 feet thick. Underlying the alluvium in the valley areas are the Blackfoot Lava flows consisting of layers of basalt that are several hundred feet thick in the center of the valley. The basalt layers are thinner to the east at the transition zone with the Salt Lake Formation associated with the Aspen Range, which consists primarily of sandstone and limestone. The Salt Lake Formation underlies the basalt units within the valley and is also hundreds of feet thick. A generalized hydrogeologic cross section of the region is shown in Figure 5. The valley is bordered on the west by the Chesterfield Range, which consists primarily of limestone and sandstones and conglomerates.

The geology of the region has been influenced structurally by thrust faulting and folding associated with mountain building events. Typically, northwest-southeast trending faults border the valleys in the region. A fault to the east of the Facility has been geomorphically altered by subsequent erosional processes and infilled by sediment whereas a fault to the west of the Facility is marked by a topographical escarpment.

A system of springs precipitated deposits of travertine and tufa in the valley areas. These white to buff colored deposits of calcium carbonate contain high levels of iron and manganese. The tufa beds are locally interbedded with basalt layers.

2.5.1.2 Site Geology

The description of the local Site geology presented below is based on a review of boring logs for 20 monitoring and 5 production wells on the Facility, logs for certain off-site production and domestic wells, and a review of readily-available published technical reports. The locations of existing monitoring, production, and domestic wells are shown on Figure 4.

The area encompassing the Site is underlain by a thin veneer of unconsolidated alluvial overburden material consisting predominately of silt and silty clay. The alluvium is generally 5 to 25 feet thick but in some areas, for example to the northeast of Tailings Pond #4, it is up to 65 feet thick. Underlying the overburden is basalt deposited by the Blackfoot Lava flows. A review of the available logs for monitoring and production wells at the Site show that there have been numerous lava flow events which are separated by cinder layers and weathered horizons. The individual flows range from 5 to 40 feet in thickness and the inter-bedded layers of cinders and weathered basalt range from 3 to 15 feet. The Site is situated at the eastern limit of the basalt units, where the Salt Lake Formation sandstone and limestone units intersect the basalt.

The overall thickness of basalt beneath the majority of the Site typically is greater than 250 feet. The basalt is thinnest near the base of the Aspen Range and increases to the west toward the center of the valley. The basalt is described as fine grained and vesicular, varying from competent to extremely weathered, and exhibits well-developed vertical columnar joints and horizontal joint sets. The joints within the basalt reportedly have 0.5 to 1 inch wide apertures and the horizontal joint sets typically are spaced approximately 1 foot apart.

The United States Geological Survey (USGS) has mapped two faults in the vicinity of the Site; one located along the eastern perimeter of the Facility, and the other to the west of the Facility (Figure 6). These northwest trending normal faults exhibit west-side down displacements and are characterized by highly fractured and weathered bedrock. Aerial photographs confirm the fault trending northwest across the adjacent Torgesen Ranch property, displaying a vertical displacement of approximately 15 feet. Radiating from this escarpment are surficial lows where surface water likely accumulates seasonally and subsequently both infiltrates into the subsurface and evaporates. Groundwater flow paths in the fault area are spatially and temporally complex due to the enhanced areal recharge and relatively higher permeability of the intensely fractured aquifer material. Given these conditions, some proportion of the water would flow in a direction parallel to the fault trend, which would be to the south based on the local topography. The remaining groundwater flow would be to the west-southwest in response to the regional hydraulic gradient. The integrated effects of the flow dynamics within the fault zone would influence the flow of water to areas hydraulically downgradient of the fault to the west-southwest. The Supplemental Work Plan to follow will address approaches to evaluating groundwater flow and water quality in the fault zone and to the west-southwest.

Based on a review of available boring logs for monitoring and production wells and published technical reports on the local geology, WSP prepared six geologic cross sections of the area (Figures 6-10) encompassing the Facility and adjacent property to the west. Figure 6 is a base map showing the locations of the six cross sections, and Figures 7 through 10 depict the geologic cross sections.

Figure 7 depicts geologic cross section A-A'. This section extends south to north along the western portion of the Facility and adjacent Torgesen Ranch property approximately 13,750 feet and is interpolated based on logs for five groundwater monitoring and production wells (A-10, Torgesen Ranch well, MW05-5, MW05-4, and MW05-01). The key geologic feature to note is the northwest trending fault escarpment present in the central portion of the area. The bedrock adjacent to this fault escarpment is highly fractured and is likely a preferential pathway for surface water infiltration. This has likely increased storativity and conductivity for groundwater flow allowing substantial groundwater yields. The Torgesen Ranch well appears to be located within the highly fractured zone associated with the faults on the

downthrown side of the fault. This well is screened within weathered basalt from approximately 185 to 225 feet below grade (5,910 to 5,950 feet NGVD).

Figure 8 presents geologic cross sections B-B' and W-W'. Section B-B' is a north to south profile approximately 8,750 feet long located immediately west of the gyp stacks and tailing ponds on the Facility. It is based on an interpolation of logs for four wells (A-7, A-4, NW-5 and A-2). Of note is the presence of a calcareous deposit (containing calcium carbonate, calcium, or lime) in the vicinity of well A-4. This feature is the result of the deposition of solubilized minerals in groundwater that flowed upward through fractures under pressure; this is consistent with the tufa and travertine (Qt) identified on the USGS geology map. Most of the Facility lies over the tufa/travertine. Although its porosity may range from high to low, tufa and travertine can be less permeable than alluvium.

Cross section W-W' extends west to east along the northern portion of the Facility and is based on an interpolation of logs for three bedrock wells (MW05-1, MW05-2, and NM-10) and one alluvial well (A-1). The thickness of the alluvial deposits increases from west to east from approximately 8 feet at MW05-1 to greater than 65 feet at A-1 and is likely due to erosional processes at the base of the Aspen Range. Well A-1 is screened within the overburden material and has relatively unvarying groundwater elevation.

Figure 9 presents geologic cross sections X-X' and Y-Y', both of which extend west to east from Tailings Pond #2 and the Old Gyp Stack, respectively. Each cross section represents the geology over a distance of approximately 6,000 feet. Section X-X' is based on an interpolation from logs for two monitoring wells (MW05-4, and MW05-3) while section Y-Y' is based on an interpolation of logs for four monitoring wells (A-4, A-3, A-11 and A-12). The general geology in this area is the same as the north portion of the Site. A thin layer of alluvium overlies basalt bedrock. Cross section Y-Y' intersects the fault feature located on the west portion of the area which is approximately midway between the Old Gyp Stack and State Road 34.

Figure 10 presents geologic cross section Z-Z'. This section is 7,500 feet long and oriented southwest to northeast across the south portion of the Site. It is represented by wells A-10, NW-9, MWB, and NW-7. Basalt bedrock is present at wells A-10, NW-9 and MWB and NW-7 is located outside the valley within the weathered limestone and sandstone associated with the Aspen Range. This is consistent with the regional geology which indicates the basalt layer thins to the east and transitions at the limits of the valley to the sandstone and limestone associated with the Aspen Range. Based on evaluation of the hydrogeologic data, groundwater along the eastern boundary of the Site is believed to be derived from the recharge of run-off and groundwater underflows from the Aspen Range. Hydrogeologic studies of the East Snake River Plain Aquifer (ESRPA), which is temporally and lithologically similar to the valley-fill basalts at the Site, indicate that approximately 80 percent of the dissolved groundwater solutes are present in drainage from the adjacent areas of granitic and sedimentary rock, and 20 percent are derived from the dissolution of mineral phases comprising the basalt (Lindholm and Vaccaro 1988). The highest solute concentrations are associated with water from areas underlain by carbonate rocks such as limestone. The sedimentary rocks forming the Aspen Range (Salt Lake Formation) consist primarily of sandstone and limestone. Therefore, using the ESRPA as a hydrogeochemical analog for the basalt aquifer at the Site, groundwater samples collected from well NW-7 are expected to provide an indication of background concentrations of dissolved constituents in the groundwater hydraulically upgradient of the Facility.

The historical monitoring data collected from Spring 2005 to Fall 2009 support that well NW-7 is representative of background. Well NW-7 does not exhibit the same chemical pattern found in the closest wells to the west on the Facility including MW-B, MW-A, and NW-9 which are screened in the basalt. For example, aluminum and fluoride have not been detected above the laboratory reporting limit (ranging from 0.01 to 0.05 mg/l) in samples collected from NW-7. Aluminum concentrations in wells MW-A, MW-B, and NW-9 have ranged from 0.76 mg/l to 353 mg/l and fluoride concentration from 4.7 mg/l to 706 mg/l. Sulfate concentrations in NW-7 have ranged from 109 mg/l to 170 mg/l while sulfate

concentrations in MW-A, MW-B and NW-9 have ranged from 579 mg/l to 1,727 mg/l. Most of the other chemical parameters analyzed demonstrate similar patterns. There is an overlap in screen intervals of water supply well NW-9 and monitoring well MW-B. The upper screen interval in well NW-9 is from approximately 6,120 to 6,060 feet NGVD and that for MW-B is approximately from 6,100 to 6,040 feet NGVD. The chemical parameters detected in wells MW-B and NW-9 show similar patterns. In summary, the available monitoring data suggests that NW-7 is likely representative of background. The need for and location of any additional background monitoring wells will be assessed based on the results obtained in accordance with this Work Plan and incorporated into the Supplemental Work Plan.

2.5.2 Hydrogeology

The predominant water bearing unit in the region is within the fractured basalt bedrock which is semi-confined and confined. The horizontal cinder layers, weathered interflow zones, and vertically fractured and fault shear zones within the basalt formation yield high volumes of groundwater. Secondarily, there is perched water within the overburden material.

The basalt bedrock aquifer is the most extensive groundwater bearing unit in the area of the Site. The thickness of the basalt is more than 250 feet and the unit can yield large amounts of water (500 to more than 2,000 gallons per minute). Depth to water in site monitoring wells constructed in the basalt aquifer ranged from approximately 15 to 190 feet below ground surface (bgs) in 2008. This variability is likely due to the different screened intervals of the wells, the degree of fracturing, variability in recharge, and potentially the influence of pumping wells. The sandstone and limestone aquifers at the valley transition also are very productive groundwater resources.

The regional and local groundwater gradient in all water bearing zones is to the west-southwest. Recharge of groundwater to the basalt aquifer likely originates from the limestone and sandstone aquifer below the Aspen Mountains to the east, as well as surface water infiltration into faulted and fractured rock and seepage from steams near the valley margins. Annual precipitation averages approximately 16 inches. Spring rainfall, in conjunction with snowmelt runoff, results in higher groundwater elevations typically in early summer. Figures 11 and 12 show the Site's groundwater potentiometric surface at 20 foot intervals, based on measurements made in October 2008 and May 2009, respectively.

2.6 SURFACE WATER

The nearest surface water is an inactive tailings pond located on the property formerly mined by Simplot. The tailings pond is approximately 1,000 feet south of the Main Processing Area.

The nearest naturally-occurring surface water is Woodall Spring which is located approximately north of the Facility. Water flowing in Woodall Spring empties into Woodall Spring Ditch and er Facility on the north between the Phase I Gyp Stack (West Gyp Stack) and Tailings Pond #4 a the Facility just west of the Old Gyp Stack (Figure 2). Woodall Spring Ditch widens to the west the west of the Facility as it reaches the adjacent Torgesen Ranch property. In periods of wet weather, surface water flows in Woodall Ditch and ponds on the Torgesen Ranch property beginning at the point where the ditch widens. The ponded water infiltrates into the subsurface.

The nearest continuous surface water body to the Site is Soda Creek, which is located about 2.5 miles to the west. There are no registered surface water intakes in the vicinity of the Facility and no connections between the Facility and Soda Creek. Soda Creek is used for irrigation, stock water, and domestic purposes. This creek flows south to the Alexander Reservoir which is used primarily for recreation and hydroelectric power generation.

2.7 DESCRIPTION OF FACILITY OPERATIONS

A summary of the Facility operations, organized by process area, is presented below. The locations of these operations are shown on Figures 2 and 3. The descriptions provided below are generally sequenced in a geographical order, proceeding from north to south along (i) the east side of the Main Processing Area, (ii) the center of the Main Processing Area, and (iii) along the west side of the Main Processing Area. Descriptions of ancillary features, gyp stacks, and ponds are provided below following the descriptions of the process area.

2.7.1 Ore Processing

The Facility receives approximately 2 million tons of phosphate ore annually. Phosphate ore is delivered by train to the Facility from the Agrium Dry Valley Mine approximately 8 months per year. Ore is graded and stockpiled as it is delivered to facilitate year-round ore processing. Activities on the north end of the Main Processing Area include ore car unloading, ore grading and stockpiling, ore washing, and ore crushing and grinding via ball mills. In addition, the north end houses the former ore calciner, which was taken out of service in 2001. The Ore Processing Area is shown on Figure 3.

Ore is unloaded at the rail car roll-over station, which inverts each car to dump the ore into a panfeeder and onto conveyor belts. At the end of each conveyor, bulldozers are used to keep the ore segregated by quality.

Ore is fed to the washplant in a blend from the stockpiles to control the concentration of phosphorous, magnesium, and aluminum. Screens remove any oversize material before it reaches the washplant. In the washplant, an impactor and a rod mill breaks the ore down to produce a slurry. The ore slurry is then spun to remove clay materials. After this process, approximately 67 percent of the ore is recovered for further processing, while the clay material remaining is pumped to the tailings pond. The wet ore is further crushed by ball mills to achieve a size of minus 35 mesh (approximately 0.02 inches or smaller in diameter).

2.7.2 North Sulfuric Acid Plant

The North Sulfuric Acid Plant consists of the Nebraska steam boiler and the sulfuric acid unloading and storage facility (Figure 3). The Nebraska boiler, the Cleaver Brooks boiler (located in a separate area of the plant), and the East Sulfuric Acid Plant supply all the steam needed for the Facility.

All sulfuric acid shipped to the plant is stored in seven storage tanks in the North Plant. The sulfuric acid shipped to the North Plant supplements the East Sulfuric Acid Plant, which produces approximately 50 percent of the sulfuric acid used in fertilizer production.

In addition to the boiler and acid storage, process water from the East Sulfuric Acid Plant and the North Plant is neutralized in the neutralization tank and can be recycled to the ore processing wash plant. The North Plant also produces treated water for use in the East Sulfuric Acid Plant.

2.7.3 East Sulfuric Acid Plant

The East Sulfuric Acid Plant converts molten elemental sulfur into sulfuric acid (Figure 3). Elemental sulfur is received in rail cars. The railcars are heated to melt the sulfur and it is unloaded into a covered sulfur pit where the sulfur is maintained in its molten state, or it pumped to a molten sulfur storage tank. The sulfur is oxidized to sulfur dioxide (SO_2) gas in a sulfur burner, converted to sulfur trioxide (SO_3) in the converter system using a vanadium catalyst, and then converted to sulfuric acid (H_2SO_4) in the absorbing towers. Waste heat generated during the process is captured using heat exchangers and is used to produce steam. The East Sulfuric Acid Plant also produces de-ionized water for boiler feedwater use.

2.7.4 Purified Phosphoric Acid Plant

The former Purified Phosphoric Acid (PPA) Plant produced food-grade (61% P_2O_5) phosphoric acid from the 26% phosphoric acid generated in the Phosphoric Acid Plant. The PPA Plant was constructed in 2000 and began operating in 2001 (Figure 3). The PPA Plant ceased operations in 2003. A few components of the PPA Plant are currently in use to support other plant operations. These components include a cooling tower, an evaporator, a scrubber, the Cleaver Brooks boiler, water treatment units, and storage tanks. Acid product from the primary tanks in the Phosphoric Acid Plant is pumped to the PPA evaporator in the PPA Plant. The evaporator concentrates the acid (typically to the 50-58% P2O5 range) which is then pumped to the primary and secondary storage tanks for solids settling or to storage tanks. Acid from the storage tanks is pumped either to storage tanks in the Phosphoric Acid plant for clarification and feed to the third stage evaporators, to the primary and secondary storage tanks, or to the merchant grade acid decant tanks for additional solids settling. From the primary and/or secondary storage tanks, the acid can be pumped either to other storage tanks or to the MGA decant tanks for additional solids settling and then loaded to rail cars or routed to storage tanks from which it is pumped to trucks. Acid from the MGA decant tanks may be pumped to the primary clarifier in the phosphoric acid plant and acid from the second stage storage tank in the phosphoric acid plant may be pumped to the MGA decant tanks or to storage tanks following the PPA evaporator.

2.7.5 North Ball Mill

The North Ball Mill is located immediately south of the Ore Processing Area (Figure 3). The North Ball Mills receive crushed ore from the Ore Processing Area, water is added, and the ball mills ensure that the ore is ground to the required size for phosphoric acid production. The ore slurry is pumped to the Phosphoric Acid Plant. No ammonia is added to the ore slurry to control viscosity. The former South Ball Mill is located immediately north of the Phosphoric Acid Plant (Figure 3). The South Ball Mill was a dry crushing process and was replaced by the North Ball Mills (wet process).

2.7.6 Phosphoric and Super-Phosphoric Acid Plant

The Phosphoric Acid Plant includes the Phosphoric Acid Building and the Filter/Digester Building located west of the South Ball Mill (Figure 3). The Phosphoric Acid Building is located just south of the South Ball Mill. Processed phosphate ore is received in the Phosphoric Acid Plant and enters the reactor as a slurry. Sulfuric acid and recycled phosphoric acid are mixed with the ore in a 7-stage reactor to form phosphoric acid. The reactor is a closed rectangular concrete tank with 7 compartments. An acid-resistant liner is present inside the reactor, and a leak detection system is present between the reactor floor and the building foundation. In addition to phosphoric acid, the reaction of ore with sulfuric acid produces gypsum slurry and minor amounts of fluorosilic acid. Gypsum is composed primarily of calcium sulfate dihydrate, silica, and trace impurities.

From the reactor, the acid/gypsum slurry is pumped to one of three filtration systems (one circular filter and two belt filters) to separate liquids from solids. The solid cake is washed and filtered to remove additional acid liquid. After filtration, the cake is routed to the Gypsum Slurry Tank to be re-slurried and pumped to the gyp stack.

The acid filtered from the slurry before washing is captured as approximately 26% P_2O_5, and is routed to the primary acid clarifiers for removal of additional solids. Clean acid from the top of the primary clarifiers is routed to primary storage tanks, and then to the first stage evaporators where the acid is strengthened - typically to 40-48%. From the first stage evaporators, the acid may go to the first stage clarifier; to the first stage storage tanks; or to a storage tank that feeds the Granulation Unit. From the first stage clarifier, acid is pumped back to the primary clarifiers and also flows to a storage tank that can feed either the Granulation Unit, or the first stage storage tanks. Acid is pumped from the first stage acid storage tanks to the second stage evaporators, which strengthen the acid typically to 50% to 56%. Next, the acid is pumped to a second stage clarifier and then either to the MGA decant tanks for additional solids

settling before being sold as MGA , or further concentrated in the third stage evaporator to a strength of typically 54 to 60% P_2O_5 for use as super-phosphoric acid feed. From the third stage evaporator, the acid is then pumped to a third stage storage tank which feeds into one or both of the super-phosphoric acid (SPA) evaporators where it is circulated through a heat exchanger, which raises the temperature of the acid to 350° Fahrenheit (F). Vapors created during the heating process are drawn to a condenser and discharged into a seal tank.

Residual organics are oxidized by adding 38% nitric acid to the hot SPA within the oxidation reactor. The SPA is then cooled to approximately 270° F through a cooler. The acid is then sent to aging tanks and, after an appropriate aging time, the acid is cooled to 200° F in another cooler. The cooled acid is pumped through filter presses to remove solids and is loaded directly into rail cars or trucks. as approximately 69% acid. The filter cake is run through a repulper, slurried, and pumped into a tank. This high-solids acid (50-60% P2O5) is added to fresh acid and used to make granular fertilizer or added back to the primary circuit to control aging properties of the acid.

2.7.7 Central Tank Farm

The Central Tank Farm is located south of the Filter/Digester Building and west of the Phosphoric Acid building (Figure 3). This area houses the primary clarifiers, clarifier overflows, primary storage tanks, first stage storage tanks, and SPA feed tank. Some tanks have concrete secondary containment.

2.7.8 Oxidation Tank Farm

The Oxidation Tank Farm is located to the southwest of the SPA Building, adjacent to the former West Sulfuric Acid Plant (Figure 3). This tank farm includes the first stage clarifier, first stage clarifier overflow, first and second stage storage tanks, second stage clarifier, second stage clarifier overflow, second stage storage tank, oxidation reactor, nitric acid tank, and cooling water heat exchangers.

2.7.9 West Sulfuric Acid Plant

The former West Sulfuric Acid Plant is bordered on the north and east by the Oxidation Tank Farm (Figure 3). The former West Sulfuric Acid Plant is currently used as a shop, and does not produce or store sulfuric acid.

2.7.10 Granulation Plant

The Granulation Plant currently produces granular MAP from phosphoric acid and ammonia (Figure 3). Previous operations included the production of ammonium phosphate sulfate (APS). In the current MAP process, phosphoric acid is mixed with ammonia in the pre-neutralizing tank, and additional ammonia is added in a pipe-cross reactor to finish ammoniation of the product. The ammoniation also partially dries the granular product before discharge.

The product from the granulator is then further dried in a gas-fired rotary dryer and screened for particle size. Undersized and oversized granules are recycled. The final product is cooled in a bulk flow cooler and then coated with a dust control agent.

2.7.11 Process Sewer Lagoon

The Process Sewer Lagoon, located west of the Phosphate Building, is a lined containment basin for overflows from the process sewer sump (Figure 3). The process sewer sump is located adjacent to the west side of the process sewer lagoon. When liquids are captured in the lagoon they flow back to the process sewer sump and are pumped to the cooling ponds.

2.7.12 Dry Products Storage and Shipping

The shipping department stores, loads, and ships dry fertilizer in rail cars and trucks. Dry fertilizer is transferred from the Granulation Plant via conveyor belts to the storage building where it is stored by

product type (Figure 3). Product is screened and resized, and a dust control agent is applied. Front end loaders and conveyors then load finished product into rail cars or trucks.

2.7.13 Ditches and Launders

Several lined ditches for conveying process water are present at the Facility (Figure 3). There are no unlined process ditches associated with the Facility's operations. The ditches include:

- Decant Ditch, an open channel lined with high-density polyethylene (HDPE) that transfers water from the gyp stacks to the cooling ponds.
- SPA Ditch, a coated concrete-lined channel on the west side of the SPA Building.
- East Ditch, a coated concrete-lined channel located along the east side of the Dry Product Storage and Shipping building. This ditch is underlain by a synthetic liner.
- Scrubber Ditch, a coated concrete-lined channel extending from the Central Tank Farm to the Process Sewer Sump.
- Grade Control Ditch, a coated concrete-lined channel inside the Oxidation Tank Farm.

Launders are smaller channels in the Main Processing Area that provide containment for releases of liquids and also collect storm water. The launders are primarily concrete coated with a vinyl ester resin with some sections lined with stainless steel. The Facility has a program in-place to coat all concrete launders. Launders discharge to nearby sumps or ditches.

The ditches in the Main Processing Area are sloped to flow to the process sewer sump, which is pumped to the cooling ponds. The SPA Ditch feeds into the East Ditch, which flows to the Scrubber Ditch. The Scrubber Ditch flows to the process sewer sump. Liquids in the process sewer sump are pumped to the cooling ponds.

2.7.14 Quality Control Laboratory

The Facility's Quality Control Laboratory is located south of the Main Processing Area (Figure 3). The laboratory tests samples of phosphate rock, phosphoric acid, and granular fertilizer products on a daily or weekly basis. The laboratory waste materials are collected in a satellite accumulation area before being transferred to the Hazardous Waste Storage Building. Non-hazardous wastewater is discharged to a leach field on the north side of the building.

2.7.15 Gyp Stacks and Tailings Ponds

The gyp stacks and tailings ponds are located west and north of the Main Processing Area and receive slurried material separated during processing (Figure 2). Slurried gypsum from phosphoric acid production are pumped to the gyp stacks. Phosphate rock fines and clay material separated from the ore slurry in the wash plant are pumped to the tailings ponds. Water from both the gyp stacks and tailings ponds is decanted from the slurry and reused.

There are two gyp stacks and three tailings ponds. The Old Gyp Stack (F-GYP-0) includes Cell #1, Cell #2/#3 and Cell TP-3. The West Gyp Stack (F-GYP-1) includes a single, large cell. The tailings ponds are designated Tailings Pond #1, Tailings Pond #2, and Tailings Pond #4.

Cells #1 and #2/#3 of the Old Gyp Stack (F-GYP-0) were placed into service between the late 1960s and early 1970s and are underlain by synthetic liners and bentonite. Cell TP-3 began operating as a tailings pond in the early 1970s. Approximately 60 feet of tailings were accumulated in Cell TP-3 before it began receiving gypsum. Approximately 80 feet of gypsum materials have been placed on top of the tailings in Cell TP-3. The Old Gyp Stack covers approximately 150 acres. The cells are between 100 and 175 feet tall.

The West Gyp Stack (Phase I Gyp Stack) (F-GYP-1) began operating in late 2005 and is located northwest of the Old Gyp Stack and west of the tailing ponds. The West Gyp Stack covers approximately 127 acres and is approximately 30 feet tall and is underlain by clay and 60-mil HDPE liners.

Tailings Ponds #1 and #2 began operating in the 1960s, and are underlain by native materials. Each pond covers approximately 20 acres. Tailings Pond #4 is the north tailings pond, which is underlain by native materials. It began operation in the mid 1980s, and covers approximately 250 acres. Currently, the tailings slurry is pumped from the Ore Processing Area to Tailings Pond #4. Water is decanted from Tailings Pond #4 and pumped to Tailings Pond #2, where the water is further clarified. Water is drawn from the top of Tailings Pond #2 and routed back to the Ore Processing Area.

2.7.16 Cooling Ponds

The East and West Cooling Ponds are located directly south-southwest of the Old Gyp Stack (Figure 2). Each cooling pond covers approximately 15 acres. Water from the evaporation process, from the granulation process, and from the process sewer sump is pumped to the cooling pond. Additionally, decant water from the gyp stacks is routed to the cooling ponds. Water from the cooling ponds is used in the plant processing areas, but not in the Ore Processing Area.

The cooling ponds are lined with a 60-mil HDPE liner, underlain by a drainage geonet, perforated polyvinyl chloride (PVC) pipe, and a clay liner. The interstitial space between liners is equipped with lysimeters to detect potential leakage through the HDPE liner.

2.8 PREVIOUS SITE INVESTIGATIONS

Two previous site assessments have been conducted by EPA at the Facility. In 1987, Ecology & Environment, Inc. (E&E) conducted an inspection of the Facility under contract with EPA, and in 1994, Roy F. Weston, Inc. (Weston), under contract with EPA, conducted an expanded site inspection of the Facility and its vicinity. The E&E site inspection was intended to evaluate the existence and nature of potential hazardous waste contamination at the Facility. Based on the results of a file review and site inspection, E&E collected six groundwater samples from production and domestic wells, five waste samples, and two sediment samples for laboratory analysis of target compound list (TCL) parameters and four anions (chlorides, fluoride, phosphate, and sulfate). No organic compounds were detected in groundwater samples collected from the six wells. Selenium was detected in all four production wells samples above the federal primary drinking water standard and manganese and sulfate were detected in one production well above secondary drinking water standards. E&E identified these constituents as occurring in phosphate rock. No organic or inorganic constituents were detected in groundwater samples from the two domestic wells at concentrations above federal primary or secondary drinking water standards. Overall, E&E did not identify a contaminant plume in groundwater beneath the Facility, but indicated that past releases may have adversely impacted local groundwater.

The scope of Weston's expanded site inspection focused on an assessment of groundwater quality in the vicinity of the Facility. Groundwater samples were collected from five on-site production wells and four off-site wells (JRS-10 and 11, Torgesen Ranch, and Durfee wells[1]). The samples were analyzed for target analyte list (TAL) metals, anions, gross alpha and beta, and radium 226. Sampling results were compared to the 1987 E&E data and relative percent differences were calculated. Weston noted the apparent increases in concentrations of phosphate and sulfate and concluded the following:

- Elevated concentrations of contaminants found in on-site and off-site production wells do not pose an immediate human health threat, as these wells are not used for drinking water.

[1] Durfee well appears to be the former name of the Lowry well

- Facility activities are impacting groundwater quality and there is a potential for the Facility activities to impact downgradient domestic wells.
- The elevated nitrate detected in the Torgesen Ranch well is not attributable to the Facility, but is most likely the result of cattle ranching and other farm activities.

In June 2004, Nu-West identified low pH water in water supply well NW-9 at the Facility. The well, which is located about 1,000 feet to the south of the Main Processing Area, is screened in the basalt unit and has been used in the phosphate process since 2001. Investigations conducted to assess groundwater quality in the area of NW-9 included an electromagnetic survey and installation of groundwater monitoring wells. Also, Nu-West inspected sumps and launders at the Facility to determine a possible source of the low pH found in NW-9. The scope and findings of the investigation and inspection activities are further elaborated in Section 5.2.2.

3 Preliminary Site Conceptual Model

This section presents a preliminary site conceptual model (CSM) of the Site. It has been developed based on a review of information regarding Facility operations, Site development, and available groundwater monitoring data. The CSM identifies potential areas of interest for contamination sources, potential constituents of interest, potential media of concern, and potential exposure pathways including exposure routes, exposure points, and receptors. The CSM will be updated, as appropriate, based on the findings of the investigations presented in this Work Plan.

3.1 FACILITY PROFILE

The Facility is a typical phosphate processing plant which produces phosphoric acid, mono ammonium phosphate, and formerly ammonium phosphate sulfate. The primary raw materials used in the manufacturing processes comprise phosphate ore, sulfuric acid, and ammonia. Ore is transported to the Facility by rail and stockpiled north of the Main Processing Area. Approximately 50 percent of the sulfuric acid used in the process is produced on-site with the remaining purchased and shipped to the site via rail car and stored in aboveground tanks. Ammonia is purchased and shipped to the Facility via rail car and stored in an aboveground sphere. Nu-West employs the wet process for converting phosphate ore into phosphoric acid. This involves digesting beneficiated phosphate-bearing ore with sulfuric acid in a closed reactor to form phosphoric acid slurry. The slurry is then pumped to a filter system where gypsum (primarily composed of calcium sulfate) is separated, slurried with process water, and pumped to the gyp stack system. The clean dilute phosphoric acid is fed to evaporators or the Granulation Plant for further processing based on product need. A generalized plant block flow diagram is provided in Figure 13.

The major features associated with the Main Processing Area consist of the following: Ore Delivery and Staging Area, Ore Wash Plant, South Ball Mill, Phosphoric Acid Plant, Granulation Plant, Dry Products Storage and Shipping Building, Product Loading and Unloading Areas and associated rail tracks, Oxidation Tank Farm, Central Tank Farm, East Sulfuric Acid Plant, North Sulfuric Acid Storage Facility, Process Sewer Lagoon, Process Water Conveyance Ditches and Launders, former West Sulfuric Acid Plant, and an inactive Purified Phosphoric Acid Plant. The majority of the process areas are housed in buildings with concrete floors which in some cases are underlain by synthetic liners. Tank farms and material storage areas have concrete slabs with secondary containment and several are also underlain by synthetic liners. Various ponds including gyp stacks, tailings ponds, and cooling ponds are located to the west and north of the Main Processing Area. The gyp stacks are underlain by either synthetic or clay liners and the cooling ponds are underlain by two synthetic liners followed by a clay liner with a collection system between the liners.

The Facility's major process streams include ore tailings, cooling water, process water (including scrubber water), gypsum, and tank cleanouts. Ore tailings are generated in the Ore Processing Area. Cooling water is used in various parts of the plant for cooling purposes (e.g., heat exchangers). Process water may be used for cleaning or other non-cooling operations. Gypsum is generated in the phosphoric acid manufacturing process, and is transported as a slurry to the gyp stacks.

Water used for ore washing and for slurrying the ore tailings comes from production wells or is recycled from the tailings ponds. Water used in other Facility processes is primarily obtained from on-site production wells or from the cooling ponds. After use, this water returns to the cooling ponds through one of several routes.

At the gyp stacks, water is decanted from the top of the stacks and routed through a lined ditch to the cooling ponds. Process waters are conveyed through lined launders and ditches to the tank farm sumps or the process sewer sump, and from there are pumped to the cooling ponds. During clean out of tanks, wash water and residual solids are directed to the gyp stacks.

3.2 LAND USE AND RESOURCE PROFILE

The Facility occupies approximately 1,012 acres and is zoned for industrial use. Approximately 240 people are employed at the Facility. The area around the Facility is sparsely populated and used primarily for ranching and agriculture and phosphate ore production. There are no incidental uses of the Facility.

The Facility is bordered to the north and east by undeveloped and agricultural properties (cattle grazing, barley, and wheat/hay). The Torgesen Ranch property, which includes a residence and cattle grazing operation, is located to the west. The residence on this property is approximately 0.5 miles west of the Facility. Conda Road is located to the south followed the J.R. Simplot property, which was formerly used for phosphate mining and contains an inactive tailings pond. Monsanto's property is located further to the south. The City of Soda Springs is located approximately five miles south-southeast of the Facility and has a population of approximately 3,000 people. There are no schools, hospitals, or day care centers within one-mile of the Facility.

The nearest continuous surface water body to the Facility is Soda Creek which is located about 2.5 miles to the west. Soda Creek flows south to the Alexander Reservoir, which is primarily used for recreation and hydroelectric power generation. There are no registered surface water intakes in the vicinity of the site and no connections between the Facility and Soda Creek. Woodall Spring, the source of an intermittent stream, is located to the north of the Facility. Woodall Spring connects with Woodall Spring Ditch which enters the Facility on the north between the West Gyp Stack and Tailings Pond #4 and exits the Facility on the west near Cell TP-3. Woodall Ditch widens to the west of the Facility. In periods of wet weather, water flowing in Woodall Spring enters Woodall Ditch and flows on the adjacent property. At a point where the ditch widens, water exiting the ditch ponds and subsequently infiltrates into the subsurface. Woodall Ditch is dry for most of the year.

There are no surface water discharges or outfalls at the Facility. Ore tailings, gypsum, and cooling water are stored in various ponds which are constructed with earthen dikes and underlain by synthetic or clay liners. Tailings Ponds #1 and #2 and the Old Gyp Stack were placed into service between 1964 and the mid-1970s. The West Gyp Stack has been in use since December 2005 and Tailings Pond #4 since the late-1970s. The gyp stacks rise as much as 150 feet above the valley floor.

Groundwater in the area of the Facility is used for industrial, domestic, and agricultural (livestock and irrigation) purposes. The Facility obtains water for industrial use from on-site permitted production wells including but not limited to: NW-5, NW-7, NW-9 and NW-10. Nu-West provides bottled water to its employees for drinking purposes. There are two registered domestic water wells (Torgesen Ranch and Lowry residence) and four production wells (JRS-8, JRS-10, JRS-11, and Arr-Maz) downgradient and in proximity to the Facility (Figure 4). Each of these wells has been sampled semiannually since 1991 in accordance with a groundwater monitoring plan approved by IDEQ. A summary of the semiannual groundwater sampling results is provided in Section 7.4.3. J.R. Simplot owns the JRS wells.

The City of Soda Springs obtains water from two springs located north and east of the city. These springs appear to be hydrologically cross-gradient from the Facility.

3.3 ECOLOGICAL PROFILE

The majority of the Facility is developed with the processing area, ancillary features, and offices on the southeast portion and ponds on the west and north portions (Figure 2). There are no known sensitive environmental areas, forested areas, water bodies, or perennial streams on-site or within a one-mile radius of the Facility. Woodall Spring Ditch is a seasonal water feature that carries irrigation water from north of the Facility and across the northwest portion of the Facility, before exiting the west side to the adjacent property (Figure 4). One small potential wetland area may be located north of the Facility. No endangered or protected species or sensitive ecosystems are known to exist at the Facility or within a

one-mile radius of the Facility that could potentially be impacted by any constituents of concern emanating from the Facility.

3.4 POTENTIAL RELEASE PROFILE

The primary feedstocks used in the production of phosphoric acid, mono ammonium phosphate, and (previously) ammonium phosphate sulfate at the Facility are phosphate ore, elemental sulfur, sulfuric acid, and ammonia. Primary potential constituents of interest from the processing operations include heavy metals (arsenic, barium, cadmium, chromium, lead, magnesium, and selenium), anions (phosphate, nitrate, fluoride, and sulfate), and certain radionuclides (gross beta, radium 226, and radium 228) all of which are associated with the feedstock materials. Sulfuric acid and phosphoric acid are associated with low pH.

As required by the Consent Order, Nu-West compiled and submitted to EPA all readily available information on spills and releases at the Facility including the date, location, nature and volume, and response. Numerous releases have been documented with the majority consisting of phosphoric acid materials and products, sulfuric acid, process water, pond water, gypsum slurry, and ammonia. Other material releases include sodium hydroxide, digester slurry, nitric acid, diesel fuel, gasoline, Therminol, and sodium hydroxide. Source areas for releases include the Main Processing Area (South Ball Mill, Phosphoric Acid and SPA Plants, Sulfuric Acid Plant, Granulation Plant, Shipping Building, Tank Farms), ponds (gyp stacks and cooling ponds), and ancillary features (rail tracks, material loading/unloading and lined ditches and launders for conveying process waters).

The Main Processing Area is several hundred feet away from the nearest property boundary. There are no surface water bodies or drainage channels in the processing areas and thus there is minimal potential concern for releases to flow or be carried overland to off-site areas. Releases in areas of the Main Processing Area not equipped with secondary containment or liners may have been mitigated by excavating impacted soil. Also, releases of low pH acid materials may have been neutralized in-place by adding crushed limestone. Releases in the Main Processing Area that were not mitigated would have percolated into the unsaturated soil and possibly migrated to the upper unconsolidated groundwater zone which occurs around 10 feet to 35 feet bgs. Also, prior releases could have migrated to the bedrock aquifer which occurs at depths ranging from approximately 13 feet to 190 feet bgs. Groundwater flow in the bedrock aquifer is to the west-southwest. Based on an initial understanding of the Site geology, releases into the basalt bedrock would potentially migrate horizontally downgradient within fractures and horizontal joint sets and move vertically downward via open joints sets that intersect fractures.

The gyp stacks and cooling ponds are located in close proximity to the west and north property boundaries. Each of these ponds is underlain by a clay or synthetic liner. In the event that a liner was compromised, process water would be released to the subsurface and likely migrate to the upper unconsolidated groundwater zone, which occurs around 10 feet to 35 feet bgs. Such releases could also possibly migrate vertically downward to the bedrock aquifer, which is present at depths ranging from approximately 13 to 190 feet bgs. Groundwater flow in the bedrock aquifer is to the west-southwest. Other potential sources of releases at the cooling ponds are through berms and the lined conveyance ditches extending between the ponds and to the Main Processing Area. Releases through berms have the potential to flow both within the Facility and onto adjacent properties. Such releases would impact soil and, if significant in volume, could also potentially migrate to the underlying unconsolidated groundwater zone and the basalt bedrock aquifer. In the basalt aquifer, releases could potentially migrate horizontally downgradient within fractures and horizontal joint sets and move vertically downward via open joints sets that intersect fractures. The only surface water feature in the area of the ponds is Woodall Spring Ditch, which extends offsite to the west. Releases from certain ponds and associated lined drainage ditches could potentially enter Woodall Spring Ditch.

3.5 POTENTIAL EXPOSURE PROFILE

Figure 14 presents a preliminary conceptual model diagram for releases at the Facility. This figure identifies linkages between the areas of potential interest for releases to the environment, the media of potential interest, potential release mechanisms and migration pathways, potential exposure routes, and potential receptors and reflects the current understanding of the CSM.

4 Data Quality Assurance and Data Quality Objectives

The objective of the sampling and analysis programs is to determine whether constituents of potential interest may be present in Site soils, sediments, and surface water at levels above applicable screening criteria and also to obtain an overall understanding of groundwater flow conditions at the Site. The following sections describe measures that will be taken to ensure the quality and utility of the data and information generated as part of the investigation activities presented in this Work Plan.

4.1 DATA QUALITY ASSURANCE

To ensure the uniformity and quality of data generated during the Site characterization assessment, all field activities will comply with EPA's "Field Branches Quality System and Technical Procedures" (EPA 2009), and with the Quality Assurance Project Plan (QAPP) included as Appendix A to this Work Plan. The QAPP includes WSP's Standard Operating Field Procedures (SOPs), which specify field procedures to be used during the implementation of this Work Plan (Appendix C in QAPP). Well construction and installation are not included as part of this Work Plan. Rather, the Supplemental Work Plan will include a groundwater sampling and analysis section that provides all required information related to well design, specifications, and construction, and the sampling and analysis procedures.

Accutest Laboratories (Accutest) is the laboratory identified to perform conventional chemical testing and ALS Laboratory Group (ALS) will perform radiological testing of the samples collected as part of this Work Plan. Accutest and ALS participate in the National Environmental Laboratory Accreditation Program (NELAP) and are also included on IDEQ's list of laboratories certified for drinking water analyses. Quality Assurance Manuals of Accutest and ALS are included as Appendix A and Appendix B to the QAPP, respectively.

The laboratory data packages for the conventional chemical analyses will be validated by a third party: Laboratory Data Consultants, Inc., of Carlsbad, California or Ectcon Inc of Imperial, Pennsylvania.

4.2 DATA QUALITY OBJECTIVES

EPA developed the DQO process to ensure that data collection is designed in a manner appropriate to support a project's decision making process (EPA 2006). The process is discussed in the following sections.

4.2.1 State the Problem

The Facility has been the location of a phosphate manufacturing plant since approximately 1964. The long operating history of the Facility along with records of spills suggests the potential for environmental impacts in the Main Processing Area. Also, data from the existing monitoring well network associated with the gyp stacks show that constituents of potential interest are present in groundwater downgradient of the Old Gyp Stack (F-GYP-0). However, the source of these constituents is uncertain and the flow of groundwater within conductive features in the basalt aquifer and the adequacy of the monitoring network are not well understood. Historical off-site spills and any additional groundwater investigation will be addressed in the Supplemental Work Plan to follow.

4.2.2 Identify the Decision

The primary decisions to be made from the Site investigation activities are:

- collect a sufficient number of representative samples to determine if constituents of potential interest are present in surface and subsurface soil and surface water and sediment at the Site at concentrations that may present a potential risk to human health or the environment and may warrant further evaluation

- ascertain the primary conductive features in the basalt aquifer that transmit groundwater and assess the appropriateness of the existing monitoring network as well as need for additional monitoring wells to characterize groundwater quality
- collect representative groundwater samples from existing Site monitoring wells, production wells, and domestic wells to determine if constituents listed in the Consent Order are present at concentrations that may present a potential risk to human health or the environment and may warrant further evaluation
- characterize the nature and extent of any environmental impacts from potential releases of hazardous waste
- determine the scope of additional investigation activities, as appropriate, based on results of the sampling performed as part of this Work Plan

4.2.3 Identify Inputs to the Decision

The primary inputs are as follows:

- develop a sampling plan that will obtain adequate samples/information to address the decisions listed above
- utilize appropriate analytical methods and reporting limits such that constituents of potential interest are quantified with reporting limits lower than corresponding screening level
- utilize appropriate geophysical survey methods to characterize the major flow features in the basalt bedrock beneath the Site

4.2.3.1 Geophysical Survey

Details of the proposed geophysical studies are presented in Section 6 of this Work Plan and include a combined electrical resistivity imaging and seismic refraction survey along with downhole geophysical logging. The surveys are designed to develop an under [illegible] conductive features within the basalt bedrock that transmit groundwater (inte [illegible] actures, and shear fractures) and to identify potential contaminant plumes.

4.2.3.2 Soil Sampling and Analysis

Details of the soil sampling and analysis presented in Section 7.1 of this Work Plan provide justification for the sample locations and laboratory parameters. Table 1 provides a summary of this information. Table 2 presents IDEQ's Risk Evaluation Manual (REM) Initial Default Target Levels (IDTLs), as well as EPA Preliminary Remediation Goal (PRG) screening levels for residential soil. Method detection limits and laboratory reporting limits are also provided in Table 1 to ensure the methods are sufficient to make appropriate decisions.

4.2.3.3 Sediment Sampling and Analysis

Details of the sediment sampling and analysis presented in Section 7.2 provide justification for the sample locations and laboratory parameters. Table 3 provides a summary of this information. Idaho IDTLs as well as EPA PRG screening levels for residential soil, method detection limits and laboratory reporting limits are provided on Table 2 to ensure the methods are sufficient to make Site-specific evaluations and appropriate decisions.

4.2.3.4 Surface Water Sampling and Analysis

Details of the surface water sampling and analysis presented in Section 7.3 provide justification for the sample locations and field and laboratory parameters that will be analyzed. Table 4 provides a summary of this information. Table 5 presents IDEQ's Surface Water Quality Standards and EPA National

Recommended Surface Water Quality Criteria. The method detection limits and laboratory reporting limits are also provided in Table 4 to ensure the methods are sufficient to make appropriate decisions.

4.2.3.5 Groundwater Sampling and Analysis

Details of the groundwater sampling and analysis program presented in Section 7.4 identify the wells that will be sampled and field and laboratory parameters that will be analyzed. Table 6 provides a summary of this information. IDEQ Groundwater Quality Standards, EPA Maximum Contaminant Levels (MCLs), method detection limits, and laboratory reporting limits are provided in Table 5 to ensure the methods are sufficient to make appropriate decisions.

4.2.4 Define the Study Boundaries

This Work Plan focuses on the Main Processing Area and the gyp stacks, tailings ponds, and cooling ponds at the Facility. The Facility occupies approximately 1,012 acres at 3010 Conda Road, Soda Springs, Caribou County, Idaho. The Facility is bordered to the north and east by undeveloped and agricultural properties (cattle grazing, barley, and wheat/hay). The Torgesen Ranch property is located to the west and includes a residence and cattle grazing operation. Conda Road is located to the south followed by the J.R. Simplot property, which contains an inactive tailings pond. Figure 2 shows the layout of the Facility and surrounding properties. A Supplemental Work Plan to follow will address off-site areas, and will be designed to ensure that the investigation fully determines the nature and extent of hazardous waste at or from the Facility. The Supplemental Work Plan will include an assessment of existing information and rationale for how the sampling satisfied the Consent Order requirements.

4.2.5 Develop a Decision Rule

The scope of the investigation activities as outlined in this Work Plan includes the generation of chemical and radiological data for sample media (soil, sediment, surface water, and groundwater) from a variety of locations. The sampling data will be evaluated relative to potentially applicable or relevant guidelines, including IDEQ IDTLs and EPA MCLs. Based on the comparison of the data with the various guidelines and other pertinent factors, a determination will be made as to whether the data are sufficient to evaluate the need for and scope of additional investigation activities.

The sampling and analytical methods described in Section 7 of this Work Plan and the attached appendices are adequate to meet these objectives.

4.2.6 Specify Limits on Decision Errors

A decision error occurs when data are misleading and the result is selection of an inappropriate response action, and where a different response action would have been chosen if "perfect data" or absolute truth were accessible. A decision error may occur as a result of a sampling design error and/or measurement error. Although the possibility of a decision error can never be totally eliminated, it can be minimized and controlled. For the investigation activities described in this Work Plan, sampling and measurement decision errors are being controlled by:

- Biasing sample collection toward areas that are suspected of having constituents of potential interest. As described in Section 7, sampling is typically biased toward areas where it is suspected that constituents of potential interest may be present due to previous spills. Therefore, by biasing the sampling toward suspected "hot spots", the Site investigation findings will be used to develop a conservative understanding of conditions within the Site and to focus potential future evaluation. In addition, locations have been selected for sample collection to provide information on general conditions within the areas of potential interest at the Facility.
- Using analytical methods that achieve reporting limits less than the screening criteria. This approach controls measurement error by ensuring that the analytical techniques provide results that will allow for Site-specific decisions. Also, the analytical methods proposed in this Work Plan are EPA-

approved methods with stringent quality assurance/quality control protocols. This minimizes any error in the precision and accuracy of the analytical program. As shown in Tables 2 and 5, the laboratory reporting limits are typically less than the screening levels.

4.2.7 Optimize the Design for Obtaining Data

As noted above, the scope of investigations presented in this Work Plan and the Supplemental Work Plan will be to determine the nature and extent of any environmental contamination from hazardous wastes at or from the Facility.

5 Areas of Potential Interest

This section describes the areas of potential interest that will be evaluated as part of this Work Plan. Sections 5.1 through 5.3 discuss the specific areas of potential interest at the Facility which are grouped as follows: the Main Processing Areas, the Ancillary Areas, and the gyp stacks and pond areas. Section 5.4 discusses groundwater and surface water areas of interest. The scope of the investigations proposed for each of these areas is discussed in Section 7. Investigation of off-site areas will be addressed in a Supplemental Work Plan in order to identify the nature and extent of potential contamination at or from the Facility.

In many cases, sub-areas within the Main Processing Area are housed in buildings with concrete floors or underlain by synthetic liners, which serve as engineering controls to mitigate or prevent releases to the environment. The documented liner locations are discussed below and shown on Figure 15.

5.1 MAIN PROCESSING AREA

The limits of the Main Processing Area and sub areas identified below are shown in Figure 15.

5.1.1 Ore Processing

The Ore Processing Area is located on the north end of the Main Processing Area. The Ore Processing Area includes the ore car unloading station, ore grading and stockpiling area, the Wash Plant, former calciner buildings, the North Ball Mill, and a maintenance shop. A hazardous waste storage building is located in the southeast part of the Ore Processing Area. There are no liners beneath the Ore Processing Area. On July 31, 2001, an unknown quantity of unspecified material was released near the hazardous waste storage building located in the Ore Processing Area.

5.1.2 North Sulfuric Acid Plant

The North Sulfuric Acid Plant area includes an unloading area, acid storage tanks, and a neutralization tank. The North Sulfuric Acid Plant is underlain by an HDPE liner. Releases of sulfuric acid have been reported in this area, and one reported release of an unknown quantity of gasoline from a truck-mounted tank.

5.1.3 East Sulfuric Acid Plant

The East Sulfuric Acid Plant is located just south of the North Sulfuric Acid Plant. An HDPE liner is present beneath a portion of this area. Several releases have occurred in this area, including sulfuric acid, pond water, process water, and sodium hydroxide.

5.1.4 PPA Plant

The PPA Plant is the most recently-constructed section in the Main Processing Area. The PPA Plant operated from 2001 to 2003. A 60-mil HDPE liner is present beneath the PPA Plant. Several releases were reported in the PPA Plant area, including phosphoric acid, merchant grade acid, sulfuric acid, and other materials.

5.1.5 South Ball Mill

The South Ball Mill is located at the north end of the Main Processing Area. There is no liner beneath the South Ball Mill. Several releases of pond water, wash water and gypsum have been reported in the South Ball Mill area.

5.1.6 Phosphoric and Super-Phosphoric Acid Plants

The Phosphoric and SPA Plants area includes the SPA Scrubber, SPA Evaporator, Phosphoric Acid Scrubber, Phosphoric Acid Evaporator, Car Wash Sumps, SPA Ditch, and process or storage tanks

including the Gypsum Tank. The larger tanks in the area are underlain by 60-mil HDPE liners. Beneath Tank #12 and the Gypsum Tank, the liner is approximately 5 feet bgs and is tacked to the foundations of the Phosphate Building and the tank support structure. Beneath Tanks #26 and #51, the liner is 4 to 6 feet bgs and spans the surrounding bermed areas. Spills or overflows of process materials may have occurred at these units, and spills have been reported at Tank #12, the Gypsum Tank, and the SPA Evaporator.

5.1.7 Railcar Washing Operations

The railcar washing facilities are located on the rail line near the decant tanks (Tanks #57 and #58). These facilities consist of a north car wash and sump and a south car wash and sump. The primary purpose of the car washes is to wash heels (residual product acid) remaining in rail cars returned to the Facility into a sump from which it is returned to the phosphoric acid process, recovering the returned phosphorous pentoxide. The sumps also collect washings and solids from various tanks.

The north car wash consists of a hydraulic washer which is lowered into a rail car. Pond water is sprayed from the washer to clean the inside of the railcar and remove the acid product heel. The washings are collected in the north car wash sump. This sump also receives washings and solids from the decant tanks (Tanks #57 and #58), washings and solids from the truck load out tank (Tanks #55 and #56), and flow from the load out sump. The north car wash is pumped to either the primary clarifiers (Tanks #20 or #24) or to the first stage storage tanks (Tanks #18 or #23) depending upon the strength of the acid in the sump.

The south car wash consists of a hydraulic washer which is lowered into a rail car. Pond water is sprayed from the washer to clean the inside of the railcar and remove the acid product heel. The washings are sent to the south car wash sump. This sump also receives washings and solids from Tank #26 via the Tank #26 containment sump, washings and solids from Tanks #28 via the Tank #28 containment sump and precipitation water. As with the north car wash sump, the south car wash sump is pumped to either the primary clarifiers (Tanks #20 or #24) or to the first stage storage tanks (Tanks #18 or #23) depending upon the concentration of the acid in the sump.

5.1.8 Central Tank Farm

The Central Tank Farm includes the Central Floor Sump and a number of large tanks containing phosphoric acid. Releases have been reported from Tanks #21 and #23 in this area. The tank farm has concrete secondary containment; no liner is present below the concrete. Several spills have been reported within the Central Tank Farm containment.

5.1.9 Oxidation Tank Farm

The Oxidation Tank Farm area includes the Oxidation Scrubber, Grade Control Ditch, Grade Control Sump, Oxidation Area Sump, and several large tanks containing phosphoric acid. The area has concrete secondary containment and is underlain by an HDPE liner. Releases have been reported in the Grade Control Area, and the Grade Control Sump was reported to have significantly deteriorated concrete.

5.1.10 West Sulfuric Acid Plant

The former West Sulfuric Acid Plant is currently the location of the West Shop. The West Shop building has a concrete floor. Releases of sulfuric acid have occurred in this area.

5.1.11 Granulation Plant

The Granulation Plant is housed in a building with a concrete slab. The primary equipment in the building includes a pre-neutralizing tank, granulator, rotary dryer, cage mill, and bulk flow cooler. The granulator and dryer are equipped with scrubbers to control dust and fumes and the weak acid from the scrubbers is collected in sumps and pumped back to the pre-neutralizer tank. The Granulation Plant building has a

concrete floor serving as a barrier, but it is not underlain by a documented liner. Spills have been reported outside the north end of the building and near the air dryer duct.

5.1.12 Process Sewer Lagoon

The Process Sewer Lagoon, located just west of the Phosphate Building and immediately adjacent to the Process Sewer Sump, is lined with a double layer of 30-mil PVC and collects overflow liquids from the Process Sewer Sump. Although the liner is maintained to be in generally good condition, one inspection report noted that one or more small breaches were noticed in the liner. Spills have been documented in the area of the Process Sewer Lagoon and the Electrical and Instrumentation (E&I) shop located just to the north.

5.1.13 Dry Products Storage and Shipping

The Dry Products Storage and Shipping building houses finished products. The building has a concrete floor. The East Ditch is located immediately outside the northeast portion of the building and a product loading area is located west of the building. The East Ditch is lined with coated concrete. Releases have been [illegible] of the East Ditch as well as in areas to the north and west of the building.

5.1.1[illegible]rs

A nu[illegible] ditches and launders are present throughout the Facility, as described in Section 2.7.13 and shown on Figure 15. Many of these features, especially the launders, are located within tank farms equipped with secondary containment or above lined areas. The launders connect to nearby sumps or ditches. The ditches and launders are primarily concrete coated with a vinyl ester resin. Some sections of launders are lined with stainless steel. Additionally, several launders, such as the East Ditch, are underlain by a synthetic liner. The Facility has a program in place to coat all concrete launders with a vinyl ester resin.

5.2 ANCILLARY AREAS

5.2.1 Quality Control Laboratory

The Facility's Quality Control Laboratory tests samples of phosphate rock, granular fertilizer, and acid. Hazardous wastes are accumulated here prior to disposal, and non-hazardous wastewater may be discharged to a leach field. There are no liners present in this area.

No spills have been documented in this area, but the presence of a leach field makes this an area of interest for groundwater quality.

5.2.2 Production Well NW-9

Production well NW-9 is located approximately 1,000 feet south of the Main Processing Area. NW-9 was drilled in 2000 to a depth of 255 feet in the fractured basalt unit. When the well was put into service in 2001, the pH of the water ranged from 6.68 to 7.01 Standard Units (S.U.). No water samples were analyzed from the well in 2002 and 2004. The pump in NW-9 failed in February 2004. In March 2004, following redevelopment of the well, the pH of the water was 4.41 S.U.. Subsequent samples collected in April and June of 2004 had pH measurements ranging from 1.8 to 2.4 S.U..

In June 2004, Nu-West notified the National Response Center of a potential release of hazardous constituents. As an initial evaluation step, Nu-West retained Blackhawk Geoservices, Inc. to conduct an electromagnetic survey (EM) in the vicinity of well NW-9 to map a suspected plume with high total dissolved solids. The EM procedures consisted of profiling and vertical soundings using a Frequency Domain Electromagnetic terrain conductivity meter to directly measure apparent conductivity to depths greater than 100 feet. Data was collected along multiple profile lines totaling approximately12,000 linear feet to map the electrical conductivity of earth materials. The profile lines were oriented north to south

extending to the east and west of well NW-9 and surveyed. After plotting the EM field data, locations were selected to conduct a series of soundings to additional geophysical data at depth. The combined survey data were used to infer from the geophysical data the occurrence of high total dissolved solids in groundwater.

The EM survey showed two areas of higher conductivity one about 400 feet northwest of NW-9 and another about 100 feet northeast. Overall, the EM survey showed an area of higher conductivity extending from the north and surrounding NW-9 and lower conductivities to the east, south, and west.

In June 2004, Nu-West retained Kleinfelder Inc. to conduct an investigation of the apparent groundwater impacts and to evaluate feasible remedial alternatives. In December 2004, two monitoring wells (MW-A and MW-B) were installed to verify the findings of the EM survey and to identify the extent and source of low pH water that was detected in well NW-9. The wells were drilled to depths of 104 feet bgs and 120 feet bgs, respectively, to the top of the sandstone unit. Locations of the wells are shown in Figure 11. Following development, samples were collected from the new monitoring wells and NW-9 and were analyzed for pH and a suite of inorganic parameters. The pH of groundwater samples collected from well MW-A was slightly acidic (6.1), well MW-B was acidic (3.3), and well NW-9 was acidic (2.9). Total dissolved solids concentrations were 4,100 mg/l in well MW-A, 4,552, mg/l in well MW-B, and 2,882 mg/l in well NW-9. One or both samples from wells MW-A and MW-B had concentrations of aluminum, antimony, cadmium, fluoride, lead, manganese, nitrate, sulfate, and zinc above the Idaho groundwater quality standards. Based on the results of the investigation Kleinfelder recommended continuing to pump well NW-9 to extract low pH water and sample wells MW-A and MW-B to monitor water quality trends. The well has been continuously pumped since 2004 to capture low pH groundwater.

In an attempt to determine a possible source of the release, Nu-West inspected sumps and launders. Two leaks were identified: one in the Process Sewer Sump located approximately 100 feet north of the northeast corner of the Shipping Building and one in a concrete lined ditch leading to the Process Sewer Sump (Kleinfelder 2004, Agrium 2004a, and Agrium 2004b). Plant drawings show that the concrete lined ditch is underlain by a synthetic liner (Agrium 1994). These leaks were repaired and Nu-West did not identify any other leaks. The sump and ditch at issue are approximately 1,540 feet and 2,010 feet cross gradient from well NW-9. It was not possible to confirm that releases from the sump or ditch were the source of the low pH conditions in well NW-9. The Process Sewer Sump is associated with the Process Sewer Lagoon (Section 5.1.12) and the concrete ditch is addressed in Section 5.1.14.

Well NW-9 has been operating since June 2004 and averages 68 gallons per minute. The water from well NW-9 is used in the phosphate production process. Well NW-9 has been monitored semi-annually since 2004 and the pH level in this well has been increasing over time and is slightly below the Idaho groundwater standard of 6.5 to 8.5 standard units (S.U.). Groundwater sampling results from the spring and fall of 2009 showed pH levels at 6.2 and 6.1 and TDS levels at 1578 mg/l and 1686 mg/l, respectively. A Mann Kendall trend analysis of the monitoring data shows that the pH in NW-9 has increased with greater than 90 percent confidence (Appendix B). Since 2007, cadmium is the only metal detected in well NW-9 at concentrations above the MCL of 0.05 mg/l.

5.3 GYP STACKS AND POND AREAS

5.3.1 Gyp Stacks and Tailing Ponds

The gyp stacks and tailings ponds were described previously in Section 2.7.15. Gypsum slurry is pumped to the top of the gyp stack for settling of solids. Water is decanted from the top of the gyp stack and pumped to the HDPE-lined Decant Ditch. The Decant Ditch routes water to the East and West Cooling Ponds, where it is then recirculated back to the Main Process Area for reuse. Decanted water from solids settling is transferred from Tailings Pond #4 to Tailings Pond #2 for additional clarification before it is pumped back to the Ore Processing Area.

The Old Gyp Stack, which occupies approximately 150 acres and includes Cell #1, Cell #2/3 and Cell TP-3, ranges from 100 to 175 feet in height. Cells #1 and #3 are underlain by synthetic liners and bentonite was placed at a rate of 2 to 4 pounds per square foot either below or above the liner. Cell TP-3 (originally Tailings Pond #3) is underlain by approximately 60 feet of tailings which was present at the time of conversion to a gyp stack. The hydraulic conductivity of the tailings was reported to be in the range of 9.12×10^{-7} and 6.26×10^{-8} centimeters per second (BCI 1997). The West Gyp Stack is underlain by clay and 60-mil HDPE liners. Tailings Ponds #1, #2, and #4 are all underlain by native materials.

5.3.2 Cooling Ponds

As described in Section 2.7.16, above, the East and West Cooling Ponds are separately lined, 15-acre ponds that receive decant water from the gyp stacks and process water from the Main Processing Area. The cooling ponds are lined with a 60-mil HDPE liner, underlain by a drainage geonet, perforated PVC pipe, and a clay liner. The interstitial space between liners is equipped with lysimeters to detect any potential leakage through the HDPE liner. Nu-West is currently investigating a potential liner leak that was reported to IDEQ. Releases of water have been reported in the vicinity of the cooling ponds.

5.4 GROUNDWATER AND SURFACE WATER

Groundwater and surface water are considered media of concern and are addressed in this Work Plan.

5.4.1 Groundwater

A groundwater monitoring network has been in-place at the Site since 1999. The monitoring network was installed to assess groundwater quality upgradient and downgradient of the gyp stacks and has been expanded as new tailings ponds were constructed. The newest groundwater monitoring wells, A-11 and A-12, were installed in May 2007. Substantial groundwater quality data have been collected from the monitoring network over the past ten years, and there is some evidence that Facility operations may be affecting groundwater quality. A detailed discussion of previous groundwater investigation activities is presented in Section 7.4.

5.4.2 Surface Water

As discussed in Section 2.4, surface water near the Facility is limited to an inactive tailings pond on the J.R. Simplot property located to the south, and Woodall Spring and Woodall Spring Ditch located to the north. The surface elevation of the water in the J.R. Simplot tailings pond is approximately 25 feet higher than the ground surface at the Facility. Some water from Woodall Spring enters Woodall Spring Ditch, travels across the gyp stack and tailings pond area, and then exits the Facility to the west in the vicinity of Tailings Pond #2 (Figures 4 and 19).

6 Site Surveys

This section summarizes the approach for conducting both a topographic Site survey and a geophysical survey to detect fractures in the subsurface bedrock.

6.1 GROUND SURVEY

A preliminary assessment of the existing data related to the Site indicated that several of the existing groundwater wells have not been surveyed. The wells and soil boring locations proposed in this Work Plan and any additional wells and borings proposed in the Supplemental Work Plan will be surveyed after installation.

A ground survey will be performed by an Idaho-registered land surveyor to determine the following:

- soil boring locations and ground surface elevations
- surface water and sediment sample locations
- if necessary, existing monitoring well locations, ground surface elevations, and top-of-casing elevations

The locations will be surveyed to an accuracy of +/- 0.1 foot; the elevations will be surveyed to an accuracy of +/- 0.01 foot. The lateral survey information will be tied to the existing site datum and elevations will be stated relative to a standard datum (e.g., NAVD88 or NGVD29).

6.2 GEOPHYSICAL SURVEY

6.2.1 Background

The predominant water bearing unit in the area of the Facility is the basalt bedrock which is semi-confined and confined. The basalt unit occurs generally around 5 to 25 feet bgs and is greater than 250 feet thick. Groundwater gradient in the basalt is to the west-southwest primarily within weathered interflow zones, vertical fractures, and shear fractures. However, the characteristics of the major flow features beneath the Site are not well understood. In order to develop an understanding of the primary conductive features within the basalt that transmit groundwater (interflow zones, vertical fractures, and shear fractures) a geophysical survey will be performed at the Site. This will consist of an electrical resistivity imaging (ERI) survey followed by a seismic refection (SR) survey, as appropriate based on the results of the ERI survey and downhole geophysical logging. The scopes of work for each technique are described below.

6.2.2 Surface Geophysics – Electrical Resistivity Imaging

An electrical resistivity imaging (ERI) surface survey will be conducted to identify and map the extent of fracturing and weathering within the basalt sequence and associated faults that may serve as preferential flow pathways of groundwater below the Site; to identify the depths within the basalt sequence that have higher conductivity and thus higher flow, and to determine if areas of affected groundwater have an identifiable resistivity feature that can be used to guide the placement of additional monitoring wells. The survey will consist of nine ERI transect lines covering upgradient, facility, and downgradient areas of the Site as shown in Figure 16.

Transects 1 and 2 will be located on the eastern upgradient portion of the Site and oriented perpendicular to groundwater flow, which is to the west-southwest. Transect 3 will be located immediately down gradient of the Main Processing Area and oriented perpendicular to groundwater flow. Transect 4 will be located to the east of the East Cooling Pond and Cell #1 of the Old Gyp Stack and oriented perpendicular

to groundwater flow. Transects 5 and 6 will be to the west of the Old Gyp Stack and perpendicular to groundwater flow. The ERI survey results from these 6 transects will provide information on conductive zones within the basalt sequence across the Site, image affected groundwater potentially emanating upgradient of the Main Plant Area and across the Main Processing Area and the Old Gyp Stack. Transects 6 through 9 will be oriented perpendicular to the fault zone on the west portion of the Site and parallel to the groundwater flow direction. ERI survey results from these transects will provide information on the orientation of the fault plane, the fracture and weathering characteristics of the fault zone, conductive features within the basalt sequence, and potentially identify affected groundwater in the fault zone.

The ERI survey will be performed by Enviroscan Inc, (Enviroscan) using an Advanced Geosciences (AGI) Supersting R8 resistivity meter or equivalent and 56-electrodes at a spacing of 20 feet to provide the best resolution to a depth of 250 feet bgs. Enviroscan will perform forward modeling to verify the spacing of the electrodes will be capable of imaging subsurface features of interest (fractures, shear zones, and interbed zones) to 300 feet bgs. Resistivity readings will be collected using a hybrid dipole-dipole Warner array. To ensure complete coverage when survey spacing extends beyond the 56-electrode configuration, data will be collected in a roll along procedure with 50 percent overlap between adjacent transects (i.e. moving electrodes #1-#28 after each data acquisition). Low amperage DC electrical current will be applied at each electrode. If necessary, a high signal generator will be employed to boost the transmitter voltage. The flow of electrical current in the ground will be mapped by measuring the electrical potential at the ground surface using the AGI Supersting R8, a very high impedence microvolt meter. Resistivity readings will be an average of several repeated readings and digitally recorded in the instrument along with quality control parameters such as the recorded voltage, electrode contact resistance, and standard error of each reading. Reciprocal readings (with transmit and receive dipoles switched) will be recorded for additional quality control.

Contact resistance will be checked at each electrode prior to data collection. In cases where elevated contact resistances are recorded prior to production data collection, the electrodes will be wetted to improve contact. Location control will be provided by global positioning system (GPS) data to ensure GIS-compatible results. Reading locations will be recorded using a mobile GPS receiver with differential corrections to be applied relative to a fixed base station receiver.

The first profile will be downloaded and inverted in the field and reviewed before proceeding to the next transects line. The remaining data will be downloaded to a laptop computer at the end of each day for review. The resistivity profile data will be inverted using Advanced Geosciences's EarthImager2D and RES2DINV software developed by M.H. Lake. Electrical models will be imported into Surfer 8 using the Golden Software program for contouring and data presentation. The representation of results will be a fence diagram of the 2-D images. Given the extensive scale of the proposed work, 3-D data acquisition is not practical.

6.2.3 Surface Geophysics – Seismic Reflection Survey

Seismic reflection surveys measure the subsurface travel times of seismic waves from a surficial shock source to a linear array of ground motion sensors or geophones. Based on an analysis of the ERI results, if ambiguities or data gaps are noted with increased profile depth below 50 feet bgs, seismic reflection scanning will be performed along the appropriate ERI profiles to further evaluate the deeper stratigraphic density and Site structural geology. Seismic reflection is a technique well-suited to deep imaging. However, it is often difficult to collect clear reflection data at depths typically less than 80 to 100 feet because of interference from high amplitude, low frequency surface waves or ground roll.

The seismic energy source will be an accelerated weight drop with relatively low mass to generate a transmittal signal with high frequency content. Seismic reflection data will be recorded along designated

transect lines using a string of Geometrics Geode digital stacking seismograph modules totaling 96 channels with high frequency (100 Hz) geophones and shot points at constant 10-foot spacing (for a single-spread length of 960 feet). The designated frequency contact is appropriate for imaging faults, fractures, and interbed zones based on the expected width and extent of these features. Seismic travel times will be recorded off-end beginning 240 feet from the first channel, proceed into the spread shooting at the mid point of every geophone pair, and extend 240 feet beyond the end of each spread to provide minimum 24-fold data with the best possible chance of resolving the desired survey targets of 300 feet. The seismic wiggle trace data from each geophone for each shot point will be recorded on the internal hard drive of the seismograph and downloaded daily to a computer hard drive and zip disk. A third party firm having a supercomputer and specialty knowledge in shallow, very high resolution seismic data processing will process the seismic data. The reflection data will be used to prepare interpretive geologic cross sections for each seismic profile. The interpretive cross sections will depict bedrock depth/elevation and general composition and will be compared to ERI and available boring data.

6.2.4 Downhole Geophysics

Following an evaluation of the ERI and seismic reflection survey results, as appropriate, locations of features will be added to the existing base map and reviewed to identify locations for conducting downhole geophysics. Based on the mapped features up to 10 locations will be identified for downhole geophysical logging. Existing wells will be selected for geophysical logging where appropriate. Alternatively, locations for new exploratory borings will be identified. At each location targeted features will be surveyed, located, and marked in the field.

The scope of the downhole geophysical logging will include video logging and collecting measurements of fluid temperature, fluid conductivity, and borehole diameter (caliper measurements). Boreholes will be thoroughly developed 24 hours prior to the initiation of logging. A high resolution acoustic televiewer or optical borehole televiewer will be used to record an image of the borehole walls, allowing identification of features such as fractures and an estimation of fracture orientation and thickness. Fluid temperature will be collected continuously from the top of bedrock to the termination depth of the borehole. Deflections in fluid temperature will be used to locate water producing features within the borehole. A caliper tool will be used to measure the borehole diameter and to identify changes in borehole diameter that indicate a potential fracture interval. Geophysical logs will be maintained in the field and include information on temperature, fluid conductivity, and caliper.

The interpretative cross sections from seismic reflection and ERI profiles will be compared to the boring data following geophysical logging. Results of the geophysical logging will provide further characterization of the measurement and orientation of fractures in the basalt unit as well as flow mechanisms of groundwater. The combined geophysical data sets will assist with developing a plan for additional monitoring wells including appropriate well construction details.

7 Site Investigation

The scope of the Site investigation activities presented in this Work Plan is designed to assess and evaluate conditions Site-wide and includes the collection of soil, sediment, surface water, and groundwater samples for laboratory analyses.

Many of the areas of interest at the Facility are underlain by HDPE and other liners (Figure 15). The gyp-stacks and cooling ponds are underlain by either HDPE liners or compacted clay soil. These liners are designed to contain potential releases and serve as barriers to releases to the environment. Investigation activities associated with lined areas are focused downgradient of areas underlain by liners to avoid puncturing the liners.

The scope of the soil, sediment, surface water, and initial groundwater investigation activities are presented in Sections 7.1 through 7.4, below. The approximate soil, sediment, and surface water sampling locations are shown in Figures 17 through 19. Section 7.4 also includes limited descriptions of historical groundwater conditions based on data generated during previous assessment activities (Engineers, Inc. 2006, 2007, 2008).

All field activities will be conducted in accordance with the QAPP for this project, which is included as Appendix A. Included in the QAPP are WSP's SOPs which will support the project objectives by ensuring that reliable data is produced from the sample collection activities (Appendix C in QAPP). The SOPs address all aspects of sample collection including field documentation; sampling procedures for soil, sediment, surface water, groundwater and private supply wells; equipment decontamination; field QA/QC samples; and managing investigation derived waste.

The field activities will also be conducted in accordance with the Health and Safety Plan (HASP) for this project, which is included as Appendix C.

7.1 SOIL INVESTIGATION

Soil quality can potentially be impacted by surface releases (e.g., spills, leaks, storage or placement of materials) and subsequent vertical migration, subsurface releases, and fugitive emissions. Investigations will be conducted in areas of interest at the Site to characterize soil quality and ascertain the physical nature of soils. The findings will be used to determine if constituents of potential concern are present at concentrations suggesting further evaluations are warranted, and to evaluate potential remedial alternatives, if indicated.

7.1.1 Objective

The objective of the soil investigation is to evaluate the impacts to native soil caused by the release of materials during Facility operations. The soil sampling locations proposed in this Work Plan have been selected due to their proximity to known or potential release areas. The results of this sampling effort may indicate that additional soil sampling is warranted. If so, additional sampling locations will be proposed and discussed with EPA.

7.1.2 Sampling Protocols

All soil sampling activities will be conducted in accordance with the project QAPP. Sampling protocol details are included in the QAPP and SOPs (Appendix A) and are summarized below.

7.1.2.1 Collection of Soil Samples

This section describes the protocols for soil sample collection. Specific sampling locations are described in section 7.1.3, below.

Soil borings will be installed using direct-push (i.e., Geoprobe®) or hollow-stem auger split-spoon methods. Continuous soil cores will be taken from each boring beginning at the ground surface and extending to the top of groundwater table or the depth where refusal is encountered. Depending upon the drilling method utilized, soil cores may be 4 or 5 feet in length and will be retrieved in acetate liners or split-spoon samplers. The groundwater table is anticipated to be encountered at depths ranging from 15 to 35 feet bgs. Samples will be collected for laboratory analysis from 0-1 foot bgs; 1-2 feet bgs; and 4-5 feet bgs; and every additional 5-foot depth until the water table is encountered or refusal occurs. SOP #10 specifies the procedures for soil sampling using split-spoon equipment with drilling rigs, and SOP #24 specifies the procedures for soil sampling using direct-push (i.e., Geoprobe®) equipment (Appendix C in QAPP).

In general, samples collected below 5 feet bgs will be held pending the analytical results of shallow samples. The analytical results for samples from 0-1 foot bgs; 1-2 feet bgs; and 4-5 feet bgs will be compared to EPA PRG Residential Soil Screening Levels (SSLs) and Protective of Groundwater Risk-Based SSLs, as well as IDEQ IDTLs. At locations where constituent concentrations in the 4-5 feet sample are above the criteria, samples from intervals below 5 feet will be analyzed by the laboratory for the same constituents.

In borings that are installed near sumps, lagoons, the cooling ponds, QC Laboratory Leach Field, or other features that extend more than 5 feet bgs, all samples from the surface to first sampling interval beneath the bottom of the structure will be analyzed by the laboratory. Samples from deeper intervals may be held, pending the results of the shallower samples. Where changes in stratigraphy or evidence of suspected contamination are observed, samples will be collected regardless of the depth interval. Criteria used to identify these points include changes in soil type, color, and density; or the observation of staining or odors.

During soil sample collection, a gamma radiation survey meter will be used to measure external radiation levels at the surficial and sub-surface intervals. The use of these readings is discussed below in Section 7.1.5, below.

7.1.2.2 Field QA/QC Samples

Soil sampling will include the collection of blind field duplicates at a ratio of 1:10, and equipment blanks on a daily basis. These field QA/QC samples will be collected in accordance with SOP #21.

7.1.2.3 Equipment Decontamination

Decontamination of drilling or direct-push equipment will be performed between each boring location, and decontaminated sampling equipment will be used for the collection of each sample. Decontamination procedures are specified in SOPs #15 and #19. Decontamination will include the use of a phosphate-free detergent, such as Liquinox®.

7.1.2.4 Sample Container Requirements

Soil samples will be placed in new laboratory-supplied, clean glass sample containers. Sample containers and preservatives will be as specified by the laboratory, in accordance with SOP #2. Each sample container will be labeled with a unique label description that will include the sample identification number, date and time of sample collection, analyses to be performed, sampler's initials, and the project name and number.

Following collection, each sample will be placed in a cooler and chilled to approximately 4 degrees Celsius. Samples will be packaged and shipped according to procedures described in Section 7.1.2.5 and chain-of-custody (COC) procedures described in Section 7.1.2.6, below.

7.1.2.5 Sample Packaging and Shipping

The lid of each sample jar will be securely tightened and samples placed in re-sealable plastic bags. Samples will be placed into a sample cooler or other appropriate shipping vessel and packed carefully to minimize the potential for breakage or spilling by using packing material (e.g., bubble wrap). In no case will glass sample containers be permitted to touch each other inside the sample transportation container.

Ice in watertight resealable plastic bags will be placed on top of the samples and packing. If shipped by common carrier, the appropriate COC forms will accompany the samples sealed in the shipping cooler in watertight packaging. The COC forms must be dry and legible upon receipt at the laboratory.

After packing, the containers must be sealed and managed in accordance with the COC requirements in Section 7.1.2.6. If being shipped by common carrier, an appropriate completed air bill or freight bill will be taped to the outside of the container.

7.1.2.6 Chain-of-Custody Procedures

COC procedures consist of several levels of documentation, including the field logbook, the COC form, and custody seals. These documents serve as the record for tracking sample collection and transport. Once a sample is obtained, it must be maintained under COC procedures until it is in the custody of the analytical laboratory. The person collecting the sample is responsible for the custody of the sample until it is properly transferred or dispatched. WSP's standard COC forms or laboratory-supplied COC forms shall be used.

Field Log Book

The field logbook serves as official documentation of sampling activities. Field logbooks will be constructed of bound, sequentially numbered, water-resistant notepaper, and records will be kept in waterproof ink. Field personnel shall make frequent detailed entries to provide an adequate record of activities conducted during each day on site. SOP #1 provides additional details of required protocol for the field log book.

Chain-of-Custody Form

A COC form will be filled out either simultaneously with the notations in the logbook or shortly after sample collection is completed for the day. The information required on the COC form includes the project name and number; sampler's name and signature; sample numbers; sample matrix; date and time of sample collection; quantity of sample containers; analyses required; and custody sequence.

If the samples are being shipped by common carrier, the COC form will include the carrier airbill number in lieu of a custody signature from a courier employee. In this event, the COC form will be packed in a cooler with the laboratory samples in a resealable plastic bag. One copy of the COC form will be retained by the sampler. The sender's copy of the air bill will be affixed to this copy of the COC form and will become a part of the COC documentation. The original COC form will remain with the samples during shipment. The receiving laboratory will be instructed to sign the COC form and return one copy with the analytical data package. The original COC form will remain with the samples until their ultimate disposal.

Custody Seals

To complete custody procedures for shipping, each sample cooler or container will be sealed with custody seals that are to be signed and dated by the shipper. The custody seal is a label with adhesive backing that is sealed over the container latch or across the closure point. If broken during transit, the sample custody has been compromised, which indicates potential tampering during transit. If unbroken, the integrity of the samples is assumed to be maintained.

7.1.3 Soil Sampling Locations

Soil samples will be collected in the areas of interest as described below. Wherever possible, the boring locations have been placed in areas where spills are known or suspected to have occurred, and where a visual assessment indicates that drill rig access may be possible. Boring locations will be subject to adjustment in the field, as required by conditions such as underground piping and utilities.

The soil boring locations are shown on Figures 17 and 18. All soil boring designations use SB-prefixes to denote that the borings will be advanced using direct-push methods (i.e., Geoprobe®) or hollow-stem auger split spoon methods. None of these borings will be used to construct groundwater monitoring wells.

Table 1 correlates the proposed boring locations and areas of interest and summarizes the rationale for soil boring placement, which is described below. Table 1 also identifies the sample intervals, anticipated number of samples, and the chemical parameters for which the soil samples will be analyzed. Laboratory analyses and methods are described in Section 7.1.4, below.

7.1.3.1 Ore Processing

As discussed in Section 5.1.1, the area of interest within the Ore Processing Area is the Hazardous Waste Storage Building. This area is not underlain by a liner. Four soil borings designated as SB-1 through SB-4 will be installed around the Hazardous Waste Storage Building, one on each side of the building. The boring locations are shown on Figure 17 and are designed to assess whether releases may have impacted soil in this area.

7.1.3.2 North Sulfuric Acid Plant

The North Sulfuric Acid Plant includes an unloading area, acid storage tanks, and a neutralization tank. The entire area is underlain by an HDPE liner. Five soil borings will be installed outside the limits of the liner underlying this area to determine if releases may have impacted soils. Borings SB-5 and SB-6 will be installed to the west of the North Sulfuric Acid Plant near the neutralization tank and unloading area. Boring SB-7 will be located at the southwest corner of the liner. Boring SB-8 will be advanced on the south side of the North Sulfuric Acid Plant. Boring SB-9 will be located east of the production plant directly outside the liner.

7.1.3.3 East Sulfuric Acid Plant

The East Sulfuric Acid Plant is partially underlain by an HDPE liner. Six soil borings will be placed outside the limits of the HDPE liner to determine if releases may have impacted soils. Boring SB-10 will be located directly west of the East Sulfuric Acid Plant. Boring SB-11 will be located at the southwest corner of the East Sulfuric Acid Plant. Boring SB-12 will be located near the southeast corner of the control room building, borings SB-13 and SB-14 will be located along the west side of the storage tank area, and boring SB-15 will be placed south of the East Sulfuric Acid Plant. Locations of the borings are shown on Figure 17.

7.1.3.4 PPA Plant

The PPA Plant is underlain by an HDPE liner. Three soil borings will be installed outside of the limits of the HDPE liner to determine if releases may have impacted soils. Boring SB-16 will be located in the northeast section of the PPA plant, boring SB-17 will be located in the east-central area of the PPA Plant, and boring SB-18 will be placed near the south edge of the PPA Plant.

7.1.3.5 South Ball Mill

The South Ball Mill is not underlain by a liner. Access on the south and west sides of the South Ball Mill is limited by equipment, piping, and support structures related to Phosphoric Acid Plant operations. Soil borings SB-19 and SB-20 will be placed north of the Digester/Filter Building and near the northwest corner of the South Ball Mill, where more than 10 releases have occurred. SB-21 will be placed along

the east side of the South Ball Mill building, which is also downgradient from the lined north end of the SPA area.

7.1.3.6 Phosphoric and Super-Phosphoric Acid (SPA) Plant and Railcar Washing Operations

The Phosphoric and SPA plant area includes scrubbers, evaporators, a sump, and process or storage tanks, as described in Section 5.1.5. Several tanks in the area are underlain by HDPE liners, as are the SPA Car Wash Sump Area and the SPA Building. The railcar washing facilities are located on the rail to immediately to the east. The facilities consist of a north car wash and sump and a south car wash and sump. Spills and overflows of process materials have occurred in this area. Eleven soil borings will be advanced in this area to determine if any prior releases may have impacted soil. All boring locations are outside areas underlain by liners or concrete secondary containment structures.

Soil borings SB-22, SB-23, and SB-24 will be advanced on the northeast end of the Phosphoric Acid Building, borings SB-25 and SB-26 near the South Car Wash Sump, borings SB-33 and SB-34 near the North Car Wash Sump, and borings SB-27 through SB-30 will be advanced to the east of the Phosphoric Acid Building adjacent to the SPA Ditch. Borings SB-31 and SB-32 will be placed to the south side of the SPA Building.

7.1.3.7 Central Tank Farm

The Central Tank Farm includes the Central Floor Sump and a number of large tanks containing phosphoric acid. It is equipped with concrete secondary containment.

There is no drilling access on the north or east side of the Central Tank Farm, due to equipment, piping, tanks, and concrete containment structures related to the Phosphoric Acid Plant. Four soil borings will be advanced outside the limits of the tank farm to determine if any releases could have impacted soils. Borings SB-35 and SB-36 will be advanced outside the northwest and southwest corners of the Central Tank Farm. Boring SB-35 also will be adjacent to the concrete lined ditch and serve to assess the potential for releases from the ditch and outside the tank farm. Borings SB-37 and SB-38 will be advanced to the south of the Central Tank Farm to assess the potential for releases. Additionally, soil boring SB-60 will be advanced to the west of the Central Tank Farm adjacent to the East Ditch, which also will serve to determine if prior releases may have impacted soil.

7.1.3.8 Oxidation Tank Farm

The Oxidation Tank Farm area includes the Oxidation Scrubber, Grade Control Ditch, Grade Control Sump, Oxidation Area Sump, and several large tanks containing phosphoric acid. This area has both concrete secondary containment and is underlain by an HDPE liner. Five soil borings will be placed around the perimeter of the tank farm. Boring SB-39 will be placed to the north, boring SB-40 to the northwest, boring SB-41 to the southwest, boring SB-42 to the south, and boring SB-43 to the east of the Oxidation Tank Farm. These borings will serve to determine if prior releases in the tank farm may have impacted surrounding soil.

7.1.3.9 West Sulfuric Acid Plant

The former West Sulfuric Acid Plant (now the West Shop) abuts the Oxidation Tank Farm to the south and west. The West Sulfuric Acid Plant building has a concrete floor. Soil boring SB-44 will be advanced immediately to the southwest of the building to determine if prior releases may have impacted soil outside the building. Additionally, boring SB-41, which will be advanced to the west of the Oxidation Tank Farm, and boring SB-62, which will be to the west of the building near the East Ditch, will serve to evaluate if prior releases may have impacted soil in the area of the former West Sulfuric Acid Plant.

7.1.3.10 Granulation Plant

The Granulation Plant building has a concrete floor and houses various equipment including scrubbers and scrubber sumps. Spills have been reported inside the Granulation Plant building, north and northeast of the building, and north of the adjacent Silica Building.

Five soil borings will be installed to the west and north of the Granulation Plant building to determine if prior releases may have impacted soils. Boring SB-45 will be advanced to the northeast of the building; boring SB-46 at the north side of the adjacent Silica Building; boring SB-47 to the northwest of the Granulation Plant building; and borings SB-48 and SB-49 to the west of the building. The area to the west is where granular fertilizer products are transported by conveyor to the Dry Product Storage building.

7.1.3.11 Process Sewer Lagoon

The Process Sewer Lagoon is lined with a double layer of 30-mil PVC and collects overflow liquids from the adjacent Process Sewer Sump. Although the liner is maintained to be in generally good condition, small breaches have been reported. Additionally, spills have been documented in the area of the Process Sewer Lagoon and the E&I shop located just to the north.

Nine soil borings will be advanced around the Process Sewer Lagoon. Borings SB-50, SB-51, and SB-52 will be advanced to the north of the Process Sewer Lagoon to determine if releases in the area of the E&I shop may have impacted soils. Borings SB-53 and SB-54 will be advanced to the north and south of the Process Sewer Sump in which a leak was identified during inspections conducted in 2004 to ascertain the source of low pH water found in well NW-9. Borings SB-55 and SB-56 will be advanced to the west, and borings SB-57 and SB-58 to the south of the Process Sewer Lagoon to assess the potential for releases.

7.1.3.12 Dry Products Storage

The Dry Products Storage and Shipping Building has a concrete floor. To the east of the north portion of the building is the East Ditch. The Product Loading Area is to the west of the central portion of the building. The East Ditch is lined with coated concrete while other areas outside the building are not covered with asphalt or concrete.

A total of 11 soil borings will be advanced around the building, East Ditch and Product Loading Area. Four soil borings (SB-59 through SB-62) will be advanced to the east of the East Ditch to determine if releases may have impacted soils. Drilling equipment access is only available to the east of the ditch, and samples from along the ditch will also be useful in evaluating soil conditions to the west of the Central Tank Farm and West Sulfuric Acid Plant.

Borings SB-63 and SB-64 will be advanced to the north of the Dry Products Storage building; borings SB-68, SB-69, and SB-70 to the east of the building (south of the East Ditch), Boring SB-71 to the south of the building, and borings SB-65, SB-66, and SB-67 in the Product Loading Area.

7.1.3.13 Ditches and Launders

Many of the launders throughout the Facility are located within the secondary containment of tank farms or above lined areas. The major ditches in the Facility have been addressed as part of the area where each is located. These include the SPA Ditch (included in the Phosphoric and SPA Plant), the East Ditch (included in the Dry Products Storage area), and the Decant Ditch (included in the gyp stacks and tailings ponds). The concrete lined ditch in which a release was identified in 2004 will be addressed by borings SB-35 (Section 7.1.3.7) and SB-59, SB-61, and SB-62 (Section 7.1.3.12).

7.1.3.14 Production Well NW-9

This investigation will include three soil borings near well NW-9 to evaluate soil quality in this area. SB-72, SB-73, and SB-74 will be located approximately 100 feet north, east, and west of the well NW-9 location. These boring locations are shown on Figure 17.

7.1.3.15 Quality Control Laboratory Leach Field

This investigation will include three soil borings near the Quality Control Laboratory Leach Field to evaluate soil quality in this area. Borings SB-75, SB-76, and SB-77 will be located approximately 50 feet north and northwest of the septic tank, within the leach field, and south of the septic tank. These boring locations are shown on Figure 17.

7.1.3.16 Gyp Stacks and Tailings Ponds

There are two gyp stacks (F-GYP-0 and F-GYP-1) and three tailings ponds (Tailings Ponds #1, Tailings Pond #2, and Tailings Pond #4). The Old Gyp Stack includes Cell #1, Cell #2/#3 and Cell TP-3. The West Gyp Stack (F-GYP-1) is a single large cell. Seven soil borings will be installed to evaluate soil conditions to the east and west of the gyp stacks and tailings ponds. Three soil borings will be placed along the east side of the Old Gyp Stack. SB-82 and SB-83 will be located on the east side of Cell TP-3 and Cell #2/#3. Boring SB-84 will be located near the southeast corner (Cell #1) of the Old Gyp Stack. Four soil borings will be placed along the west side of the Decant Ditch, between the ditch and the Facility's property line. Borings SB-78 through SB-81 will extend in a line from north to south, as shown on Figure 18. The Supplemental Work Plan will address off-site areas and will be designed to ensure that the investigation fully determines the nature and extent of hazardous waste at or from the Facility. The Supplemental Work Plan will include an assessment of existing information from previous investigation and remediation activities and a rationale for how the off-site sampling proposal satisfies Consent Order requirements.

7.1.3.17 Cooling Ponds

The East and West Cooling Ponds receive decanted water from the gyp stacks and process water from the Main Processing Area. The cooling ponds are lined with a 60-mil HDPE liner, underlain by a drainage geonet, perforated PVC pipe, and a clay liner. The interstitial space between liners is equipped with lysimeters to detect potential leakage through the HDPE liner. Potential liner leaks were recently reported to IDEQ.

Three soil borings will be installed to the south of the cooling ponds to determine if releases may have impacted soils. Boring SB-85 will be installed near the northeast corner of the cooling ponds, and boring SB-86 to the south. Boring SB-87 will be installed to the south of boring SB-85 to evaluate whether any prior releases in this area have impacted soil.

7.1.4 Analytical Program

Laboratory analyses for conventional chemical parameters will be performed by Accutest Laboratories located in Wheat Ridge, Colorado. Accutest Laboratories participates in the National Environmental Laboratory Accreditation Program (NELAP) and are certified by the NELAP accrediting authority in Idaho. Radiological analyses will be performed by ALS Laboratory Group located in Fort Collins, Colorado (formerly Paragon Analytics). ALS Laboratory Group holds NELAP certification, several state certifications for radiochemistry, and is listed on IDEQ's current list of laboratories certified for drinking water analysis.

Soil samples will be analyzed for the following parameters:

- antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, lead, magnesium, nickel, potassium, selenium, sodium, thallium, vanadium by EPA SW-846 Method 6010B

- fluoride by EPA SW-846 Method 9056A
- pH using EPA SW-846 Method 9045
- total phosphorous by EPA Method 365.3
- total Kjeldahl nitrogen (TKN) by EPA Method 351.2
- nitrate by EPA SW-846 Method 9056A
- ammonia by EPA Method 350.1
- gross alpha and gross beta by EPA Method 900
- radium 226 and radium 228 by EPA Method 901.1; and gasoline range organics and benzene, ethylbenzene, toluene, and xylene by EPA Method 8260 for soil samples collected at the North Sulfuric Acid Plant

Surface soil samples (0-1 feet bgs) and subsurface soil samples (1-2 feet bgs and 4-5 feet bgs) will be submitted for laboratory analysis of the 15 metals specified above and on Table 2 (hereinafter collectively referred to as "metals"), fluoride, pH, total phosphorus, TKN, nitrate, ammonia, gross alpha, and gross beta. Due to the limited mobility of radiological parameters, only the 1-2 feet bgs interval will be analyzed for gross alpha and gross beta. Twenty-five percent of the samples submitted for gross alpha and gross beta will be analyzed for radium 226 and radium 228 analyses, covering a broad range of gross gamma field measurements and gross alpha laboratory analyses.

Tables 1 and 2 summarize the assessment soil sample collection and analytical program. Table 1 indicates the boring number, sample depths and intervals, samples to be analyzed immediately, samples to be held, number of samples to be analyzed, and the analyses to be performed. Analytical parameters and method requirements (e.g., bottle requirements, preservatives, and holding times), method detection limits, and laboratory reporting requirements are presented in Table 2 for solids, including soil and sediment. Table 2 also provides EPA PRG Screening levels and IDEQ IDTL values for soil.

7.1.5 Data Analysis

The analytical results will be compared to the more stringent of EPA PRG Screening levels for residential soil or IDEQ risk-based rules and IDTLs for commercial/industrial direct exposure and for the protection of groundwater and surface water. The results will also be evaluated as part of an overall assessment of conditions across the Site.

The radiological data will be used to confirm that gross alpha, and potentially radium 226 and radium 228, activity concentrations in soil within the areas of interest at the Facility are similar to those identified in soil and sediment samples collected throughout the rest of the Site, including areas upgradient from the Main Processing Area, during the assessment. Radium 226 and other radionuclides in the naturally-occurring uranium decay series emit gamma radiation, and field gamma radiation measurements will be compared with laboratory results to create a correlation. Field gamma radiation measurements will be compared to the generated correlation to estimate the concentration of radium 226 in the soil samples not submitted for laboratory analysis.

For purposes of ascertaining background soil quality samples will be collected at 7 locations designated BK-1 through BK-7. Locations of the background samples are shown in Figure 18. The protocol for collecting soil samples will be the same as described in Section 7.1.2.1 and the analytical program will be the same as described in Section 7.1.4. Samples from all depth intervals will be analyzed. The background soil sample collection and analytical program are summarized in Tables 1 and 2.

Laboratory results for the samples that are analyzed immediately will be reviewed to determine the required laboratory analyses (if any) for deeper samples that are initially held pending data review. If the analytical results for shallower samples indicate that concentrations of one or more analytes exceed the

more stringent of the either EPA PRG screening levels for residential soil or IDTL value in the deepest sample analyzed, then all deeper samples from that boring will be analyzed for the parameters that exceeded those values in the shallower sample.

7.1.6 Investigation Derived Waste

Soil cuttings and unused soil cores from each boring will be collected in labeled drums or a lined roll-off box. Decontamination water, purge water, and other waste liquids generated during the investigation will be stored in properly-labeled drums for waste characterization and disposal. Used disposable personal protective equipment (PPE) will be placed in a properly labeled drum, pending disposal. A composite sample or samples of the material generated from the various areas will be analyzed to determine appropriate disposal methods. SOP #26 specifies the procedures for the management of investigation-derived waste materials.

7.2 SEDIMENT INVESTIGATION

An investigation will be conducted to characterize current sediment conditions within Woodall Spring and Woodall Spring Ditch, which is unlined (Figure 19). The Facility does not have any National Pollutant Discharge Elimination System (NPDES)-permitted outfalls. Other surface water features located at the Facility, including the Process Sewer Lagoon, East and West Cooling Ponds, and process ditches described in Section 2.7.13 are lined. The tailings ponds are not included in the sediment investigation.

7.2.1 Objective

Sediment quality could be impacted by runoff, water within the ditches, groundwater discharges, the presence of pond seepage water, or in some areas, prior releases from the gyp stacks. The objective of the sediment investigation is to determine if Facility operations have resulted in detrimental impacts to sediment in Woodall Spring and Woodall Spring Ditch.

7.2.2 Sampling Protocols

The sediment sampling event will be conducted concurrent with the soil sampling activities. Sediment samples will be collected in accordance with the QAPP and SOP numbers 4, 5, or 6, depending upon the depth and density of sediment encountered. Samples will be collected following collection of surface water samples from Woodall Spring Ditch during a period of normal flow.

7.2.2.1 Collection of Sediment Samples

This section describes the protocols for sediment sample collection. Specific sampling locations are described in Section 7.2.3, below.

At all locations, sediment samples will be collected from two depths: (1) from the sediment surface to 0.5-feet, and (2) from the bottom of the sediment layer, which is expected to be no deeper than 2 feet. The shallow sediment samples will be collected using a stainless steel scoop or Ponar or Eckman dredge, depending on the depth of water at the time of sampling. The deeper sediment sample will be collected using a stainless steel coring device. The coring device used will depend on the type of material encountered. Sample equipment refusal will be indicative of the presence of the underlying native soil.

Sediment samples will be collected after all surface water samples are collected. Sediment sampling will begin with the most downstream location and will progress upstream to minimize the possibility of cross-contamination.

7.2.2.2 Field QA/QC Samples

Sediment sampling will include the collection of blind field duplicates at a ratio of 1:10, and equipment blanks on a daily basis. These field quality assurance/quality control samples will be collected in accordance with SOP #21.

7.2.2.3 Equipment Decontamination

Decontamination of sampling equipment using phosphate-free detergent, such as Liquinox®, will be performed after collecting each sample. Decontamination procedures are specified in SOPs #15 and #19.

7.2.2.4 Sample Container Requirements

Sample container requirements for sediment sampling are identical to the requirements for soil sampling, discussed in Section 7.1.2.4.

7.2.2.5 Sample Packaging and Shipping

Sample packaging and shipping requirements for sediment sampling are identical to the requirements for soil sampling, which are discussed in Section 7.1.2.5.

7.2.2.6 Chain-of-Custody Procedures

COC procedures for sediment sampling are identical to the requirements for soil sampling, which are discussed in Section 7.1.2.6.

7.2.3 Sediment Sampling Locations

Sediment sampling locations in Woodall Spring Ditch will be co-located with surface water sample locations. The sediment and surface water sampling locations are shown on Figure 19. The sediment and surface water sampling locations use WSD-prefixes to designate that they are from Woodall Spring Ditch.

Sampling location WSD-1 is at Woodall Spring, approximately 1 mile north of the Facility. WSD-2 is located approximately 1,000 downstream from Woodall Spring. WSD-4 is located approximately 800 feet northeast of Tailings Pond 4, where the ditch turns from south to southwest. WSD-5 and WSD-6 are located near the north edge of Tailings Pond 4 along the west-flowing ditch. WSD-7 is located at the point where the ditch turns 90 degrees to begin flowing south along the west side of Tailings Pond #4. WSD-8 is located approximately 150 feet south of the northeast corner of the West Gyp Stack. WSD-9 is located near the southeast corner of the West Gyp Stack, where Woodall Spring Ditch enters a pipe to pass beneath an access road and the Decant Ditch. WSD-10 is located at the point where the ditch leaves the Facility and enters the Torgesen Ranch property to the west. WSD-3 is an upgradient sample located along an ephemeral stream originating at Woodall Spring. Location WSD-3 is approximately 800 feet north of location WSD-6 in an area that is topographically higher than the outer toe of the tailings pond and gyp stack berms.

Table 3 provides the proposed sediment sampling locations, the sample intervals, anticipated number of samples, and the chemical parameters for which each sediment sample will be analyzed.

7.2.4 Analytical Program

The laboratories and analytical parameters for the sediment samples are the same as those discussed in Section 7.1.4 for the soil samples. The frequency of analysis for radium 226 and radium 228 will be 100 percent of the sediment samples.

Tables 2 and 3 summarize the sediment sample collection and analytical program. Table 3 indicates the boring number, sample depths and intervals, number of samples to be analyzed, and the analyses to be performed. Analytical parameters and method requirements (e.g., bottle requirements, preservatives, and holding times), method detection limits, and laboratory reporting requirements are presented in Table 2 for both soil and sediment.

7.2.5 Data Analysis

Sediment sample data will be compared to the more stringent of EPA PRG screening levels for residential soil or IDEQ IDTLs for sediments to assess if the metals concentrations are within the range of natural conditions and if a spatial pattern exists.

The radiological data will be used to confirm that gross alpha, and potentially radium 226 and radium 228 activity concentrations in sediment within the areas of interest at the Facility are no higher than those identified in soil and sediment samples collected at the Site, including areas upgradient from the Main Processing Area, in accordance with this Work Plan.

7.2.6 Investigation Derived Waste

The sediment sampling event will generate used disposable PPE and liquids from the decontamination of sampling equipment. These items will be managed as described in Section 7.1.6.

7.3 SURFACE WATER INVESTIGATION

Surface water conditions will be evaluated within Woodall Spring and Woodall Spring Ditch (Figure 19). Woodall Spring Ditch is unlined. Other surface water features located at the Facility, including the Process Sewer Lagoon, East and West Cooling Ponds, and process ditches described in Section 2.7.13, are lined and completely contained. Because of the arid nature of the climate, rainfall events resulting in stormwater run-off are rare. The Facility does not have any NPDES-permitted outfalls. Two sampling events will be performed as described below.

7.3.1 Objective

Surface water quality in Woodall Spring Ditch could potentially be impacted by occasional runoff, leaching from the sediments, groundwater discharges, and fugitive emissions. The objective of the surface water investigation is to determine if Facility operations have resulted in degradation of water quality in Woodall Spring Ditch.

7.3.2 Sampling Protocols

The surface water sampling events will be conducted concurrent with the soil sampling activities. One sampling event will be conducted when water is flowing during a run-off event such as during snow-melt or a significant rain event and the second event will be conducted under typical flow conditions. Surface water samples will be collected in accordance with the QAPP and SOP #4. Surface water samples will be collected before sediment samples are taken from Woodall Spring Ditch.

In addition to the laboratory analyses that will be performed (Section 7.3.4), the following field parameters will be measured in situ at each sampling location: pH, temperature, specific conductance, turbidity, dissolved oxygen (DO), and oxidation/reduction potential (ORP). The ORP results will be converted to Eh for all samples. The field testing will be performed to evaluate those parameters (excluding specific conductance and turbidity) that will change ex-situ and for comparison with nearby groundwater conditions. Because these data are to be used for qualitative purposes, only pH will have confirmatory laboratory analysis performed.

7.3.2.1 Collection of Surface Water Samples

This section describes the protocols for surface water sample collection. Specific sampling locations are described in Section 7.3.3.

Surface water sampling will begin with the most downstream location and will progress upstream to minimize the possibility of cross-contamination. The samples will be collected from the bank of the ditch, if possible. Caution will be taken to limit turbulence in the sample areas. Samples will generally be collected directly into the appropriate sample containers. The container will be placed in the flowing

water just beneath the stream surface. In the event that the sample container has been pre-preserved at the laboratory, a new clean glass jar will be used to transfer the sample from the flowing water to the pre-preserved sample container.

7.3.2.2 Field QA/QC Samples

Surface water sampling will include the collection of blind field duplicates at a ratio of 1:10, and, if necessary, equipment blanks on a daily basis. These field quality assurance/quality control samples will be collected in accordance with SOP #21.

7.3.2.3 Equipment Decontamination

In the event that sampling equipment is required, decontamination will be performed such that decontaminated sampling equipment will be used for the collection of each sample. Decontamination procedures are specified in SOPs #15 and #19. Decontamination will include the use of a phosphate-free detergent, such as Liquinox®.

7.3.2.4 Sample Container Requirements

Sample container requirements for surface water sampling are identical to the soil sampling requirements discussed in Section 7.1.2.4.

7.3.2.5 Sample Packaging and Shipping

Sample packaging and shipping requirements for surface water sampling are identical to the soil sampling requirements discussed in Section 7.1.2.5.

7.3.2.6 Chain-of-Custody Procedures

COC procedures for surface water sampling are identical to the soil sampling requirements discussed in Section 7.1.2.6.

7.3.3 Surface Water Sampling Locations

Surface water sampling locations in Woodall Spring and Woodall Spring Ditch will be co-located with sediment sample locations. The surface water and sediment sampling locations are shown on Figure 19. The surface water and sediment sampling locations use WSD-prefixes to designate that they are from Woodall Spring or Woodall Spring Ditch.

Sampling location WSD-1 is at Woodall Spring, approximately 1 mile north of the Facility. WSD-2 is located approximately 1,000 downstream from Woodall Spring. WSD-4 is located approximately 800 feet northeast of Tailings Pond #4, where the ditch turns from south to southwest. WSD-5 and WSD-6 are located near the north edge of Tailings Pond #4 along the west-flowing ditch. WSD-7 is located at the point where the ditch turns 90 degrees to begin flowing south along the west side of Tailings Pond #4. WSD-8 is located approximately 150 feet south of the northeast corner of the West Gyp Stack. WSD-9 is located near the southeast corner of the West Gyp Stack, where Woodall Spring Ditch enters a pipe to pass beneath an access road and the Decant Ditch. WSD-10 is located at the point where Woodall Spring Ditch leaves the Facility and enters the Torgesen Ranch property to the west. WSD-3 is an upgradient sample located along an ephemeral stream originating at Woodall Spring. Location WSD-3 is approximately 800 feet north of location WSD-6 in an area that is topographically higher than the outer toe of the tailings pond and gyp stack berms.

Table 4 provides the proposed surface water sampling locations and the chemical parameters for which the samples will be analyzed.

7.3.4 Analytical Program

The laboratories that will analyze the surface water samples are the same companies that will analyze soil samples as discussed in Section 7.1.4.

Surface water samples will be analyzed for:

- antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, lead, magnesium, nickel, potassium, selenium, sodium, thallium, vanadium by EPA SW-846 Method 6010B or EPA Method 200.8
- fluoride by EPA SW-846 Method 9056A
- nitrate by EPA SW-846 Method 9056A
- TKN by EPA Method 351.2
- orthophosphate by EPA Method 365.3
- total phosphorous by EPA Method 365.3
- sulfate by EPA Method 300
- sulfide by Standard Method 4500
- total dissolved solids (TDS) by Standard Method 2540C
- total suspended solids (TSS) by Standard Method 2540D
- pH using EPA SW-846 Method 9045
- gross alpha and gross beta by EPA Method 900
- radium 226 and radium 228 by EPA Method 901.1

Tables 4 and 5 summarize the surface water sample collection and analytical program. Table 4 indicates sample number and the analyses to be performed. Analytical parameters and method requirements (e.g., bottle requirements, preservatives, and holding times), method detection limits, and laboratory reporting requirements are presented in Table 5.

7.3.5 Data Analysis

The surface water data will be compared to both EPA National Recommended Surface Water Quality Criteria and to IDEQ Surface Water Quality Standards (Table 5), for qualitative evaluation of surface water conditions. For each constituent of concern detected, the screening level will be the more restrictive of the State of Idaho Water Quality Standard or EPA National Recommended Surface Water Quality Criteria. Water criteria values for metals are based in a hardness value of 100 mg/l $CaCO_3$. Thus, adjustments will be made to account for water hardness before comparing such water quality criteria.

The surface water quality and elevation data will be evaluated in conjunction with the groundwater quality and elevation data to determine if there is a hydraulic relationship between Woodall Spring Ditch and groundwater, or between Woodall Spring Ditch and the Decant Ditch.

7.3.6 Investigation Derived Waste

The sediment sampling event will generate used disposable PPE. These items will be placed in a drum and managed as described in Section 7.1.6.

7.4 GROUNDWATER INVESTIGATION

A groundwater monitoring network has been in-place at the Facility since 1999. The monitoring network was installed to assess groundwater quality upgradient and downgradient of the gyp stacks and has been expanded as new ponds were constructed. Substantial groundwater quality data has been collected from this network over the past ten years; however, decisions on the need for any additional monitoring

wells can best be determined following the completion and evaluation of the proposed geophysical surveys described in Section 6.2 in combination with an evaluation of the existing monitoring network data and the results of the soil investigation described in Section 7.1. The information generated from the geophysical surveys will provide a better understanding of the Site geology and groundwater flow features and flow mechanisms within the basalt bedrock at the Site. This information will be used to assess the efficacy of the existing groundwater monitoring network, and along with the results of the soil investigation, will provide the basis for determining locations and appropriate construction details of any additional groundwater monitoring wells.

Upon completion of the above evaluation, Nu-West will prepare and submit to EPA a Supplemental Work Plan, which will detail and provide (1) the results of the geophysical surveys, (2) an evaluation of the survey results relative to the existing monitoring network, (3) the findings of the soil investigation, (4) the rationale for additional monitoring wells, (5) well installation protocols, (6) sampling procedures, and (7) approaches for characterizing flow in the aquifer. The number and locations of additional wells will be designed to sufficiently characterize the nature and extent of releases which have migrated to groundwater from the Facility or offsite.

The following section provides background information on the existing groundwater monitoring network. Included is information on well locations, historical sampling events, groundwater elevation measurements and flow direction, and a summary of the sampling results for key constituents of potential concern. This is followed by a section describing a groundwater monitoring event that will be performed of the existing monitoring well network including the well designations, sampling protocols, analytical methods, quality assurance procedures, and an approach for data analysis.

7.4.1 Existing Monitoring Network

Nu-West has been implementing a Groundwater Monitoring Plan approved by IDEQ since November 1999. Sampling is conducted semiannually (fall and spring) and the analytical results are detailed in reports submitted to IDEQ. The objectives of the Groundwater Monitoring Plan prepared by BCI Engineers and Scientists, Inc. are:

- confirm background groundwater quality upgradient of the gyp stacks
- determine the extent and magnitude of horizontal and vertical migration of potentially impacted groundwater in areas surrounding the gyp stacks

The current groundwater monitoring network consists of 20 on-site monitoring wells (A-1 through A-12, A-2A, MW-05-1 through MW-05-5, MWA and MWB), 5 on-site production wells (NW-1, NW-5, NW-7, NW-9, and NW-10), 5 off-site production wells (JRS-7, JRS-8, JRS-10, and JRS-11 and Arr -Maz) and 2 off-site domestic wells (Torgesen Ranch and Lowry). Figure 4 shows these well locations. Monitoring well A-1 was installed as an upgradient well and, along with well A-2, is screened in unconsolidated deposits. The remaining on-site monitoring wells are screened in the basalt bedrock with the exception of well A-5, which is completed partially in the underlying sandstone formation. For these wells, the shallowest screened interval begins at 60 feet bgs (MWA and MWB) and the deepest at 173 feet bgs (A-05). The on-site production wells were drilled to depths ranging from 272 feet bgs to 500 feet bgs and have either long or multiple screened intervals beginning at depths ranging from 40 to 104 feet bgs, generally within the basalt. The screen interval of production well NW-7 is placed entirely into the sandstone aquifer, east of the edge of the basalt aquifer. According to available logs, the JRS production wells were drilled to depths ranging from 97 to 300 feet bgs within the basalt aquifer. Information on the construction of Arr-Maz production well has not been identified. The Torgesen Ranch domestic well was drilled to a depth of 225 feet bgs and is screened from 185 to 225 feet bgs in the basalt aquifer. A log for the Lowry well has not been identified. Table 7 summarizes the construction details for these wells as well as the depth to water measurements recorded in October 2008.

7.4.2 Historical Monitoring Events

Monitoring events have taken place in October 2000, April, August, and November 2001, June and October 2002, May and October 2003, May and October 2004, June and October 2005, June and December 2006, May and October 2007, June and October 2008, and May 2009. During each event, water levels are measured in the on-site monitoring wells only. During some events, monitoring wells A-3, A-8, A-11, and A-12 have been dry and not sampled. The screen sections start at 80 feet bgs in A-3, 72 feet bgs in A-8 and A-12, and 100 feet bgs in A-11. Before sampling, monitoring, production, and domestic wells were purged of three well volumes. Field parameters including temperature, pH, and specific conductance are measured after each well volume. Following purging, groundwater samples are collected from on-site monitoring wells using a submersible pump and low flow techniques. Production and domestic wells are sampled directly from the well head. All samples are analyzed by an approved laboratory for TAL metals, ammonia, fluoride, phosphorous, nitrate, nitrogen, chloride, total dissolved solids, specific conductance, gross alpha, radium-226 and radium-228, and gross beta using EPA test methods.

7.4.3 Summary of Monitoring Results

Groundwater level measurements obtained since 1999 show a consistent west-southwest flow direction. Typically, higher groundwater levels occur in the spring, which is likely the result of snowmelt recharge and spring rainfall. Historical groundwater elevations are presented in Table 8 and contour maps for October 2008 and May 2009 are provided on Figures 11 and 12, respectively.

The discussion of groundwater monitoring results starts with the monitoring wells associated with the gyp stacks and the on-site production wells, and then addresses the five off-site production wells and the two off-site domestic wells. Sampling results for October 2008 and May 2009 are presented and historical data is also referenced, as appropriate. This summary focuses on the chemical constituents detected at concentrations above the more restrictive of the groundwater quality standards established in the State of Idaho Groundwater Quality Rule or EPA MCL (40 C.F.R. Part 141, Subpart O, Appendix A).

7.4.3.1 Gyp Stack Monitoring Wells and On-site Production Wells

No constituents have been detected in the two unconsolidated monitoring wells (A-1 and A-2) at concentrations above the primary or secondary water quality standards. A-1 is located upgradient of Tailings Pond #4, and A-2 is located directly downgradient of Tailings Pond #4 and upgradient of the West Gyp Stack (Figure 4). In summary, the historical monitoring results show no impacts in the unconsolidated groundwater table in the area of these wells.

Monitoring wells MW05-1 through MW05-5 were installed around the West Gyp Stack and screened in the basalt aquifer (Figure 4). No site-related constituents of potential concern have been detected at concentrations above the primary drinking water standards in samples collected from these wells. Levels of total dissolved solids in samples from MW05-3 and MW05-4 have been above the secondary drinking water standard. However, these levels are not substantially greater than levels detected in MW05-1, MW05-2, MW05-5 and NW-7, which is considered a background well. In summary, the monitoring data do not indicate any impacts in the bedrock aquifer around the West Gyp Stack.

Monitoring wells west of the Old Gyp Stack and the East and West Cooling Ponds include from north to south: A-4, A-3, A-11, A-12, A-5, A-6, A-7, A-9A, and A-10. Total dissolved solids have been detected in each of these wells above the secondary groundwater standard. Also, pH levels measured in all wells except A-5 and A-10 have been below 6.5 S.U. Historically, wells A-4, A-6, A-7, A-8 and A-9A exhibit concentrations of nitrate and sulfate above the groundwater quality standards. Well A-5 has exhibited only elevated sulfate concentrations. Wells A-6, A-7, A-8, and A-9A also exhibit elevated levels of manganese and total phosphorous. The distribution of nitrate and sulfate in groundwater for the October 2008 and May 2009 sampling events is shown in Figures 20 and 21, respectively. Overall, there is no apparent concentration gradient in nitrate and sulfate concentrations west of the Old Gyp Stack, but the

concentrations generally decrease in the west- southwest downgradient flow direction. Since 2007, metals detected above their respective MCLs in wells to the west of the Old Gyp Stack include arsenic and selenium. Arsenic has been detected above its MCL of 0.01 mg/l in wells A-6, A-7, and A-8. Selenium has been detected above its MCL of 0.05 mg/l in well A-4.

Current on-site production wells include NW-5, NW-7, NW-9, and NW-10 (Figure 4). A former production well, NW-1, is no longer in service. Production well NW-7 is located upgradient of the Main Processing Area at the Facility and screened in the sandstone unit. Based on an evaluation of the hydrogeologic data, groundwater along the eastern boundary of the Site is likely derived from the recharge of run-off and groundwater underflows from the Aspen Range. Hydrogeologic studies of the East Snake River Plain Aquifer (ESRPA), which is temporally and lithologically similar to the valley-fill basalts at the site, indicate that approximately 80 percent of the dissolved groundwater solutes are present in drainage from the adjacent areas of granitic and sedimentary rock, and 20 percent are derived from the dissolution of mineral phases comprising the basalt (Lindholm and Vaccaro 1988). The highest solute concentrations are associated with water from areas underlain by carbonate rocks such as limestone. The sedimentary rocks forming the Aspen Range (Salt Lake Formation) consist primarily of sandstone and limestone. Therefore, using the ESRPA as a hydrogeochemical analog for the basalt aquifer at the site, groundwater samples collected from well NW-7 are expected to provide an indication of background concentrations of dissolved constituents in the groundwater hydraulically upgradient of the Facility. No constituents of potential concern have been detected in samples collected from NW-7. Total dissolved solids have been reported at concentrations above the secondary groundwater standard and are possibly attributable to a localized source of dissolved carbonates.

Production well NW-9 is about 1,000 feet to the south of the Main Processing Area. The well is screened in the basalt unit and has been used in the phosphate process since 2001. In 2004, the pump in well NW-9 failed and, following redevelopment, a low pH value was measured in the water (summarized in Section 5.2.1). The pump in well NW-9 has been operating continuously since 2004. The pH level in well NW-9 has been increasing (6.2 and 6.1 S.U. in 2009) but remains below the Idaho groundwater quality standards. Other constituents of concern currently detected in well NW-9 above Idaho groundwater quality standards are nitrate, sulfate, manganese, selenium, fluoride, and TDS. The impacts in well MW-9 may be attributable to the Main Processing Area.

Wells MW-A and MW-B were installed to identify the extent and source of low pH water that was detected in NW-9 in 2004. Well MW-A is located northwest and MW-B is northeast of well NW-9. Constituents detected at concentrations above their respective MCLs in wells MW-A and MW-B include chloride, TDS, total nitrogen, sulfate, cadmium, manganese, and fluoride.

Production well NW-5 is located to the northwest of Cell TP-3 in the Old Gyp Stack. No constituents of potential concern have been detected in this well. This well exhibits pH reading less than 6.5 S.U. Production well NW-10 is the north of Tailings Pond #4. The only constituent of potential concern detected above Idaho groundwater quality standards in NW-10 is manganese. Total dissolved solids have been detected at slightly elevated levels in NW-10 and NW-5, which is possibly attributable to a localized source of dissolved carbonates.

In summary, the two unconsolidated wells around Tailings Pond #4 do not show any evidence of impacts. Also, the monitoring well data indicate that the bedrock aquifer around the West Gyp Stack has not been impacted by Facility operations. Elevated concentrations of nitrate, sulfate, phosphorous, and total dissolved solids have been detected west of the Old Gyp Stack in the basalt aquifer, and the extent of the impacts appears to be limited. Elevated levels of nitrate, sulfate, manganese and fluoride have been detected south of the Main Processing Area in the bedrock aquifer, and pH measurements have been less than 6.5 S.U. These impacts extend offsite to the west-southwest.

7.4.3.2 Off-Site Production Wells

Production wells JRS-7, JRS-8 and JRS-10 are located immediately to the south of the Facility and downgradient of the Main Processing Area. JRS-10 is possibly downgradient of the cooling ponds. Nitrate, sulfate, manganese, and total dissolved solids have historically been detected in these wells at concentration above Idaho groundwater quality standards. The results of a 1994 Expanded Site Investigation conducted by EPA found that water collected from JRS-10 had elevated concentrations of manganese, sodium, ammonia, chloride, sulfate, nitrate, and phosphate. The extent to which impacts extend to the west-southwest of JRS-10 is uncertain. The source of these constituents may be the Facility. Production well JRS-11 is located southeast of the Facility. No constituents have been detected at concentrations above such water quality standards in JRS-11 (EPA, 1994; Engineers, Inc, 2003-2009).

The Arr-Maz production well is located approximately 4,700 feet south southwest of the Facility. The Arr-Maz well has exhibited slightly elevated total dissolved solids concentrations, which is likely from a localized source of dissolved carbonates.

7.4.3.3 Off-Site Domestic Wells

Two registered domestic water wells are located downgradient of the Facility (Torgesen Ranch and Lowry). The Torgesen Ranch well is located approximately 2,500 feet west of Cell TP-3 in the Old Gyp Stack, and is also downgradient of Tailings Ponds #1, #2, and #4 as well as the West Gyp Stack (Figure 4). The Lowry well is located more than 3,600 feet southwest of the Facility. Historically, nitrate has been detected at concentrations above the Idaho groundwater quality standard in samples collected from the Torgesen Ranch well (EPA, 1994; Engineers, Inc, 2003-2009). In addition, levels of total dissolved solids in the Torgesen Ranch well have been above the secondary drinking water quality standard. However, no other primary Facility-related constituents of potential concern (phosphorous and sulfate) have been detected in the Torgesen Ranch well at concentrations above drinking water quality standards. Nitrate levels in the Torgesen Ranch well are higher than levels detected in monitoring wells to the west of the gyp stacks and tailings ponds at the Facility (Figures 20 and 21).

Nitrate levels in the Torgesen Ranch well were evaluated by EPA in 1994 and WSP in 2009. EPA's evaluation concluded that the source for the nitrate contamination in the Torgesen Ranch well may be cattle ranching and farming activities near the Torgesen Ranch (EPA, 1994). WSP conducted a more comprehensive evaluation of groundwater conditions on the Facility and surrounding areas to ascertain whether the elevated nitrate concentrations found in the Torgesen Ranch well may be attributed to operations on the Facility. Information reviewed included groundwater monitoring reports for the Site prepared by Engineers, Inc. from 2003 through 2009; well records and boring logs for monitoring, production, and domestic wells included in the monitoring program; and available geologic reports for the Soda Springs area. WSP concluded that the likely source of nitrate found in the Torgesen Ranch well was attributable to use of the land as a livestock pasture, presence of septic systems on the property, and recharge that occurs within the adjacent fault zone from other upland areas.

Sampling results for the Lowry well also show historically elevated nitrate concentrations. No other Facility-related potential constituents of concern have been detected at concentrations above drinking water quality standards in the Lowry well. The nitrate concentrations do not appear to be attributable to Facility operations. Nitrate levels detected in well A-10, the nearest upgradient monitoring well, have consistently been below drinking water quality standards. The Lowry well is more than 3,600 feet downgradient of the Facility and west of a northwest trending fault zone, which likely intercepts groundwater migrating from the Facility. The fault feature is likely a preferential flow pathway.

7.4.4 Groundwater Monitoring - Existing Well Network

A round of groundwater samples will be collected from wells associated with the existing monitoring network (monitoring wells A-1 through A-12, A-2A, MW-05-1 through MW-05-5, MWA, MWB; on-site production wells NW-1, NW-5, NW-7, NW-9, and NW-10; off-site production wells JRS-7, JRS-8, JRS-10,

JRS-11, and Arr-Maz; and off-site domestic wells of Torgesen Ranch and Lowry). The groundwater sampling event will be conducted concurrent with the geophysical survey described in Section 6.2. Groundwater sampling and sample handling will be performed in accordance with SOP #3. Field duplicates and MS/MSDs (as appropriate) will be collected at a ratio of 1:10, equipment blanks will be prepared daily, and preservative blanks will be prepared at the beginning and end of the groundwater sampling activity.

Purge water generated during groundwater sampling will be contained in appropriate drums meeting UN specifications, labeled as hazardous waste if previous analytical data for a well shows that the purge water could be classified as hazardous and placed in the Facility's waste storage area. If the previous analytical data for a well demonstrates that the purge water is non-hazardous it will be labeled as such.

7.4.5 Analytical Program

The laboratories and analytical parameters for the groundwater samples collected from the monitoring wells, production wells, and domestic wells are the same as those discussed in Section 7.3.4 for the surface water samples. Also, samples exhibiting gross alpha above 15 pico curies per liter (pCi/L) will be analyzed for radium 226 and radium 228. Analytical methods will be those specified in Table 5, which summarizes the scope of the groundwater sampling event and the method requirements (e.g., bottle requirements, preservatives, and holding times), method detection limits, laboratory reporting limits, and the Idaho Primary and Constituent Standards set forth in the Idaho Ground Water Quality Rule (IDAPA 58.01.11).

The following field parameters will be measured at each monitoring well location during implementation of the groundwater sampling events: pH, temperature, specific conductance, turbidity, dissolved oxygen (DO), and oxidation reduction potential (ORP). The ORP results will be used to calculate Eh.

7.4.6 Data Analysis

The chemical analytical results for the groundwater samples will be compared to the Idaho Primary and Secondary Constituent Standards for groundwater (IDAPA 58.01.11) and EPA Drinking Water Standards (40 C.F.R. Parts 9, 141, and 142). Additional details regarding data evaluation and management are included in Section 11 of this Work Plan.

The well screen intervals, spatial distribution of the wells, the direction of groundwater flow, will be evaluated along with the geophysical survey results to determine the potential need for, location, and depth of additional monitoring wells within or beyond the Site.

8 Potable Well Survey

The current groundwater monitoring program for the Facility includes semi-annual sampling of three residential wells located west and southwest of the Facility. These are the Torgesen Ranch well, the Lowry well, and the Arr-Maz well (Figure 4). These potable water wells are located within one mile of the Facility.

To ensure that all potable water wells with one-half mile are included in the investigation, a potable well survey will be conducted as described below.

8.1 IDENTIFICATION OF WELLS

Potable wells will be identified using the following methods:

- review of Idaho and Caribou County records for potable wells
- conduct a visual survey of residences within one-half mile downgradient of the Facility and look for evidence of groundwater use

8.2 SAMPLING ACCESS

If additional potable wells are identified in the designated area, Nu-West will contact the property owners to arrange access for sampling. Access agreements are already in place for the three potable wells in the current sampling program.

8.3 SAMPLING PROGRAM

Table 5 summarizes the scope of the groundwater sampling event and the method requirements (e.g., bottle requirements, preservatives, and holding times), method detection limits, laboratory reporting limits, the Primary and Secondary Constituent Standards set forth in Idaho's Ground Water Quality Rule (IDAPA 58.01.11) and EPA MCLs.

Samples will be collected from each potable well using the following procedure:

- If available, historical information regarding well depth, diameter, screened intervals, materials of construction, and depth to water will be obtained from the property owner or the public information sources listed above.
- the well volume will be calculated or estimated
- three well volumes will be purged prior to sampling
- Samples will be collected from a spigot or other access point between the well and any water treatment apparatus that may be present (e.g., water softener or filter). Potable water samples will be collected in laboratory-supplied glassware and analyzed for the following parameters: arsenic, barium, cadmium, chromium, lead, selenium, antimony, beryllium, nickel, thallium, pH, sodium, sulfate, orthophosphate, calcium, magnesium, potassium, total dissolved solids, conductivity, fluoride, and gross alpha radiation.
- Samples will be transported to the laboratory for arrival no later than the next day using procedures described in the QAPP.
- Samples will be analyzed by the laboratory as described in the QAPP.

- If gross alpha radiation exceeds 15 pCi/L, an analysis for radium 226 and radium 228 will be conducted.
- If analytical results indicate any exceedances of Idaho drinking water quality standards or EPA MCLs for analytes that may have originated from the Facility, the well survey will be extended by one-half mile radial increments in the appropriate direction. If additional potable water wells are identified within the larger radius, then sampling will be conducted for relevant constituents in accordance with this Work Plan.

8.4 REPORTING

After analytical data has been received and validated as described in Section 11 of this Work Plan, the data will be presented in the Site Assessment Report described in Section 12. Each property owner will be provided with a copy of the laboratory results for samples taken from the well on his property.

EPA Region 10 Quality Assurance requirements will be adhered to for all sampling, analysis, and data management activities.

9 Wetland and Surface Water Survey

An investigation will be conducted to identify any wetlands, creeks, or lakes within a one mile radius downgradient and beyond the Facility's property boundary (Figure 22). This survey will also identify any such bodies of water which are used for public recreational purposes or may contain endangered species.

Survey Program

The scope of the survey will include:

- obtaining existing air photos and topography from public domain sources including but not limited to the State of Idaho and Caribou County
- identifying the location and approximate boundaries/size of all significant surface water features, including wetlands consistent with EPA regulations and relevant guidance
- measuring and recording stream flow for surface water features
- identifying and documenting waters and wetlands that are used for public recreation and type of public recreational purposes

Stream flow will be measured in Woodall Spring Ditch where it enters (WSD-6) and exits (WSD-10) the Facility (Figure 19). Stream flow will be measured using a Marsh-McBirney Flo-Mate Portable Flow Meter in accordance with SOP #31.

9.1 REPORTING

The results of the wetland and surface water survey will be discussed in the text of the Site Assessment report and displayed on a corresponding map. To create this map, WSP will:

- consult available maps (e.g. US Geological Survey, National Wetland Inventory, State of Idaho, Caribou County, Water District or Town of Soda Springs)
- obtain recent and historical air photos taken at various times of year
- determine if any of the waters and wetlands within the project area have been previously delineated (via town, Caribou County or Corps of Engineers records)
- conduct a field reconnaissance/survey to verify locations and boundaries of waters/wetlands within a 1-mile radius down-gradient and beyond the Facility boundary

The results of the investigation will be summarized, including all mapping layers and data, in Geographic GIS) for easy access and interpretation. The map depicting the observed surface water bodies and/or wetlands, including information on recreation use and endangered species, will be compiled into a report summarizing means, methods, and results. Surface water sampling analytical results identifying the constituent concentrations will be included on a GIS map.

10 Project Management Plan

Project management is addressed in detail in the QAPP. This section provides a summary of how the investigation activities described in this Work Plan and Supplemental Work Plan will be organized and managed to help assure consistent quality.

10.1 PROJECT ORGANIZATION

The core project team will consist of Nu-West and WSP personnel. Jim Cagle, EH&S Risk Manager at the Facility, will direct the project. Jim Bulman, Executive Vice President of WSP, will be the project coordinator and manager. Manley Tom, Senior Technical Director of WSP, and Laura Tobin, Project Director of WSP, will be key personnel overseeing the planning and performance of the work and the evaluation and interpretation of data collected.

Other project roles, such as Quality Assurance Officer, Field Team Leader, and Analytical Coordinator are defined in the QAPP.

10.2 RESPONSIBLITIES

The specific responsibilities of core project team members are described below.

Jim Cagle, EH&S Risk Manager – Mr. Cagle will coordinate with regulatory agencies, provide Facility information, provide logistical assistance for on-site work, review results and reports prepared by WSP, and ensure proper distribution of documents.

Jim Bulman, WSP Project Coordinator and Project Manager – Mr. Bulman will be the primary point of contact at WSP. He will ensure necessary resources for the project team, maintain consistency in work products, provide technical oversight, and resolve conflicts if necessary. Mr. Bulman will oversee project activities to ensure adequate progress and timely completion of the work. He will assign technical staff, ensure compliance with QC protocols, ensure communication between project team members, and supervise the field work and reporting activities.

10.3 PROFESSIONAL CERTIFICATIONS

Throughout the project, WSP will utilize registered professional engineers and geologists to ensure accurate technical evaluation and interpretation of Site conditions.

Manley Tom is an Idaho-licensed Professional Engineer, and Laura Tobin is an Idaho-registered Professional Geologist. These two professionals will be responsible for supervising the collection and interpretation of Site data, evaluating Site conditions, determining the adequacy and completeness of the data obtained, and making recommendations based on the investigation results.

11 Data Management Plan

Data quality objectives and data management are discussed in Section 4 of this Work Plan and addressed in detail in the QAPP. This section provides a summary of how data will be managed.

11.1 LABORATORY ANALYSIS

The laboratories will supply electronic data deliverables (EDDs) that will be incorporated into the existing database and downloaded into the project data tables. Exceptions could include data for TOC, mineralogy, geotechnical and other boutique parameters not available via EDD and which will be hand entered into the database, if required.

The data packages for the conventional chemical parameters will be Level III with deliverables similar to those required by EPA's contract laboratory program. To ensure the quality and utility of the data approximately 20 percent of the data packages will be validated consistent with EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review and EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

11.2 DATABASE MANAGEMENT

EDDs from laboratory analyses will be imported into the Electronic Records Information Management System (ERIMS) - WSP's proprietary data management tool. ERIMS is a secure, web-based information management system for data and documents.

The Analytical Data module within ERIMS will enable seamless data transfer between the laboratory and WSP for this project. Laboratory personnel will access the secure online ERIMS system and load EDDs directly. The system then automatically processes the EDDs into the database for evaluation, and alerts the project manager via email. The alert summarizes which lab loaded the data, how many records were loaded, and any discrepancies encountered with the data. Field and laboratory data will be provided on a GIS map to allow for spatial viewing of constituents of concern across the Site.

11.3 DATA REDUCTION, VALIDATION, AND REPORTING

To help ensure that data management activities provide an accurate and controlled means of summarizing information to support conclusions, data handling and reporting steps will be defined and implemented for every field or laboratory measurement that is collected.

11.3.1 Data Reduction

The reduction of laboratory analytical data will be performed in accordance with the format specified in the EPA methods.

11.3.2 Data Validation

Data validation includes reviewing, accepting, rejecting, or qualifying data on the basis of sound criteria. WSP will validate 20 percent of the data associated with the activities described in this Work Plan. Laboratory results and QC summaries will be validated and reviewed according to the Contract Laboratory Program criteria outlined in EPA Contract Laboratory Program Data National Functional Guidelines for Organic Data Review (EPA 1999).

A systematic effort will be made to identify any method criteria outliers or errors prior to reporting data. Method outliers can result from improper sampling or analytical methodology, matrix interferences, and errors in data transcription, and real but extreme changes in analytical parameters. The outliers will be identified by non-compliance with the sampling and analytical protocols specified in this Work Plan.

Outliers resulting from errors found during data validation and review will be identified and corrected. Outliers that cannot be attributed to sampling, analytical, calculation, or transcription errors will be identified in the certified laboratory report and data validation report, and will be retained in order for the database to be complete. These outliers will not be corrected after the data is generated, but will be qualified in accordance with EPA guidelines. All analytical results for the investigation will be maintained as a complete document for the project file.

11.3.3 Data Reporting

Data reporting will consist of summaries of interpretations of the collected sample information. Results for each collected sample will be presented in tabular form with qualifiers generated during the data validation and review process.

EDDs will be maintained on the ERIMS system and on backup files. Paper or electronic disk copies of laboratory data packages and reports will be archived at WSP. Once verified, the data will be compiled and reported in summary tables and figures, as appropriate.

12 Site Assessment Report

The data and information generated through implementation of the Site investigation activities described in this Work Plan will be presented in the Site Assessment Report. One hard copy and one electronic copy of the final report will be submitted to EPA, and one hard copy and one electronic copy of the report will be submitted to IDEQ.

Consistent with IDEQ's Risk Evaluation Manual, where applicable, the Site Assessment Report will, at a minimum, include the following:

- a summary of all tasks completed, including documentation of conformance with protocols;
- a description of the Site setting, addressing;
  - local land and potable well use
  - geology
  - hydrogeology and hydrology, including an evaluation of the groundwater chemistry, direction of groundwater flow, and vertical and lateral hydraulic gradients
- a discussion and refinement of the Preliminary CSM, including constituent fate and transport and the potential for migration beyond the Facility boundary
- figures illustrating Site conditions, including but not limited to:
  - Site location map
  - layouts of the Facility and Main Processing Area showing pertinent features
  - geophysical survey results
  - Site stratigraphy including subsurface information on updated cross sections
  - soil, sediment, surface water, and groundwater sample locations
  - sample concentrations that exceed IDEQ screening criteria or other potentially applicable screening levels for various media
  - principal constituents of potential concern detected in groundwater
  - the groundwater elevation contours including inferred groundwater flow direction in the bedrock aquifer
  - locations of identified water supply wells
  - locations of identified potable water wells
  - results of surface water and wetlands surveys
- tabular information, including, but not limited to:
  - well construction information
  - groundwater and surface water elevations
  - sample depths and elevations
  - sample analytical results for each media, including soil and sediment classifications and (as appropriate) identification of samples in which constituents are detected at concentrations above IDEQ IDTLs, EPA PRGs or MCLs, or other potentially applicable screening levels

- compilation of historical water quality information

The Site Assessment Report will include lithologic logs, well construction diagrams, field sampling data sheets, laboratory data analysis summaries, electronic data deliverables for chemical and radiological parameters, and photographs.

The Site Assessment Report will also provide a summary evaluation of Site conditions based on the results of the investigation activities. The report will include recommendations for additional activities, if necessary, to address data gaps relative to delineation (lateral and vertical) or evaluation or selection of future Site remedial alternatives. During implementation of the assessment activities, Nu-West may periodically submit data and information to the agencies for the purpose of obtaining consensus on open-ended issues and apprising the agencies of unanticipated conditions that may require variations in the planned assessment activities. Any proposed modifications to the approved Work Plan will be submitted to EPA for approval in accordance with paragraph 129 of the Consent Order. Nu-West will also submit quarterly progress reports documenting the status of activities required by the Consent Order.

13 Project Schedule

Implementation of the assessment activities is tentatively scheduled to commence within 30 days following EPA's approval of this Work Plan. Figure 23 presents the project schedule reflecting the activities described in this Work Plan. In mid-2010, after notice to EPA and IDEQ, Nu-West anticipates conducting the majority of the Site investigation activities, including:

- ground survey to ascertain spatial relationship of sampling locations and site features
- geophysical surveys to characterize subsurface fractures
- advancement of soil borings and collection of soil samples from SB-1 through SB-87
- sediment sampling
- surface water sampling
- sampling existing groundwater monitoring wells
- conducting potable well survey
- conducting wetland and surface water survey

As indicated in Figure 23, Nu-West anticipates that the majority of the field investigation activities will be completed within approximately 90 days following EPA's approval of this Work Plan. As described in Section 7.3, surface water sampling from Woodall Spring and Woodall Spring Ditch will be dependent upon surface water flow conditions.

The Site Assessment Report and Supplemental Work Plan will be submitted to the appropriate parties approximately 90 days after receipt of the final electronic data deliverables, which is anticipated to be approximately 240 days following EPA's approval of this Work Plan.

This Work Plan identifies a phased approach to laboratory testing such that analyses for some samples are dependent on the receipt and review of data for other samples. Nu-West will make every reasonable attempt to adhere to this schedule. However, unforeseeable or uncontrollable conditions or situations could occur that may impact this schedule. Updates to the schedule will not require approval by EPA unless an update would change the date set forth above for submission of the Site Assessment Report or Supplemental Work Plan. Should Nu-West be unable to obtain necessary access to off-site properties after best efforts, Nu-West and EPA shall discuss whether alternative sampling locations should be selected so that Nu-West can remain on schedule, or whether EPA or IDEQ will seek access for Nu-West from any recalcitrant third parties. If the inability to obtain timely access prevents Nu-West from meeting the of the schedule to submit the Site Assessment Report or Supplemental Work Plan, Nu-West will request from EPA additional time to complete the work at any off-site properties.

14 References

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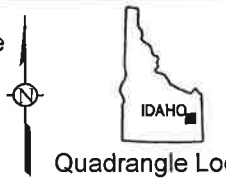
15 List of Acronyms

APS	ammonium phosphate sulfate
bgs	below ground surface
CPO	Conda Phosphate Operations
CSM	conceptual site model
DO	dissolved oxygen
DQO	data quality objective
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ERI	electrical resistivity imaging
HDPE	high density polyethylene
IDTL	Initial Default Target Level
IDEQ	Idaho Department of Environmental Quality
IDWR	Idaho Department of Water Resources
MAP	mono ammonium phosphate
MS	matrix spike
MSD	matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
NGVD	National Geodetic Vertical Datum
ORP	oxidation-reduction potential
PVC	polyvinyl chloride
REM	Risk Evaluation Manual
SR	seismic refraction
TAL	target analyte list
TCL	target compound list
TDS	total dissolved solids
TOC	total organic carbon
UN	United Nations

Figures

Reference
7.5 Minute Series Topographic Quadrangle
Soda Springs, Idaho
Photorevised 1982 Scale 1:24,000

Note: Some USGS-designated "Tailings Pond" are actually gyp stock cells.



Quadrangle Location

Scale in Feet

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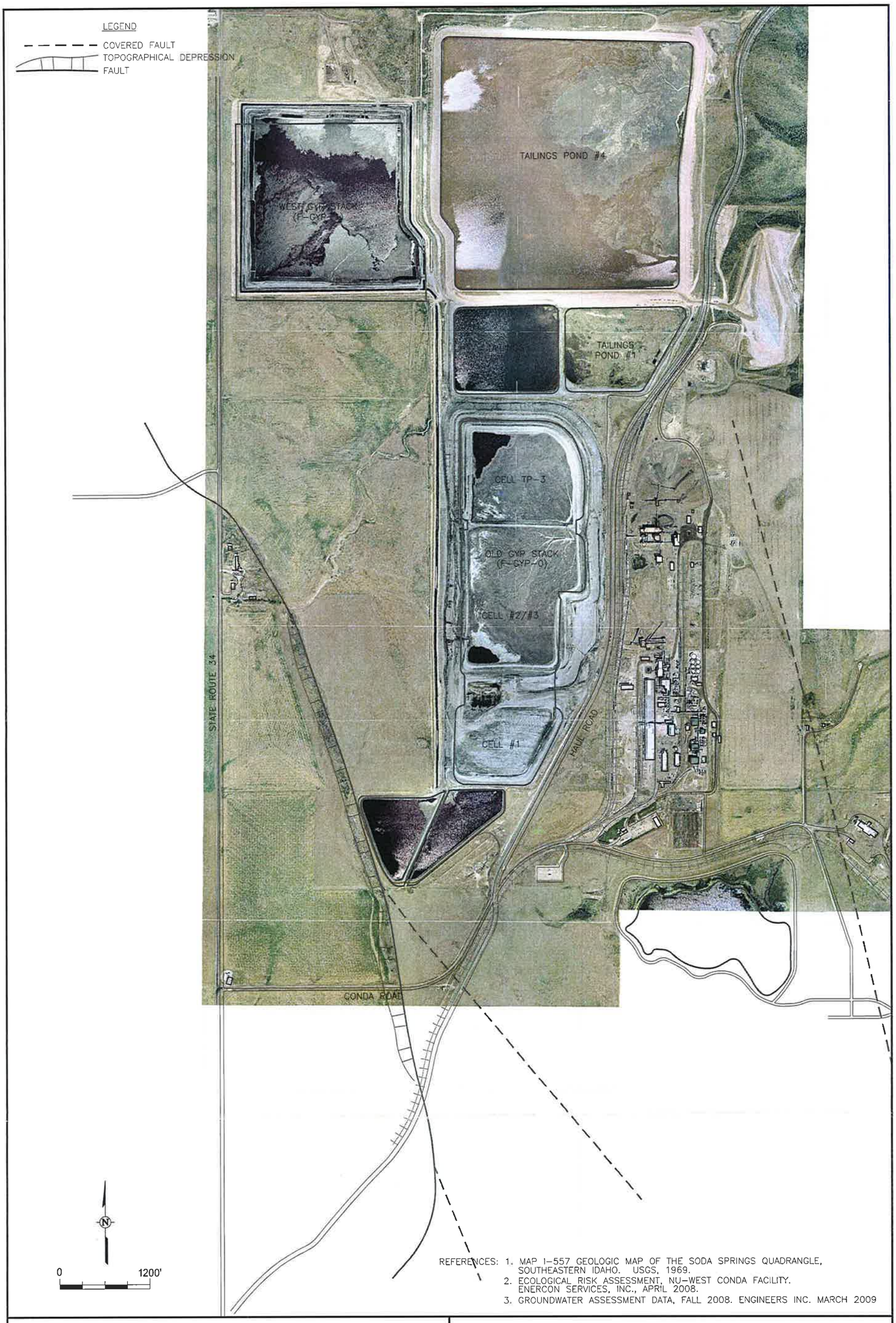
Figure 1
Site Location
Nu-West CPO Facility
Soda Springs, Idaho



REFERENCES:
1. MAP I-557 GEOLOGIC MAP OF THE SODA SPRINGS QUADRANGLE, SOUTHEASTERN IDAHO. USGS, 1969.
2. ECOLOGICAL RISK ASSESSMENT, NU-WEST CONDA FACILITY. ENERCON SERVICES, INC., APRIL 2008.
3. GROUNDWATER ASSESSMENT DATA, FALL 2008. ENGINEERS INC. MARCH 2009

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Figure 2
Facility Layout
Nu-West CPO Facility
Soda Springs, Idaho

10002704.DWG

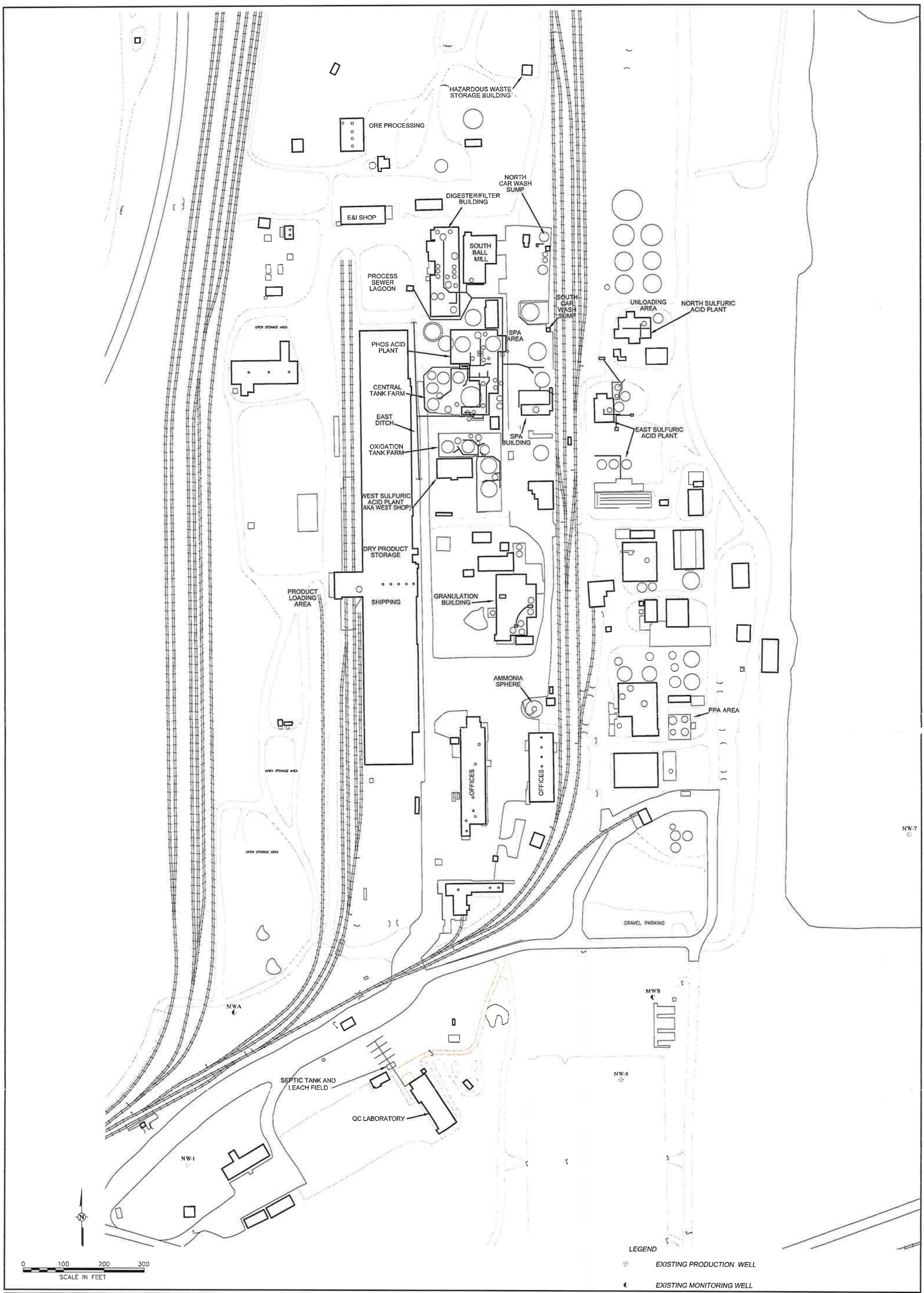

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FIGURE 3

Drawing Number
10002703

MAIN PROCESSING AREA LAYOUT

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

DRAWN BY	JME
CHECKED	LT
APPROVED	

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REFERENCES:
1. MAP I-557 GEOLOGIC MAP OF THE SODA SPRINGS QUADRANGLE, SOUTHEASTERN IDAHO, USGS, 1979.
2. ECOLOGICAL RISK ASSESSMENT, NU-WEST CONDA FACILITY, ENERCON SERVICES, INC., APRIL 2008.
3. GROUNDWATER ASSESSMENT DATA, FALL 2008, ENGINEERS INC. MARCH 2009

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SODA SPRINGS, IDAHO

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Figure 4

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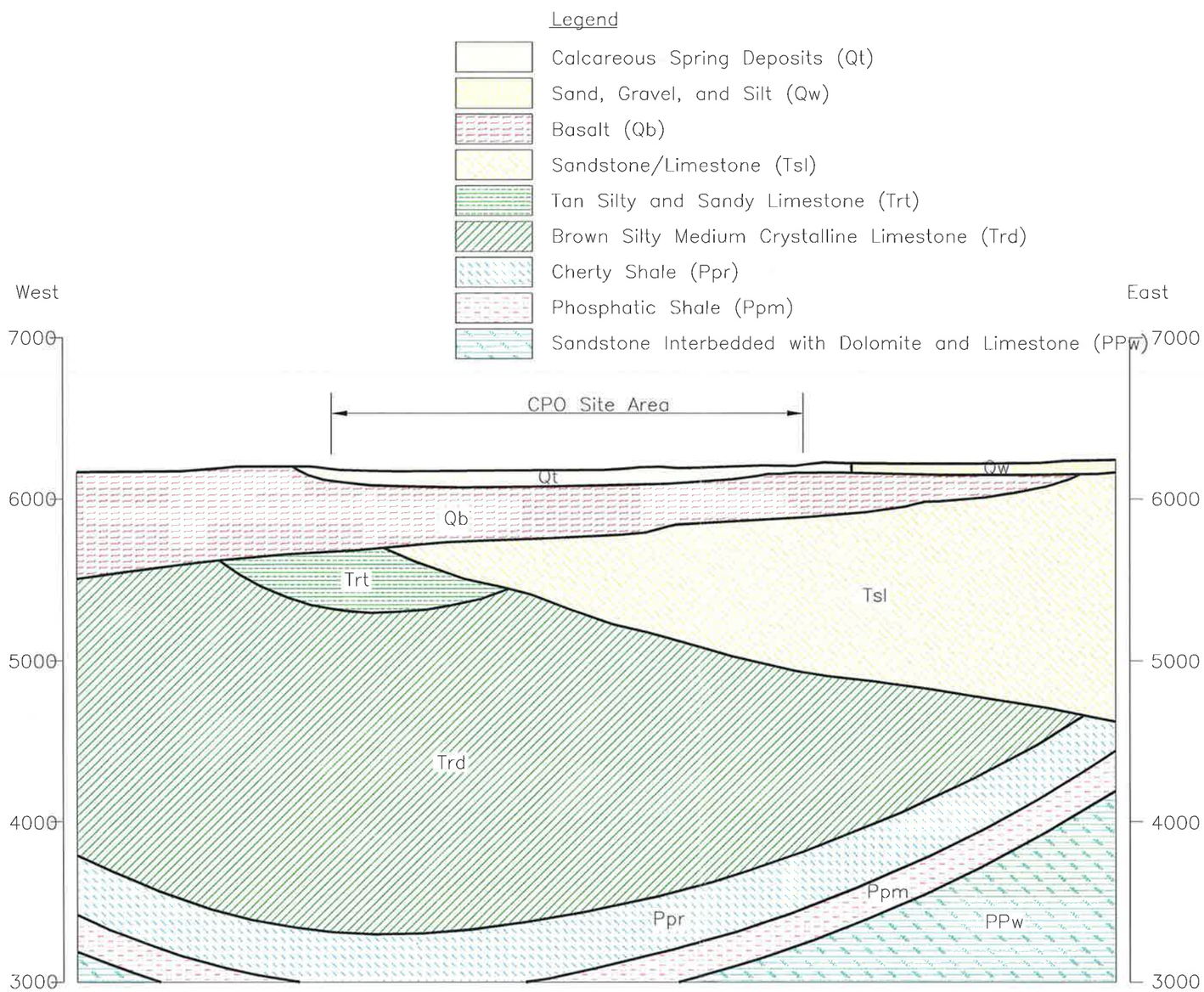

REFERENCE: USGS MAP I-557 (1969) GEOLOGIC MAP OF THE SODA SPRINGS QUADRANGLE, SOUTHEASTERN IDAHO.

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FIGURE 5

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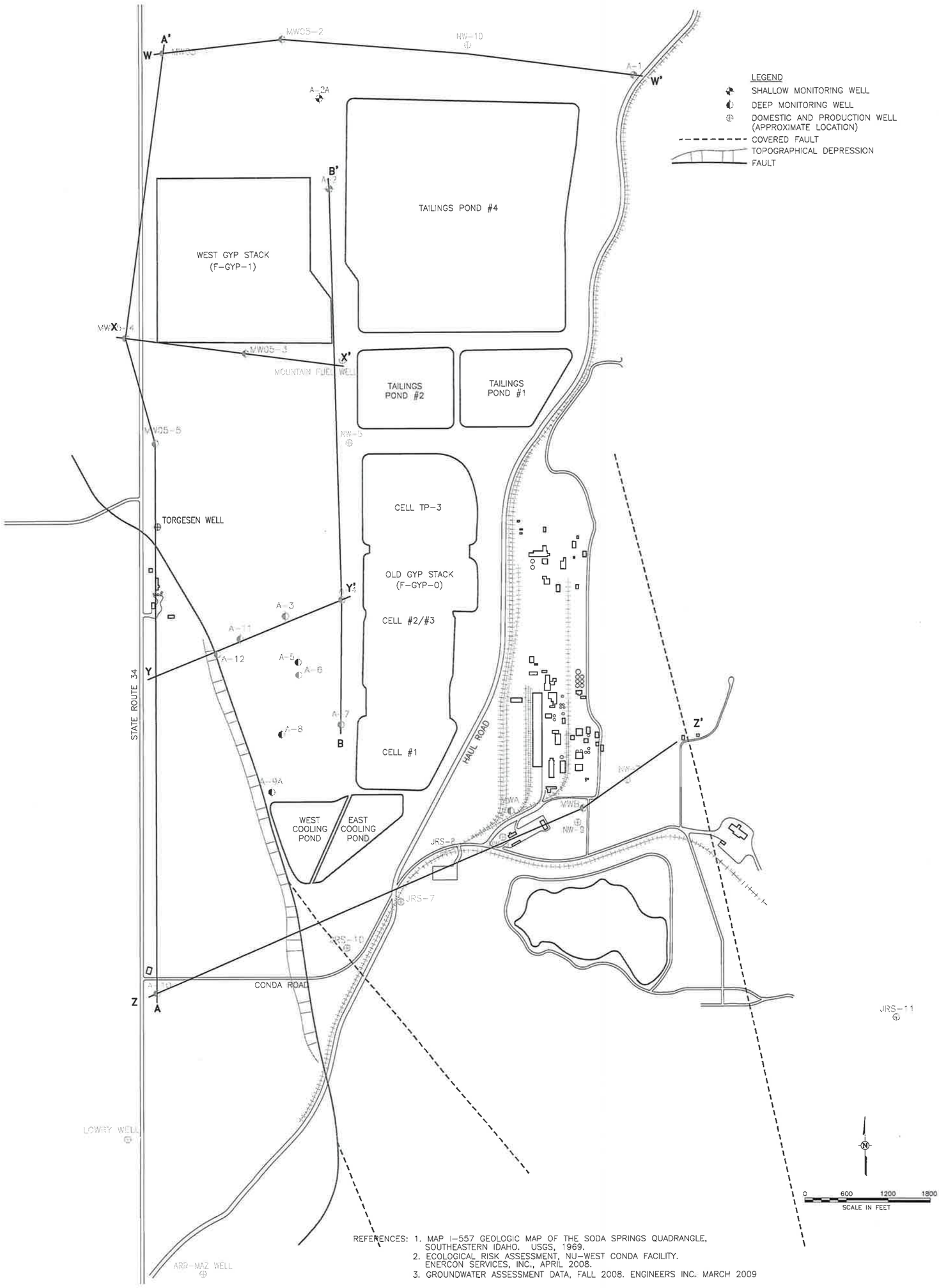

REFERENCES:
1. MAP I-557 GEOLOGIC MAP OF THE SODA SPRINGS QUADRANGLE, SOUTHEASTERN IDAHO. USGS, 1969.
2. ECOLOGICAL RISK ASSESSMENT, NU-WEST CONDA FACILITY. ENERCON SERVICES, INC., APRIL 2008.
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FIGURE 6

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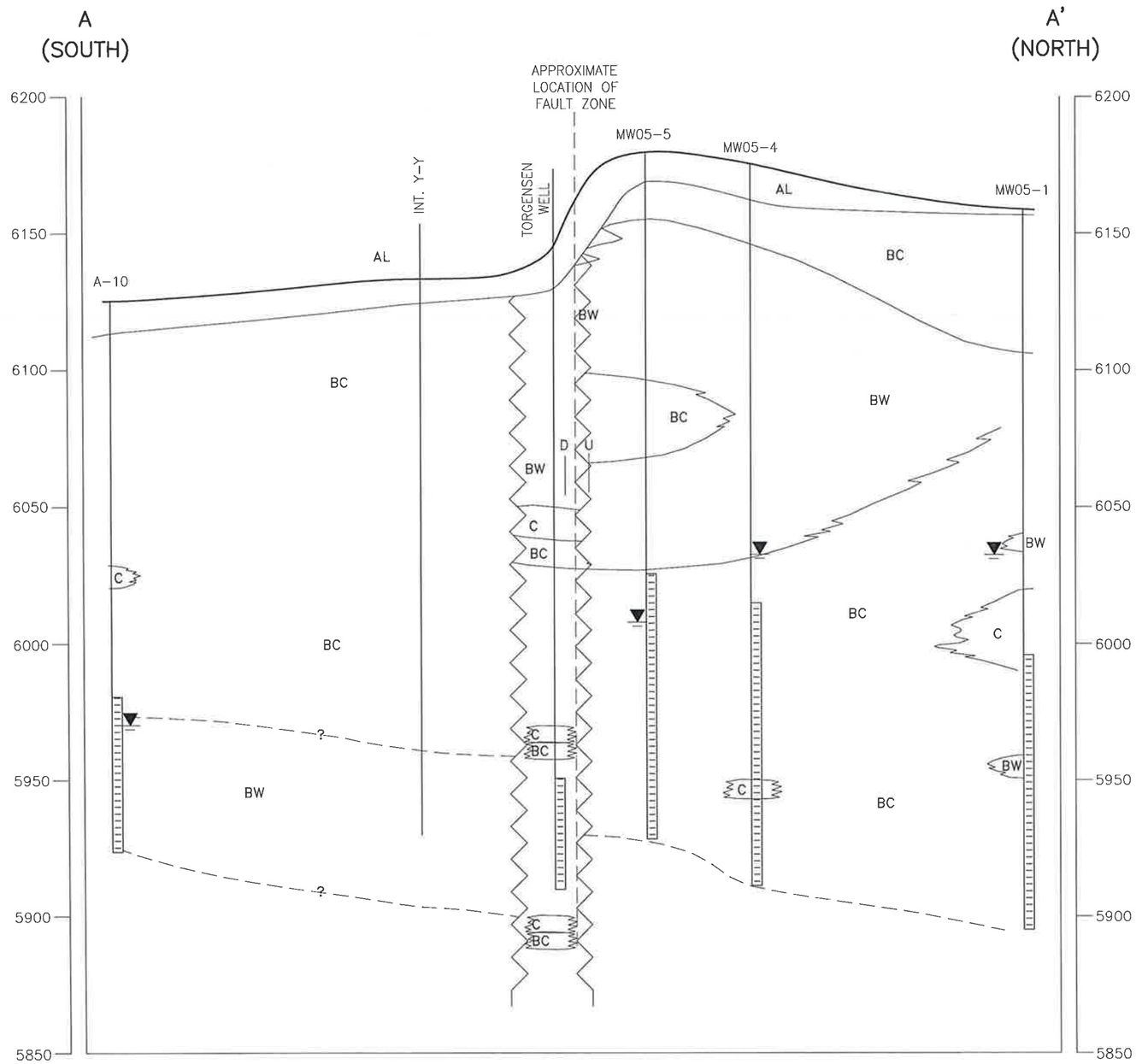

LEGEND

AL	ALLUVIUM
BC	BASALT, COMPETENT
BW	BASALT, WEATHERED
C	CINDERS (MAY INCLUDE ASH SAND)
SS	SANDSTONE
LC	LIMESTONE, COMPETENT
LW	LIMESTONE, WEATHERED

MONITORING WELL

SCREENED INTERVAL

UNDERGROUND WATER WAS ENCOUNTERED DURING DRILLING

SHEAR ZONE

D | U APPROXIMATE FAULT LOCATION
U – UPTHROWN SIDE
D – DOWNTHROWN SIDE

0 250 500 750
HORIZONTAL SCALE IN FEET

0 25 50 75
VERTICAL SCALE IN FEET

REVISIONS

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2	INITIAL	DATE
3	INITIAL	DATE
4	INITIAL	DATE

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FIGURE 7

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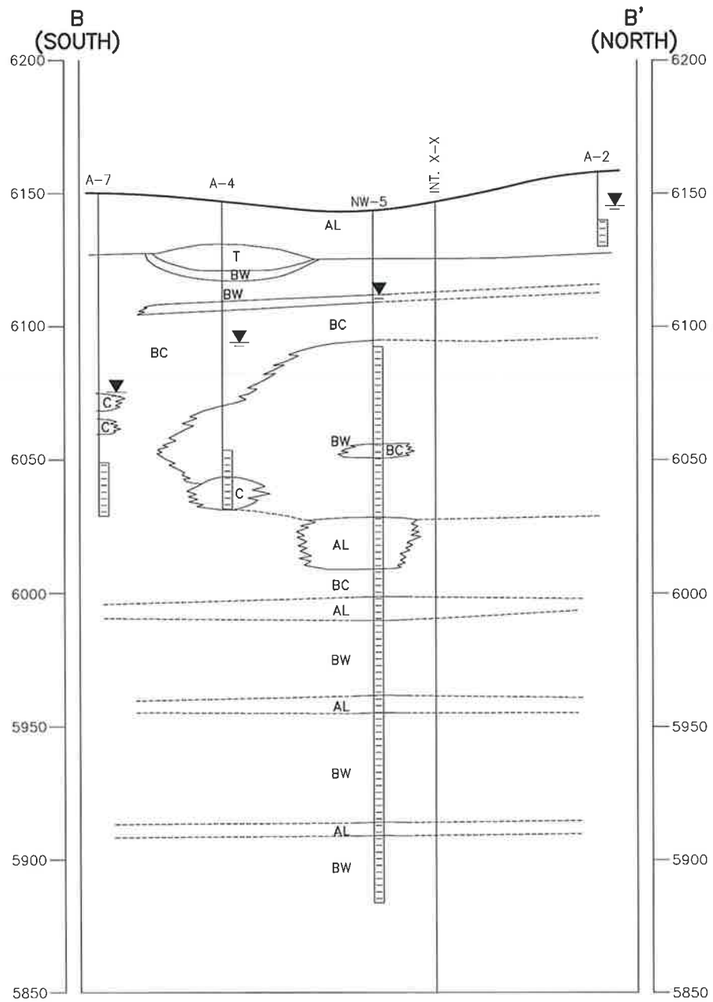

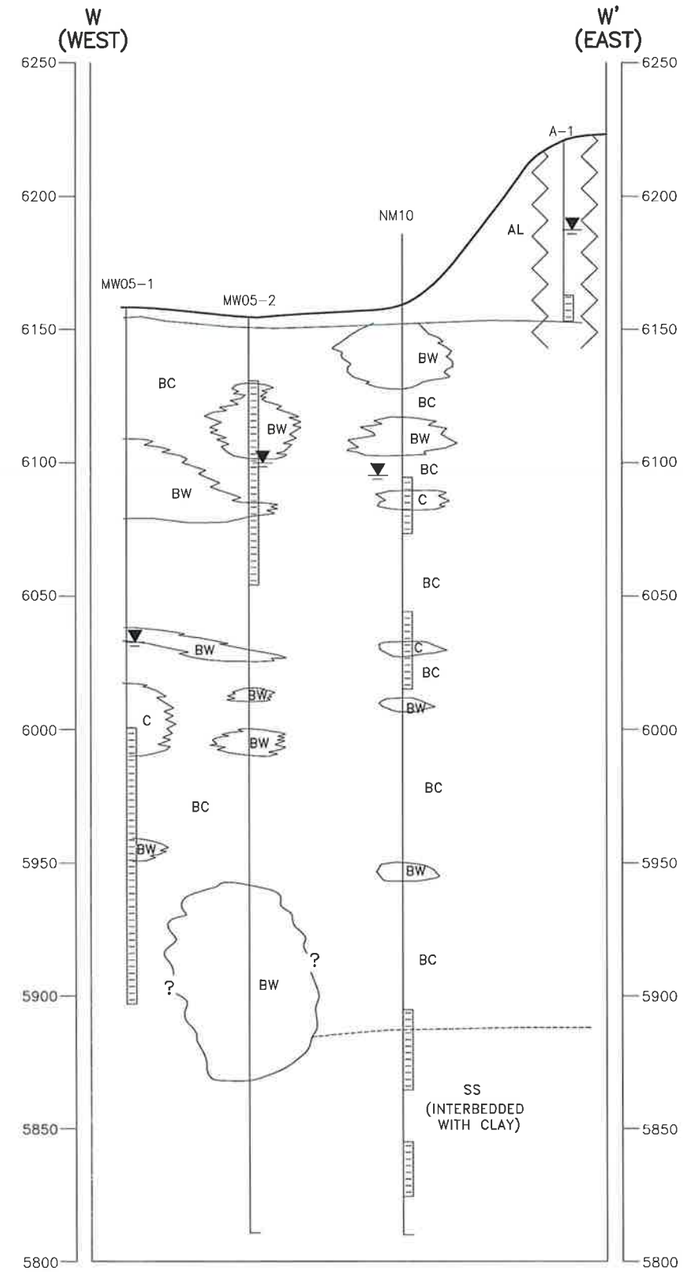

LEGEND

AL	ALLUVIUM
BC	BASALT, COMPETENT
BW	BASALT, WEATHERED
C	CINDERS (MAY INCLUDE ASH SAND)
SS	SANDSTONE
LC	LIMESTONE, COMPETENT
LW	LIMESTONE, WEATHERED
T	TUFF, CALCAREOUS

MONITORING WELL

SCREENED INTERVAL

WATER SURFACE

SHEAR ZONE

D U

APPROXIMATE FAULT LOCATION
U – UPTHROWN SIDE
D – DOWNTHROWN SIDE

0 250 500 750
HORIZONTAL SCALE IN FEET

0 25 50 75
VERTICAL SCALE IN FEET

REVISIONS

REV	DESCRIPTION
1	Revised: Date: Engr:
2	Revised: Date: Engr:
3	Revised: Date: Engr:

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FIGURE 8

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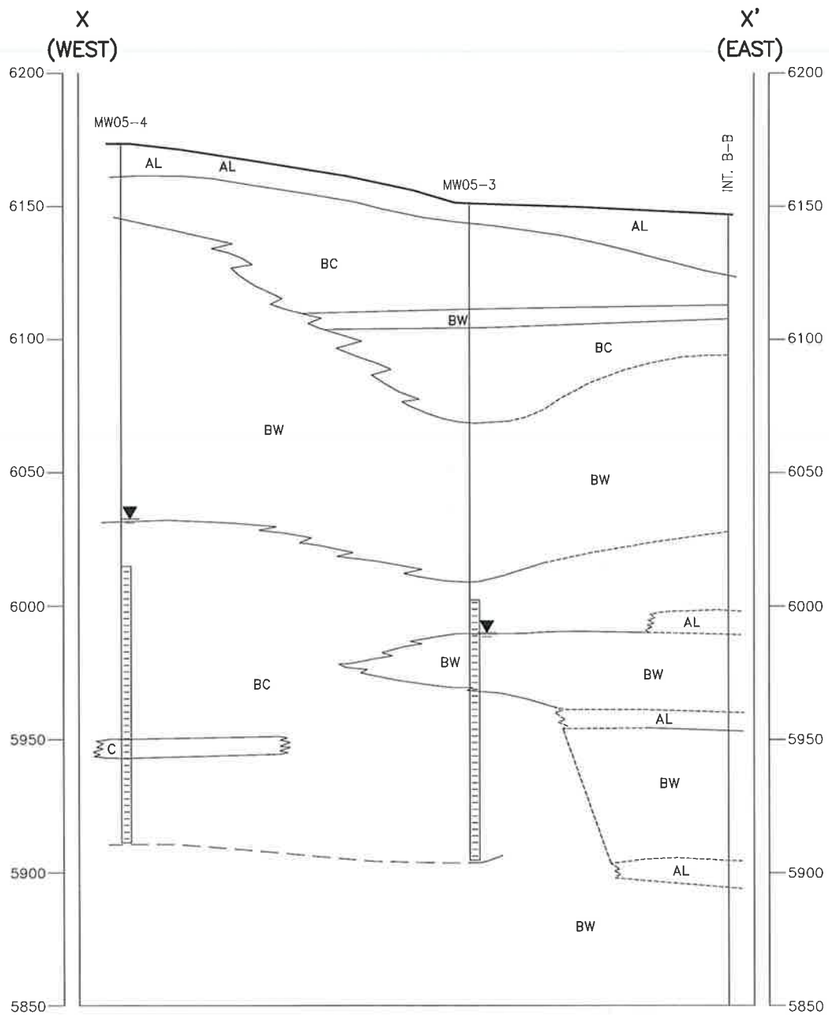

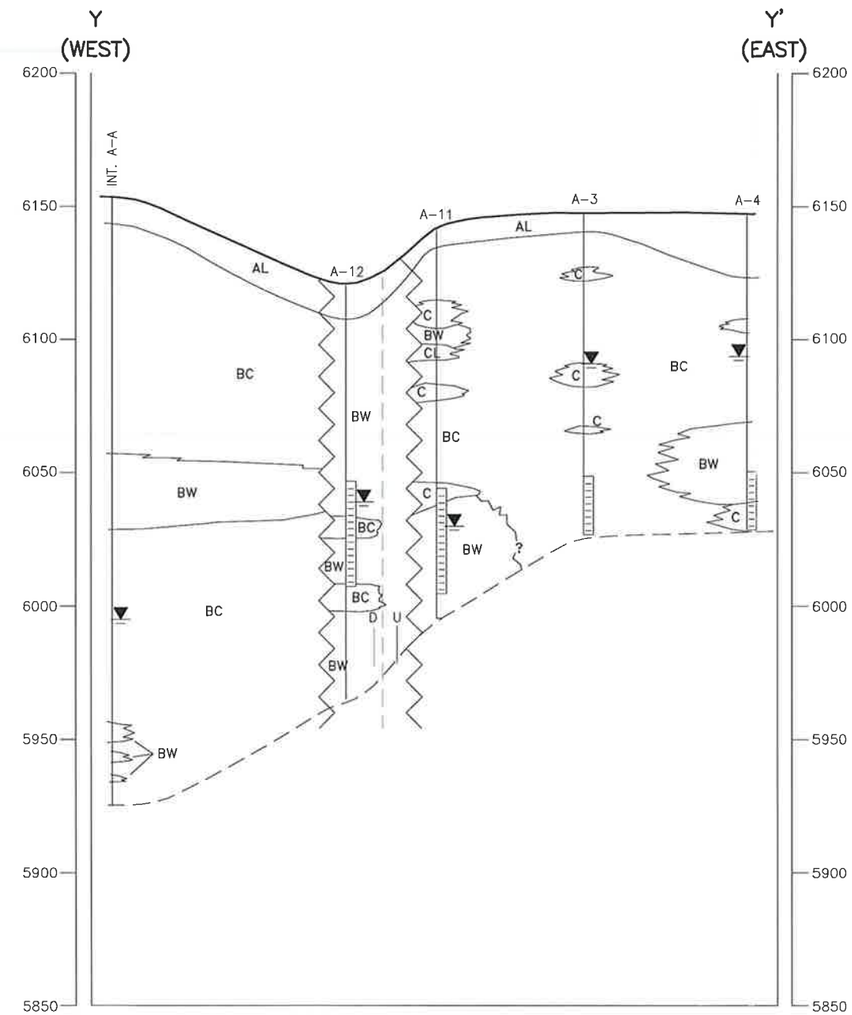

LEGEND

AL	ALLUVIUM
BC	BASALT, COMPETENT
BW	BASALT, WEATHERED
C	CINDERS (MAY INCLUDE ASH SAND)
SS	SANDSTONE
LC	LIMESTONE, COMPETENT
LW	LIMESTONE, WEATHERED

MONITORING WELL

SCREENED INTERVAL

WATER SURFACE

SHEAR ZONE

D U APPROXIMATE FAULT LOCATION
U – UPTHROWN SIDE
D – DOWNTHROWN SIDE

0 250 500 750
HORIZONTAL SCALE IN FEET

0 25 50 75
VERTICAL SCALE IN FEET

REVISIONS

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1	Initial
2	Initial
3	Initial

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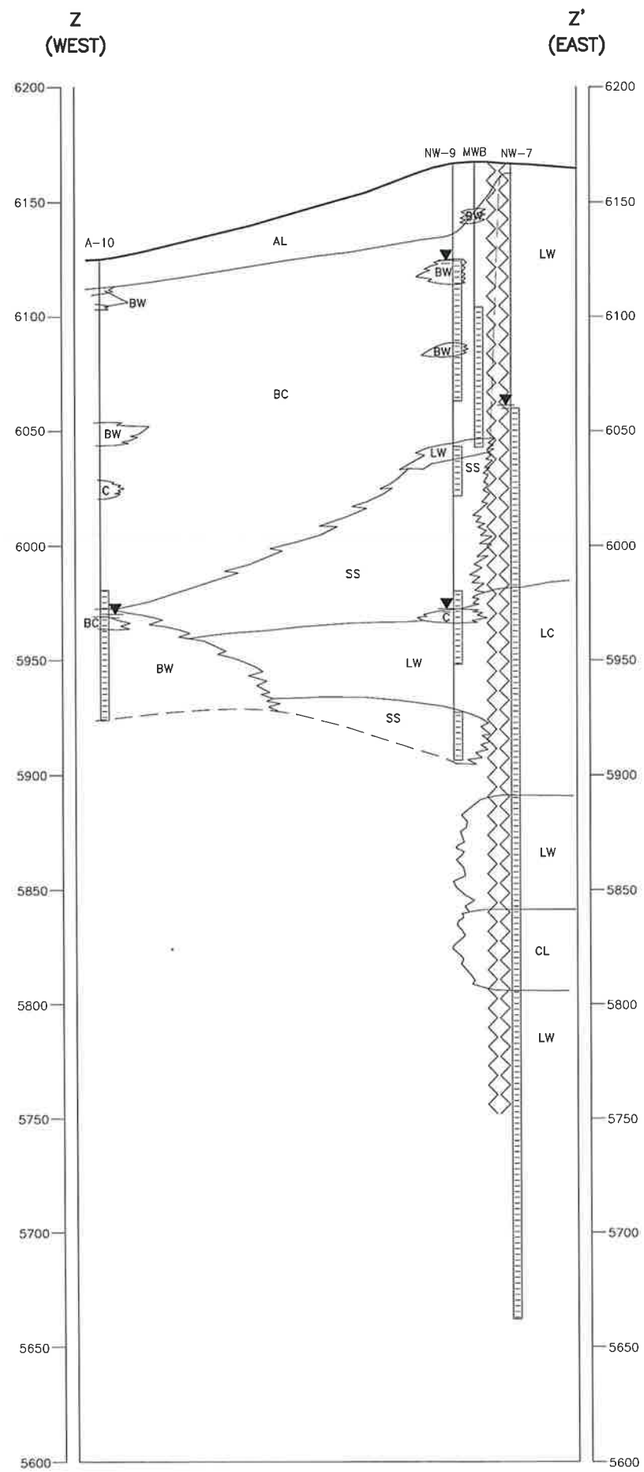
FIGURE 9

Drawing Number
10002706



LEGEND

AL	ALLUVIUM
BC	BASALT, COMPETENT
BW	BASALT, WEATHERED
C	CINDERS (MAY INCLUDE ASH SAND)
SS	SANDSTONE
LC	LIMESTONE, COMPETENT
LW	LIMESTONE, WEATHERED
CL	CLAY

MONITORING WELL

SCREENED INTERVAL

WATER SURFACE

APPROXIMATE FAULT LOCATION

SHEAR ZONE

0 250 500 750
HORIZONTAL SCALE IN FEET

0 25 50 75
VERTICAL SCALE IN FEET

REVISIONS

REV	DESCRIPTION
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GEOLOGIC CROSS SECTION Z-Z'

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

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FIGURE 10

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10002706

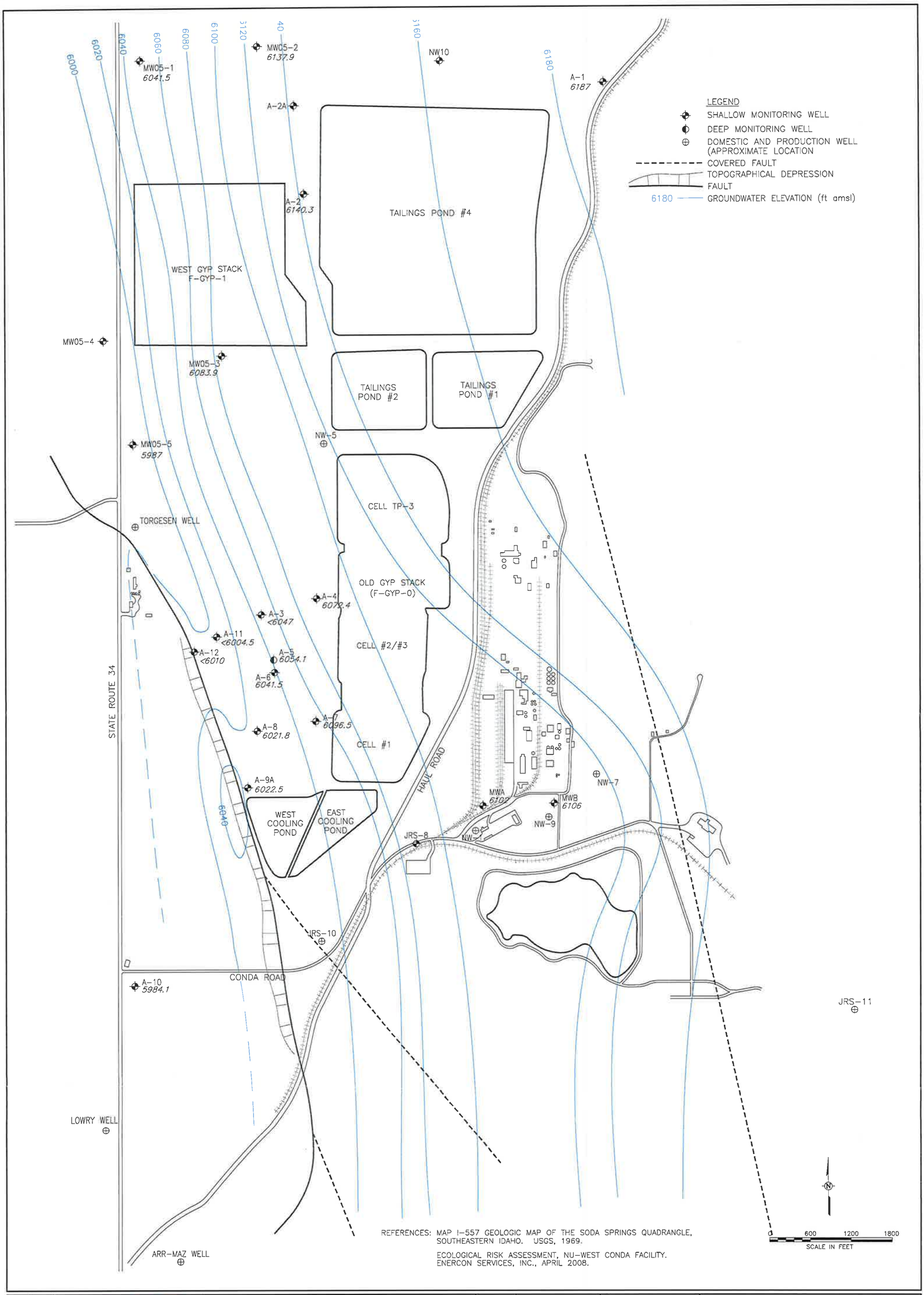

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FIGURE 11

Drawing Number
10002708

GROUNDWATER POTENTIOMETRIC SURFACE
BEDROCK AQUIFER (OCTOBER 2008)

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

DRAWN BY	JME
CHECKED	LT
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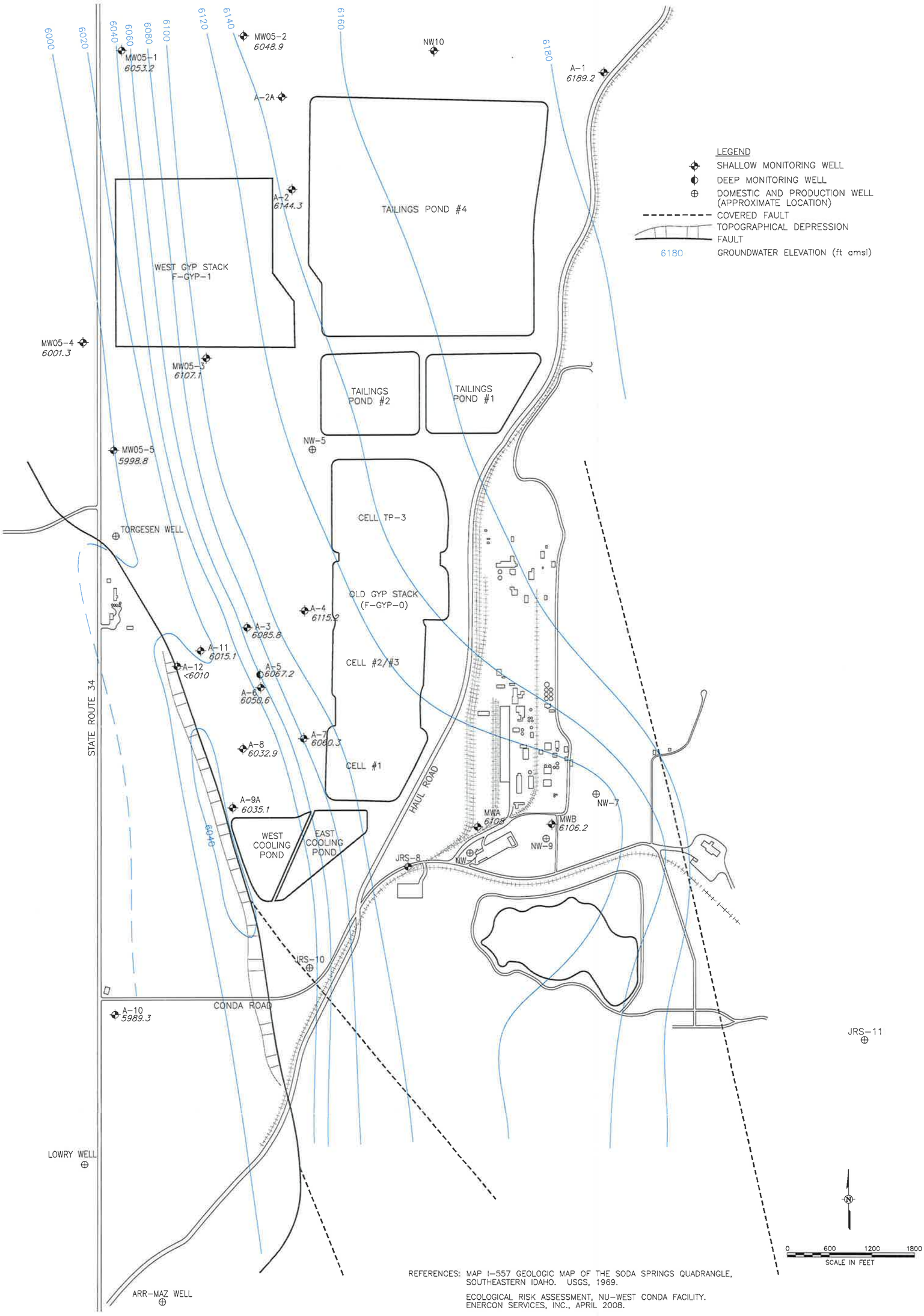

REFERENCES: MAP I-557 GEOLOGIC MAP OF THE SODA SPRINGS QUADRANGLE, SOUTHEASTERN IDAHO. USGS, 1969.

ECOLOGICAL RISK ASSESSMENT, NU-WEST CONDA FACILITY. ENERCON SERVICES, INC., APRIL 2008.

Drawing Number 10002708	FIGURE 12	WSP Environment & Energy 4600 South Ulster Street Suite 930 Denver, Colorado 80237 (303) 850-9200	**GROUNDWATER POTENTIOMETRIC SURFACE BEDROCK AQUIFER (MAY 2009)** NU-WEST CPO FACILITY SODA SPRINGS, IDAHO PREPARED FOR **HUNTON & WILLIAMS**

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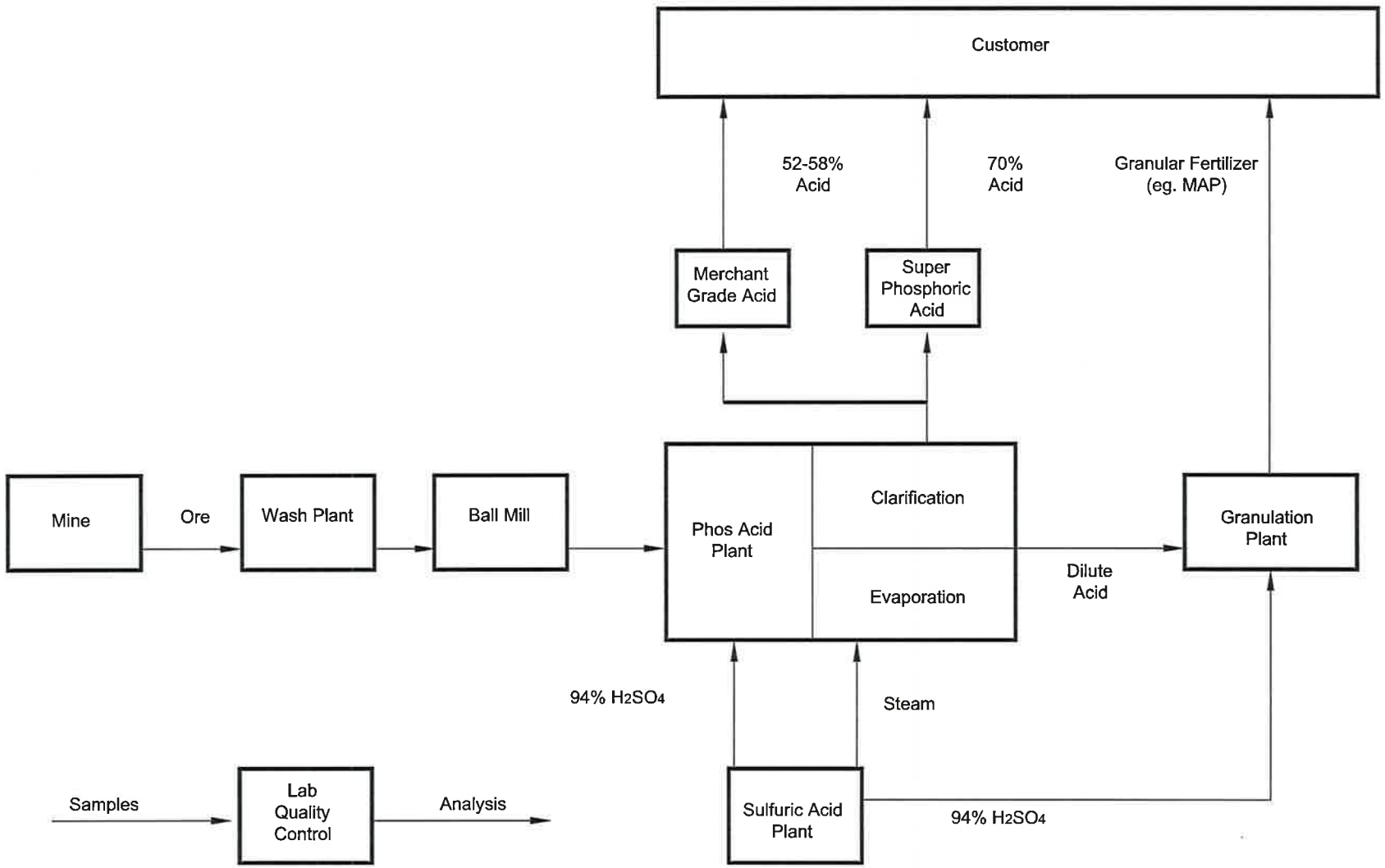

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Figure 13
General Plant Block Flow Diagram
Nu-West CPO Facility
Soda Springs, Idaho

10002705.DWG

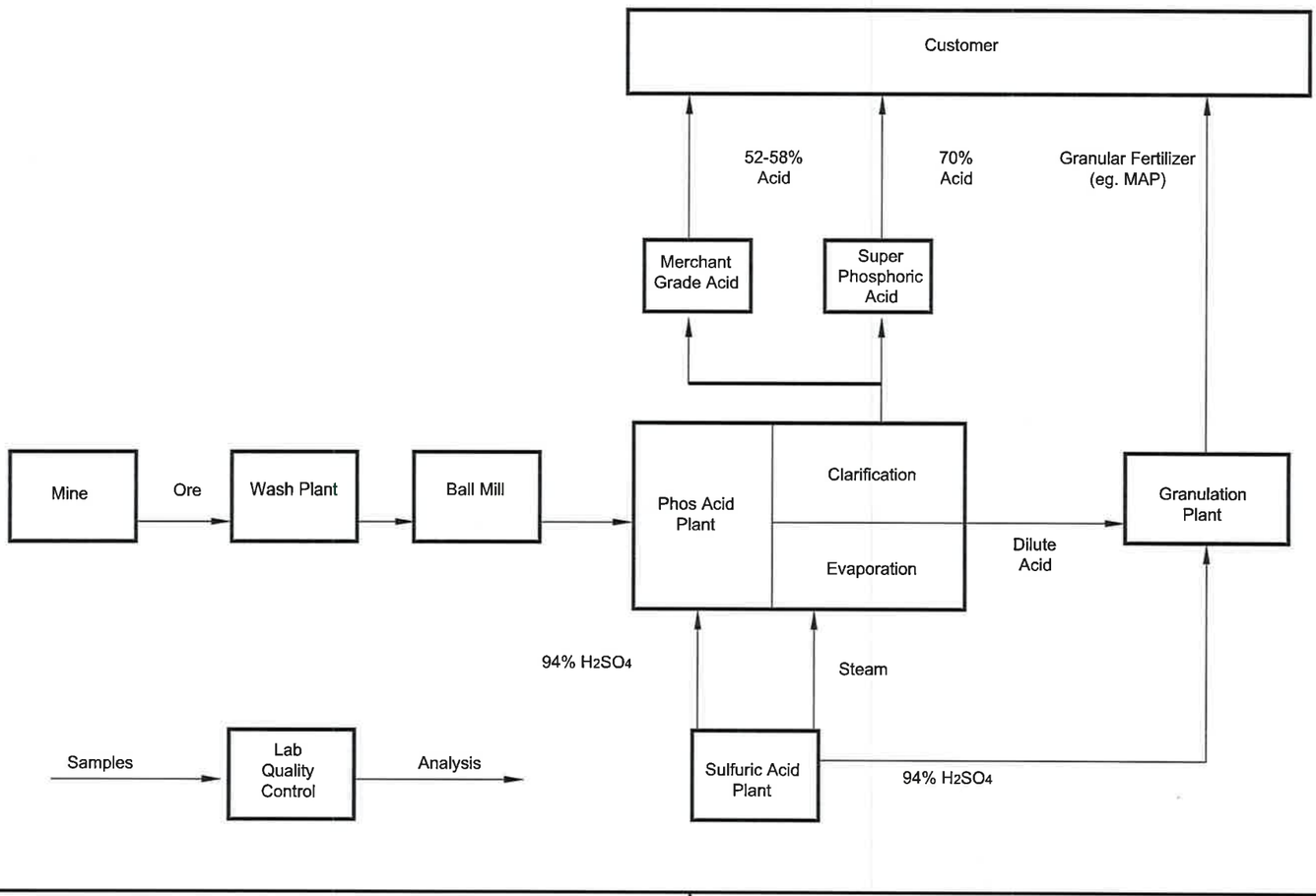

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Figure 13
General Plant Block Flow Diagram
Nu-West CPO Facility
Soda Springs, Idaho

10002705.DWG

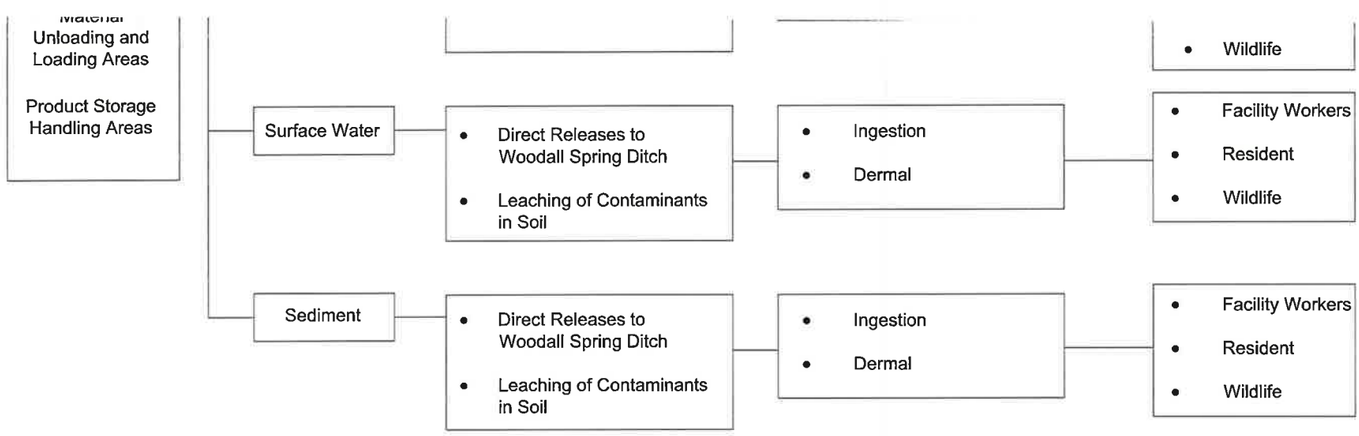

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FIGURE 14

Drawing Number 10002706

PRELIMINARY SITE CONCEPTUAL MODEL

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

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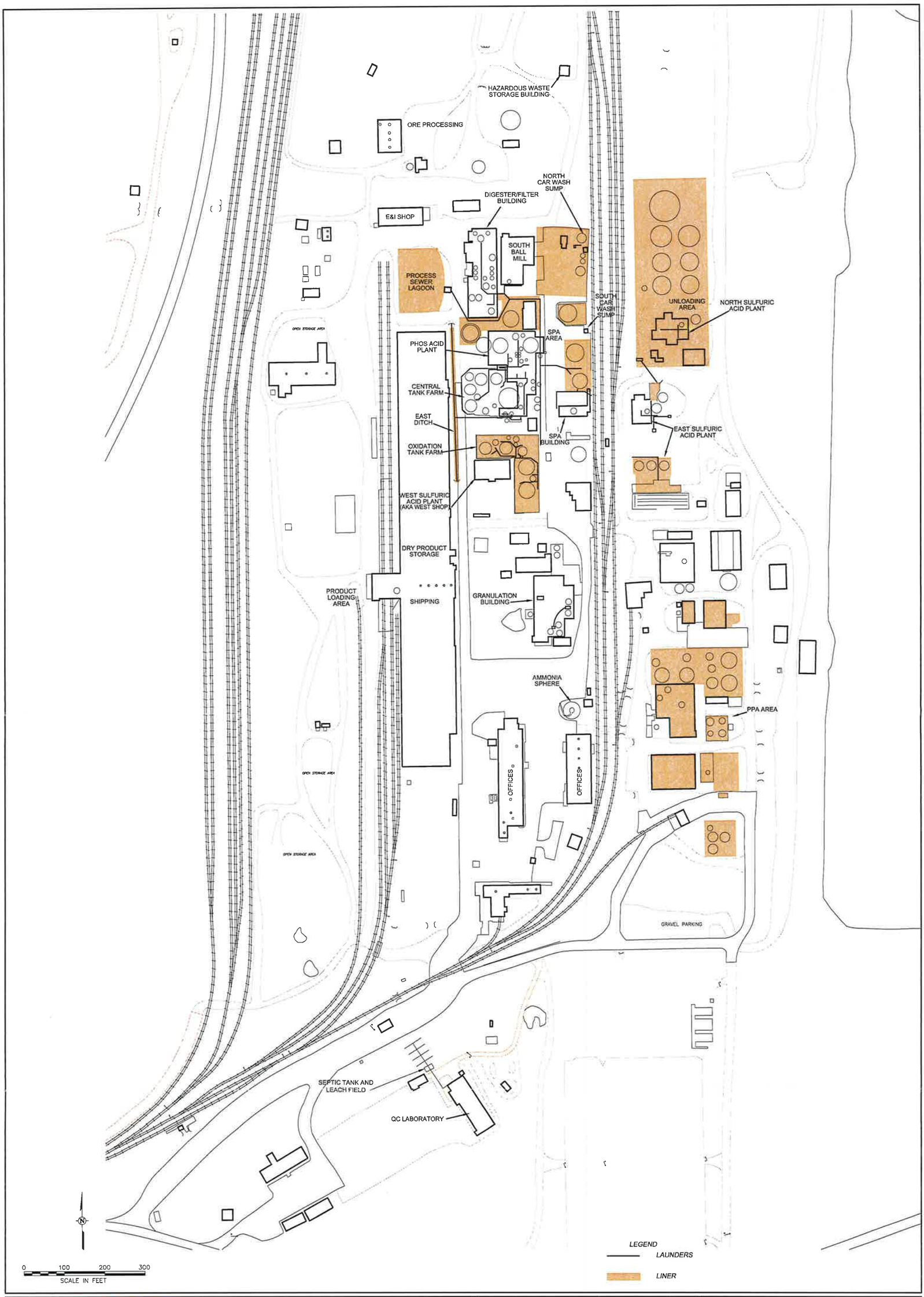

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FIGURE 15

Drawing Number: 10002703

MAIN PROCESSING AREA,
AREAS OF INTEREST AND EXISTING LINERS

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

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CHECKED	LT
APPROVED	

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REFERENCES:
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2. ECOLOGICAL RISK ASSESSMENT, NU-WEST CONDA FACILITY. ENERCON SERVICES, INC., APRIL 2008.
3. GROUNDWATER ASSESSMENT DATA, FALL 2008. ENGINEERS INC. MARCH 2009

Drawing Number 08036118

Figure 16

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ELECTRICAL RESISTIVITY IMAGING TRANSECTS

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

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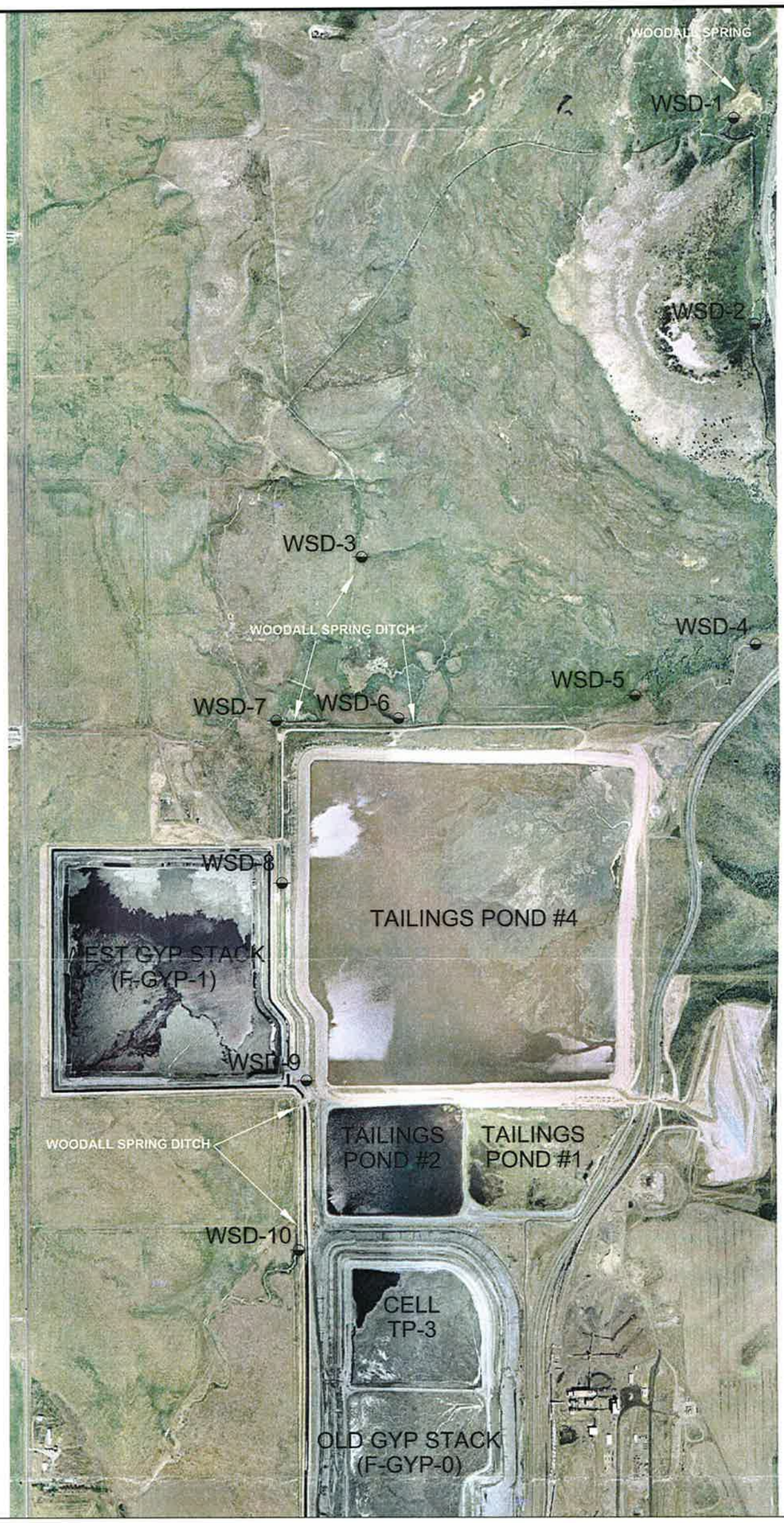

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SCALE IN FEET

PROPOSED SEDIMENT AND PROPOSED SURFACE WATER SAMPLING LOCATIONS

Drawing Number 10002709

Figure 19

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PROPOSED SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

DRAWN BY	SRS
CHECKED	DAC
APPROVED	

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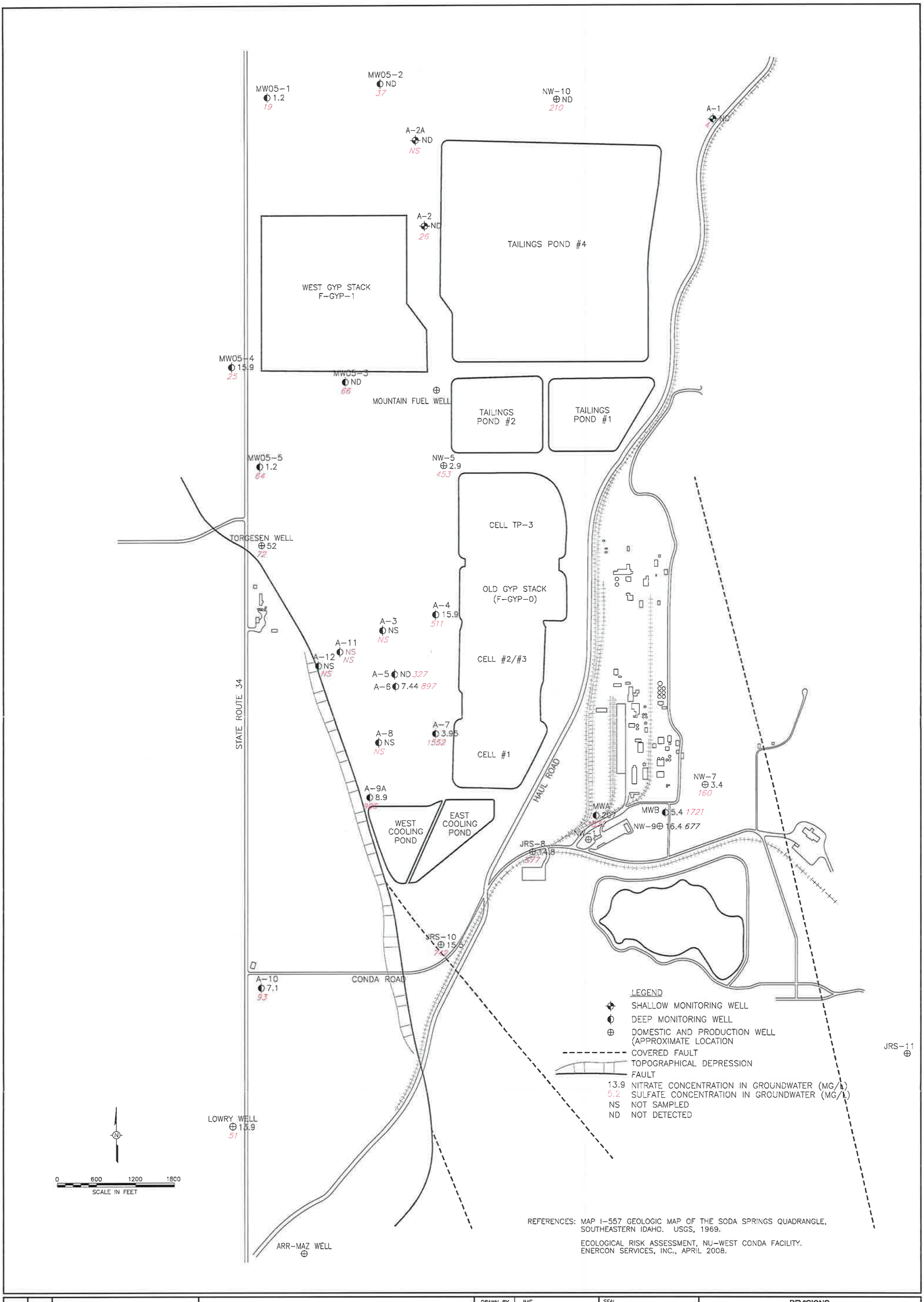

FIGURE 20

Drawing Number
10002706

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NITRATE AND SULFATE CONCENTRATIONS IN GROUNDWATER – OCTOBER 2008

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

DRAWN BY	JME
CHECKED	LT
APPROVED	

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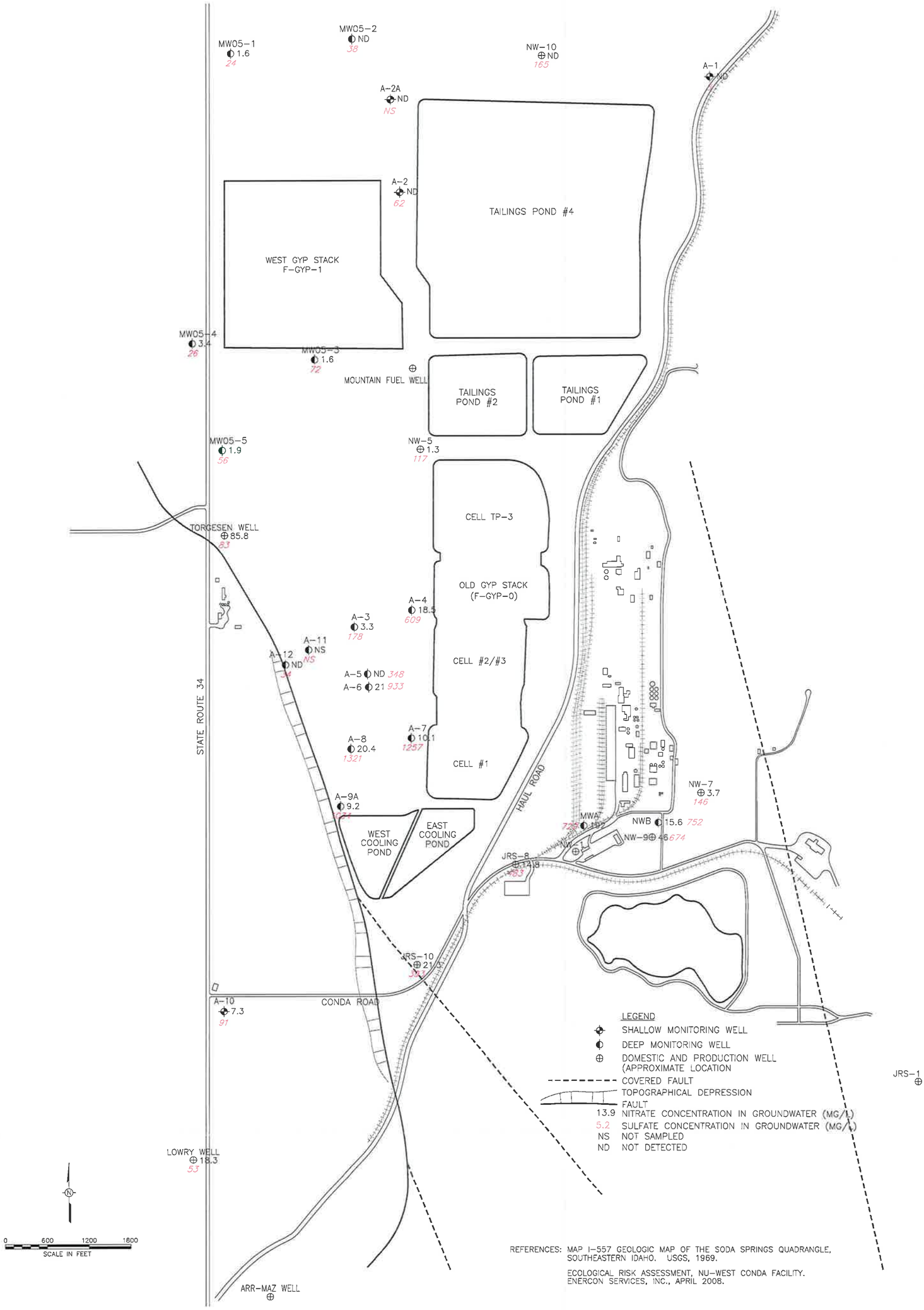

REFERENCES: MAP I-557 GEOLOGIC MAP OF THE SODA SPRINGS QUADRANGLE, SOUTHEASTERN IDAHO. USGS, 1969.

ECOLOGICAL RISK ASSESSMENT, NU-WEST CONDA FACILITY. ENERCON SERVICES, INC., APRIL 2008.

Drawing Number
10002706

FIGURE 21

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NITRATE AND SULFATE CONCENTRATIONS IN GROUNDWATER – MAY 2009

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

PREPARED FOR
HUNTON & WILLIAMS

DRAWN BY	JME
CHECKED	LT
APPROVED	

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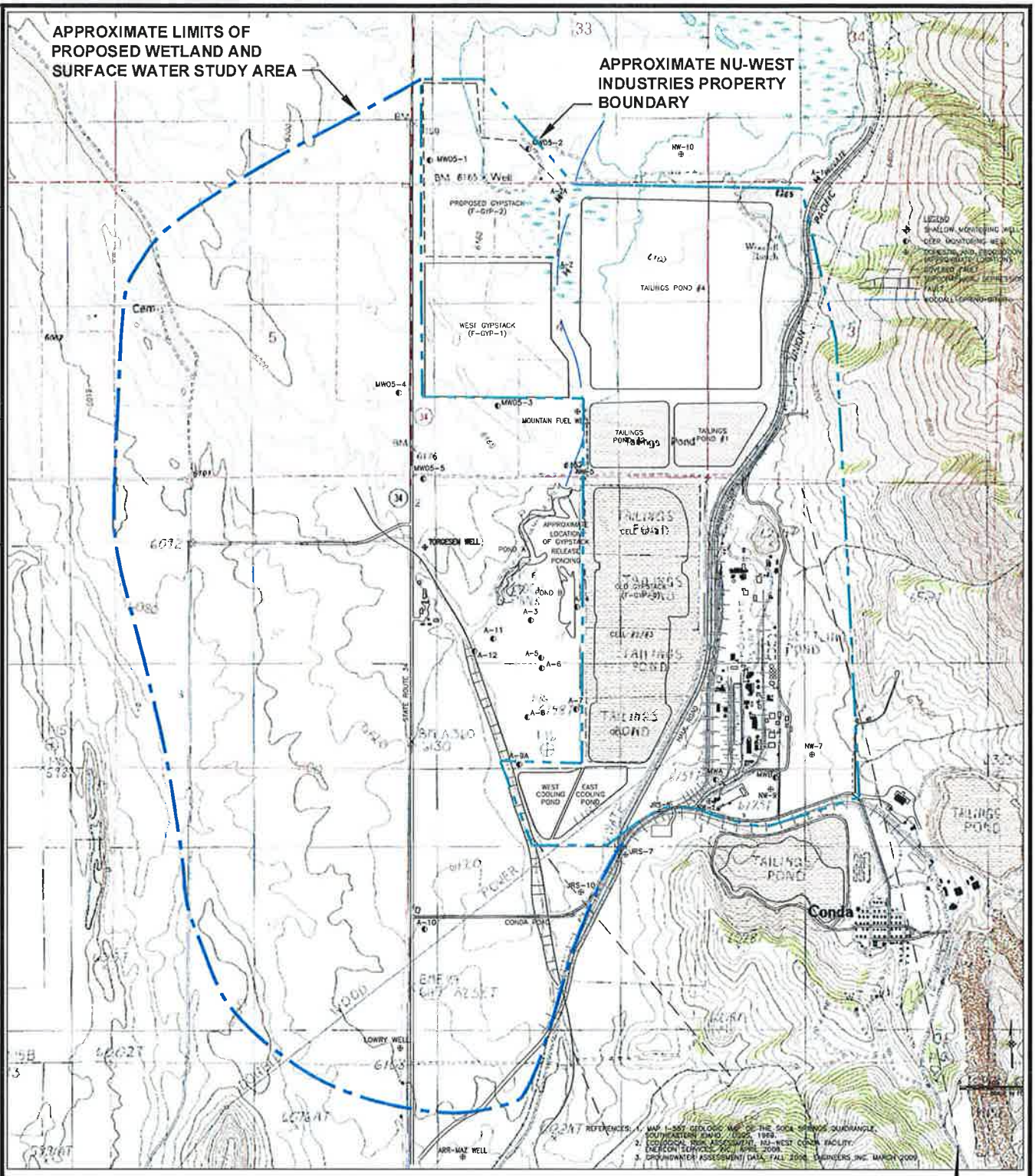

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SCALE IN FEET

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NOTES:

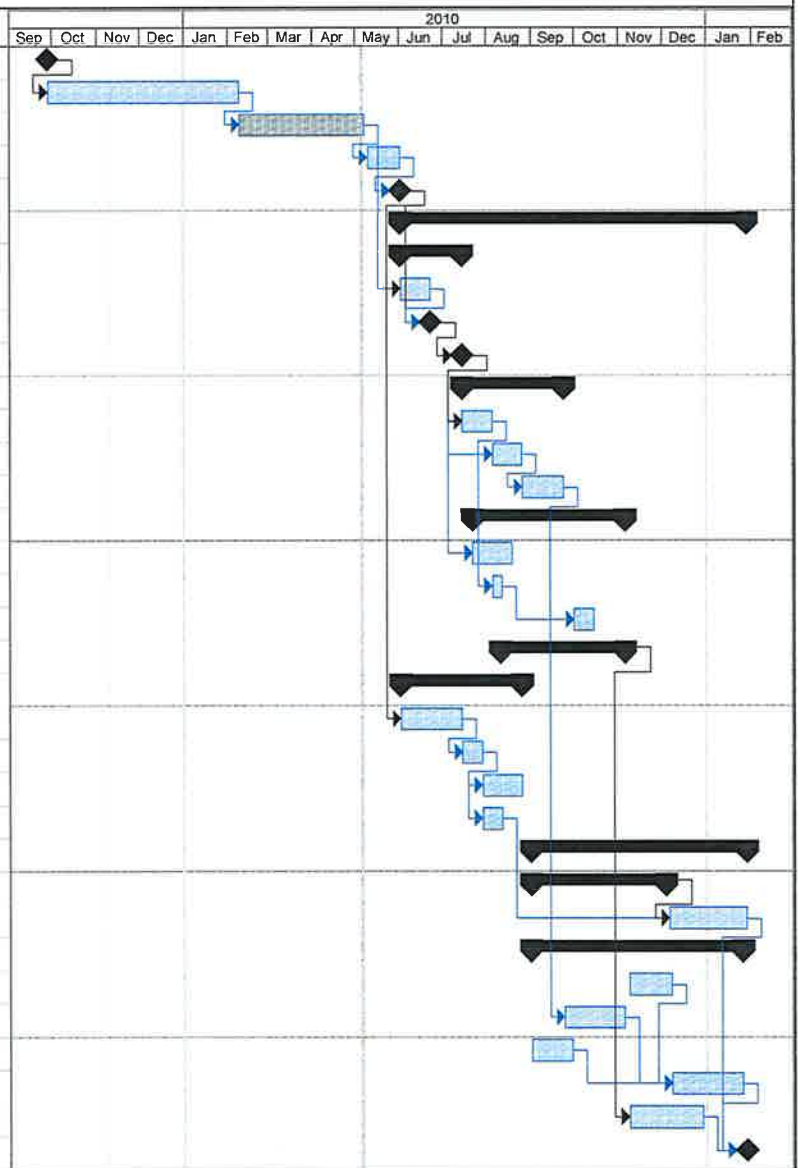
1. EXACT LIMITS OF THE PROPERTY BOUNDARY AND WETLANDS AND SURFACE WATER STUDY AREAS ARE SUBJECT TO CHANGE BASED ON LAND SUREY.
2. TOPOGRAPHIC MAP FROM USGS.

WSP WSP Environment & Energy 11190 Sunrise Valley Drive Suite 300 Reston, Virginia 20191 (703) 709-6500	Figure 22 PROPOSED WETLAND AND SURFACE WATER STUDY	NU-WEST CPO FACILITY SODA SPRINGS, IDAHO PREPARED FOR HUNTON & WILLIAMS

DWG Name: 10002711
Checked: LT
Approved:
Drawn By: JME

Figure 23
Project Schedule
Site Characterization
Nu-West CPO Facility
Soda Springs, Idaho

ID	Task Name	Duration	Start	Finish
1	**Work Plan Submitted to EPA**	0 days	Mon 9/28/09	Mon 9/28/09
2	**EPA Review and Comment on Work Plan**	93 days	Mon 9/28/09	Mon 2/8/10
3	**CPO Address Comments and Revise Work Plan**	63 days	Tue 2/9/10	Fri 5/7/10
4	**EPA Final Review of Work Plan**	16 days	Mon 5/10/10	Tue 6/1/10
5	**EPA Approval of Work Plan**	0 days	Tue 6/1/10	Tue 6/1/10
6	**Work Plan Implementation**	**169 days**	**Wed 6/2/10**	**Fri 1/28/11**
7	**Preparation for Field Work**	**30 days**	**Wed 6/2/10**	**Wed 7/14/10**
8	Subcontractor Procurement (incl. final scope adjustments)	15 days	Wed 6/2/10	Tue 6/22/10
9	Issue Notice to Proceed to Subcontractors	0 days	Tue 6/22/10	Tue 6/22/10
10	Contractor on Site	0 days	Wed 7/14/10	Wed 7/14/10
11	**Site Surveys**	**50 days**	**Thu 7/15/10**	**Thu 9/23/10**
12	Ground Survey and Utility Clearance	15 days	Thu 7/15/10	Wed 8/4/10
13	Geophysical Surveys	15 days	Thu 8/5/10	Wed 8/25/10
14	Geophysical Report	20 days	Thu 8/26/10	Thu 9/23/10
15	**Sampling and Analysis**	**76 days**	**Thu 7/22/10**	**Fri 11/5/10**
16	Soil Boring and Sampling	20 days	Thu 7/22/10	Wed 8/18/10
17	Surface Water and Sediment Sampling (dependent on flow)	5 days	Thu 8/5/10	Wed 8/11/10
18	Groundwater Sampling	10 days	Fri 10/1/10	Thu 10/14/10
19	Laboratory Analysis	62 days	Wed 8/11/10	Fri 11/5/10
22	**Potable Well and Wetland Surveys**	**60 days**	**Wed 6/2/10**	**Wed 8/25/10**
23	Well Identification and Access Agreements	30 days	Wed 6/2/10	Wed 7/14/10
24	Potable Well Sampling	10 days	Thu 7/15/10	Wed 7/28/10
25	Laboratory Analysis	20 days	Thu 7/29/10	Wed 8/25/10
26	Wetlands and Surface Water Survey	10 days	Thu 7/29/10	Wed 8/11/10
27	**Data Evaluation and Reporting**	**105 days**	**Wed 9/1/10**	**Fri 1/28/11**
28	Data Validation and Review	65 days	Wed 9/1/10	Fri 12/3/10
32	Prepare Report (incl. internal drafts)	40 days	Mon 12/6/10	Fri 1/28/11
33	**Supplemental Work Plan**	**102 days**	**Wed 9/1/10**	**Tue 1/25/11**
34	Evaluate Groundwater Chemistry	20 days	Mon 11/8/10	Tue 12/7/10
35	Evaluate Geophysical Survey Report	30 days	Fri 9/24/10	Thu 11/4/10
36	Evaluate Soil Analyses	20 days	Wed 9/1/10	Wed 9/29/10
37	Prepare Supplemental Groundwater Well Work Plan	35 days	Wed 12/8/10	Tue 1/25/11
38	Prepare Supplemental Soil Sampling Work Plan (contingency)	35 days	Mon 11/8/10	Tue 12/28/10
39	**Submit Report and Supplemental Work Plans to EPA**	0 days	Fri 1/28/11	Fri 1/28/11



Date: Wed 5/5/10

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Note: Duration shown in working days.

Tables

Table 1
Soil Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Areas of Interest and Soil Boring Locations[a]	Anticipated Sample Intervals [b]	Chemical Parameters: Metals [c]	pH	General Chemistry [d]	Radiological Parameters [e]	Gasoline Range Organics & BTEX [f]	Comments	Rationale
Ore Processing Area								
Hazardous Waste Storage Building								
SB-1	3	3	3	3	1	0	north side	Reported spill in area;
SB-2	3	3	3	3	1	0	west side	storage of hazardous waste.
SB-3	3	3	3	3	1	0	south side	
SB-4	3	3	3	3	1	0	east side	
North Sulfuric Acid Plant								
Neutralization tank & unloading								
SB-5	3	3	3	3	1	3	west side	Near neutralization tank and
SB-6	3	3	3	3	1	3		unloading area.
Acid Plant Building								
SB-7	3	3	3	3	1	3	west side	Spills reported
SB-8	3	3	3	3	1	3	south side	Spills reported
SB-9	3	3	3	3	1	3	east side	Spills reported
East Sulfuric Acid Plant								
Control room and tanks								
SB-10	3	3	3	3	1	0	east side	
SB-11	3	3	3	3	1	0	east side	
SB-12	3	3	3	3	1	0	east side	Spills reported
SB-13	3	3	3	3	1	0	southwest side	
SB-14	3	3	3	3	1	0	southwest side	
SB-15	3	3	3	3	1	0	south side	
PPA Plant								
Control room and tanks								
SB-16	3	3	3	3	1	0	west side	Spills reported
SB-17	3	3	3	3	1	0	west side	
SB-18	3	3	3	3	1	0	south side	
South Ball Mill								
SB-19	3	3	3	3	1	0	northeast	Spills reported
SB-20	3	3	3	3	1	0	north	Spills reported
SB-21	3	3	3	3	1	0	east	Spills reported
Phosphoric and Super Phosphoric Acid Area								
North SPA Area								
SB-22	3	3	3	3	1	0	North area of SPA	Spills reported
SB-23	3	3	3	3	1	0	plant	
SB-24	3	3	3	3	1	0		

Table 1
Soil Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Areas of Interest and Soil Boring Locations[a]		Anticipated Sample Intervals [b]	Chemical Parameters: Metals [c]	pH	General Chemistry [d]	Radiological Parameters [e]	Gasoline Range Organics & BTEX [f]	Comments	Rationale
South Car Wash Sump Area									
	SB-25	4	4	4	4	1	0	Adjacent	Inspections in 2004, 2005, and 2007
	SB-26	4	4	4	4	1	0	to sump	identified several holes in tank.
SPA Ditch									
	SB-27	3	3	3	3	1	0	Along ditch	
	SB-28	3	3	3	3	1	0		
	SB-29	3	3	3	3	1	0		
	SB-30								
SPA Building									
	SB-31	3	3	3	3	1	0	Downgradient of building	
	SB-32	3	3	3	3	1	0		
North Car Wash Sump Area									
	SB-33	4	4	4	4	1	0	Adjacent	
	SB-34	4	4	4	4	1	0	to sump	
Central Tank Farm Area									
Central Tank Farm									
	SB-35	3	3	3	3	1	0	North side	Spills reported,
	SB-36	3	3	3	3	1	0		most inside containment.
	SB-37	3	3	3	3	1	0	South side	
	SB-38	3	3	3	3	1	0		
Oxidation Tank Farm Area									
	SB-39	3	3	3	3	1	0		Numerous launders within farm
	SB-40	3	3	3	3	1	0	Adajcent to	reported to be or have been
	SB-41	3	3	3	3	1	0	tank farm	corroded, oxidation tank farm
	SB-42	3	3	3	3	1	0		sump is reportedly brick lined
	SB-43	3	3	3	3	1	0		and deteriorated.
West Sulfuric Acid Plant									
West Shop									
	SB-44	3	3	3	3	1	0	South side	Spills reported

Table 1
Soil Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Areas of Interest and Soil Boring Locations[a]		Anticipated Sample Intervals [b]	Chemical Parameters: Metals [c]		pH		General Chemistry [d]	Radiological Parameters [e]	Gasoline Range Organics & BTEX [f]	Comments	Rationale
Granulation Area											
Granulation Building											
	SB-45	3	3		3		3	1	0	East, west and north sides surrounding building	Spills reported
	SB-46	3	3		3		3	1	0		
	SB-47	3	3		3		3	1	0		
	SB-48	3	3		3		3	1	0		
	SB-49	3	3		3		3	1	0		
Process Sewer Lagoon Area											
North of Lagoon											
	SB-50	3	3		3		3	1	0	Near E&I shop	Spills reported
	SB-51	3	3		3		3	1	0		
	SB-52	3	3		3		3	1	0		
Process Sewer Lagoon Sump											Inspected 9/04 - several areas of deterioration detected. Inspected 10/06 - several breaches in liner identified.
	SB-53	5	5	5	5	5	5	1	0	Adjacent to sump	
	SB-54	5	5	5	5	5	5	1	0		
Process Sewer Lagoon											
	SB-55	5	5	5	5	5	5	1	0		
	SB-56	5	5	5	5	5	5	1	0	West, south sides of lagoon	Spills reported
	SB-57	5	5	5	5	5	5	1	0		
	SB-58	5	5	5	5	5	5	1	0		
Dry Products Storage & East Ditch											
East Ditch											
	SB-59	3	3		3		3	1	0	Along length of ditch	Approximately 200 feet of ditch that has experienced spills and overflows.
	SB-60	3	3		3		3	1	0		
	SB-61	3	3		3		3	1	0		
	SB-62	3	3		3		3	1	0		
North End of Building											
	SB-63	3	3		3		3	1	0		
	SB-64	3	3		3		3	1	0		
Loading Area											
	SB-65	3	3		3		3	1	0		Spills reported
	SB-66	3	3		3		3	1	0		
	SB-67	3	3		3		3	1	0		

Table 1
Soil Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Potential Areas of Concern and Sample Locations		Anticipated Sample Intervals	Chemical Parameters: Metals [c]	pH	General Chemistry [d]	Radiological Parameters [e]	Gasoline Range Organics & BTEX [f]	Comments	Rationale
East and South of Building									
	SB-68	3	3	3	3	1	0	Southeast perimeter	
	SB-69	3	3	3	3	1	0		
	SB-70	3	3	3	3	1	0		
	SB-71	3	3	3	3	1	0		
Production Well NW-9									
	SB-72	3	3	3	3	1	0		
	SB-73	3	3	3	3	1	0		
	SB-74	3	3	3	3	1	0		
QC Laboratory Leach Field									
	SB-75	3	3	3	3	1	0	Within and downgradient of septic area and leach field	Determine if releases may have occurred
	SB-76	3	3	3	3	1	0		
	SB-77	3	3	3	3	1	0		
Gypstack Area									
Decant ditch									
	SB-78	3	3	3	3	1	0	West side of ditch	Spills reported
	SB-79	3	3	3	3	1	0		Borings between ditch and
	SB-80	3	3	3	3	1	0		
	SB-81	3	3	3	3	1	0		
East Gypstack Area									
	SB-82	3	3	3	3	1	0	East of gyp stacks	Spills reported
	SB-83	3	3	3	3	1	0		
	SB-84	3	3	3	3	1	0		
Cooling Pond Area									
	SB-85	3	3	3	3	1	0	South and west perimeter	Between ponds and property line
	SB-86	3	3	3	3	1	0		
	SB-87	3	3	3	3	1	0		
Background									
	BK-1	3	3	3	3	1	0		
	BK-2	3	3	3	3	1	0	Background soil conditions	
	BK-3	3	3	3	3	1	0		
	BK-4	3	3	3	3	1	0		
	BK-5	3	3	3	3	1	0		
	BK-6	3	3	3	3	1	0		
	BK-7	3	3	3	3	1	0		

The table indicates the analysis of samples from specific locations and estimates the number of samples from each location.
Actual sample locations, intervals, and analyses may be adjusted based on observations made in the field or based on the results of data for other (shallower) samples as described in the Work Plan.

a/ Oxidation Tank Farm includes Tank #11, Tank #11A, Tank #25, Tank #25A, Tank #38, Tank #41, and Tank #50. Central Tank Farm includes Tank #12, Tank #13, Tank #18, Tank #20, Tank #21, Tank #23, Tank #24, Tank #24A, and Tank #47.

b/ Samples will be collected from 0-1 ft bgs; 1-2 ft bgs, and 4-5 ft bgs; followed by every 5 feet until top of groundwater table or refusal at bedrock. In general, samples deeper than 5 feet to be held pending initial analysis. Borings adjacent to sumps, lagoons, or ponds will have deeper samples submitted.

c/ Metals include list presented in Table 2.

d/ General chemistry parameters include total phosphorus, nitrate, Total Kjeldahl Nitrogen, ammonia, and fluoride.

e/ Radiological analysis includes gross alpha and gross beta radiation for samples from 0-1 ft bgs. 25% of these samples will also be analyzed for radium-226 and radium-228.

f/ BTEX = Benzene, toluene, ethylbenzene, and xylenes.

Table 2
Soil and Sediment Sample Analytical Methods
Nu-West Industries, Inc.
Agrium Conda Phophate Operations Facility
Soda Springs, Idaho

				Regulatory Criteria								
				EPA Region 9 Preliminary Remediation Goals [c]			Idaho Department of Environmental Quality [d]		Sample Criteria [e]			
Analytes	Test Method [b]	Method Detection Limit (mg/kg)	Laboratory Reporting Limit (mg/kg)	Industrial Soil (mg/kg)	Residential Soil (mg/kg)	Protection of Groundwater SSL (mg/kg)	Risk Based IDTLs (mg/kg)	Critical Pathway	Container	Quantity (grams)	Preservative	Holding Time
Fuel (mg/kg)												
Gasoline Range Organics	EPA 8015	5.0	2.5	NS	NS	NS	NS	NS	2 40ml-Voa vials	5 grams in each	MeOH	48hrs to FREEZE
Volatile Organic Compounds (mg/kg)												
Benzene	SW-846 8260B	0.005	0.001	5.4	1.1	0.00021	0.0178	GWP	3 40ml-Voa vials	5 grams in each	2 vials H2O, 1 vial MeOH	48hrs to FREEZE
Ethylbenzene	SW-846 8260B	0.005	0.0011	27	5.4	0.0017	10.2	GWP	3 40ml-Voa vials	5 grams in each	2 vials H2O, 1 vial MeOH	48hrs to FREEZE
Toluene	SW-846 8260B	0.005	0.0012	45,000	5,000	0.69	4.89	GWP	3 40ml-Voa vials	5 grams in each	2 vials H2O, 1 vial MeOH	48hrs to FREEZE
Xylene	SW-846 8260B	0.015	0.0022	2,700	630	0.2	1.67	Subsurface Soil	3 40ml-Voa vials	5 grams in each	2 vials H2O, 1 vial MeOH	48hrs to FREEZE
Metals (mg/kg)												
Antimony	SW-846 6010B	0.24	3	410	31	0.66	4.8	GWP	G	100	none	180 days
Arsenic	SW-846 6010B	0.18	0.4	1.6	0.39	0.0013	0.39	Surficial Soil	G	100	none	180 days
Barium	SW-846 6010B	0.5	10	190,000	1,000	300	896	GWP	G	100	none	180 days
Beryllium	SW-846 6010B	0.1	0.25	2,000	160	3.2	1.6	GWP	G	100	none	180 days
Cadmium	SW-846 6010B	0.05	0.2	800	70	NS	1.4	GWP	G	100	none	180 days
Calcium	SW-846 6010B	5	250	NS	NS	NS	NS	NS	G	100	none	180 days
Chromium, Total	SW-846 6010B	0.08	0.5	NS	NS	180,000	2,135	GWP	G	100	none	180 days
Lead	SW-846 6010B	0.23	5	800	400	14	50	GWP	G	100	none	180 days
Magnesium	SW-846 6010B	5	250	NS	NS	NS	NS	NS	G	100	none	180 days
Nickel	SW-846 6010B	0.16	2	20,000	1,500	48	59	GWP	G	100	none	180 days
Potassium	SW-846 6010B	5	500	NS	NS	NS	NS	NS	G	100	none	180 days
Sodium	SW-846 6010B	42	500	NS	NS	NS	NS	NS	G	100	none	180 days
Selenium	SW-846 6010B	0.16	5	5,100	390	0.26	2.0	GWP	G	100	none	180 days
Thallium	SW-846 6010B	0.17	0.5	NS	NS	0.14	1.6	GWP	G	100	none	180 days
Vanadium	SW-846 6010B	0.033	2.5	5,200	390	180	NS	NS	G	100	none	180 days
General Chemistry (mg/kg)												
Fluoride	EPA 9056A	1	0.5	41,000	3,100	NS	7.4	GWP	G	100	4°C	28 days
pH (S.U.)	SW-846 9045	0.01	0.01	NS	NS	NS	NS	NS	G	100	4°C	ASAP
Total Phosphorous	EPA 365.3	6.7	3.35	NS	NS	NS	NS	NS	G	100	4°C	28 days
Total Kjeldahl Nitrogen	EPA 351.2	11	4.2	NS	NS	NS	NS	NS	G	100	4°C	28 days
Nitrate	EPA 9056A	1	0.5	1,600,000	130,000	NS	18.4	GWP	G	100	4°C	48 hours
Ammonia	EPA 350.1	1.2	0.6	NS	NS	NS	4.1	Subsurface Soil	G	100	4°C	28 days
Radiological Parameters (pCi/g) [c]												
Gross alpha	EPA 900	3	NS	NS	NS	NS	NS	NS	G	100	4°C	28 days
Gross beta	EPA 900	3	NS	NS	NS	NS	NS	NS	G	100	4°C	28 days
Radium-226 - surface	EPA 901/HASL-300	1	NS	5	NS	NS	NS	NS	G	100	4°C	28 days
Radium-226 - subsurface	EPA 901/HASL-300	1	NS	15	NS	NS	NS	NS	G	100	4°C	28 days
Radium-228	EPA 901/HASL-300	1	NS	15	NS	NS	NS	NS	G	100	4°C	28 days

Table 2
Soil and Sediment Sample Analytical Methods
Nu-West Industries, Inc.
Agrium Conda Phophate Operations Facility
Soda Springs, Idaho

a/ mg/kg = milligrams per kilogram; RBCA = risk-based corrective action;
DTL = default target level; P = plastic; G = glass; °C = degrees Celsius; S.U. = standard units; TCL = target compound list;
µg/kg = micrograms per kilogram; MeOH = methanol; Na_2SO_4 = sodium bisulfate;
mg/l = milligrams per liter; pCi/g = picoCuries per gram; "NS" = not applicable or standard not developed.
SSLs = soil screening levels

b/ SW-846 source: EPA. 1986. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. As updated and revised.
SM source: American Public Health Association. 1998. Standard Methods for Examination of Water and Wastewater. As updated and revised.
EPA sources: EPA. 1983. Methods for Chemical Analysis of Water and Waste. EPA 600/4-70-020. As updated and revised.
EPA. 1980. EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water. EPA 600 4-80-032. As updated and revised
HASL source: U.S. Department of Energy. EML Procedures Manual (HASL-300). Environmental Measurements Laboratory. 28th Edition.
ASTM source: American Society for Testing and Materials.
Methods for sample preparation include SW-846 3050B for metals.
ASTM D3987-85, Standard Test Method for Shake Extraction of Solid Waste with Water, will be used to prepare samples for analysis of fluoride.

c/ Soil Cleanup Criteria in 40 CFR Part 192, http://www.epa.gov/superfund/health/conmedia/soil/cleanup.htm
USEPA Preliminary Remediation Goals Table (December 2009), http://www.epa.gov/region/superfund/prg/

d/ Idaho Risk Reduction Manual, July 2004.

e/ Accutest Laboratories.

Table 8
Historical Groundwater Elevations
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soad Springs, Idaho

Well ID	Well TOC Elevation (ft. NGVD)	Well Bottom Elevation (ft. NGVD)	Measurement Date and Water Elevation (feet NGVD)							
			Nov-99	Oct-00	Apr-01	Jul-01	Nov-01	Jun-02	Oct-02	May-03
A-1	6,221.71	6,155.01	6,188.4	6,188.0	6,188.7	6,191.8	6,192.9	6,189.9	6,188.2	6,188.4
A-2	6,156.75	6,126.55	6,145.0	6,146.5	6,147.2	6,144.8	6,145.2	6,143.3	6,138.4	6,127.1
A-3	6,149.77	6,041.77	6,068.4	6,050.3	6,053.9	6,043.0	-	6,054.7	-	-
A-4	6,149.83	6,034.43	6,095.5	6,096.1	6,099.2	6,087.5	6,089.1	6,104.2	6,085.1	6,083.4
A-5	6,150.42	5,937.42	6,064.9	6,061.0	6,061.4	6,056.1	6,050.2	6,065.8	6,051.1	6,049.6
A-6	6,150.18	6,031.08	6,055.7	6,046.7	6,043.9	6,041.7	6,033.9	6,052.1	6,037.9	6,032.6
A-7	6,150.47	6,029.27	6,063.3	6,053.2	6,052.9	6,051.1	6,041.4	6,058.8	6,042.4	6,039.8
A-8	6,148.99	6,021.89	6,051.5	6,035.7	6,034.7	6,033.8	-	6,039.2	6,022.7	-
A-9/A-9A	6,146.25	5,995.25	6,054.8	6,038.7	6,038.3	6,035.5	6,022.1	6,040.6	6,024.4	6,020.1
A-10	6,124.25	5,925.15	-	-	-	-	-	-	5,985.2	5,986.6
MW05-1	6,160.0	5,895.0	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE
MW05-2	6,160.0	6,060.0	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE
MW05-3	6,152.0	5,912.0	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE
MW05-4	6,174.0	5,914.0	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE
MW05-5	6,178.0	5,938.0	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE
MWA	6,155.8	6,045.8	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE
MWB	6,152.5	6,032.5	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE
A-11	6,147	6,007	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE
A-12	6,125	6,013	DNE	DNE	DNE	DNE	DNE	DNE	DNE	DNE

Table 8
Historical Groundwater Elevations
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soad Springs, Idaho

Well ID	Well TOC Elevation (ft. NGVD)	Well Bottom Elevation (ft. NGVD)	Measurement Date and Water Elevation (feet NGVD)							
			Oct-03	May-04	Oct-04	Jun-05	Oct-05	Jun-06	Dec-06	May-07
A-1	6,221.7	6,155.0	6,188.5	6,188.2	6,186.8	6,189.7	6,190.7	6,189.0	6,190.7	6,187.8
A-2	6,156.8	6,126.6	-	-	6,134.7	6,127.0	6,146.0	6,144.9	6,144.8	6,139.6
A-3	6,149.8	6,041.8	-	-	-	-	-	6,060.4	6,062.8	6,056.0
A-4	6,149.8	6,034.4	6,067.7	6,063.3	6,057.5	6,062.4	6,062.8	6,111.5	6,111.5	6,102.4
A-5	6,150.4	5,937.4	6,036.3	6,033.4	6,030.1	6,032.4	6,029.2	6,067.0	6,066.9	6,064.9
A-6	6,150.2	6,031.1	-	-	-	6,033.4	6,031.9	6,044.2	6,054.2	6,054.1
A-7	6,150.5	6,029.3	6,030.6	6,029.6	-	-	-	6,063.8	6,058.5	6,059.0
A-8	6,149.0	6,021.9	-	-	-	-	-	6,037.0	6,035.0	6,041.6
A-9/A-9A	6,146.3	5,995.3	6,012.1	6,011.4	6,009.8	6,011.4	6,010.4	6,039.7	6,036.3	6,043.3
A-10	6,124.3	5,925.2	5,983.1	5,985.2	5,982.5	5,988.3	5,983.3	5,992.0	5,988.3	5,991.2
MW05-1	6,160.0	5,895.0	DNE	DNE	DNE	DNE	DNE	6,057.6	6,049.2	6,054.2
MW05-2	6,160.0	6,060.0	DNE	DNE	DNE	DNE	DNE	6,144.3	6,147.0	6,145.6
MW05-3	6,152.0	5,912.0	DNE	DNE	DNE	DNE	DNE	6,104.0	6,104.5	6,092.7
MW05-4	6,174.0	5,914.0	DNE	DNE	DNE	DNE	DNE	6,002.0	6,003.0	6,005.0
MW05-5	6,178.0	5,938.0	DNE	DNE	DNE	DNE	DNE	5,999.8	6,002.2	6,002.8
MWA	6,155.8	6,045.8	DNE	DNE	DNE	DNE	6,087.70	6,103.8	6,101.8	6,103.3
MWB	6,152.5	6,032.5	DNE	DNE	DNE	DNE	6,089.40	6,103.2	6,101.7	6,102.1
A-11	6,147	6,007	DNE	DNE	DNE	DNE	DNE	DNE	DNE	6,025.3
A-12	6,125	6,013	DNE	DNE	DNE	DNE	DNE	DNE	DNE	6,041.3

Table 8
Historical Groundwater Elevations
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soad Springs, Idaho

Well ID	Well TOC Elevation (ft. NGVD)	Well Bottom Elevation (ft. NGVD)	Measurement Date and Water Elevation (feet NGVD)				
			Oct-07	Jun-08	Oct-08	May-09	Oct-09
A-1	6,221.7	6,155.0	6,187.7	6,188.4	6,187.0	6,189.2	6,187.8
A-2	6,156.8	6,126.6	6,146.8	6,145.9	6,146.2	6,144.3	6,141.9
A-3	6,149.8	6,041.8	dry	6,054.4	<6,044	6,065.8	6,054.9
A-4	6,149.8	6,034.4	6,080.8	6,104.6	6,092.4	6,115.2	6,104.2
A-5	6,150.4	5,937.4	6,046.0	6,061.3	6,054.1	6,067.2	6,065.5
A-6	6,150.2	6,031.1	6,038.2	6,046.4	6,041.5	6,050.6	6,052.4
A-7	6,150.5	6,029.3	6,038.5	6,052.8	6,046.5	6,060.3	6,060.2
A-8	6,149.0	6,021.9	6,021.5	6,026.6	6,021.8	6,032.9	6,040.7
A-9/A-9A	6,146.3	5,995.3	6,018.3	6,027.9	6,022.5	6,035.1	6,042.4
A-10	6,124.3	5,925.2	5,986.3	5,986.6	5,984.1	5,989.3	5,990.3
MW05-1	6,160.0	5,895.0	6,045.0	6,046.4	6,041.5	6,053.2	6,058.5
MW05-2	6,160.0	6,060.0	6,145.4	6,145.1	6,137.9	6,148.4	6,147.8
MW05-3	6,152.0	5,912.0	6,072.0	6,096.0	6,083.9	6,107.1	6,095.2
MW05-4	6,174.0	5,914.0	5,991.0	5,994.1	5,990.6	6,001.3	5,999.4
MW05-5	6,178.0	5,938.0	5,988.0	5,993.3	5,987.4	5,998.8	5,996.3
MWA	6,155.8	6,045.8	6,099.8	6,103.7	6,102.1	6,108.0	6,112.0
MWB	6,152.5	6,032.5	6,100.3	6,101.3	6,101.6	6,106.2	6,110.7
A-11	6,147	6,007	dry	6,008.2	<6,004.5	6,015.1	6012.4
A-12	6,125	6,013	6,015.0	6,016.3	<6,010	6,030.6	6,016.4

DNE = did not exist
- = not sampled
NGVD = National Geodetic Vertical Datum

Table 3
Sediment Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Sample Location	Anticipated Sample Intervals [a]	Metals [b]	pH	General Chemistry [c]	Radiological Parameters [d]	Rationale
Woodall Spring Source						
WSD-1	2	2	2	2	1	Source-background
WSD-2	2	2	2	2	1	Source-background
Woodall Spring Upgradient						
WSD-3	2	2	2	2	1	Upgradient-agricultural area
WSD-4	2	2	2	2	1	Upgradient-along haul road
WSD-5	2	2	2	2	1	Upgradient-NE of Facility
WSD-6	2	2	2	2	1	pgradient-near Facility boundary
Woodall Spring Ditch						
WSD-7	2	2	2	2	1	NW corner of Facility
WSD-8	2	2	2	2	1	Onsite near gyp stacks
WSD-9	2	2	2	2	1	Onsite near gyp stacks
WSD-10	2	2	2	2	1	y bounday-near documented releases

a/ The table indicates the estimated number of samples from each location. Sampling locations and intervals may be adjusted based on field conditions.
b/ Metals listed in Table 2.
c/ General chemistry parameters include total phosphorus, nitrate, total Kjeldahl nitogen, ammonia, and fluoride.
d/ Radiological analysis includes gross alpha and gross beta radiation for shallowest samples.
These samples will also be analyzed for radium-226 and radium-228.

Table 4
Surface Water Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Sample Location	Chemical Parameters: Metals [a]	pH	General Chemistry	Radiological Parameters	Field Parameters [d]	Rationale
Woodall Spring Source						
WSD-1	2	2	2	2	2	Source-background
WSD-2	2	2	2	2	2	Source-background
Woodall Spring Upgradient						
WSD-3	2	2	2	2	2	Upgradient-agricultural area
WSD-4	2	2	2	2	2	Upgradient-along haul road
WSD-5	2	2	2	2	2	Upgradient-NE of Facility
WSD-6	2	2	2	2	2	Upgradient-near Facility boundary
Woodall Spring Ditch						
WSD-7	2	2	2	2	2	NW corner of Facility
WSD-8	2	2	2	2	2	Onsite near gy pstacks
WSD-9	2	2	2	2	2	Onsite near gy pstacks
WSD-10	2	2	2	2	2	Facility bounday-near releases

a/ Metals listed in Table 5.
b/ General chemistry parameters include orthophosphate, total phosphorus, nitrate, total Kjeldahl nitrogen, fluoride, sulfide, sulfate, TSS, TDS, and hardness.
c/ Radiological analyis includes gross alpha and gross beta radiation, and radium-226 and radium-228.
d/ Field parameters include: pH, temperature, specific conductance, turbidity, dissolved oxygen, and oxidation-reduction potential. Discharge will be gauged at WSD-6 and WSD-10. Sampling will occur during two events: (1) run-off and (2) normal conditions.

Table 5
Surface Water Groundwater Sample Analytical Methods
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Analytes	Test Method [b]	Method Detection Limit (mg/l)	Laboratory Reporting Limit (mg/l)	EPA Maximum Contaminant Level [c] (mg/l)	EPA National Recommended Water Quality Criteria [d] (mg/l)	Idaho Groundwater Standard [e] (mg/l)	Idaho Water Quality Standard [f] (mg/l)	Sample Criteria [g] Container	Quantity (ml)	Preservative	Holding Time
Total Dissolved Metals (mg/l)											
Antimony	SW-846 6010B	0.0045	0.006	0.006	NS	0.006	0.0056	P	500	4oC; HNO3 <2 S.U.	6 months
Arsenic	SW-846 6010B	0.0054	0.01	0.01	3.4	0.01	0.05	P	500	4oC; HNO3 <2 S.U.	6 months
Barium	SW-846 6010B	0.005	0.2	2	NS	2	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Beryllium	SW-846 6010B	0.001	0.004	0.004	NS	0.004	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Cadmium	SW-846 6010B	0.001	0.005	0.005	0.002	0.005	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Calcium	SW-846 6010B	0.1	1	NS	NS	NS	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Chromium	SW-846 6010B	0.002	0.01	0.1	0.57	0.1	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Lead	SW-846 6010B	0.002	0.005	0.015	0.065	0.015	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Magnesium	SW-846 6010B	0.1	5	NS	NS	NS	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Nickel	SW-846 6010B	0.0023	0.04	NS	4.7	0.209	0.061	P	500	4oC; HNO3 <2 S.U.	6 months
Potassium	SW-846 6010B	0.1	10	NS	NS	NS	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Selenium	SW-846 6010B	0.0034	0.01	0.05	NS	0.05	0.17	P	500	4oC; HNO3 <2 S.U.	6 months
Sodium	SW-846 6010B	1	20	NS	NS	NS	NS	P	500	4oC; HNO3 <2 S.U.	6 months
Thallium	EPA 200.8	0.00016	0.00125	0.002	NS	0.002	0.00024	P	500	4oC; HNO3 <2 S.U.	6 months
Vanadium	SW-846 6010B	0.0009	0.05	NS	NS	NS	NS	P	500	4oC; HNO3 <2 S.U.	6 months
General Chemistry (mg/l)											
Fluoride	EPA 300	0.2	0.1	NS	NS	4	NS	P	500	4°C	28 days
Nitrate	EPA 300	0.1	0.05	10	NS	10	10	P, G	1,000	4oC; H2SO4 <2 S.U.	28 days
Total Kjeldahl Nitrogen	EPA 351.2	0.1	0.05	NS	0.228	NS	NS	P	1,000	4oC; H2SO4 <2 S.U.	28 days
Orthophosphate	EPA 365.3	0.1	0.009	NS	NS	NS	NS	P	100	4°C	48 hours
Total Phosphorous	EPA 365.3	0.1	0.009	NS	28.75	NS	NS	P	100	4oC; H2SO4 <2 S.U.	28 days
Sulfate	EPA 300	2	1	NS	NS	NS	NS	P	500	4°C	28 days
Sulfide	SM4500S=F	1.0	0.6	NS	NS	NS	NS	P, G	500	4oC; NaOH+Zn acetate >9 S.U.	7 days
TDS	SM2540C	100	10	NS	250,000	500	500	P	100	4°C	7 days
TSS	SM2540D	10	4	NS	NS	NS	NS	P	100	4°C	7 days
pH (S.U.)	SM4500 H+B	0.01	0.01	NS	6.5 to 9.0	6.5 to 8.5	6.5 to 8.5	P	100	4°C	immediate
Hardness ($CaCO_3$)	SM2340B	4	4	NS	(h)	NS	(h)	P	500	4oC; HNO3 <2 S.U.	6 months
Radiological Parameters (pCi/l)											
Gross alpha	EPA 900	3 piC/l	NS	15 pCi/l	NS	15 piC/l	NS	P	5 liters	HNO3 < 2 S.U.	6 months
Gross beta	EPA 900	4 piC/l	NS	4 mrem/yr	NS	15 piC/l	NS	P	5 liters	HNO3 < 2 S.U.	6 months
Radium 226 and 228	EPA 903.0/904.0	1 piC/l	NS	5 pCi/l	NS	5 pCi/l	60 pCi/l	P	5 liters	HNO3 < 2 S.U.	6 months

a/ mg/l = milligrams per liter; NS = not applicable or standard not developed; ml = milliliter; P = plastic; G = glass; oC = degrees Celsius; HNO3 = nitric acid; H2SO4 = sulfuric acid; NaOH+Zn acetate = sodium hydroxide plus zinc acetate; HCl = hydrochloric acid; S.U. = standard units; TDS = total dissolved solids; µg/l = micrograms per liter; pCi/l = picoCuries per liter; TDS will be analyzed for groundwater only.
b/ SW-846 source: EPA. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. (1986, as updated and revised).
SM source: American Public Health Association. Standard Methods for Examination of Water and Wastewater. (1998, as updated and revised).
EPA sources:
EPA. Methods for Chemical Analysis of Water and Waste. EPA 600/4-70-020. (1983, as updated and revised).
EPA. EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water. EPA 600 4-80-032. (1980, as updated and revised).
c/ National Primary Drinking Water Regulations, Title 40, Part 141, Appendix A, Regulated Contaminants. EPA, (March 2010).
d/ National Recommended Water Quality Criteria, Environmental Protection Agency, (2009). Freshwater CMC acute. Based on a hardness value of 100 mg/l $CaCC_3$.
Ambient Water Quality Criteria Recommendations, Environmental Protection Agency, EPA 822-B-00-016, (December 2000).
e/ Idaho Groundwater Quality Rule, Idaho Administrative Code IDAPA 58.01.11, Numerical Ground Water Quality Standards, Primary and Secondary Standards.
f/ Idaho Administrative Code IDAPA 58.01.02, Water Quality Standards.
g/ Accutest Laboratories.
h/ Metals values based on a hardness value of 100 mg/l CaCO3.

Table 6
Groundwater Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Sample Location	Metals [a]	General Chemistry [b]	Radiological Parameters [c]	Field Parameters [d]	Rationale
Site Wide Monitoring Wells					
MW-A	1	1	1	1	Monitor existing site conditions
MW-B	1	1	1	1	Monitor existing site conditions
A-1	1	1	1	1	Monitor existing site conditions
A-2	1	1	1	1	Monitor existing site conditions
A-2A	1	1	1	1	Monitor existing site conditions
A-3	1	1	1	1	Monitor existing site conditions
A-4	1	1	1	1	Monitor existing site conditions
A-5	1	1	1	1	Monitor existing site conditions
A-6	1	1	1	1	Monitor existing site conditions
A-7	1	1	1	1	Monitor existing site conditions
A-8	1	1	1	1	Monitor existing site conditions
A-9	1	1	1	1	Monitor existing site conditions
A-9A	1	1	1	1	Monitor existing site conditions
A-10	1	1	1	1	Monitor existing site conditions
A-11	1	1	1	1	Monitor existing site conditions
A-12	1	1	1	1	Monitor existing site conditions
MW05-1	1	1	1	1	Monitor existing site conditions
MW05-2	1	1	1	1	Monitor existing site conditions
MW05-3	1	1	1	1	Monitor existing site conditions
MW05-4	1	1	1	1	Monitor existing site conditions
MW05-5	1	1	1	1	Monitor existing site conditions
Main Plant Area Production Wells					
NW-1	1	1	1	1	Monitor existing site conditions
NW-5	1	1	1	1	Monitor existing site conditions
NW-7	1	1	1	1	Monitor existing site conditions
NW-8	1	1	1	1	Monitor existing site conditions
NW-9	1	1	1	1	Monitor existing site conditions

Table 6
Groundwater Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Sample Location	Metals [a]	General Chemistry [b]	Radiological Parameters [c]	Field Parameters [d]	Rationale
Main Plant Area Production Wells (continued)					
NW-10	1	1	1	1	Monitor existing site conditions
NMW-11	1	1	1	1	Monitor existing site conditions
Offsite Production Wells					
JRS-7	1	1	1	1	Monitor existing site conditions
JRS-8	1	1	1	1	Monitor existing site conditions
JRS-10	1	1	1	1	Monitor existing site conditions
JRS-11	1	1	1	1	Monitor existing site conditions
Arr-Maz	1	1	1	1	Monitor existing site conditions

a/ Samples will be field filtered for dissolved phase sampling. Metals listed in Table 5.
b/ The general chemistry parameters will include pH, sulfate, sulfide, orthophosphate, total dissolved solids, total suspended solids. fluoride, nitrate, total Kjeldahl nitrogen, and total phosphorus.
c/ The initial radiological parameters include total and dissolved gross alpha radiation. Based on the results, additional testing for radium-226 and radium-228 may be performed.
d/ Field parameters include pH, temperature, specific conductance, turbidity, dissolved oxygen, and oxidation/reduction potential (ORP).
e/ Dissolved oxygen will not be recorded for production wells because downhole meters/flow-through cells is prohibited by construction.

Table 7
Summary of Monitoring and Production Well Construction Information
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soad Springs, Idaho

Well	Sampling Frequency	Northing	Easting	Top of Casing (ft-msl)	Casing Diameter (inches)	Well Depth (ft)	Approximate Screened Interval (ft-bgs)		Screen Slot Type	Screen Slot Size	Screen Length (ft)	Filter Pack Type	Filter Pack Method	Well Casing Materials	Well Screen Materials	Annual Seal	Well Development	Driller	Date Installed	Comments
Site Wide Monitoring Wells																				
A-1	Semi-Annual	4734932.7	456000.4	6,221.71	2	65	55	65	2" diam. PVC	0.01	10	16/30 silica sand	--	PVC	PVC	bentonite & cement grout	--	Bedke Engineering	Nov-99	Licensed driller
A-2	Semi-Annual	4734410.8	454611.5	6,156.75	2	30	20	30	2" diam. PVC	0.01	10	16/40 silica sand	--	PVC	PVC	bentonite & cement grout	--	Bedke Engineering	Nov-99	Licensed driller
A-2A	Semi-Annual	4734814.8	454561.4	6161*	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
A-3	Annual	4732458.6	454422.8	6,149.77	2	108	88	108	2" diam. PVC	0.01	20	16/30 silica sand	--	PVC	PVC	bentonite & cement grout	--	Ray Nelson Drilling	Nov-99	Licensed driller
A-4	Semi-Annual	4732532.3	454679.3	6,149.83	2	115	95	115	2" diam. PVC	0.01	20	16/30 silica sand	--	PVC	PVC	bentonite & cement grout	--	Ray Nelson Drilling	Nov-99	Licensed driller
A-5	Semi-Annual	4732249.2	454481.8	6,150.42	2	213	173	193	2" diam. PVC	0.01	20	16/30 silica sand	--	PVC	PVC	bentonite & cement grout	--	Bedke Engineering	Nov-99	Licensed driller
A-6	Semi-Annual	4731963.2	454679.3	6,150.18	2	118	98	118	2" diam. PVC	0.01	20	16/30 silica sand	--	PVC	PVC	bentonite & cement grout	--	Ray Nelson Drilling	Nov-99	Licensed driller
A-7	Semi-Annual	4731963.2	454682.3	6,150.47	2	120	100	120	2" diam. PVC	0.01	20	16/30 silica sand	--	PVC	PVC	bentonite & cement grout	--	Ray Nelson Drilling	Nov-99	Licensed driller
A-8	Annual	4731916.0	454408.1	6,148.99	2	127	107	127	2" diam. PVC	0.01	20	16/30 silica sand	--	PVC	PVC	bentonite & cement grout	--	Bedke Engineering	Nov-99	Licensed driller
A-9	NS	4731916*	454408.1*	6,146.25	2	98.5	88	98	2" diam. PVC	0.01	10	16/30 silica sand	--	PVC	PVC	bentonite & cement grout	--	Bedke Engineering	Nov-99	Licensed driller
A-9A	Semi-Annual	4731653.6	454363.9	6146*	2	150	90	150	2" diam. PVC	0.01	50	20/40 silica sand	tremmie	PVC	PVC	bentonite & cement grout		Nelson Drilling	Aug-01	Licensed driller
A-10	Semi-Annual	4730730.7	453844.8	6,124.25	2	199	139	199	2" diam. PVC	0.01	60	3/8 pea gravel	overbore	PVC	PVC	bentonite & cement grout	--	Nelson Drilling	Oct-02	Licensed driller
A-11	Annual	4732352.1	454215.6	6147*	2	148	100	140	2" diam. PVC	0.01	40	20/40 silica sand	--	PVC	PVC	bentonite	--	--	May-07	--
A-12	Annual	4732283.5	454111.8	6125*	2	148	72	112	2" diam. PVC	0.01	40	20/40 silica sand	--	PVC	PVC	bentonite	--	--	May-07	--
MW05-1	Semi-Annual	4735024.1	453847.8	6160*	2	265	165	265.0	2" diam. PVC	0.02	100	gravel	overbore	steel & PVC	PVC	bentonite	--	Vollmer Drilling	Aug-05	Licensed driller
MW05-2	Semi-Annual	4735083.1	454390.4	6160*	2	345	20	100	2" diam. PVC	0.02	80	gravel	overbore	steel & PVC	PVC	bentonite	--	Vollmer Drilling	Aug-05	Licensed driller
MW05-3	Semi-Annual	4733655.9	454234.1	6152*	2	247	140	240	2" diam. PVC	0.02	100	gravel	overbore	steel & PVC	PVC	bentonite	--	Vollmer Drilling	Aug-05	Licensed driller
MW05-4	Semi-Annual	4733723.7	453679.7	6152*	2	265	160	260	2" diam. PVC	0.02	100	gravel	overbore	steel & PVC	PVC	bentonite	--	Vollmer Drilling	Aug-05	Licensed driller
MW05-5	Semi-Annual	4733234.1	453818.3	6178*	2	240	140	240	2" diam. PVC	0.02	100	gravel	overbore	steel & PVC	PVC	bentonite	--	Vollmer Drilling	Aug-05	Licensed driller
MW-A	Semi-Annual	4731577.0	455457.8	6,155.75	2	110	60	110	2" diam. PVC	0.02	50	10/20 silica sand	pour in	steel & PVC	PVC	bentonite & bentonite grout	pumping	Ray Nelson Drilling	Nov-04	Licensed driller
MW-B	Semi-Annual	4731589.9	455786.7	6,162.53	2	120	60	120	2" diam. PVC	0.02	60	8/12 silica sand	pour in	steel & PVC	PVC	bentonite & bentonite grout	pumping	Ray Nelson Drilling	Nov-04	Licensed driller

Table 7
Summary of Monitoring and Production Well Construction Information
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soad Springs, Idaho

Well	Sampling Frequency	Northing	Easting	Top of Casing (ft-msl)	Casing Diameter (inches)	Well Depth (ft)	Approximate Screened Interval (ft-bgs)		Screen Slot Type	Screen Slot Size	Screen Length (ft)	Filter Pack Type	Filter Pack Method	Well Casing Materials	Well Screen Materials	Annual Seal	Well Development	Driller	Date Installed	Comments
Main Plant Area Production Wells																				
NW-1	Annual	--	--	--	20 & 16	280	45	240	steel	3/8 x 3"	195	--	--	steel	steel	cement grout	pumping	Ivan Bertz	Oct-64	open borehole 240-280 ft
NW-5	Semi-Annual	4733249.0	454708.8	--	16	272	50	260	steel	3/8 x 3"	210	--	--	steel	steel	cement grout	pumping	Robert Lee	Nov-65	--
NW-7	Semi-Annual	4731724.5	455982.7	--	24 & 16	503	104	465	steel	1/4" x 12"	361	1/2" gravel	--	steel	steel	cement grout	pumping	Ray Nelson Drilling	Sep-88	Licensed driller
NW-8	Semi-Annual	--	--	--	24 & 16	600	367	527	steel	1/4" x 12"	160	1/2" gravel	--	steel	steel	cement grout	pumping	Ray Nelson Drilling	Sep-92	Licensed driller
NW-9	Semi-Annual	4731526.9	455761.5	--	20 & 16	255	40-100, 120-140	180-220, 235-255	steel	1/8 x 2 1/2"	140	10/20 silica sand	--	steel	steel	cement grout	pumping	American Well Drilling	Feb-00	Licensed driller
NW-10	Semi-Annual	4735022.5	455238.1	--	20	355	70-90, 120-150	270-300, 320-350	steel	--	110	10/20 silica sand	--	steel	steel	cement grout	pumping	--	--	--
NW-11	NS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mtn Fuel	NS	--	--	--	--	250	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite Production Wells																				
JRS-7	NS	--	--	--	20 & 16	300	50-224	236-295	steel	3/8 x 4"	233	--	--	steel	steel	cement grout	pumping	Ivan Bertz	May-65	--
JRS-8	Semi-Annual	4731397.2	455148.2	--	10	300	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JRS-10	Semi-Annual	4730945.7	454711.2	--	20 & 16	220	60	210	steel	5/16 x 4"	220	--	--	steel	steel	cement grout	pumping	Ivan Bertz	Nov-65	--
JRS-11	Semi-Annual	--	--	--	--	180	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arr-Maz	Semi-Annual	4729457.3	454068.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite Residential Wells																				
Torgesen	Semi-Annual	4732862.7	453836.0	--	6	225	185	225	steel	1/8 x 3"	40	--	--	steel	steel	cement grout	pumping	Ivan Bertz	Dec-70	--
Lowry	Semi-Annual	4730065.7	453716.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* = estimated from topographic map, -- = information not available.
NS = not sampled.
Northing and easting coordinates are NAD83 UTM Zone 12N, units are meters, estimated from Nu-West Industries base map.
ft-msl = feet mean sea level; ft-bgs = feet below ground surface; ft = feet.

Appendix A – WSP Quality Assurance Project Plan

QUALITY ASSURANCE PROJECT PLAN

NU-WEST INDUSTRIES, INC.
CONDA PHOSPHATE OPERATIONS
SODA SPRINGS, IDAHO

PREPARED BY

WSP ENVIRONMENT & ENERGY

REVISION: 1

DATE: MAY 6, 2010

WSP

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Appendix A – Accutest Laboratory Quality Assurance Manual
Appendix B – ALS Laboratory Quality Assurance Manual
Appendix C – Standard Operating Procedures

1 Project Management

This Quality Assurance Project Plan (QAPP) was prepared to support the implementation of the Sampling and Analysis Work Plan (Work Plan) for Site Characterization of environmental conditions at the Nu-West Industries, Inc. Conda Phosphate Operations Site located in Soda Springs, Idaho. The QAPP was prepared in accordance with the U. S. Environmental Protection Agency (EPA) guidance documents, *EPA Requirements for Quality Assurance Project Plans* (2001; reissued in 2006) and *Guidance for Quality Assurance Project Plans* (2002) and related guidance documents.

1.1 DISTRIBUTION LIST

The approved QAPP and any subsequent revisions will be distributed to the following:

QAPP Distribution List		
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The data generated for this project and subject to the QAPP will be distributed to the following:

Data Distribution				
		Validated Data		Preliminary Data
Name	Project Title	Hard Copy	Electronic	
Keith Green	Quality Assurance Manager			X
James Bulman	Project Manager	X	X	
Peter Magolske	U.S. EPA Region 10 Project Coordinator	X	X	
Brian Monson	Idaho Department of Environmental Quality	X	X	
James Cagle	Nu-West Industries, Inc. Project Coordinator	X	X	

1.2 PROJECT ORGANIZATION

The Work Plan for characterizing environmental conditions in the areas of potential interest at the Nu-West Industries, Inc. Conda Phosphate Operations site in Soda Springs, Idaho will be executed by WSP Environment & Energy. The EPA Region 10 and Idaho Department of Environmental Quality (IDEQ) will be overseeing the characterization work.

The project organization chart is shown on Figure A-1. Following are the key personnel for this project:

- U.S. EPA Project Coordinator – Peter Magolske
- IDEQ Designated Contact – Brian Monson
- WSP Project Director and Manager – James Bulman
- WSP Project Quality Assurance Manager – Keith Green
- WSP Analytical Coordinator – Laura Tobin
- WSP Project Health and Safety Manager (HSM) – Keith Green
- WSP Site Health and Safety Manager (SHSM) – Variable based on task
- WSP Site Sample Manager – Variable based on task
- Primary Analytical Laboratory – Accutest Laboratories
- Secondary Analytical Laboratory – ALS Laboratory Group

This organizational structure is designed to provide project control and proper quality assurance/quality control (QA/QC) for the field investigation. The roles and responsibilities of the key personnel are described below.

1.2.1 U.S. EPA Project Coordinator

Peter Magolske is the U.S. EPA Project Coordinator and will be responsible for management and direction of the project.

1.2.2 Idaho Department of Environmental Quality Designated Contact

The Idaho Department of Environmental Quality Designated Contact Brian Monson is the IDEQ Designated Contact. Copies of data, reports, revisions to the work plan, and other documentation generated shall be provided to the IDEQ Designated Contact.

1.2.3 WSP Project Director and Manager

The WSP Project Director and Manager, James Bulman, has primary responsibility for the completion of project activities. He will be responsible for day-to-day planning, scheduling, and cost control. The WSP Project Manager is responsible for assigning technical staff; maintaining communication between team members, contractors, and the client; compliance with all project programs and protocols; providing technical oversight; supervising the document control process; and maintaining consistency in and reviewing all work products. Mr. Bulman will be directly responsible for the development of technical reports and other project documents and for implementing the Health and Safety Plan (HASP). Mr. Bulman will assist project personnel in planning, coordinating, and controlling technical aspects of the project. He will be responsible for monitoring the quality of the technical and management aspects of the project, implementing the QAPP, implementing tasks, and maintaining communication with the EPA and IDEQ so that the objectives of the project are met.

Additionally, Mr. Bulman will provide strategic direction during the project regarding client and contract requirements, work quality, and compliance with budget and schedule requirements, as well as review project deliverables.

1.2.4 WSP Project Quality Assurance Manager

The WSP Project QA Manager, Keith Green, is responsible for overall project QA/QC including verification of all field and laboratory requirements (including potential field and laboratory auditing), data validation, and document preparation, and ensuring that all nonconformances are identified and appropriate corrective actions are taken. As such, the QA Manager will coordinate with the project manager, field personnel, Analytical Coordinator, Laboratory QA Manager, and data validation personnel to ensure that the data generated will be of appropriate quality and integrity for management decisions. Mr. Green will perform QA management tasks and coordinate third party validation of the laboratory deliverables. The QA Manager is responsible for maintaining the approved QAPP and for revising it and arranging for redistribution, as necessary.

Mr. Green will participate in coordinating field sampling activities and will be responsible for the QC of the analytical chemistry and data management documentation. He will resolve problems that may occur with laboratories and sampling activities in accordance with the Work Plan. He is responsible for providing guidance or assistance and resolving problems on QA/QC topics, approving quality-related changes to the field sampling activities, and communicating regularly with the Project Manager.

1.2.5 WSP Analytical Coordinator

The WSP QA Manager will be assisted by the WSP Analytical Coordinator, Laura Tobin. The Analytical Coordinator is responsible for ensuring that the laboratories implement the requirements of the Work Plan, coordinating with the laboratories on QA/QC matters, reviewing laboratory data before release, coordinating data validation and review activities, ensuring data are uploaded into the web-based database, and providing QA/QC updates to the Project Manager and QA Manager.

1.2.6 WSP Project Health and Safety Manager

The WSP HSM, Keith Green, will work directly with the WSP Project Manager and other project personnel to monitor and verify that the work is performed in accordance with the HASP.

1.2.7 WSP Site Manager

The WSP Site Manager will be designated depending on the nature of the field work to be performed. The Site Manager will direct all onsite activities, including those of subcontractors, and will ensure adherence to all procedures described in the Work Plan. The Site Manager will be responsible for the implementation of the QAPP in the field and report directly to the WSP Project Manager. The WSP Site Manager will be responsible for scheduling field activities and overseeing day-to-day field activities including all field calibrations, measurements, and data collection activities to ensure that they are conducted in accordance with the QAPP.

1.2.8 WSP Site Health and Safety Manager

The WSP SHSM will be designated depending on the nature of the field work to be performed. The SHSM will oversee all onsite health and safety activities, including those of subcontractors, and will ensure adherence to all procedures described in the HASP including: personnel protective equipment (PPE), monitoring equipment, and decontamination procedures. The SHSM coordinates preparation of the task-specific HASP; reviews proposed changes to the HASP; provides guidance to field personnel; and assists with PPE selection.

1.2.9 WSP Site Sample Manager

The WSP Site Sample Manager will report to the WSP Project Manager and be in communication with the field staff and WSP Analytical Coordinator. It is likely that the WSP Site Manager and Site Sample Manager will coincide for each task, and will be designated depending on the nature of the field work to be performed. The Site Sample Manager will inspect samples to confirm adequate sample volume has been collected for the analyses requested, complete sample preservation if required, and ensure all samples have been collected in accordance with the Work Plan and QAPP. The Site Sample Manager will be responsible for documentation, packaging, and shipment of the samples to the analytical laboratory. Documentation will include chain of custody (COC) forms, sample labels, custody seals, and courier/transportation forms. The Site Sample Manager will also be responsible for field records retention.

1.2.10 Project Technical Staff

Manley Tom is an Idaho-registered Professional Engineer, and Laura Tobin is an Idaho-registered Professional Geologist. These two professionals will be responsible for interpretation of site data and conditions, determining the adequacy and completeness of the data obtained in coordination with the QA Manager, and making recommendations based on the investigation results.

Each member of the project staff will be responsible to the WSP Project Manager for completion of assigned project activities. Members of the project staff are responsible for understanding and implementing their project tasks along with associated QA/QC procedures and this QAPP.

1.2.11 Field and Laboratory Subcontractors

WSP may delegate to others, in writing, the responsibility of establishing and executing certain portions of the project, but shall retain responsibility for their conformance with contractual scopes of work. When organizations other than WSP are involved in the execution of activities covered by the requirements of the QAPP or project-specific Work Plan, the activities will be monitored by the WSP Project Manager,

WSP Site Manager, WSP QA Officer, and WSP project staff, as appropriate. Subcontractor activities will be monitored against technical requirements specified in the Scope of Work, which is generated during the procurement process. When nonconformances are identified, the WSP Site Manager and project staff will report the nonconformance to the WSP Project Manager and WSP QA Manager to determine if the project objectives have been affected. Resolution of nonconformances will be made and, if necessary, corrective actions implemented. In the case of subcontracted laboratories, performance will be measured through the data review and validation process. The laboratory QA Managers will be responsible for assuring data generated are of the quality specified in the scope of work and for documenting any nonconformances and associated corrective actions required during the analysis of project samples.

WSP has identified Accutest Laboratories to analyze the majority of the soil, sediment, and water samples collected from the site. ALS Laboratory Group will analyze samples for radiological parameters through a subcontract agreement with Accutest Laboratories. The selected laboratories are part of the list approved by the IDEQ. Laboratory QA manuals for each are provided in Appendices A and B.

1.3 PROBLEM DEFINITION AND BACKGROUND

1.3.1 Introduction

Nu-West Industries, Inc. operates a phosphate manufacturing facility on a 1,012-acre site located approximately 5 miles north of Soda Springs, Idaho. The Facility, which is known as Conda Phosphate Operations (CPO) has been in operation since 1964. The El Paso Natural Gas Products Company purchased the property in 1961 and constructed a phosphate ore processing plant. Beker Industries purchased the facility in 1971 and operated it until 1985, when operations were shut down. Nu-West Industries, Inc. purchased the Facility in July 1987 and reactivated the operation following re-conditioning of the plant. The Facility currently produces granular mono ammonium phosphate (MAP) and liquid phosphate fertilizer products.

The Main Processing Area, which occupies the east-central and southeastern portions of the Facility, is approximately 120 acres and consists of production facilities, tank farms, storage areas for materials and products, and related buildings such as the office and laboratory buildings. A series of ponds and gyp stacks are located immediately to the west of the Main Processing Area. The primary surface features include the Main Processing Area, railroad tracks and service roads, laboratory area, two cooling ponds, four tailings ponds, and four gyp stacks.

Operations at the Facility include unloading phosphate ore from rail cars, washing and crushing the ore, acid production from crushed ore and elemental sulfur, production of MAP and liquid phosphate fertilizer for agricultural application, and loading of bulk fertilizer on trucks and trains for shipment. Phosphate ore is delivered by train to the Facility from the Agrium Dry Valley Mine approximately 8 months per year, and is stockpiled to allow year-round processing. Phosphoric acid production creates a gypsum byproduct which is pumped to gyp stacks for storage. A series of tailings ponds and gyp stacks are located immediately to the west of the Main Processing Area.

The major process streams generated in the operations include ore tailings, phosphogypsum, process water, scrubber water, cooling water, and tank cleanouts. Ore tailings are slurried to the tailings ponds with recycled water and phosphogypsum is slurried to the gyp stack with recycled water. Process water and scrubber water are conveyed through lined ditches and launders to the gyp stacks. Cooling water is used in various parts of the plant for cooling purposes and as make-up water for slurrying the tailings and phosphogypsum; it is stored in the cooling pond. Water is decanted off the gypsum pond and conveyed

through a lined ditch to the cooling pond. During clean out of tanks, wash water and residual solids are released to the process water conveyance system and directed to the gypsum pond.

A groundwater monitoring network has been in place at the CPO site since 1999. The monitoring network was installed to assess groundwater quality upgradient and downgradient of the gyp stacks and has been expanded as new ponds were constructed. Substantial groundwater quality data have been collected from this network over the past ten years. CPO has been implementing a Groundwater Monitoring Plan approved by the IDEQ since November 1999. Sampling is conducted semiannually (fall and spring) and results are detailed in reports submitted to IDEQ. The objectives of the monitoring plan, which was prepared for Nu-West by BCI Engineers and Scientists, Inc. (1999), are:

- Confirm background groundwater quality upgradient of the gyp stacks
- Determine the extent and magnitude of horizontal and vertical migration of potentially affected groundwater in areas surrounding the gypsum stack areas.

The current monitoring network consists of 20 onsite monitoring wells (A-1 through A-12, A-2A, MW-05-1 through MW-05-5, MWA and MWB), 5 onsite production wells (NW-1, NW-5, NW-7, NW-9, and NW-10), 5 offsite production wells (JRS-7, JRS-8, JRS-10, JRS-11 and ARR-MAZ) and 2 offsite domestic wells (Torgesen and Lowry). Additional details of the existing network and data are presented in the Work Plan.

The Work Plan was prepared in accordance with the requirements of the Administrative Order on Consent that Nu-West Industries and the EPA formally executed on June 23, 2009. The objectives of the Work Plan and the Supplemental Work Plan are to: (i) characterize Facility soil quality, focusing specifically in production and storage areas where past spills and releases have or may have occurred; (ii) characterize Site-wide surface water and sediment quality (within unlined water bodies); and (iii) characterize Site-wide groundwater quality. The scope of work presented in the Work Plan is designed to provide an overall assessment of soil and groundwater at the Facility including areas of potential interest within the Main Processing Area and the various ponds and an assessment of groundwater quality across the Site. Through the collection of soil, surface water, sediment, and groundwater samples, the investigation outlined in the Work Plan and the Supplemental Work Plan will allow Nu-West to assess the potential for impacts associated with plant operations, characterize the nature of any impacts, identify the sources of any impacts, and assess potential pathways of contaminant migration as well as any potential or actual human and ecological receptors.

1.3.2 Investigation Approach

The scope of the Site characterization assessment activities, including activities outlined in the Work Plan and the Supplemental Work Plan, is designed to provide an understanding of the effects, if any, of historical operations on conditions within and proximate to the Facility and to determine the need for and scope of potential remedial alternatives. The primary decisions to be made from the Site characterization are:

- determine if constituents of potential concern are present in surface water, sediment, soil, or groundwater at levels that warrant further evaluation
- determine the chemical and physical nature of the soils
- determine soil, sediment, and aquifer characteristics
- determine the direction and scope of additional investigation or information needs necessary to support the selection of remedial alternatives

The areas of potential interest that will be evaluated as part of the investigation include the Phosphoric and Super Phosphoric Acid Plant, the Granulation Plant, the Dry Products Storage and Shipping areas, the Central Tank Farm, the Oxidation Tank Farm, The North Sulfuric Acid Plant, the East Sulfuric Acid Plant, the West Sulfuric Acid Plant, the PPA Plant, the Laboratory, the Ore Processing Area/Ball Mill, the Gyp Stacks, the Tailings Ponds, the Cooling Ponds, the Process Sewer Lagoon, the Scrubber Ditch, the East Ditch, and the Launders.

1.4 PROJECT DESCRIPTION AND SCHEDULE

WSP has prepared this QAPP on behalf of Nu-West Industries, Inc. The QAPP has been prepared in accordance with the EPA guidance documents, *EPA Requirements for Quality Assurance Project Plans* (2001; reissued in 2006) and *Guidance for Quality Assurance Project Plans* (2002) and related guidance documents. The QAPP provides the direction and procedures for implementing the Work Plan field investigation activities for the CPO site. The field investigation involves characterization of soil, groundwater, surface water, and sediment throughout the facility. Data are being collected to satisfy the data needs identified during the Administrative Order on Consent process.

The scope of the Site investigation activities presented in the Work Plan is designed to assess and evaluate conditions Site-wide and includes the collection of soil, sediment, surface water, and groundwater samples for laboratory analyses and an evaluation of aquifer characteristics.

Initially, WSP will conduct a topographic Site survey and a geophysical survey to detect fractures in the subsurface bedrock. The characteristics of the major flow features beneath the Site are not well understood. To develop an understanding of the primary conductive features within the basalt that transmit groundwater (interflow zones, vertical fractures, and shear fractures) a geophysical survey will be performed at the Site. This will consist of a combined electrical resistivity imaging and seismic refraction survey with downhole geophysical logging.

Soil quality can potentially be affected by surface releases (e.g., spills, leaks, storage activities, or placement of materials) and subsequent vertical migration, subsurface releases, and fugitive emissions. Investigations will be conducted in Areas of Interest within the Site to characterize soil quality and ascertain the physical nature of soils. The findings will be used to determine if constituents of potential concern are present at concentrations suggesting further evaluations are warranted, and to evaluate potential remedial alternatives, if indicated. The objective of the soil investigation is to determine the nature and extent, if any, of impacts to native soil caused by materials released from Facility operations. The soil sampling locations presented in the Work Plan have been selected based on proximity to known or potential release areas. Samples will be collected for laboratory analysis from 0 to 1 foot below the ground surface (bgs); 5 to 6 feet bgs, and 10 to11 feet bgs; followed by every 5 feet until refusal at bedrock. A summary of the soil testing program is presented in Work Plan. Analytical results will be compared to the IDEQ risk-based rules and Idaho Default Target Levels (IDTLs), for commercial/industrial direct exposure and for the protection of groundwater and surface water and EPA Preliminary Remediation Goals (PRGs) Residential Soil Screening Levels (SSLs) and the Protection of Groundwater Risk-Based SSL. The results will also be evaluated as part of an overall assessment of conditions across the Site. Radiological data will be used to confirm that gross alpha, and potentially Ra-226/228, activity concentrations in soil within the Areas of Interest at the Facility are similar to those identified in soil and sediment samples collected throughout the rest of the Site, including areas upgradient from the Main Processing Area, during the assessment.

An investigation will be conducted to characterize current sediment conditions within the Woodall Spring and Woodall Spring Ditch, which is unlined. Sediment quality could be impacted by runoff and fugitive emissions, water within the ditches, groundwater discharges, and the presence of pond seepage water. The findings of the sediment evaluation will be used to determine if constituents of potential concern are present at concentrations suggesting that further evaluations are warranted, and to evaluate potential remedial alternatives, if necessary. The sediment sampling locations are presented in the Work Plan and include locations upgradient of the Site boundary, onsite, and downgradient of the Site boundary. At all locations, sediment samples will be collected from two depths; from the sediment surface to 0.5 feet, and from the bottom of the sediment layer, which is expected to be no deeper than 2 feet. A summary of the sediment testing program is presented in Work Plan. Sediment sample data will be compared to the IDEQ IDTLs and EPA screening criteria for sediments to assess if the metals concentrations are within the range of natural conditions and if a spatial pattern exists.

Surface water conditions will be evaluated within the Woodall Spring and Woodall Spring Ditch. Surface water quality in the Woodall Spring Ditch could potentially be affected by occasional runoff, leaching from the sediment, groundwater discharges, and fugitive emissions. The surface water sampling locations are presented in the Work Plan and include locations upgradient of the Site boundary, onsite, and downgradient of the Site boundary. Sampling will be conducted during a run-off condition and during normal flow conditions. Discharge measurements will be made during each sampling event. Samples will be collected from the approximate mid-point of the water column using a peristaltic pump and dedicated lengths of tubing. A summary of the surface water testing program is presented in the Work Plan. The surface water data will be compared to IDEQ Surface Water Quality Standards and EPA National Recommended Surface Water Quality Criteria.

Groundwater samples will be collected from the monitoring wells, production wells, and domestic wells. A summary of the groundwater testing program is presented in the Work Plan. The chemical analytical results for the groundwater samples will be compared to Idaho Primary and Secondary Constituent Standards for groundwater and EPA Maximum Contaminant Levels (MCLs). The radiological results will be compared to Idaho and EPA Drinking Water Standards (40 CFR 9, 141, and 142).

CPO's current groundwater monitoring program includes semi-annual sampling of three residential wells located west and southwest of the Facility (Torgesen well, the Lowry well, and the Arr-Maz well). These potable water wells are located within one mile of the Facility. If additional potable wells are identified in the designated area, CPO will contact the property owners to arrange access for sampling. A summary of the potable well testing program is presented in the Work Plan. The results will be compared to the Idaho drinking water standards for analytes that may have originated from the facility.

It is currently anticipated that the implementation of the field activities outlined in the Work Plan will commence in the Summer 2010 field season. A schedule is shown on Figure A-2. The field activities starting with premobilization are estimated to begin following review and approval of the QAPP. Mobilization of field staff and drilling subcontractors should begin around July 1, 2010. Field activities would continue through the end of October. Laboratory analysis is expected to be completed by the end of November 2010. The schedule for the field investigation activities is dependent on review and approval of the final Work Plan and QAPP.

1.5 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The purpose of this QAPP is to provide for the collection of samples and generation of reliable data to characterize environmental conditions in the Areas of Interest at the Site.

1.5.1 Data Quality Objectives

Data quality objectives (DQO) are qualitative and quantitative statements developed by data users to specify the quality of data needed from a particular data collection activity to support specific decisions or regulatory actions. The three-stage process for developing data quality objectives, as described in EPA guidance (EPA 2006), is based on the following:

- identifying project objectives
- specifying the data necessary to meet project objectives
- describing the methods that will yield data of acceptable quality and quantity to support the required decisions

The first stage of the DQO process is to identify project objectives, which includes performing all sampling and analysis required by the Administrative Order, as described in the relevant Work Plan. It is important to ensure that the chosen analytical methods provide detection limits sufficiently low to yield meaningful and useful data. The second stage of the process is the basis for preparing a QAPP; it includes appropriate field techniques and appropriate analytical methods (presented above) and measurement objectives for precision, accuracy, representativeness, completeness, and comparability (PARCC). The PARCC measurement objectives are presented below.

1.5.2 Measurement Performance Criteria

The data quality indicators for this project are precision, accuracy, representativeness, completeness, comparability, sensitivity, and bias. Measurement performance criteria for these indicator parameters were developed based on the DQO process and the objectives of the project. The Work Plan was designed to meet these objectives.

1.5.2.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under prescribed similar conditions. For duplicate measurements, precision is expressed as the relative percent difference (RPD) of the pair and is calculated using the following equation:

$$RPD = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} \times 100$$

where:

D_1 = concentration of analyte in original sample

D_2 = concentration of analyte in duplicate sample

The precision of chemical and radiological analyses will be assessed through the analysis of field duplicate samples, matrix spike/matrix spike duplicates (MS/MSD), and internal laboratory control samples. Each QC sample type will provide unique information regarding the precision of the sample collection and laboratory programs, as described below:

- field duplicate samples: sampling and intra-laboratory analytical precision
- MS/MSDs: intra-laboratory analytical precision
- internal laboratory QC samples: inter-laboratory precision

General precision acceptance criteria for duplicate samples and MS/MSDs are presented in Appendix A. When analytes are present in samples either near the method detection limit or substantially above the detection limit, these objectives may not be appropriate. Because of the way RPD is calculated, concentrations near the detection limit or substantially above the detection limit skew the RPD values. If precision objectives are not met, other QC data will be evaluated to determine the validity of the data.

1.5.2.2 Accuracy

Accuracy refers to the degree of agreement of a measurement to the true value. The accuracy of a measurement system is affected by errors introduced through the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques. Sampling accuracy will be evaluated based on the result of the analysis of trip blanks, preservative blanks, and equipment samples. To evaluate laboratory accuracy, a program of sample spiking will be conducted by the analytical laboratory. This program includes the analysis of MS/MSD samples, laboratory control samples (LCS) or blank spikes, surrogate standards, and method blanks. Appropriate levels for spike and surrogate standards are specified in the analytical methods. Where none are specified, the spike and/or surrogate standards will be added such that a mid-calibration level is present in the sample at the time of analysis.

The results of spiked samples will be expressed as percent recovery and will provide information on positive and negative bias. Measurement criteria are presented in Appendix A.

Accuracy is expressed in terms of percent recovery and is calculated using the following equation:

$$\text{Percent Recovery} = \frac{\text{Measured Spike Value} - \text{Unspiked Value}}{\text{Known Spike Value}} \times 100$$

1.5.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, parameter variations at a sampling point, or an environmental condition the samples are intended to represent. Representativeness is a qualitative parameter; hence, no specific criteria must be met. For this project, representative data will be obtained by consistent application of standard sample collection and handling procedures and laboratory methods. To aid in the evaluation of the representativeness of the samples field and laboratory blanks will be evaluated for the presence of contaminants. Problems with contamination in blank samples will be considered in determining the validity of the data.

1.5.2.4 Completeness

Completeness is a qualitative measure of the amount of valid data obtained from a measurement program compared to the amount that was expected to be obtained under normal conditions. Consequently, an evaluation of data completeness includes both evaluating the percentage of field samples collected versus the number of field samples proposed in the project plans and evaluating the success of the laboratory analyses. It is expected that the laboratory will provide valid data for at least 95 percent for all samples tested.

Project completeness will be determined at the conclusion of the data validation phase and will be calculated using the following equation:

$$C = \frac{V}{D} \times 100$$

where:

C = the percentage of valid data for each parameter

V = the number of complete, valid results for each parameter

D = the total number of samples submitted for validation for each parameter

Complete results are defined as results that meet all QC criteria such as sample holding times and acceptable surrogate recoveries. Samples that do not meet all QC criteria will be identified as incomplete. Incomplete results may be used qualitatively as part of the project, but will not be used for final decision making.

1.5.2.5 Comparability

Comparability is a qualitative parameter that expresses the confidence that one data set may be compared to another. This goal is achieved using standardized techniques to collect and analyze samples, and appropriate units to report analytical results. The standard methods for field and laboratory procedures are described in Section 2 of this QAPP and in the Work Plan.

1.5.2.6 Analytical Program Sensitivity

The analytical laboratories for this project are identified in Section 1.2. As shown in Tables 2 and 5 of the Work Plan and as discussed in Section 2 of this QAPP, the laboratory method detection limits for the majority of analytical parameters meet the screening levels. Based on the limitations of best available technology, reporting limits for a few analytes do not meet the associated screening levels. In these instances, the absence of the constituents will be confirmed if not detected at the method detection limit.

As noted on Table 2, many of the EPA's default preliminary remediation goals for radioactive analytes in solids are lower than the method detection limit. Because background concentrations of radionuclides in Idaho soil may be above many of the preliminary remediation goals, a detection limit of 2 picocuries per gram for Radium-226 in soil or sediment will preliminarily be used.

1.5.2.7 Evaluation and Control of Bias in Sample Analysis

Bias is the degree of agreement between an observed value and an accepted reference value. The following items will be used to evaluate the potential for bias during sample analysis:

- Laboratory Control Sample
- Matrix Spike
- System Monitoring Compounds
- Compound Method Blank
- Instrument Blank

For this project, laboratory control limits will be used to assess these quality control items. If the percent recovery of an item is greater than the acceptable upper control limit, then bias will be high and the analytical result may be greater than the actual value. If the percent recovery of an item is less than the acceptable lower control limit, then the bias will be low and the analytical result may be less than the

actual value. The control of these QC items will be conducted in accordance with the laboratory standard operating procedures which are based on the selected laboratory analytical methods.

1.6 SPECIAL TRAINING/CERTIFICATIONS

Strict adherence to the protocols established in the QAPP will be required for all project participants, including subcontractors. All field personnel conducting intrusive activities will be required to demonstrate compliance with the applicable training and medical monitoring requirements established by the Occupational Safety and Health Administration. In addition, all field personnel involved with the packaging and transportation of hazardous materials will be required to demonstrate compliance with the applicable training requirements of the U.S. Department of Transportation and International Air Transport Association regulations. Evidence of completion of the required training programs will be required to be demonstrated (e.g., copies of training certificates to be provided) by all personnel before field work begins and will be verified by WSP Project Manager Richard Long.

Project activities requiring specific certification or licensing include:

- ground survey – to be performed by or under the direction of a Idaho-registered land surveyor; the surveyors identified in Section 1.2 are appropriately licensed
- drilling – to be performed by personnel licensed by the Idaho Department of Water Resources; the drilling company identified in Section 1.2 is appropriately licensed

Conventional chemical analyses will be performed by Accutest Laboratories Southeast located in Orlando, Florida. Accutest participates in the National Environmental Laboratory Accreditation Program (NELAP) and are certified by the NELAP accrediting authority in Idaho. Radiological analyses will be performed by ALS Laboratory Group, located in Fort Collins, Colorado, whom will be subcontracted through Accutest. ALS holds NELAP certification, several state certifications for radiochemistry, and is listed on the IDEQ's current list of laboratories certified for drinking water analysis.

1.7 DOCUMENTATION AND RECORDS

The critical field records for this project are expected to include field notebooks and sample collection documentation, field testing records, chain of custody forms and other sample custody documentation, and field corrective action reports. Laboratory records will include complete analytical data packages and all supporting documentation. Other records that will be generated for this project may include geophysical survey data and reports, land surveying data and associated mapping, historical reports and analytical data, aerial photographs and topographic maps, published literature regarding regional characteristics, and similar information.

The following is the list of documents to be generated for this project:

- Sampling and Analysis Work Plan for Site Characterization
- Quality Assurance Project Plan
- Site Assessment Report
- interim deliverables, as needed to obtain consensus on specific issues
- quarterly progress reports

All records and documents produced in support of this project will be of sufficient quality and detail to complete the scope of work as described in the Work Plan, meet the project DQOs, and address the requirements of this QAPP.

The approved project documents and any subsequent updates will be distributed by the Project Manager to the EPA and IDEQ as required in the Consent Order. The QAPP will also be provided to those individuals identified in the distribution list provided in Section 1.1. It is the responsibility of these individuals to distribute the documents and its revisions to appropriate project personnel and subcontractors.

The Project Manager will be responsible for retaining all hard copy and electronic data and records which will be used to support document preparation and to develop appropriate findings and conclusions for this project. These records and documents will be retained in a secure location pursuant to the terms of the Consent Order. The Project Manager will be responsible for insuring that all contractors and agents similarly preserve such project data and information. Procedures for document destruction (i.e., following the required retention period) are addressed in the Consent Order.

2 Data Generation and Acquisition

The purpose of this QAPP is to provide for the generation and acquisition of valid data of sufficient quality to meet the DQOs for this project, which will allow for effective decision making based on the documented environmental condition of the Site.

2.1 SAMPLING PROCESS DESIGN

The scope of the investigation activities described in the Work Plan is designed to assess soil, groundwater, surface water, and sediment conditions at the Site. The initial work is focused on areas of the Facility where releases are known to have occurred or areas that are believed to have significant potential for past releases to have occurred. These areas are described in Sections 5.1 through 5.3 of the Work Plan, and are collectively referred to as the Areas of Interest. The sampling program was designed based on existing analytical data, Site records regarding historical spills and releases, Site-specific geological and physical characteristics, and professional experience and judgment. Sampling locations were selected to evaluate the nature and extent of potential contamination at the Site through the comparison of sample results with applicable or relevant and appropriate state standards or federal screening criteria for each medium. Based on the results of this phase of the investigation, decisions will be made regarding the need for additional phases of investigation or appropriate response actions, if necessary.

2.1.1 Ground and Geophysical Surveys

A ground survey will be performed by an Idaho-registered land surveyor to determine the soil boring locations and ground surface elevations, surface water and sediment sample locations, and if necessary, existing monitoring well locations, ground surface elevations, and top-of-casing elevations. The locations will be surveyed to an accuracy of +/- 0.1 foot; the elevations will be surveyed to an accuracy of +/- 0.01 foot. The survey information will be tied to the existing Site datum.

To develop an understanding of the primary conductive features within the basalt that transmits groundwater (interflow zones, vertical fractures, and shear fractures) a geophysical survey will be performed at the Site. This will consist of an electrical resistivity imaging (ERI) survey followed by seismic refection (SR) survey, as appropriate based on the results of the ERI survey , and downhole geophysical logging.

An ERI surface survey will be conducted to identify and map the extent of fracturing and weathering within the basalt sequence and associated faults that may serve as preferential flow pathways of groundwater below the Site; to identify the depths within the basalt sequence that have higher conductivity and thus higher flow, and to determine if areas of affected groundwater have an identifiable resistivity feature that can be used to guide the placement of additional monitoring wells. The survey will consist of nine ERI transect lines covering upgradient, facility, and downgradient areas of the Site as shown in Figure 16.

Transects 1 and 2 will be located on the eastern upgradient portion of the Site and oriented perpendicular to groundwater flow, which is to the west-southwest. Transect 3 will be located immediately down gradient of the Main Processing Area and oriented perpendicular to groundwater flow. Transect 4 will be located to the east of the East Cooling Pond and Cell #1 of the Old Gyp Stack and oriented perpendicular to groundwater flow. Transects 5 and 6 will be to the west of the Old Gyp Stack and perpendicular to groundwater flow. The ERI survey results from these 6 transects will provide information on conductive zones within the basalt sequence across the Site, image affected groundwater

potentially emanating upgradient of the Main Processing Area and across the Main Processing Area and the Old Gyp Stack. Transects 6 through 9 will be oriented perpendicular to the fault zone on the west portion of the Site and parallel to the groundwater flow direction. ERI survey results from these transects will provide information on the orientation of the fault plane, the fracture and weathering characteristics of the fault zone, conductive features within the basalt sequence, and potentially identify affected groundwater in the fault zone

The ERI survey will be performed by Enviroscan Inc (Enviroscan) using an Advanced Geosciences (AGI) Supersting R8 resistivity meter or equivalent and 56-electrodes at a spacing of 20 feet to provide the best resolution to a depth of 250 feet bgs. Enviroscan will perform forward modeling to verify the spacing of the electrodes will be capable of imaging subsurface features of interest (fractures, shear zones, and interbed zones) to 300 feet bgs. Resistivity readings will be collected using a hybrid dipole-dipole Warner array. To ensure complete coverage when survey spacing extends beyond the 56-electrode configuration, data will be collected in a roll along procedure with 50 percent overlap between adjacent transects (i.e. moving electrodes #1-#28 after each data acquisition). Low amperage DC electrical current will be applied at each electrode. If necessary, a high signal generator will be employed to boost the transmitter voltage. The flow of electrical current in the ground will be mapped by measuring the electrical potential at the ground surface using the AGI Supersting R8 – a very high impedence microvolt meter. Resistivity readings will be an average of several repeated readings and digitally recorded in the instrument along with quality control parameters such as the recorded voltage, electrode contact resistance, and standard error of each reading. Reciprocal readings (with transmit and receive dipoles switched) will be recorded for additional quality control.

Contact resistance will be checked at each electrode prior to data collection. In cases where elevated contact resistances are recorded prior to production data collection, the electrodes will be wetted to improve contact. Location control will be provided by global positioning system (GPS) data to ensure GIS-compatible results. Reading locations will be recorded using a mobile GPS receiver with differential corrections to be applied relative to a fixed base station receiver.

The first profile will be downloaded and inverted in the field and reviewed before proceeding to the next transects line. The remaining data will be downloaded to a laptop computer at the end of each day for review. The resistivity profile data will be inverted using Advanced Geosciences's EarthImager2D and RES2DINV software developed by M.H. Lake. Electrical models will be imported into the Surfer 8 software program for contouring and data presentation developed by Golden Software. The representation of results will be a fence diagram of the 2-D images. At the scale of the proposed work, 3-D data acquisition is not practical.

The potential sources of interference for ERI data collection include buried utilities, overhead power lines, and linear metallic structures that are well grounded (rail tracks and fence lines). The location of ERI transects will be evaluated and, if necessary, adjusted to avoid paralleling underground utilities, overhead power lines, and metallic structures. The profile will be oriented so that it is at an angle greater than 45 degrees to the source of noise, or moved it so that it is at a lateral distance greater than approximately 2/3 the desired survey depth to avoid interference. Since it is not possible to check for this type of "short-circuiting" noise in the field data, any sources of interference that were not avoidable we will be noted during data collection. Anomalies in areas of known interference (i.e. conductive anomaly in place of metal utility) will not be considered in our site interpretation.

Seismic reflection surveys measure the subsurface travel times of seismic waves from a surficial shock source to a linear array of ground motion sensors or geophones. Based on an analysis of the ERI results, if ambiguities or data gaps are noted with increased profile depth below 50 feet bgs, seismic reflection scanning will be performed along the appropriate ERI profiles to further evaluate the deeper

stratigraphic density and Site structural geology. Seismic reflection is a technique well-suited to deep imaging. However, it is often difficult to collect clear reflection data at depths typically less than 80 to 100 feet because of interference from high amplitude, low frequency surface waves or ground roll.

Potential sources of interference for seismic data collection include heavy equipment for loading/unloading rail cars and large trucks, ore crushing, and traffic from large trucks. Prior to seismic data collection, an inspection will be conducted to determine local sources of noise, record several no-source "noise records" to check for non-obvious noise (e.g. wind in the trees, distant sources, etc.), and record a pre-production "walk-away noise test" to determine the size of shot offset that we can use and still have arrivals that exceed the local noise level.

The seismic energy source will be an accelerated weight drop with relatively low mass to generate a transmittal signal with high frequency content. Seismic reflection data will be recorded along designated transect lines using a string of Geometrics Geode digital stacking seismograph modules totaling 96 channels with high frequency (100 Hz) geophones and shot points at constant 10-foot spacing (for a single-spread length of 960 feet). The designated frequency contact is appropriate for imaging faults, fractures, and interbed zones based on the expected width and extent of these features. Seismic travel times will be recorded off-end beginning 240 feet from the first channel, proceed into the spread shooting at the mid point of every geophone pair, and extend 240 feet beyond the end of each spread to provide minimum 24-fold data with the best possible chance of resolving the desired survey targets of 300 feet. The seismic wiggle trace data from each geophone for each shot point will be recorded on the internal hard drive of the seismograph and downloaded daily to a computer hard drive and zip disk. A third part firm having a supercomputer and specialty knowledge in shallow, very high resolution seismic data processing will process the seismic data. The reflection data will be used to prepare interpretive geologic cross sections for each seismic profile. The interpretive cross sections will depict bedrock depth/elevation and general composition and compared to ERI and available boring data.

Following an evaluation of the ERI and seismic reflection survey results, as appropriate, locations of features will be added to the existing base map and reviewed to identify locations for conducting downhole geophysics. Based on the mapped features up to 10 locations will be identified for downhole geophysical logging. Existing wells will be selected for geophysical logging where appropriate. Alternatively, locations for new exploratory borings will be identified. At each location targeted features will be surveyed, located, and marked in the field.

The scope of the downhole geophysical logging will include video logging and collecting measurements of fluid temperature, fluid conductivity, and borehole diameter (caliper measurements). Boreholes will be thoroughly developed 24 hours prior to the initiation of logging. A high resolution acoustic televiewer or optical borehole televiewer will be used to record an image of the borehole walls, allowing identification of features such as fractures and estimation of fracture orientation and thickness. Fluid temperature will be collected continuously from the top of bedrock to the termination depth of the borehole. Deflections in fluid temperature will be used to locate water producing features within the borehole. A caliper tool will be used to measure the borehole diameter and to identify changes in borehole diameter that indicate a potential fracture interval. Geophysical logs will be maintained in the field for reference (temperature, fluid conductivity, and caliper).

The interpretative cross sections from seismic reflection and ERI profiles will be compared to the boring data following geophysical logging. Results of the geophysical logging will provide further characterization of the measurement and orientation of fractures in the basalt unit as well as flow mechanisms of groundwater. The combined geophysical data sets will assist with developing a plan for additional monitoring wells including appropriate well construction details.

2.1.2 Soil

The objective of the soil investigation is to determine the nature and extent, if any, of impacts to native soil caused by materials released from Facility operations. The discrete soil sampling locations proposed in the Work Plan were selected based on proximity to known or potential release areas and are intended to confirm or refute the potential for contamination that may have resulted from historical operations. If the results of the soil sampling program suggest that a release has affected the subsurface, but the data are not sufficient to adequately delineate the affected area, then additional sampling locations will be proposed and discussed with EPA. The proposed soil sample locations for each Area of Interest are shown on Figures 17 and 18, and a summary of the soil sample locations, anticipated number of sample intervals, analytical parameters, and sampling rationale are provided in Table 1 of the Work Plan. Background sampling locations are shown in Figure 18.

2.1.3 Sediment

An investigation will be conducted to characterize current sediment conditions within the Woodall Spring and Woodall Spring Ditch, which is unlined. The Facility does not have any permitted outfalls. Sediment quality could be affected by runoff and fugitive emissions, water within the ditches, and the presence of pond seepage water. The findings of the sediment evaluation will be used to determine if constituents of potential concern are present at concentrations suggesting that further evaluation is warranted. The proposed sediment sample locations are shown on Figure 19 of the Work Plan and a summary of the sediment sample locations, anticipated number of sample intervals, analytical parameters, and sampling rationale are provided in Table 3 of the Work Plan.

2.1.4 Surface Water

Surface water conditions will be evaluated within the Woodall Spring and Woodall Spring Ditch. The Woodall Spring Ditch is unlined. Because of the arid nature of the climate, rainfall events resulting in storm water run-off are rare. The Facility does not have any permitted outfalls. Surface water quality in the Woodall Spring Ditch could potentially be affected by occasional runoff, leaching from the sediments, and fugitive emissions. The proposed surface water sample locations are shown on Figure 19 of the Work Plan and a summary of the surface water sample locations, number of samples, analytical parameters, and sampling rationale are provided in Table 4 of the Work Plan.

2.1.5 Groundwater

A groundwater monitoring network has been installed at the Site since 1999 to assess groundwater quality upgradient and downgradient of the gyp stacks. The network has been expanded as new ponds were constructed. Substantial groundwater quality data have been collected from this network over the past 10 years; however, decisions on the need for and extent of additional monitoring is best determined following the completion and evaluation of the proposed geophysical surveys and in combination with an evaluation of the existing monitoring network and the results of the soil investigation described. The information generated from the geophysical surveys will provide a better understanding of the Site geology and groundwater flow features and flow mechanisms within the basalt bedrock. This information will be used to asses the efficacy of the existing monitoring network and along with the results of the soil investigation will provide the basis for determining locations and appropriate construction details of additional monitoring wells.

Should additional monitoring wells be recommended, a supplemental groundwater investigation work plan will be prepared and submitted to EPA and this QAPP will be revised as necessary. The work plan and revised QAPP will detail the results of the geophysical surveys, present an evaluation of the survey

results relative to the existing monitoring network as well as the findings of the soil investigation, the rationale and details for additional monitoring wells, well installation protocols, sampling procedures, and approaches for characterizing flow in the aquifer. The number and locations of additional wells will be designed to sufficiently characterize the nature and extent of releases which may have migrated to groundwater.

During the current site investigation, a round of groundwater samples will be collected from monitoring wells associated with the existing monitoring network, which will include:

- monitoring wells A-1 through A-12, A-2A, MW-05-1 through MW-05-5, MWA, MWB
- onsite production wells NW-1, NW-5, NW-7, NW-9, and NW-10
- offsite production wells JRS-8, JRS-10, JRS-11, and ARR-MAZ
- offsite domestic wells of Torgesen and Lowry.

The groundwater sampling event will be conducted concurrent with the geophysical survey. The existing groundwater monitoring network is shown on Figure 4 of the Work Plan and a summary of the proposed groundwater sample locations, number of samples, analytical parameters, and sampling rationale are provided in Table 4 of the Work Plan.

2.1.6 Potable Well Survey and Sampling

A well survey will be conducted to identify potable wells located within a 0.5-mile radius of the Facility. If potable wells are identified that are in addition to the potable wells already included in the groundwater sampling program described in Section 2.1.5, the property owners will be contacted to arrange access for sample collection. It is unknown at this time what the potential extent of this sampling program will be.

2.2 SAMPLING METHODS

All sample collection activities will be performed in accordance with the Standard Operating Procedures (SOPs) provided in Appendix C of this QAPP. These SOPs have been developed by experienced professionals for the purpose of collecting samples for the purpose of providing reliable data to support the project objectives. The SOPs included in this QAPP address all aspects of sample collection including field documentation; sampling procedures for soil, sediment, surface water, groundwater and private supply wells; equipment decontamination; field QA/QC samples; and managing investigation derived waste. A summary of the sample container requirements, preservatives, and holding times for each medium is presented in Tables 2 and 5 of the Work Plan.

All field personnel will be qualified to conduct sampling in accordance with the SOPs. The Site Manager will be responsible to ensure that all SOPs are followed, and in conjunction with the QA Manager and Project Manager, to develop and implement any corrective action needed to address discrepancies or issues of non-conformance with the Work Plan, the SOPs, and this QAPP.

It should be noted that the Work Plan includes sampling of existing monitoring wells only and does not include the installation of any new monitoring wells. As such, no SOPs are provided that address the installation and construction of monitoring wells. Should these activities be required in the future, this QAPP will be updated to include the appropriate SOPs. In addition, any activities related to monitoring well installation and construction will be performed in accordance with applicable IDEQ requirements.

2.3 SAMPLE HANDLING AND CUSTODY

The SOPs document the requirements for sample handling in the field to preserve sample integrity and generate reliable, usable data. SOPs are included for all aspects of sample handling including selection of containers, container labeling, preservatives, and holding times; and packaging and shipping of sample containers, including chain-of-custody.

The analytical laboratories supporting this project will be requested to provide the appropriate sample containers and preservatives to collect the samples as described in the Work Plan and this QAPP. Field personnel will be responsible for inspecting the containers and verifying that the correct number and type have been received and that the containers are intact and suitable for intended use. Each container will be labeled in accordance with the applicable SOP before the intended samples are collected. Following sample collection, the samples will be stored in the shipping containers provided by the analytical laboratories on ice, before being shipped to the laboratory under completed chain-of-custody via overnight delivery service. Sample shipping will be arranged such that the samples arrive at the appropriate analytical laboratory for analysis within the designated holding time.

The chain-of-custody documentation will be maintained in the active project file and will be verified against the laboratory data package when received to determine that the samples were received intact and analyzed as requested. Field log books will be used to record pertinent sampling data (e.g., location, time, and depth), and also will be used to verify that the appropriate samples were collected and analyzed in accordance with the Work Plan.

2.4 ANALYTICAL METHODS

All samples will be analyzed using the methods listed in Table 2 (soil and sediment) and Table 5 (surface water and groundwater) of the Work Plan by the laboratories identified in Section 1.2 of this QAPP. These tables also include applicable method detection limits, laboratory reporting limits, and proposed screening criteria. The analytical data packages will be consistent with Level III QA/QC with laboratory deliverables similar to those required by the EPA's contract laboratory program.

2.5 QUALITY CONTROL

The purpose of this QC program is to generate data of sufficient quality to satisfy the project data quality objectives and are consistent with the requirements of the standard analytical methods. The QC program will apply to both field and laboratory activities.

2.5.1 Field Sampling

Field sampling QC checks for samples collected during implementation of the Work Plan will include field duplicates and equipment blanks. The QC samples will be labeled, documented, and handled in accordance with the SOPs and in the same manner as other field samples.

Duplicate samples will be collected to allow determination of analytical precision. One duplicate sample will be collected for every 10 samples collected of the same matrix and submitted for analysis. The duplicate samples will be treated as any other sample and will therefore, be submitted as a blind sample to the laboratory.

Equipment blanks will be collected for each 10 samples per medium collected during implementation of the Work Plan. These water samples will be used as a QC check of the decontamination procedures and disposable sampling devices used during sampling activities.

2.5.2 Laboratory Quality Control

The accuracy of analytical techniques and instrument calibration is monitored through the use of calibration standards. Laboratory QC checks, such as the analysis of laboratory control samples or blank spikes with each batch of samples, will provide guidance and ascertain the integrity of analyses.

The laboratory quality control protocols are specified in the quality assurance manuals provided in Appendices A and B.

2.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

As applicable, the SOPs (Appendix C) describe the required testing, inspection, and maintenance procedures for most field equipment, measuring devices, or tools used for sample collection. In addition, manufacturers' instructions that document appropriate procedures for the use, inspection, and maintenance of field equipment will be available to field personnel. The field team will follow appropriate procedures for use, inspection, and maintenance of all field measurement and testing equipment and will document the procedures used (traceable to each piece of equipment) in the daily field log books. Notation will be made of any malfunction or failure of the field equipment and the required corrective action, or resulting impact on data collection activities also will be recorded. As appropriate, field measurements or testing will be repeated if the equipment is determined to be defective and the resulting data are determined to be unreliable. Field equipment that is deemed to be unusable will be repaired or replaced, as appropriate.

The quality control protocols for each laboratory, including instrument testing, inspection, and maintenance, are specified in the quality assurance manuals provided in Appendices A and B.

2.7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

As applicable, the SOPs (Appendix C) describe the required calibration methods and frequency for field equipment, measuring devices, or tools used for sample collection. In addition, manufacturers' instructions that document appropriate procedures for the initial and continuing calibration of field equipment will be available to field personnel. The field team will follow appropriate procedures to calibrate (initially and periodically throughout use as required) all field measurement and testing equipment and will document such calibration procedures used (traceable to each piece of equipment) and the associated results in the daily field log books. Notation will be made of any malfunction or failure of the field equipment and the required corrective action, or resulting impact on data collection activities also will be recorded. As appropriate, field measurements or testing will be repeated if the equipment cannot be properly calibrated and the resulting data are determined to be unreliable. Field equipment that is deemed to be unusable due to inability to achieve proper calibration will be repaired or replaced, as appropriate.

The quality control protocols for each laboratory, including calibration methods and frequency, are specified in the quality assurance manuals provided in Appendices A and B.

2.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The field team leader will be responsible for ordering the supplies and consumables needed to complete the project in accordance with the Work Plan and this QAPP. Supplies and consumables will be inspected by experienced field personnel for quality and consistency with the original order. Any

discrepancies will be addressed immediately and the associated vendor will be contacted for replacement or repair, as appropriate.

Supplies and consumables required for sample collection and analysis (i.e., sample bottles and preservatives) will be provided by the designated analytical laboratory. It will be the responsibility of the laboratory to provide sample collection and shipping containers that are consistent with the requirements of the Work Plan and QAPP, and the selected analytical methods. The field team will be responsible for checking the sample containers in the field and reconciling any discrepancies with respect to number, type, and quality with the analytical laboratory.

2.9 NON-DIRECT MEASUREMENTS

Historical data that are used to evaluate site conditions and make decisions regarding the site will be subject to a usability review consistent with the EPA Region 10 and IDEQ QA requirements. Data determined to be of sufficient quality will be used quantitatively. Data that do not meet QA requirements can be used qualitatively to evaluate site conditions or guide additional sampling, but will not be used for decision making with regard to the need for and type of any response actions at the Site.

An investigation will be conducted to identify wetlands, creeks, or lakes within a one-mile radius downgradient and beyond the Facility's property boundary. This survey will also identify any bodies of water used for public recreational purposes or that may contain endangered species or species of conservation concern. This work will involve using existing aerial photographs and topographic maps from publicly available resources, identifying and locating the wetlands or surface water bodies, and summarizing the relevant data using a Geographic Information System.

2.10 DATA MANAGEMENT

All data generated in accordance with the Work Plan and this QAPP, including hard copy and electronic files, will be preserved in a manner which will protect the integrity of the files and provide for access and distribution, as required, by authorized project personnel. The data managed for this project will include, but may not be limited to, field documentation, laboratory analytical packages, geophysical survey results, wetlands and surface water survey results, and potable well survey and sampling results. Electronic files, including laboratory deliverables, will be maintained in a web-based data management system, known as Electronic Records Information Management System (ERIMS). ERIMS is a secure, server-based system that provides management of facility information, data, maps, and documents. It is a database driven system that uses industry standard software to ensure long-term support. Backup files also will be maintained for all electronic files. Hard copy files will be maintained in a secure, central project file repository. All files (electronic and hard copy) will be maintained in a project-specific directory or location with a designated, unique project number.

2.10.1 Data Recording

All field notes will be recorded in waterproof, non-erasable ink in project-dedicated, bound field logbooks. Corrections will be made by drawing one line through the incorrect entry, entering the correct information, and initialing and dating the change. Additionally, information such as field equipment manufacturers, equipment models, and equipment-specific identifiers (inventory numbers) will be recorded in the logbooks. Daily equipment calibration information will be recorded on calibration sheets or in the field logbooks, as appropriate.

All field logbooks and other field documentation will be spot checked in the field by the field team leader for consistency with the project SOPs, Work Plan, and this QAPP. When the field documentation is returned to the project office, all hard copies will be scanned, preserved in electronic format (i.e., pdfs), and the files maintained in ERIMS with all other electronic project files. All field documentation (hard copies and electronic files) will be retained in accordance with the requirements of the Administrative Consent Order.

The data generated as a result of the land and geophysical surveys will be managed by the designated subcontractors from data collection in the field through preparation of the required submittal to the project team in hard copy or electronic format, as appropriate. Data management from that point forward will become the responsibility of the project team and all documents and data will be managed in accordance with the established procedure, i.e., electronic files will be maintained and access through ERIMS, and hard copy files will be maintained and access through the central project filing system.

Data from the wetlands and surface water survey and from the potable well survey will be recorded by the project team in the form of field notes, mapping or aerial photography, and sampling documentation. Similar to other data generated by the project team, electronic files will be maintained and accessed through ERIMS and hard copy files will be maintained and access through the central project filing system.

The analytical laboratories will be responsible for recording and managing the data generated by the analytical procedures from sample receipt through the submittal of the analytical data packages. The analytical data from each laboratory will be supplied in the form of an electronic data deliverable (EDD) that will be imported directly into ERIMS. Laboratory personnel will access the secure online ERIMS system and load EDDs directly. The system then automatically processes the EDDs into the database for evaluation, and alerts the project manager via email. The alert summarizes which lab loaded the data, how many records were loaded, and any discrepancies encountered with the data.

The QA Manager will check the EDD against the chain of custody forms generated in the field to determine if all requested analyses were performed and that all samples submitted to the laboratory were analyzed. The EDDs will be subject to verification and formal validation in accordance with the procedures described in Section 4 of this QAPP.

The EDDs will be maintained on the ERIMS system and in backup files. Paper or electronic copies of laboratory data packages and reports will be archived in accordance with the document retention requirements of the Administrative Order. Once verified and validated, the data will be compiled and reported in summary tables and figures, as appropriate.

2.10.2 Data Transformation and Reduction

To the extent feasible, data generated for this project will be managed electronically to minimize the potential for errors during transformation and reduction. The QA Manager and Project Manager will spot check the data periodically to make sure that the data being used to generate the project reports and supporting tables and figures is consistent with the original data. In addition, the Project Manager will be responsible for review of all project deliverables for adherence to the Work Plan, this QAPP, and applicable regulatory agency or program guidance.

2.10.3 Data Transmittal

Again to the extent feasible, data generated for this project will be transmitted electronically to facilitate timely submittal of all deliverables and to minimize the potential for data files to be lost or misdirected. The QA Manager and Project Manager will be responsible for ensuring that all requested data, regardless of its source, is received in the required format and within the required timeframe.

2.10.4 Data Management

As described previously, all project data will be managed using a secure system and will be associated with a unique project number. Electronic files will be uploaded to ERIMS either directly by the analytical laboratories or by an authorized member of the project team. Backup copies of electronic files also will be made and stored in a secure location. Hard copy files will be transferred to the central project filing system for storage, also by an authorized member of the project team. The QA Manager and Project Manager will be responsible for overseeing all aspects of project data management and for ensuring that all files are retained as required by the Administrative Consent Order.

2.10.5 Data Storage

Data generated for this project will be stored either electronically or in hard copy form as described previously until such time as it is needed for interpretation and preparation of the Site Assessment Report or other project deliverables. Storage of the project data will continue in a secure manner until the active project is completed and long-term data storage will be conducted in accordance with the requirements of the Administrative Consent Order.

2.10.6 Data Retrieval

Only authorized project team personnel will be permitted to access and retrieve electronic or hard copy project files. Access to the ERIMS database is password protected and will only be granted to project team members who will be responsible for uploading and maintaining project files, or for using the electronic data files for data validation, data interpretation, or preparation or project deliverables. Access to hard copy files will be limited to designated project team members and files that are retrieved from the central project file will need to be signed out by and returned by the person who will be using the files.

3 Assessment and Oversight

This section identifies the number, frequency and type of planned assessment activities that will be performed for the project. Assessments will be conducted periodically throughout the project to ensure that work is being implemented in accordance with the approved Work Plan and QAPP and that usable data are generated. The documentation, reporting and corrective measures associated with the assessments are also presented.

3.1 ASSESSMENTS AND RESPONSE ACTIONS

The data collection procedures will be evaluated and any findings of deviation or nonconformity will be documented. Such findings will be evaluated with respect to the impact on data quality and usability and the need for corrective measures will be determined. Should corrective measures be required, the implementation of those measures will be documented along with the adequacy and effectiveness.

3.1.1 Assessment of Field Procedures

No internal field audits are planned for this project. Experienced field personnel will be used. All field personnel will be fully briefed regarding the scope of the field activities, the applicable SOPs, and this QAPP before field activities are initiated. The Project Manager will be responsible for verifying that all field activities were conducted in accordance with the Work Plan, SOPs, and this QAPP.

3.1.2 Assessment of Laboratory Procedures

3.1.2.1 Internal Laboratory Audits

The QA/QC Manager or appropriate designee of each subcontracted laboratory is responsible for performing routine internal audits of the laboratory. At a minimum, each laboratory will conduct internal system audits of each of its analytical departments on an annual basis. In addition, proficiency testing will be conducted by each analytical department on two samples per year.

Internal laboratory system audits are comprehensive technical and system evaluations covering each operational and support area. Internal systems audits are conducted to detect any problems in sample flow, analytical procedures, or documentation and to ensure adherence to laboratory standard operating procedures.

Proficiency testing samples are analyzed to verify the ability of the laboratory to correctly identify and quantify compounds in these samples. Proficiency testing samples may be supplied internally or externally as single blind or double blind samples. They can be used to assess if a deficiency has been corrected, they can be used to document the proficiency of the analyst performing the analysis, or they can be used to assess the overall performance of an analytical method. Proficiency testing samples are handled and tested in the same manner as environmental samples, and sample data are archived using the same requirements as for project and raw data record retention. For internal proficiency testing samples, an external vendor is contracted to submit double blind samples to the laboratory. The external contractor assesses both the level of customer service and the accuracy of the test results objectively. The proficiency testing contractor provides a detailed report to the QA Manager and to each of the laboratories.

3.1.2.2 External Laboratory Audits

It is understood that external field audits may be conducted at the discretion of the EPA and the EPA may also elect to conduct an audit of the selected laboratories for this project. External laboratory audits may

include (but are not limited to) review of laboratory analytical procedures, laboratory onsite audits, and/or submission of performance evaluation samples to the laboratory for analysis.

3.1.3 Response Actions

In accordance with this QAPP, it is required that any and all project team personnel noting conditions adverse to quality report these conditions immediately to the Project Manager and QA Manager. These parties, in turn, are charged with performing root-cause analyses and implementing appropriate corrective action, as necessary, in a timely manner. It is ultimately the responsibility of the QA Manager to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed.

3.1.3.1 Field Corrective Action

Field nonconformance issues or conditions adverse to quality must be identified and corrected as quickly as possible so that work integrity or quality of product is not compromised. The need for corrective action may arise based on deviations from project plans and procedures, adverse field conditions, or other unforeseen circumstances. Corrective action needs may become apparent during the performance of daily work tasks or as a consequence of internal or external field audits. Corrective action will be monitored by the Project Manager.

3.1.3.2 Laboratory Corrective Action

In general, laboratory corrective actions are warranted whenever an out-of-control event or potential out-of-control event is noted. The specific corrective action taken depends on the specific analysis and the nature of the event.

In the event of a problem, a Nonconformance Corrective/Preventative Action report and/or LabTrack is completed. The report provides a routine written or electronic communication vehicle to describe most types of problems which may occur throughout the laboratory. The Nonconformance Corrective/Preventative Action system requires that the provider of the corrective action sign and date the report and send secondary copies of the solution to the problem back to the report originator, the QA Manager, and the Laboratory Manager. The QA Manager or designee shall monitor and log the progress of the Nonconformance Corrective/Preventative Action report and will report in the QA Progress Report the status of the major corrective actions taken in the past month. It is the QA Manager's responsibility to see that laboratory problems are documented and solved in a timely manner.

3.1.3.3 Corrective Action During Data Validation and Data Assessment

The need for corrective action may become apparent during data validation, interpretation, or presentation activities. The performances of rework (i.e., re-sampling or re-analysis), the institution of a change in work procedures, or the provision of additional/refresher training are possible corrective actions relevant to data evaluation activities. The QA Manager, in conjunction with the Project Manager, will be responsible for approving the implementation of a specified corrective action.

3.2 REPORTS TO MANAGEMENT

The data validation reports will address all major and minor laboratory noncompliance issues as well as noted sample matrix effects. In the event that major problems occur with an analytical laboratory (e.g., repeated or extreme holding time violations or calibration noncompliance), the data validator will notify the Project Manager. Such notifications (if necessary) are typically provided via e-mail and are placed in the project file. These reports contain a summary of the noncompliance issues, a synopsis of the impact on the individual project, and recommendations regarding corrective action.

The field team leader will provide the Project Manager with reports during the course of the sampling events which summarize work completed, deviations from the Work Plan, upcoming activities, and a QA summary.

The lab will provide a QA report to the QA Manager if QC limits for parameters associated with the project sampling program are updated or if significant plan deviations result from unanticipated circumstances. Since reporting limits, as applicable, will be included in the analytical data packages for the samples, it is not necessary for the laboratories to include updated reporting limits in their QA reports unless the updates result in reporting limits that exceed risk-based target levels.

The following frequencies will apply to QA reports for project sampling events: (1) data validation QA reports - contingent on sample collection; (2) field progress reports - daily or weekly during the event; (3) laboratory QA reports - as required based on QC limit updates or the occurrence of plan deviations resulting from unanticipated circumstances.

The quarterly progress reports, as required by the Administrative Consent Order, will summarize findings of validation, field audits, QA reports and identify the intended corrective actions, as necessary. The Site Assessment Report will include an assessment of the overall analytical program results in terms of precision, accuracy, representativeness, completeness, and sensitivity and will note any limitations on the use of the analytical results.

Data validation QA reports will be provided to the Project Manager for inclusion in the project files. In the event that major problems are observed for a given laboratory, the QA Manager and the Laboratory Project Manager will be provided with copies of the QA report. The Project Manager will also receive weekly field progress reports and, as appropriate, laboratory QA reports. Pertinent information will be provided to the EPA and IDEQ in the quarterly progress reports.

4 Data Validation and Usability

All data collected will be evaluated for consistency with the QA requirements of the project and its intended use. The means used to evaluate the data are established within the Work Plan and this QAPP and will be consistent with applicable regulatory agency or program requirements. The data evaluation process will be based on the DQOs established for this project and will include formal validation of a specified percentage of the laboratory analytical data by a third party.

4.1 DATA REVIEW, VERIFICATION, AND VALIDATION

At a minimum, all project data will be subject to a quality review to verify that all required deliverables are included in the analytical data package or other data submittal. A detailed QA review will be performed to verify the qualitative and quantitative reliability of the data as they are presented. This review will include a detailed evaluation and interpretation of all data generated by the analytical laboratory or other subcontractor (e.g., geophysical surveys). The primary tools to be used to evaluate any data collected will be applicable EPA guidance documents, method-specific QC, and professional judgment.

Any limitations on data usability will be expressed quantitatively, if possible, and will be recorded in any project documentation where the data are reported. The effect of the limitation will be evaluated and presented in appropriate project deliverables. The Project Manager will solicit review of that data by an independent senior professional to determine if the resulting deliverable accurately reflects the limitations on the data usability.

4.2 VERIFICATION AND VALIDATION METHODS

Following a preliminary review of all data for completeness and consistency with the project requirements, a more formal review will be conducted.

4.2.1 Field Data

The Project Manager or designee will review the field data for precision, accuracy, representativeness, completeness and comparablitity. Field data includes all of the field records and measurements compiled by the field sampling team. In general, the field data verification procedures will include:

- a review, for completeness, of field records contained in the field sampling logs
- verification that equipment blanks and replicates were properly prepared, identified, and analyzed
- a review of the chain of custody forms for proper completion, signatures of laboratory custodians and site sample custodian, and associated dates

Field duplicate samples will be used to assess precision. Equipment blanks will be used to assess field accuracy. To assess the impact of equipment blanks on field samples a comparison between the constituents detected in the blank samples and associated field samples will be conducted. Constituents detected in the field sample at a concentration less than five times the concentration of the same constituent detected in the equipment blank will be attributed to field cross contamination. In this case, the presence of the constituent will not be associated with Site conditions and will not be used in the decision making process. Completeness will be assessed based on the number of usable data points from the overall project data points. Completeness will be calculated on an overall project basis. For this project, a completeness goal of 95 percent or greater is required for all samples and parameters. Data points identified as unusable (i.e., data qualified as "R") are not included in the completeness calculation.

Information on data completeness will be presented in the Site Assessment Report. If the completeness DQO is not met for the overall project, re-sampling will be required. The comparability of the data will be assessed by ensuring that the field samples were collected in accordance with the field standard operating procedures and that the analytical methods are consistent throughout the sampling program. Representiveness is assessed by ensuring that the samples are collected at the locations specified in the sampling plan and that the correct number of samples is collected.

4.2.2 Laboratory Data

In general, laboratory data review procedures will be done in stages and may comprise computerized or manual checks applied at appropriate levels of the measurement process. Data review begins with the reduction or processing of data and continues through verification of the data and the reporting of analytical results. A series of checks are performed to review and verify the integrity of the data and adherence to SOPs and QC criteria. Data review checklists may be used to facilitate systematic review of the data. Data reduction can be performed by the analyst who obtained the data or by another analyst. Data verification starts with the analyst who performs a 100 percent review of the data to ensure the work was done correctly the first time. Data verification continues with review by a second reviewer (i.e., Manager or an analyst designated by the Manager who has been rated proficient in the specific analysis or an analysis with similar technology). This check is performed to ensure that the initial review has been completed correctly and thoroughly. The second level reviewer examines the data signed by the analyst. This review includes an evaluation of items required in the raw data package. Any exceptions noted by the analyst must be reviewed.

Following receipt of the analytical data packages from the laboratories, the QA Manager will review the chain-of-custody forms against the data packages to verify that all of the samples submitted were analyzed as required and that all holding times were met. The QA Manager will conduct a data assessment to evaluate if the analytical data quality is in compliance with the performance measures identified previously including precision, accuracy, representativeness, completeness, comparability, bias, and sensitivity. Additionally, the data will be reviewed for indications of interferences to results caused by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies.

The QA Manager will designate certain packages to be subject to formal validation by a third party. The third party independent data validator will perform the final review and approval of the data before it is designated as valid. The data packages for the conventional chemical parameters will be Level III with deliverables similar to those required by the EPA's contract laboratory program. The radiological data packages will contain full documentation required pursuant to the Multi-Agency Radiological Laboratory Analytical Protocols Manual (EPA 2004b). To ensure the quality and utility of the data for this project, approximately 20 percent of the data packages will be validated by a third party consistent with:

- USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 2004a)
- Multi-Agency Radiological Laboratory Analytical Protocols Manual (EPA 2004b)

Deviations in the QC criteria will be reported via data qualifying flags, when applicable, or explained in the case narrative if qualification of the data is not deemed necessary.

4.3 RECONCILIATION WITH USER REQUIREMENTS

The verification and validation of field and laboratory data will be used to determine if all data collected for this investigation is usable with respect to the project DQOs. Deviations from the DQOs established for this project will be explained in a specific section of the Site Assessment Report. Any uncertainty (e.g., biased high or biased low) associated with the data based on these deviations will be described and incorporated into the decision making process.

Only data generated in association with QC results meeting the DQOs and deemed usable by the QA Manager through verification or formal data validation will be considered usable for decision-making purposes. Limitations on the data will be reported via validation qualifying flags on the data, when applicable. For situations in which validation qualifying flags are not appropriate, a description of the limitation and the impact on the use of the data will be presented in the Site Assessment Report and taken into consideration in the decision making process.

In general, the demonstration of attainment of DQOs will be presented in the Site Assessment Report in a tabular format. The table will contain the applicable screening criteria and the analytical results. Analytical results that exceed the screening criteria will be highlighted on the table.

5 References

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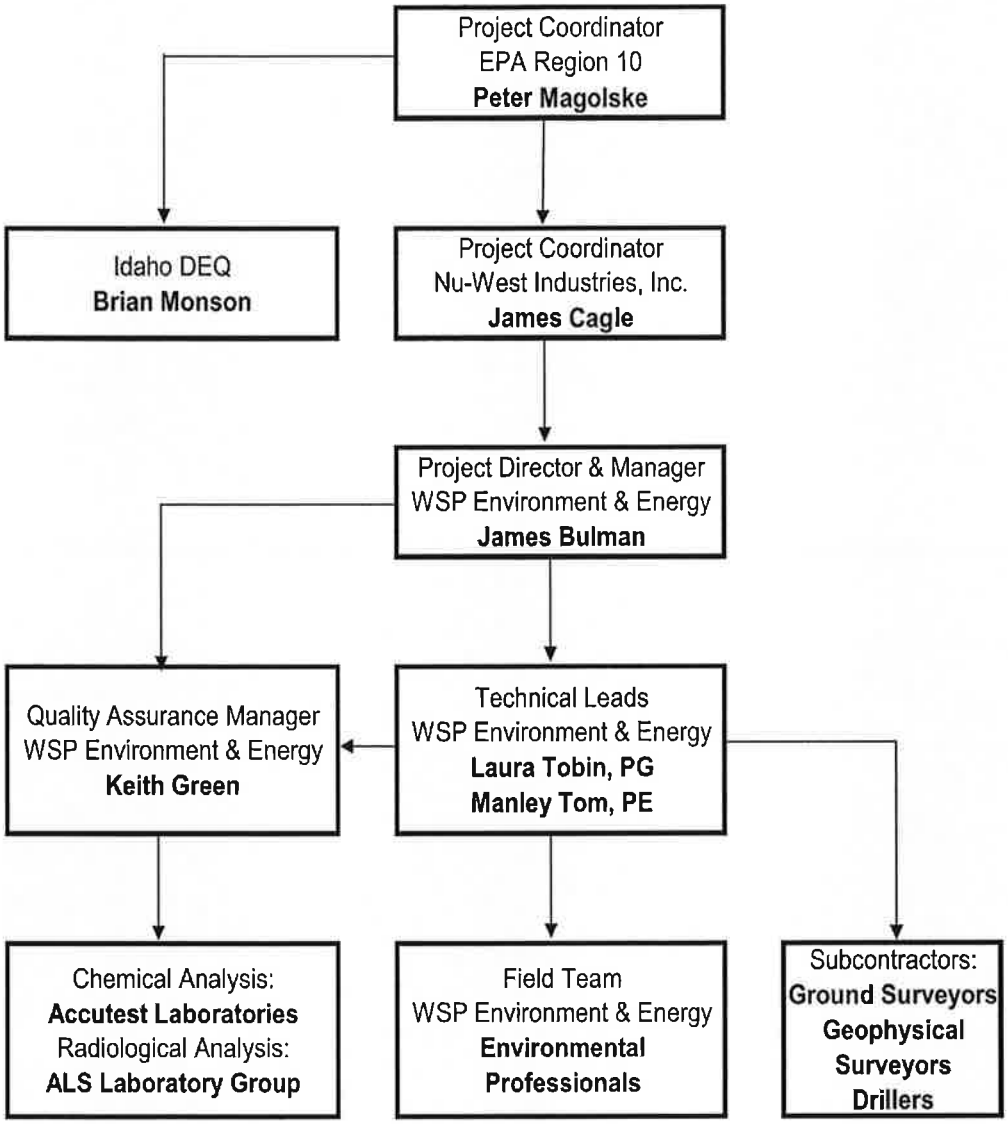
Figures

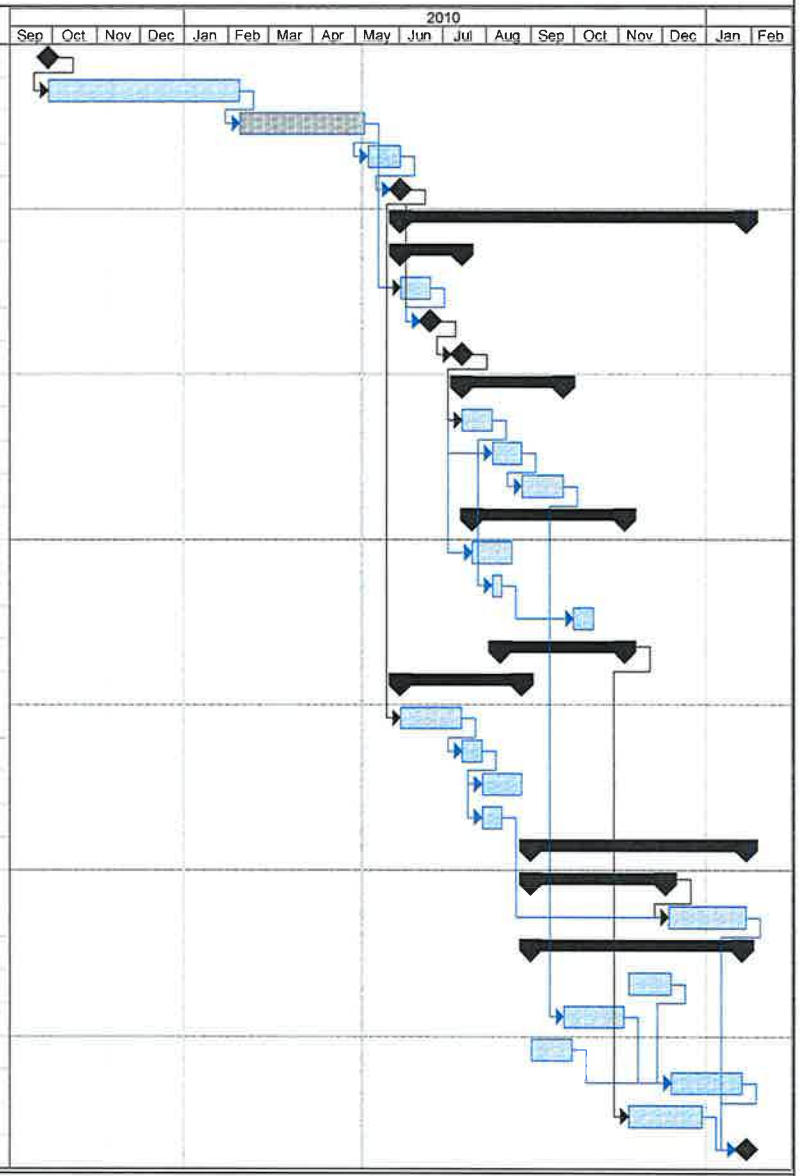


WSP Environment & Energy
4600 South Ulster Street
Suite 930
Denver, Colorado 80237
303-850-9200

Figure A-1
Project Organization Chart
Site Assessment Sampling and Analysis
Nu-West CPO
Soda Springs, Idaho

Figure A-2
Project Schedule
Site Characterization
Nu-West CPO Facility
Soda Springs, Idaho

ID	Task Name	Duration	Start	Finish
1	**Work Plan Submitted to EPA**	0 days	Mon 9/28/09	Mon 9/28/09
2	**EPA Review and Comment on Work Plan**	93 days	Mon 9/28/09	Mon 2/8/10
3	**CPO Address Comments and Revise Work Plan**	63 days	Tue 2/9/10	Fri 5/7/10
4	**EPA Final Review of Work Plan**	16 days	Mon 5/10/10	Tue 6/1/10
5	**EPA Approval of Work Plan**	0 days	Tue 6/1/10	Tue 6/1/10
6	**Work Plan Implementation**	**169 days**	**Wed 6/2/10**	**Fri 1/28/11**
7	**Preparation for Field Work**	**30 days**	**Wed 6/2/10**	**Wed 7/14/10**
8	Subcontractor Procurement (incl. final scope adjustments)	15 days	Wed 6/2/10	Tue 6/22/10
9	Issue Notice to Proceed to Subcontractors	0 days	Tue 6/22/10	Tue 6/22/10
10	Contractor on Site	0 days	Wed 7/14/10	Wed 7/14/10
11	**Site Surveys**	**50 days**	**Thu 7/15/10**	**Thu 9/23/10**
12	Ground Survey and Utility Clearance	15 days	Thu 7/15/10	Wed 8/4/10
13	Geophysical Surveys	15 days	Thu 8/5/10	Wed 8/25/10
14	Geophysical Report	20 days	Thu 8/26/10	Thu 9/23/10
15	**Sampling and Analysis**	**76 days**	**Thu 7/22/10**	**Fri 11/5/10**
16	Soil Boring and Sampling	20 days	Thu 7/22/10	Wed 8/18/10
17	Surface Water and Sediment Sampling (dependent on flow)	5 days	Thu 8/5/10	Wed 8/11/10
18	Groundwater Sampling	10 days	Fri 10/1/10	Thu 10/14/10
19	Laboratory Analysis	62 days	Wed 8/11/10	Fri 11/5/10
22	**Potable Well and Wetland Surveys**	**60 days**	**Wed 6/2/10**	**Wed 8/25/10**
23	Well Identification and Access Agreements	30 days	Wed 6/2/10	Wed 7/14/10
24	Potable Well Sampling	10 days	Thu 7/15/10	Wed 7/28/10
25	Laboratory Analysis	20 days	Thu 7/29/10	Wed 8/25/10
26	Wetlands and Surface Water Survey	10 days	Thu 7/29/10	Wed 8/11/10
27	**Data Evaluation and Reporting**	**105 days**	**Wed 9/1/10**	**Fri 1/28/11**
28	Data Validation and Review	65 days	Wed 9/1/10	Fri 12/3/10
32	Prepare Report (incl. internal drafts)	40 days	Mon 12/6/10	Fri 1/28/11
33	**Supplemental Work Plan**	**102 days**	**Wed 9/1/10**	**Tue 1/25/11**
34	Evaluate Groundwater Chemistry	20 days	Mon 11/8/10	Tue 12/7/10
35	Evaluate Geophysical Survey Report	30 days	Fri 9/24/10	Thu 11/4/10
36	Evaluate Soil Analyses	20 days	Wed 9/1/10	Wed 9/29/10
37	Prepare Supplemental Groundwater Well Work Plan	35 days	Wed 12/8/10	Tue 1/25/11
38	Prepare Supplemental Soil Sampling Work Plan (contingency)	35 days	Mon 11/8/10	Tue 12/28/10
39	**Submit Report and Supplemental Work Plans to EPA**	0 days	Fri 1/28/11	Fri 1/28/11



Date: Wed 5/5/10

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Note: Duration shown in working days.

Appendix A – Accutest Laboratory Quality Assurance Manual

ACCUTEST

Quality Systems Manual

Volume X, Revision II: September 2009

Effective Date: September 23, 2009

Document Control Number: _____

Harry Behzadi, Ph.D., VP Southeast Operations

Norman D. Farmer, Regional Technical Director

Rick Watkins, Laboratory Manager, Technical Director

Svetlana Izosimova, Ph.D., Quality Assurance Officer

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The Accutest Laboratories Southeast, Inc. (Accutest SE) Quality Assurance Program, detailed in this plan, has been designed to meet the quality program requirements of the National Environmental Laboratories Accreditation Conference (NELAC), DoD QSM Ver 4.1, 2009 and ISO 17025. The plan establishes the framework for documenting the requirements of the quality processes regularly practiced by the Laboratory. The Quality Assurance Officer is responsible for changes to the Quality Assurance Program, which are appended to the LQSM as they occur. The plan is reviewed annually for compliance purposes by the Laboratory Director and Technical Director and edited if necessary. Changes that are incorporated into the plan are summarized in the plan introduction. Changes to the plan are communicated to the general staff in a meeting conducted by the Quality Assurance Officer following the plan's approval.

The Accutest SE plan is supported by standard operating procedures (SOPs), which provide specific operational instructions on the execution of each quality element and assure that compliance with the requirements of the plan are achieved. Accutest SE employees are responsible for knowing the requirements of the SOPs and applying them in the daily execution of their duties. These documents are updated as changes occur and the staff is trained to apply the changes.

At Accutest, we believe that satisfying client requirements and providing a product that meets or exceeds the standards of the industry is the key to a good business relationship. However, client satisfaction cannot be guaranteed unless there is a system that assures the product consistently meets its design requirements and is adequately documented to assure that all procedural steps are executed and are traceable.

This plan has been designed to assure that this goal is consistently achieved and the Accutest product withstands the rigors of scrutiny that are routinely applied to analytical data and the processes that support its generation.

Accutest Laboratories Southeast is a permanent location facility and is part of Accutest Laboratories, Inc.

Summary of Changes
Accutest SE Quality System Manual – May 2009

Section	Description	Page #
Title Page	new revision number	Title
Introduction and Policy statement (sec. 1.2)	Commitment to DoD requirements	i, 5
Introduction	Accutest designation as permanent location facility and part of parent organization	i
2.2	Technical Director absence time limits	6
6.1	Form generation and control, personnel approving and issuing documents within the system	22
6.1	QSM controlled status and tracked status	23
6.1	SOP distribution to the clients ad watermarked documents	24
6.2	Secure status of irretrievable records and access with the access log	24
15.1	Clients' complaint documentation via Data Challenge system added	62
16.0	Significance of non-conformances in case narrative and sample repot footnotes	63
18.7	Client notification procedure added	67
App V	**SOP List – new section added**, table of contents amended accordingly	**92**

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1.0 QUALITY POLICY

1.1 *Accutest Mission*:

Accutest Laboratories provides analytical services to commercial and government clients in support of environmental monitoring and remedial activities as requested. The Laboratory's mission is dedicated to providing reliable data that satisfies clients requirements as explained in the following: "Provide easy access, high quality, analytical support to commercial and government clients which meet or exceeds data quality objectives and provides them with the data needed to satisfy regulatory requirements and/or make confident decisions on the effectiveness of remedial activities."

These services are provided impartially and are not influenced by undue commercial or financial pressures, which might impact the staff's technical judgment. Coincidentally, Accutest does not engage in activities that endanger the trust in our independent judgment and integrity in relation to the testing activities performed.

1.2 *Policy Statement*:

The management and staff of Accutest Laboratories share the responsibility for product quality. Accordingly, Accutest's quality assurance program is designed to assure that all processes and procedures, which are components of environmental data production, meet established industry requirements, are adequately documented from a procedural and data traceability perspective, and are consistently executed by the staff. It also assures that analytical data of known quality, meeting the quality objectives of the analytical method in use and the data user's requirements, is consistently produced in the laboratory. This assurance enables the data user to make rational, confident, cost-effective decisions on the assessment and resolution of environmental issues.

The laboratory Quality System also provides the management staff with data quality and operational feedback information. This enables them to determine if the laboratory is achieving the established quality and operational standards, which are dictated by the client or established by regulation, such as NELAC, ISO 17025 or DoD QSM. The information provided to management, through the QA program, is used to assess operational performance from a quality perspective and to perform corrective action as necessary.

All employees of Accutest Laboratories participating in environmental testing receive quality system training and are responsible for knowing and complying with the system requirements. The entire staff shares Accutest's commitment to good professional practice.

H Behzadi

Harry Behzadi, Ph.D.
VP Southeast Operations

2.0 ORGANIZATION

2.1 ***Organizational Entity***. Accutest Laboratories, Inc. is a testing laboratory founded in 1956 and registered as a New Jersey Corporation. In 2007 the laboratory has changed ownership to Accutest Holdings, Inc. Operations, staff and physical locations were not affected by the change. The laboratory headquarters are located in Dayton, New Jersey where it has conducted business since 1987. Satellite laboratories are maintained in Marlborough, Massachusetts; Orlando, Florida; San Jose, California ; Denver, Colorado, and Houston, Texas.

2.2 ***Management Responsibilities***

Requirement: Each laboratory facility will have an established chain of command. The duties and responsibilities of the management staff are linked to the President/CEO of Accutest Laboratories who establishes the agenda for all company activities.

President/CEO. Primarily responsible for all operations and business activities. Delegates authority to laboratory directors, general managers, and quality assurance director to conduct day-to-day operations and execute quality assurance duties. Each of the three operational entities (New Jersey, Florida and Massachusetts) reports to the President/CEO.

Corporate Quality Assurance Director. Responsible for design, oversight, and facilitation of all quality assurance activities established by the Quality Program. Directly reports to the President/CEO.

Vice President Operations/Laboratory Director. There is Laboratory Director assigned to each of the operational entities: New Jersey, Massachusetts and Florida. Executes day-to-day responsibility for laboratory operations including technical aspects of production activities and associated logistical procedures. Directly reports to the President/CEO.

Quality Assurance Officer *(on location)*. Responsible for oversight, implementation and facilitation of all quality assurance activities established by the Quality Program. Directly reports to the Laboratory Director. Also exchanges information with and submits laboratory performance data (PE scores, audit reports, accreditation changes, etc.) to Corporate QA Director. Takes program directions from Corporate QA Director.

Technical Director. Responsible for oversight and implementation of technical aspects of production activities in the environmental testing laboratory. In the event of prolonged absence Quality Assurance Officer is designated a deputy Technical Director, and Technical Director is designated a deputy Quality Assurance Officer. For Technical Director absences in excess of 15 consecutive calendar days a full-time staff member is designated to temporary perform this function. If this absence exceeds 65 consecutive calendar days, the Accreditation Body(ies) is to be notified in writing.

Department Managers. Executes day-to-day responsibility for specific laboratory areas including technical aspects of production activities and associated logistical procedures. Directly report to the Laboratory Director.

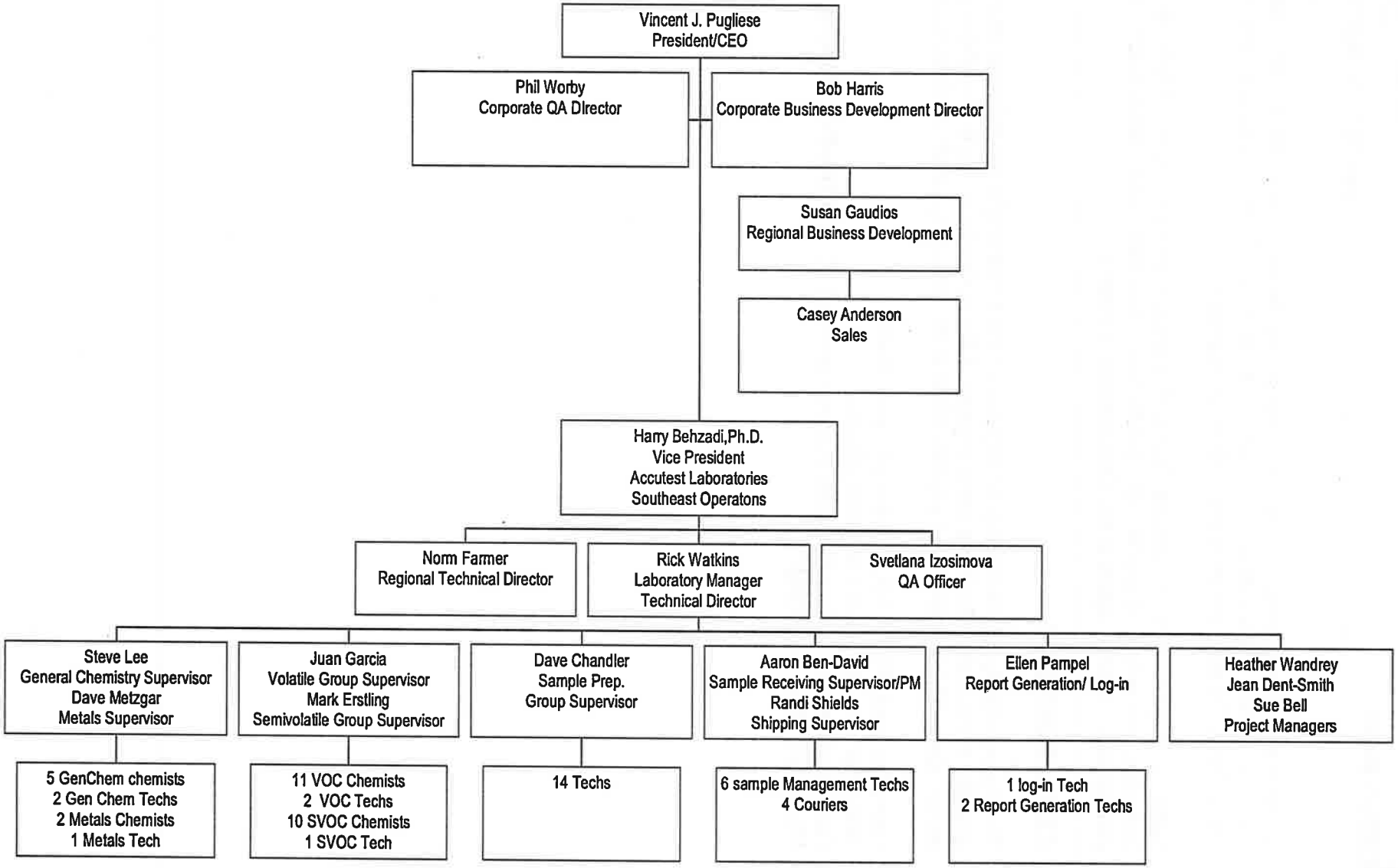
Section Supervisors. Executes day-to-day responsibility for specific laboratory units including technical aspects of production activities and associated logistical procedures. Directly report to the Department Manager.

2.3 *Chain of Command*

The responsibility for managing all aspects of the Company's operation is delegated to specific individuals, who have been assigned the authority to act in the absence of the senior staff. These individuals are identified in the following Chain of Command:

Harry Behzadi, Ph.D., VP, Southeast Operations
Norm Farmer, Regional Technical Director
Rick Watkins, Laboratory Manager (Operations and IT) ***and*** Heather Wandrey, Project Manager (Client Services)

Accutest Laboratories Southeast Organizational Chart



3.0 QUALITY RESPONSIBILITIES OF THE MANAGEMENT TEAM

3.1 ***Requirement***: Each member of the management team has a defined responsibility for the Quality Program. Program implementation and operation is designated as an operational management responsibility. Program design and implementation is designated as a Quality Assurance Responsibility.

President/CEO*:* Primary responsibility for all quality activities. Delegates program responsibility to the Quality Assurance Director. Serves as the primary alternate in the absence of the Quality Assurance Director. Has the ultimate responsibility for implementation of the Quality Program.

Vice President Operations/Laboratory Director*.* Responsible for implementing and operating the Quality Program in all laboratory areas. Responsible for the design and implementation of corrective action for defective processes. Has the authority to delegate Quality Program implementation responsibilities.

Corporate Quality Assurance Director*.* Responsible for design, implementation support, training, and monitoring of the quality system. Identifies product, process, or operational defects using statistical monitoring tools and processes audits for elimination via corrective action. Empowered with the authority to halt production if warranted by quality problems. Monitors implemented corrective actions for compliance.

Quality Assurance Officer *(on location).* Responsible for design support, implementation support, and monitoring support of the quality system. Training personnel in various aspects of quality system. Conducts audits and product reviews to identify product, process, or operational defects using statistical monitoring tools and processes audits for elimination via corrective action. Empowered with the authority to halt production if warranted by quality problems. Monitors implemented corrective actions for compliance.

Technical Director. Responsible for oversight and implementation of technical aspects of Quality System as they are integrated into method applications and employed to assess analytical controls on daily basis. The Technical Director reviews and acknowledges the technical feasibility of proposed quality system involving technical applications.

Department Managers*.* Responsible for applying the requirements of the Quality Program in their section and assuring subordinate supervisors and staff apply all program requirements. Initiates, designs, documents, and implements corrective action for quality deficiencies.

Group Leaders*.* Responsible for applying the requirements of the Quality Program to their operation and assuring the staff applies all program requirements. Initiates, designs, documents, and implements corrective action for quality deficiencies.

Bench Analysts. Responsible for applying the requirements of the Quality Program to the analyses they perform, evaluating QC data and initiating corrective action for quality control deficiencies within their control. Implements global corrective action as directed by superiors.

3.2 *Program Authority*:

Authority for program implementation on corporate level originates with the President/CEO who bears ultimate responsibility for program design, implementation, and enforcement of requirements. This authority and responsibility is delegated to the Director of Quality Assurance who performs quality functions independently without the encumbrances or biases created by operational or production responsibilities to ensure an honest, independent assessment of quality issues.

Laboratory Director and Quality Assurance Officer mirror this authority on location.

3.3 *Data Integrity Policy*:

The Accutest Data Integrity Policy reflects a comprehensive, systematic approach for assuring that data produced by the laboratory accurately reflects the outcome of the tests performed on field samples and has been produced in a bias free environment by ethical professionals. The policy includes a commitment to technical ethics, staff training in ethics and data integrity, an individual attestation to data integrity and procedures for evaluating data integrity. Senior management assumes the responsibility for assuring compliance with all technical ethics elements and operation of all data integrity procedures. The staff is responsible for compliance with the ethical code of conduct and for practicing data integrity procedures.

The Accutest Data Integrity Policy is as follows:

"Accutest Laboratories is committed to producing data that meets the data integrity requirements of the environmental regulatory community. This commitment is demonstrated through the application of a comprehensive data integrity program that includes ethics and data integrity training, data integrity evaluation procedures, staff participation and management oversight. Adherence to the specifications of the program assures that data provided to our clients is of the highest possible integrity and can be used for decision making processes with high confidence."

Data Integrity Responsibilities

Management. Senior management retains oversight responsibility for the data integrity program and retains ultimate responsibility for execution of the data integrity program elements. Senior management is responsible for providing the resources required to conduct ethics training and operate data integrity evaluation procedures. They also include responsibility for creating an environment of trust among the staff and being the lead advocate for promoting the data integrity policy and the importance of technical ethics.

Staff. The staff is responsible for adhering to the company ethics policy as they perform their duties and responsibilities associated with sample analysis and reporting. By executing this responsibility, data produced by Accutest Laboratories retains its high integrity characteristics and withstands the rigors of all data integrity checks.

The staff is also responsible for adhering to all laboratory requirements pertaining to manual data edits, data transcription and data traceability. These include the application of approved manual peak integration and documentation procedures. It also includes establishing traceability for all manual results calculations and data edits.

Ethics Statement. The Accutest ethics statement reflects the standards that are expected for businesses that provide environmental services to regulated entities and regulatory agencies on a commercial basis. The Ethics Policy is comprised of key elements that are essential to organizations that perform chemical analysis for a fee. As such, it focuses on elements related to personal, technical and business activities.

Accutest Laboratories provides analytical chemistry services on environmental matters to the regulated community. The data the company produces provides the foundation for determining the risk presented by a chemical pollutant to human health and the environment. The environmental industry is dependent upon the accurate portrayal of environmental chemistry data. This process is reliant upon a high level of scientific and personal ethics.

It is essential to the Company that each employee understands the ethical and quality standards required to work in this industry. Accordingly, Accutest has adopted a code of ethics, which each employee is expected to adhere to as follows:

- Perform chemical and microbiological analysis using accepted scientific practices and principles.
- Perform tasks in an honest, principled and incorruptible manner inspiring peers & subordinates.
- Maintain professional integrity as an individual.
- Provide services in a confidential, honest, and forthright manner.

- Produce results that are accurate and defensible.
- Report data without any considerations of self-interest.
- Comply with all pertinent laws and regulations associated with assigned tasks and responsibilities.

Data Integrity Procedures.

Four key elements comprise the Accutest data integrity system. Procedures have been implemented for conducting data integrity training and for documenting that employees conform to the Accutest Data Integrity and Ethics policy.

The data integrity program consists of routine data integrity evaluation and documentation procedures to periodically monitor and document data integrity. These procedures are documented as SOPs. SOPs are approved and reviewed annually following the procedures employed for all Accutest SOPs. Documentation associated with data integrity evaluations is maintained on file and is available for review.

Data Integrity Training, .Accutest employees receive technical ethics training during new employee orientation. Employees are also required to attend annual ethics refreshment training and sign an ethical conduct agreement annually, which verifies their understanding of Accutest's ethics policy and their ethical responsibilities. The agreement is refreshed annually and appended to each individual's training file.

The training focuses on the reasons for technical ethic training, explains the impact of data fraud on human health and the environment, and illustrates the consequences of criminal fraud on businesses and individual careers. Accutest's ethics policy and code of ethics are reviewed and explained for each new employee. Employees receive Accutest brochure for further review.

Training on data integrity procedures are conducted by individual departments for groups involved in data operations. These include procedures for manual chromatographic peak integration, standards traceability.

Data Integrity Training Documentation. Records of all data integrity training are maintained in individual training folders. Attendance at all training sessions is documented and appended to the training file.

Accutest Data Integrity and Ethical Conduct Agreement. All employees are required to sign a Data Integrity and Ethical Conduct Agreement annually. This document is archived in individual training files, which are retained for duration of employment.

The Data Integrity and Ethical Conduct Agreement is as follows:

I. *I understand the high ethical standards required of me with regard to the duties I perform and the data I report in connection with my employment at Accutest Laboratories.*

II. *I have received formal instruction on the code of ethics that has been adapted by Accutest Laboratories and agree to comply with these requirements.*

III. *I have received formal instruction on the elements of Accutest Laboratories' Data Integrity Policy and have been informed of the following specific procedures:*

   a. *Routine data integrity monitoring is conducted on sample data, which may include an evaluation of the data I produce,*

   b. *Formal procedures for the confidential reporting of data integrity issues are available, which can be used by any employee,*

   c. *A data integrity investigation is conducted when data issues are identified that may negatively impact data integrity.*

IV. *I am aware that data fraud is a punishable crime that may include fines and/or imprisonment upon conviction.*

V. *I also agree to the following:*

   a. *I shall not intentionally report data values, which are not the actual values observed or measured.*

   b. *I shall not intentionally modify data values unless the modification can be technically justified through a measurable analytical process.*

   c. *I shall not intentionally report dates and times of data analysis that are not the true and actual times the data analysis was conducted.*

   d. *I shall not condone any accidental or intentional reporting of inauthentic data by other employees and immediately report it's occurrence to my superiors.*

   e. *I shall immediately report any accidental reporting of inauthentic data by myself to my superiors.*

Data Integrity Monitoring. Several documented procedures are employed for performing data integrity monitoring. These include regular data review procedures by supervisory and management staff (Section 12.7), supervisory review and approval of manual integrations and periodic reviews of GALP audit trails from the LIMS and all computer controlled analysis.

Data Review. All data produced by the laboratory undergoes several levels of review, which includes two levels of management review. Detected data anomalies that appear to be related to data integrity issues are isolated for further investigation. The investigation is conducted following the procedures described in this section.

Manual Peak Integration Review and Approval. Routine data review procedures for all chromatographic processes includes a review of all manual chromatographic peak integrations. This review is performed by the management staff and consists of a review of the machine integration compared to the manual integration. Manual integrations, which have been performed in accordance with Accutest's manual peak integration procedures are approved for further processing and release. Manual integrations which are not performed to Accutest's specifications are set aside for corrective action, which may include analyst retraining or further investigation as necessary.

GALP Audit Trail Review. Good Automated Laboratory Practice (GALP) audits are comprehensive data package audits that include a review of raw data, process logbooks, processed data reports and GALP audit trails from individual instruments and LIMS. GALP audit trails, which record all electronic data activities, are available for the majority of computerized methodology and the laboratory information management system (LIMS). These audit trails are periodically reviewed to determine if interventions performed by technical staff constitute an appropriate action. The review is performed on a recently completed job and includes interviews with the staff who performed the analysis. Findings indicative of inappropriate interventions or data integrity issues are investigated to determine the cause and the extent of the anomaly.

Confidential Reporting Of Data Integrity Issues. Data integrity concerns may be raised by any individual to their supervisor. Employees with data integrity concerns should always discuss those concerns with their immediate supervisors as a first step unless the employee is concerned with the confidentiality of disclosing data integrity issues or is uncomfortable discussing the issue with their immediate supervisors. The supervisor makes an initial assessment of the situation to determine if the concern is related to a data integrity violation. Those issues that appear to be violations are documented by the supervisor and referred to the Director of Quality Assurance for investigation.

Documented procedures for the confidential reporting of data integrity issues in the laboratory are part of the data integrity policy. These procedures assure that laboratory staff can privately discuss ethical issues or report items of ethical concern without fears of repercussions with senior staff.

Employees with data integrity concerns that they consider to be confidential are directed to the Corporate Human Resources Manager in Dayton, New Jersey. The HR Manager acts as a conduit to arrange a private discussion between the employee and the Corporate QA Director or a local QA Officer.

During the employee - QA discussion, the QA representative evaluates the situation presented by the employee to determine if the issue is a data integrity concern or a legitimate practice. If the practice is legitimate, the QA representative clarifies the process for the employee to assure understanding. If the situation appears to be a data integrity concern, the QA representative initiates a Data Integrity Investigation following the procedures specified in SOP EQA059.

Data Integrity Investigations. Follow-up investigations are conducted for all reported instances of ethical concern related to data integrity. Investigations are performed in a confidential manner by senior management according to a documented procedure. The outcome of the investigation is documented and reported to the company president who has the ultimate responsibility for determining the final course of action in the matter. Investigation documentation includes corrective action records, client notification information and disciplinary action outcomes, which is archived for a period of five years.

The investigations are conducted by the senior staff and supervisory personnel from the affected area. The investigation team includes the Laboratory Director and the Quality Assurance Director. Investigations are conducted in a confidential manner until it is completed and resolved.

The investigation includes a review of the primary information in question by the investigations team. The team performs a review of associated data and similar historical data to determine if patterns exist. Interviews are conducted with key staff to determine the reasons for the observed practices.

Following data compilation, the investigations team reviews all information to formulate a consensus conclusion. The investigation results are documented along with the recommended course of action.

Corrective Action, Client Notification & Discipline. Investigations that reveal systematic data integrity issues will go through corrective action for resolution and disposition (Section 13). If the investigation indicates that an impact to data has occurred and the defective data has been released to clients, client notification procedures will be initiated following the steps in Section 17.6.

In all cases of data integrity violations, some level of disciplinary action will be conducted on the responsible individual. The level of discipline will be consistent with the violation and may range from retraining and/or verbal reprimand to termination.

4.0 JOB DESCRIPTIONS OF KEY STAFF

4.1 ***Requirement*:** Descriptions of key positions within the organization must defined to ensure that clients and staff understand duties and the responsibilities of the management staff and the reporting relationships between positions.

President/Chief Executive Officer. Responsible for all laboratory operations and business activities. Establishes the company mission and objectives in response to business needs. Direct supervision of the Vice President of Operations, each laboratory director, client services, management information systems, and quality assurance.

Vice President, Operations/Laboratory Director. Reports to the company president. Establishes regional laboratory operations strategy and business development. Authorized to enter into contractual agreements on Company's behalf.

Director, Quality Assurance. Reports to the company president. Establishes the company quality agenda, develops quality procedures, provides assistance to operations on quality procedure implementation, coordinates all quality control activities monitors the quality system and provides quality system feedback to management to be used for process improvement.

Chief Information Officer (CIO) Reports to the company president. Develops the MIS software and hardware agenda. Provides system strategies to compliment company objectives. Maintains all software and hardware used for data handling.

Client Services, Sales, Account Manager(s). Reports to the company president. Establishes and maintains communications between clients and the laboratory pertaining to client requirements which are related to sample analysis and data deliverables. Initiates client orders and supervises sample login operations.

Quality Assurance Officer *(on location)*. Reports to the Laboratory Director. Develops quality procedures, provides assistance to operations on quality procedure implementation, coordinates all quality control activities, monitors the quality system, and provides quality system feedback to management to be used for process improvement. In the event of prolonged absence QAO also designated a Deputy Technical Director, unless otherwise specified by internal memo from Laboratory Director.

Manager Client Services *(on location)*. Reports to the Laboratory Director. Establishes and maintains communications between clients and the laboratory pertaining to client requirements which are related to sample analysis and data deliverables. Initiates client orders and supervises sample login operations.

Technical Director (On Location). Reports to the laboratory director. Establishes laboratory operations strategy. Direct supervision of organic chemistry and inorganic chemistry. Directs the operations, preparation and instrumental analysis. Responsible

for following Quality Program requirements. Assumes operational responsibilities of Lab Director in his absence.

Laboratory Manager. Reports to the Laboratory Director. Directs the day-to day operations of entire laboratory, direct supervision of organic chemistry, inorganic chemistry, field services, and sample management.
Oversees daily work schedule as developed by respective departments. Supervises method implementation. Responsible for following Quality Program requirements. Maintains laboratory instrumentation in an operable condition.

Supervisors, Shipping and Receiving Departments. Reports to the Laboratory Manager. Develops, maintains and executes all procedures required for transport and receipt of samples, verification of preservation, and chain of custody documentation. Responsible for maintaining and documenting secure storage, delivery of samples to laboratory units on request, and disposal following completion of all analytical procedures.

Supervisor, Wet Chemistry. Reports to the Laboratory Manager. Directs the operations of the wet chemistry group. Establishes and executes daily work schedule. Supervises method implementation, application, and data production. Supervises the analysis of samples for wet chemistry parameters using valid, documented methodology. Maintains instrumentation in an operable condition. Reviews data for compliance to quality and methodological requirements. Responsible for following Quality Program requirements.

Supervisor, Metals. Reports to the Laboratory Manager. Directs the operations of the metals group. Establishes and executes daily work schedule. Supervises method implementation, application, and data production. Supervises the analysis of samples for metallic elements using valid, documented methodology. Documents all procedures and data production activities. Maintains instrumentation in an operable condition. Reviews data for compliance to quality and methodological requirements. Responsible for following Quality Program requirements

Supervisor, Organic Preparation. Reports to the Laboratory Manager. Directs the operations of the sample preparation group. Establishes and executes daily work schedule. Supervises method implementation, and application. Supervises the preparation of samples for organic compounds using valid, documented methodology. Documents all procedures and data production activities. Maintains laboratory equipment in an operable condition. Reviews records for compliance to quality and methodological requirements. Responsible for following Quality Program requirements.

Volatile and Semivolatie Supervisors, Organics. Reports to the Laboratory Manager. Directs the operations of the respective organics group. Establishes and executes daily work schedule. Supervises method implementation, application, and data production. Supervises the analysis of samples for organic compounds using valid, documented methodology. Documents all procedures and data production activities. Maintains instrumentation in an operable condition. Reviews data for

compliance to quality and methodological requirements. Responsible for following Quality Program requirements

Report Generation Supervisor. Reports to Laboratory Manager. Oversees report generation and fulfillment of client specifications as applied to data deliverables. Responsible for data delivery in timely manner.

4.2 ***Employee Screening, Orientation, and Training.***

All potential laboratory employees are screened and interviewed by human resources and technical staff prior to their hire. The pre-screen process includes a review of their qualifications including education, training and work experience to verify that they have adequate skills to perform the tasks of the job. Minimum qualifications for non-technical personnel require High School diploma (couriers also shall posses clean driving record), technical personnel must also demonstrate basic laboratory experience, such as balance and syringe use, aseptic practices, etc. College-level science coursework is favored.

Newly hired employees receive orientation training beginning the first day of employment by the Company. Orientation training consists of initial health and safety training and a detailed review of the personal protection policies, technical ethics training and data integrity procedures and quality assurance program training (including Company's goals, objectives, mission, and vision).

All technical staff receives training to develop and demonstrate proficiency for the methods they perform. New analysts work under supervision until the supervisory staff is satisfied that a thorough understanding of the method is apparent. Organics/Inorganics analysts are required to demonstrate method proficiency through a precision and accuracy study. Data from the study is compared to method acceptance limits. If the data is unacceptable, additional training is required. The analyst must also demonstrate the ability to produce acceptable data through the analysis of an independently prepared proficiency sample.

Proficiency is demonstrated annually. Data from initial and continuing proficiency demonstration is archived in the individual's training folder. In the instance where analyte can not be spiked in the clean matrix, such as TSS or pH, the results of an external Performance Evaluation (PE) sample may be used to document analyst's proficiency.

Minimum training required for administrative staff consists of laboratory safety and ethical conduct.

4.3 ***Training Documentation.*** The QA Officer prepares a training file for every new employee. All information related to qualifications, experience, external training courses, and education are placed into the file. Verification documentation for orientation, health & safety, quality assurance, and ethics training is also included in the file.

Additional training documentation is added to the file as it occurs. This includes data for initial and continuing demonstrations of proficiency, performance evaluation study data and notes and attendance lists from group training sessions.

The Quality Assurance Department maintains the employee training database. This database is a comprehensive inventory of training documentation for each individual employee. The database enables supervisors to obtain current status information on training data for individual employees on a job specific basis. It also enables the management staff to identify training documentation in need of completion.

Employee specific database records are created by human resources on the date of hire. Data base fields for job specific requirements such as SOP documentation of understanding and annual demonstration of analytical capability are automatically generated when the supervisor assigns a job responsibility. Employees acknowledge that their SOP responsibilities have been satisfied using a secure electronic process, which updates the database record. Reports are produced which summarize the qualifications of individual employees or departments.

5.0 SIGNATORY APPROVALS

Requirement: Procedures are required for establishing the traceability of data and documents. The procedure consists of a signature hierarchy, indicating levels of authorization for signature approvals of data and information within the organization. Signature authority is granted for approval of specific actions based on positional hierarchy within the organization and knowledge of the operation that requires signature approval. A log of signatures and initials of all employees is maintained for cross-referencing purposes.

5.1 *Signature Hierarchy*.

President/Chief Executive Officer. Authorization for contracts and binding agreements with outside parties. Approval of final reports, quality assurance policy, SOPs, project specific QAPs, data review and approval in lieu of technical managers. Contract signature authority resides with Company Officers only, which include the President/CEO, CFO and VP Administration.

Vice President, Operations/Laboratory Director. Approval of final reports and quality assurance policy in the absence of the President. Approval of SOPs, project specific QAPs, data review and approval in lieu of technical managers. Technical policy.

Technical Director (on location): Approval of final reports and quality assurance policy in the absence of the Laboratory Director. Approval of SOPs, project specific QAPs, data review and approval in lieu of technical managers. Technical policy review. In the event of prolonged absence Technical Director also designated a Deputy QAO, unless otherwise specified by internal memo from Laboratory Director.

Director, Quality Assurance. Approval of final reports and quality assurance policy in the absence of the President. Approval of SOPs, project specific QAPs, data review and approval in lieu of technical managers.

Quality Assurance Officer (on location). Approval of final reports and quality assurance policy in the absence of the Laboratory Director. Approval of SOPs, project specific QAPs, data review and approval in lieu of technical managers. In the event of prolonged absence QAO also designated a Deputy Technical Director, unless otherwise specified by internal memo from Laboratory Director.

Director, Management Information Systems (MIS). Department specific supplies purchase. MIS policy.

Manager, Sample Management. Initiation of laboratory sample custody and acceptance of all samples. Approval of department policies and procedures. Department specific supplies purchase. Waste manifesting and disposal.

Manager Client Services. QAP and sampling and analysis plan approval. Project specific contracts, pricing, and price modification agreements. Approval and acceptance of incoming work, Client services policy.

Supervisors, Technical Departments. Methodology and department specific QAPs. Data review and approval, department specific supplies purchase. Technical approval of SOPs.

Supervisors, Technical Departments. Data review approval, purchasing of expendable supplies.

5.2 ***Signature Requirements***. All laboratory activities related to sample custody and generation or release of data must be approved using either initials or signatures. The individual, who applies his signature or initial to an activity or document, is authorized to do so within the limits assigned to them by their supervisor. All signatures and initials must be applied in a readable format that can be cross-referenced to the signatures and initials log if necessary.

5.3 ***Signature and Initials Log***. *The QA Officer maintains a signature and initials log. New Employee signatures and initials are appended to the log on the first day of employment. Signature of individuals no longer employed by the company are retained.*

6.0 DOCUMENTATION and DOCUMENT CONTROL

Requirement: Document control policies have been established which specify that any document used as an information source or for recording analytical or quality control information must be managed using defined document control procedures. Accordingly, policies and procedures required for the control, protection, and storage of any information related to the production of analytical data and the operation of the quality system to assure its integrity and traceability have been established and implemented in the laboratory. The system contains sufficient controls for managing, archiving and reconstructing all process steps, which contributed to the generation of an analytical test result. Using this system, an audit trail for reported data can be produced, establishing complete traceability for the result.

6.1 Administrative Records. The Quality Assurance Officer manages Administrative (non-analytical) records. These records consist of electronic documents that are retained in a limited access electronic directory , which are released to the technical staff upon specific request.

Form Generation & Control. The Quality Assurance Officer approves all forms used as either stand-alone documents or in logbooks to ensure their traceability. Forms are generated as computer files only and maintained in a limited access master directory. Access to the electronic forms and applications is granted to QA Officer, Laboratory Manager and Technical Director(s) (local and regional). Approved forms must display the date of current revision and initials of person who revised the form. Modifications to existing forms are approved by QA, obsolete forms moved to archive directory and retained for minimum of five years.

New forms must include Accutest SE identification and appropriate spaces for signatures of approvals and dates. Further design specifications are the responsibility of the originating department.

Technical staff is required to complete all forms to the maximum extent possible. If information for a specific item is unavailable, the analyst is required to cross out the information block. The staff is also required to cross out the uncompleted portions of a logbook or logbook form if the day's analysis does not fill the entire page of the form.

Logbook Control. All laboratory logbooks are controlled documents that are comprised of approved forms used to document specific processes. Logbook control is maintained by QA staff.

New logs are numbered and issued to a specific individual who is assigned responsibility for the log. Supervisor performs periodical review of the logbooks. Old logs are returned to QA for entry into the document archive system where they are retained for minimum of five (5) years. Laboratory staff may hold a maximum of two consecutively dated logbooks of the same type in the laboratory, not including the most recently issued book to simplify review of recently completed analysis.

Controlled Documents. Key laboratory documents are designated for controlled document status to assure that identities of individuals receiving copies and the number of copies that have been distributed are known. Controlled status simplifies document updates and **retrieval** of outdated documents. Control is maintained through a document numbering procedure and document control logbook designating the individual receiving the controlled document. Document control is also maintained by pre-designating the numbers of official copies of documents that are placed into circulation within the laboratory.

Quality Systems Manual (QSM). All QSMs are assigned a number prior to distribution. The QSMs are distributed as controlled documents i.e. ones that will be collected back and replaced with next version (documents distributed to the Accutest Inc. staff). QSMs distributed to outside entities are considered tracked documents – since there is no possibility of collecting them back and ensuring that current revision is in use. These situation include bid submissions, client requests, etc. These copies are watermarked as "Uncontrolled Documents" The control/tracking number, date of distribution, and identity of the individual receiving the document are recorded in the document control spreadsheet. QA staff maintains tracking spreadsheet. The numbering system is continuous.

Standard Operating Procedures (SOPs). SOPs are maintained by pre-designating the numbers of official copies of documents that are placed into circulation within the laboratory. Official documents are printed and placed into the appropriate laboratory section as follows:

Sample Management: One copy for the sample receiving file
Bottle preparation area – One copy for shipping area
Organics Laboratories: One for the affected laboratory area.
Inorganics Laboratories: One for the affected laboratory area.

The original, signed copy of the SOP is maintained in the master SOP binder by the QA staff.

Documents are controlled using an "Official Copy" stamp in red ink. Additional copies could be issued to individuals for training purposes. Distribution is documented on SOP cover page. Superceded copies collection is conducted accordingly to cover page distribution list.

SOPs distributed to clients as part of bid submission, pre-audit evaluation, etc. are watermarked as "Proprietary Information".

Quick reference cards: These documents are compiled for lab staff convenience and are based on current SOP revision and/or recent regulatory updates. These one- or two-sided documents are footnoted with reference to SOP/regulatory standard, stamped with "Official Copy" stamp in red ink and laminated for durability. *Use of these quick references does not substitute reading and acknowledging the parent SOP.*

6.2 ***Technical Records***. All records related to the analysis of samples and the production of an analytical result are archived in secure document storage or on electronic media and contain sufficient detail to produce an audit trail, which re-creates the analytical result. These records include information related to the original client request, bottle order, sample login and custody, storage, sample preparation, analysis, data review and data reporting.

Records that can not be maintained on electronic media are considered irretrievable records, segregated into separate secured storage and access controlled with access log maintained by QA Staff. Examples of such records are employee training files, obsolete SOPs and acknowledgement form originals, training files, logbooks, etc.

Each department involved in this process maintains controlled documents, which enable them to maintain records of critical information relevant to their department's process.

6.3 ***Quality Assurance Directory.*** All Quality Assurance documentation and quality control limit data is stored in a restricted QA directory on the network server. The directory has been designated as read only. The QA staff, technical director and the laboratory manager have write capability in this directory. Information on this directory is backed-up daily.

This directory contains all current and archived Quality System Manuals, SOPs, control limits, MDL studies, precision and accuracy data, internal and external audit reports, official forms, Health and Safety materials, PT scores, State Certifications and metrics calibration information.

6.4 ***Analytical Records***. All data related to the analysis of field samples are retained as either paper or electronic records that can be retrieved to compile a traceable audit trail for any reported result. All information is linked to the client job and sample number, which serves as a reference for all sample related information tracking.

Critical times in the life of the sample from collection through analysis to disposal are documented. This includes date and time of collection, receipt by the laboratory, preparation times and dates, analysis times and dates and data reporting information. Analysis times are calculated in hours for methods where holding time is specified in hours (≤72 hours).

Sample preparation information is recorded in a separate controlled logbook. It includes sample identification numbers, types of analysis, preparation and cleanup methods, sample weights and volumes, reagent lot numbers and volumes and any other information pertinent to the preparation procedure.

Information related to the identification of the instrument used for analysis is permanently attached to the electronic record. The record includes an electronic data file that indicates all instrument conditions employed for the analysis, including the type of analysis conducted. The analyst's identification is electronically attached to the record. The instrument tuning and calibration data is electronically linked to the sample

or linked though paper logs, which were used in the documentation of the analysis. Quality control and performance criteria are permanently linked to the paper archive or electronic file.

Paper records for the identity, receipt, preparation and evaluation of all standards and reagents used in the analysis are documented in prepared records and maintained in controlled documents or files. Lot number information linking these materials to the analysis performed is recorded in the logbooks associated with the samples in which they were used.

Manual calculations or peak integrations that were performed during the data review are retained as paper or electronically generated PDF documents and included as part of the electronic archive. Signatures for data review are retained on paper or as electronic stamps on PDF versions of the paper record for the permanent electronic file.

6.5 ***Confidential Business Information (CBI).*** Operational documents including SOPs, Quality Manuals, personnel information, internal operations statistics, and laboratory audit reports are considered confidential business information. Strict controls are placed on the release of this information to outside parties.

Release of CBI to outside parties or organizations may be authorized upon execution of a confidentiality agreement between Accutest and the receiving organization or individual. CBI information release is authorized for third party auditors and commercial clients in electronic mode as Adobe Acrobat .PDF format only.

6.6 ***Software Change Documentation & Control.*** Changes to software are documented as text within the code of the program undergoing change. Documentation includes a description of the change, reason for change and the date the change was placed into effect. Documentation indicating the adequacy of the change is prepared following the evaluation by the user who requested the change.

6.7 ***Report and Data Archiving***. Accutest Laboratories maintains electronic image file copies of original reports in archive for a minimum period of five (5) years. After five years, the files are automatically discarded unless contractual arrangements exist which dictate different requirements. Client specific data retention practices are employed for government organizations such as the Department of Defense Agencies and MA DEP that require a retention period of ten (10) years, as well as commercial clients upon contractual requirements agreement.

Complete date and time stamped client repots are generated from LIMS using the source documents archived on Document server. These source documents are maintained on document server and backed up to primary and clone tapes. Accutest archives the original report (organized by job number) and the organic and inorganic support data. Organic support data is archived according to instrument batch numbers. All organics data is backed up to the tape or archive drive via Networker Backup software and/or AccuBack backup software. Data from the archive drive is then written to tape at periodic intervals.

Wet chemistry support data is archived by Analytical Batch (GN). Metals support data is archived by instrument batch (MA...). Metals digestion data is archived as digestion logbooks.

The reports generation group electronically scans completed reports and stores them by job number on the document server. The document server is backed up daily to a digital tape. Copies of these files remain active on the document server for easy review access. The digital tapes remain in secure storage for the remainder of the archive period.

6.8 ***Training***. The company maintains a training record for all employees that documents that they have received instruction on administrative and technical tasks that are required for the job they perform. Training records for individuals employed by the company are retained for a period of five years following their termination of employment.

Training File Origination. The Quality Assurance Officer (QAO) initiates training files. Quality Assurance officer retains the responsibility for the maintenance and tracking of all training related documentation in the file. The file is begun on the first day of employment. Information required for the file includes a copy of the individual's most current resume, detailing work experience and a copy of any college diplomas or transcript(s). Information added on the first day includes documentation of health and safety training and a signed Ethics and Data Integrity agreement. These two constitute minimal necessary training for Project Management and Administrative staff. Training documentation, training requirements, analyst proficiency information and other training related support documentation is tracked using a customized database application. Database extracts provide an itemized listing of specific training requirements by job function. Training status summaries for individual analysts portray dates of completion for job specific training requirements.

Technical Training. The supervisor of each new employee is responsible for developing a training plan for each new employee. The supervisor updates the outline, adding signatures and dates as training elements are completed at regular frequency. Supporting documentation, such as precision and accuracy studies, which demonstrate analyst capability for a specific test, are added as completed. When analyte can not be spiked, such as pH or TSS, external PE sample is purchased and analyzed. Where no external PE sample is available, sample duplicates must be successfully analyzed. Method review records are retained where analysis of duplicates is not possible. Employees and supervisors verify documentation of understanding (DOU) for all assigned standard operating procedures in the training database. Certificates or diplomas for any off-site training are added to the file.

7.0 REFERENCE STANDARD TRACEABILITY

Requirement: Documented procedures, which establish traceability between any measured value and a national reference standard, must be in place in the laboratory. All metric measurements must be traceable to NIST reference weights or thermometers that are calibrated on a regular schedule. All chemicals used for calibration of a quantitative process must be traceable to an NIST reference that is documented by the vendor using a certificate of traceability. The laboratory maintains a documentation system that establishes the traceability links. The procedures for verifying and documenting traceability must be documented in standard operating procedures.

7.1 ***Traceability of Metric Measurements - Thermometers***. Accutest uses NIST-traceable thermometers to calibrate commercially purchased working laboratory thermometers prior to their use in the laboratory and annually thereafter for liquid in glass thermometers or quarterly for electronic temperature measuring devices. If necessary, these working thermometers are assigned correction factors that are determined during their calibration using an NIST-traceable thermometer as the standard. The correction factor is documented in a thermometer log and on a tag attached to the working thermometer. The correction factor is applied to temperature measurements before recording the measurement in the temperature log. The NIST-traceable reference thermometer is checked for accuracy by an outside vendor minimum every five (5) years following the specifications for NIST-traceable thermometer calibration verification detailed in the United States Environmental Protection Agency's "Manual for the Certification of Laboratories Analyzing Drinking Water", Fifth Edition, January 2005. Currently the NIST thermometer is verified by outside vendor on triennial basis due to contract-specific requirements. Calibration log and Certificate(s) of calibration are maintained on file with QAO.

7.2 ***Traceability of Metric Measurements – Calibration Weights***. Accutest uses calibrated weights, which are traceable to NIST standard weights to calibrate all balances used in the laboratory. Balances must be calibrated to specific tolerances within the intended use range of the balance. Calibration checks are required on each day of use. If the tolerance criteria are not achieved, corrective action specified in the balance calibration SOP must be applied before the balance can be used for laboratory measurements. All weights are recalibrated by outside vendor every five years following the specifications for weight calibration verification detailed in the United States Environmental Protection Agency's "Manual for the Certification of Laboratories Analyzing Drinking Water", Fifth Edition, January 2005. Certificate(s) of calibration are maintained on file with QAO. Balances are inspected and maintained by professional service technicians annually. Certificate(s) of inspection are maintained with QAO.

7.3 ***Traceability of Chemical Standards and Reagents***. All chemicals and reagents, with the exception of bulk dry Na2SO4 and solvents purchased as reference standards for use in method calibration must establish traceability to NIST referenced material through a traceability certificate. Process links are established that enable a

calibration standard solution to be traced to its NIST reference certificate. Solvents, acids and other supplies are being tested to verify their suitability for the analytical process.

7.4 ***Assignment Of Reagent and Standard Expiration Dates.*** Expiration date information for all purchased standards and reagents is provided to Accutest with all prepared standard solutions and unstable reagents as a condition of purchase. Neat materials and inorganic reagents are not required to be purchased with expiration dates. Certified prepared solutions are labeled with the expiration date provided by the manufacturer. In-house prepared solutions are assigned expiration dates that are consistent with the method that employs their use unless documented experience indicates that an alternate date can be applied. If alternate expiration dates are employed, their use is documented in the method SOP. Expiration dates for prepared inorganic reagents, which have not exhibited instability, are established at two years form the date of preparation for tracking purposes. All containers shall be labeled with the date of preparation and expiration date clearly indicated.

The earliest expiration date is always the limiting date for assigning expiration dates to prepared solutions. Expiration dates that are later than the expiration date of any derivative solution or material are prohibited.

7.5 ***Documentation of Traceability***. Traceability information is documented in individual logbooks designated for the measurement process in use. The QA Officer maintains calibration documentation for metric references in pertinent folders and logbooks.

Balance calibration verification is documented in logbooks that are assigned to each balance. The individual conducting the calibration is required to initial and date all calibration activities. Any defects that occur during calibration are also documented along with the corrective action applied and a demonstration of return to control. Annual service reports and certificates retained on file with QA staff.

Temperature control is documented in logbooks assigned to the equipment being monitored. A calibrated thermometer is assigned to each individual item. Measurements are recorded along with date and initials of the individual conducting the measurement on a daily or as used basis. Corrective action, if required, is also documented including the demonstration of return to control.

Initial traceability of chemical standards and reagents is documented via a vendor-supplied certificate (see also 7.3) that includes lot number and expiration date information. Solutions prepared using the vendor supplied chemical standard are documented in logbooks assigned to specific analytical processes. Alternatively, documentation may be entered into the electronic standards and reagent tracking log The documentation includes links to the vendors lot number, an internal lot number, dates of preparation, and the preparer's initials. Standards received without certificate of analysis can not be used for calibration or calibration verification and are rejected.

Supervisors conduct regular reviews of logbooks, which are verified using a word "rev'd", signature and date. QA Staff monitors the process and documents it in the same manner.

8.0 TEST PROCEDURES, METHOD REFERENCES, AND REGULATORY PROGRAMS

Requirements: The laboratory must use client specified or regulatory agency approved methods for the analysis of environmental samples. The laboratory maintains a list of active methods, which specifies the type of analysis performed, and cross-references the methods to applicable environmental regulation. Routine procedures used by the laboratory for the execution of a method must be documented in a standard operating procedure. Method performance and sensitivity must be demonstrated annually where required. Defined procedures for the use of method sensitivity for data reporting purposes must be established by the Director of Quality Assurance and used consistently for all data reporting purposes.

8.1 ***Method Selection.*** Accutest employs methods for environmental sample analysis that are consistent with the client's application, which are appropriate and applicable to the project objectives. Accutest informs the client if the method proposed is inappropriate or outdated and suggests alternative approaches.

Accutest employs documented, validated regulatory methods in the absence of a client specification and informs the client of the method selected. These methods are available to the client and other parties as determined by the client. Documented and validated in-house methods may be applied if they are appropriate to the project. The client is informed of the method selection.

8.2 ***Method Validation***. Standard methods from regulatory sources are primarily used for all analysis. Standard methods do not require validation by the laboratory. Non-standard, in-house methods are validated prior to use. Validation is also performed for standard methods applied outside their intended scope of use. Validation is dependent upon the method application and may include analysis of quality control samples to develop precision and accuracy information for the intended use. A final method validation report is generated, which includes all data in the validation study. A statement of adequacy and/or equivalency is included in the report. A copy of the report is archived in the quality assurance directory of the company server.

Non-standard methods are validated prior to use. This includes the validation of modified standard methods to demonstrate comparability with existing methods. Demonstrations and validations are performed and documented prior to incorporating technological enhancements and non-standard methods into existing laboratory methods used for general applications. The demonstration includes method specific requirements for assuring that significant performance differences do not occur when the enhancement is incorporated into the method. Validation is dependent upon method application and may include the analysis of quality control samples to develop precision and accuracy information for intended use.

The study procedures and specifications for demonstrating validation include comparable method sensitivity, calibration response, method precision, method accuracy and field sample consistency for several classes of analytical methods are

detailed in this document. These procedures and specifications may vary depending upon the method and the modification.

8.3 ***Standard Operating Procedures***. Standard operating procedures (SOP) are prepared for routine methods executed by the laboratory and processes related to sample or data handling. The procedures describe the process steps in sufficient detail to enable an individual, who is unfamiliar with the procedure to execute it successfully. SOPs are reviewed annually and edited if necessary. SOPs can be edited on a more frequent basis if systematic errors dictate a need for process change or the originating regulatory agency promulgates a new version of the method. Procedural modifications are indicated using a revision number. SOPs are available for client review at the Accutest facility upon request.

8.4 ***Method Detection Limit Determination***. Annual method detection limit (MDL) studies are performed as appropriate for routine methods used in the laboratory. MDL studies are also performed when there is a change to the method that affects how the method is performed or when an instrumentation change that impacts sensitivity occurs. The procedure used for determining MDLs is described in 40 CFR, Part 136, Appendix B. Studies are performed for each method on water, soil and air matrices for every instrument that is used to perform the method. MDLs are established at the instrument level. The highest MDL of the pooled instrument data is used to establish a laboratory MDL. MDLs are experimentally verified through the analysis of spiked quality control samples at 2-4 times the concentration of the experimental MDL. The verification is performed on every instrument used to perform the analysis. The quality assurance staff manages the annual MDL determination process and is responsible for retaining MDL data on file. Approved MDLs are appended to the LIMS and used for data reporting purposes.

8.5 ***Method Reporting Limit.*** The method reporting limit is established at the lowest concentration calibration standard in the calibration curve. The low calibration standard is selected by department managers as the lowest concentration standard that can be used while continuing to meet the calibration linearity criteria of the method being used. The validity of the Method Reporting Limits is confirmed via analysis of a spiked quality control sample at the Method reporting limit concentration.

By definition, detected analytes at concentrations below the low calibration standard cannot be accurately quantitated and must be qualified accordingly.

8.6 ***Reporting of Quantitative Data.*** Analytical data for all methods is reported without qualification to the reporting limit established for each method. Data may be reported to MDL depending upon the client's requirements provided that all qualitative identification criteria for the parameter have been satisfied. All parameters reported at concentrations between the reporting limit and MDL are qualified as an estimated concentration.

Measured concentrations of detected analytes that exceed the upper limit of the calibration range are either diluted into the range and reanalyzed or qualified as an estimated value. The only exception to this applies to ICP and ICP/MS analysis, which

can be reported to the upper limit of the experimentally determined linear range without qualification.

8.7 ***Estimated Uncertainty.*** A statement of the estimated uncertainty of an analytical measurement accompanies the test result when required. Estimated uncertainty is derived from the performance limits established for spiked samples of similar matrices. The degree of uncertainty is derived from the negative or positive bias for spiked samples accompanying a specific parameter. When the uncertainty estimate is applied to a measured value, the possible quantitative range for that specific parameter at that measured concentration is defined. Well recognized regulatory methods that specify values for the major sources of uncertainty and specify the data reporting format do not require a further estimate of uncertainty.

8.8 ***Precision and Accuracy Studies***. Annual precision and accuracy (P&A) studies, which demonstrate the laboratories ability to generate acceptable date, are performed for all routine methods used in the laboratory. The procedure used for generating organic P&A data is referenced in the majority of the regulatory methodology in use. The procedure requires quadruplicate analysis of a sample spiked with target analytes at a concentration in the working range of the method. This data may be compiled from a series of existing blank spikes or laboratory control samples. Accuracy (percent recovery) of the replicate analysis is averaged and compared to established method performance limits. Values within method limits indicate an acceptable performance demonstration. (See also Sec 4, Training, Demonstration of capability)

8.9 ***Method Sources, References and Update Mechanism.*** The Quality Assurance Staff maintains a list of active methods used for the analysis of samples. This list includes valid method references such as EPA, American Society of Testing and Materials (ASTM) or Standard Methods designations and the current version and version date.

Updated versions of approved reference methodology are placed into use as changes occur. The Quality Assurance Director informs operations management of changes in method versions as they occur. The operations management staff selects an implementation date. The operations staff is responsible for completing all method requirements prior to the implementation date. This includes modification to SOPs, completion of MDL and precision and accuracy studies and staff training. Documentation of these activities is provided to the QA staff who retains this information on file. The updated method is placed into service on the implementation date and the old version is de-activated.

Multiple versions of selected methods may remain in use to satisfy client specific needs. In these situations, the default method version becomes the most recent version. Client specific needs are communicated to the laboratory staff using method specific analytical codes method, which clearly depict the version to be used. The old method version is maintained as an active method until the specified client no longer requires the use of the older version.

Accutest will not use methodology that represents significant departures from the reference method unless specifically directed by the client. In cases where clients

direct the laboratory to use a method modification that represents a significant departure from the reference method, the request will be documented in the project file. The LQSM lists active methods used for the analysis of samples in Table 8.1. This list includes valid method references from sources such as USEPA, ASTM or Standard Methods designations and the current version and version date.

8.10 ***Analytical Capabilities***. Appendix II provides a detailed listing of the methodology employed for the analysis of test samples.

9.0 SAMPLE MANAGEMENT, LOGIN, CUSTODY, STORAGE AND DISPOSAL

Requirement: A system to ensure that client supplied product is adequately evaluated, acknowledged, and secured upon delivery to the laboratory must be practiced by the laboratory. The system must assure that chain of custody is maintained and that sample receipt conditions and preservation status are documented and communicated to the client and internal staff. The login procedure must assign, document, and map the specifications for the analysis of each unique sample to assure that the requested analysis is performed on the correct sample and enables the sample to be tracked throughout the laboratory analytical cycle. The system must include procedures for reconciling defects in sample condition or client provided data, which occur at sample arrival. The system must specify the procedures for proper sample storage, transfer to the laboratory, and disposal after analysis. The system must be documented in a standard operating procedure.

9.1 ***Order Receipt and Entry***. New orders are initiated and processed by the client services group (See Chapter 14, Procedures for Executing Client Specifications). The new order procedure includes mechanisms for providing sampling containers to clients. These containers must meet the size, cleanliness, and preservation specifications for the analysis to be performed.

For new orders, the project manager prepares a bottle request form, which is submitted to sample management. This form provides critical project details to the sample management staff, which are used to prepare and assemble the sample bottles for shipment to the client prior to sampling.

The bottle order is assembled using bottles that meet USEPA specifications for contaminant free sample containers. Accutest-SE uses a combination of pre-cleaned bottles, which are purchased from commercial suppliers and bottles that are checked for cleanliness. Precleaned bottle certificates are reviewed by both the analyst and sample management technician. Results of bottle analyses are retained for 5 years.

All preservative solutions are prepared in the laboratory and are checked to assure that they are free of contamination from analytes of interest before being released for use. Sample management department retains a copy of the documentation of in-house contamination checks.

Reagent water for trip and field blanks is poured into appropriately labeled containers. All bottles are packed into ice chests with blank chain of custody forms and the original bottle order from. Completed bottle orders are delivered to clients using Accutest couriers or commercial carriers for use in field sample collection.

9.2 ***Sample Receipt and Custody***. Samples are delivered to the laboratory using a variety of mechanisms including Accutest couriers, commercial shippers, and client self-delivery. Documented procedures are followed for arriving samples to assure that custody and integrity are maintained and that handling and preservation requirements are documented and continued.

Sample custody documentation is initiated when the individual collecting the sample collects field samples. Custody documentation includes all information necessary to provide an unambiguous record of sample collection, sample identification, and sample collection chronology. Initial custody documentation employs either Accutest or client generated custody forms.

Accutest generates a Sample Receipt Confirmation form in situations where the individuals who collected the sample did not generate custody documentation in the field. Accutest SE Project Manager then contacts the client for the CoC information to be faxed or e-mailed from the client to the lab.

Accutest defines sample custody as follows:

* The sample is in the actual custody or possession of the assigned responsible person,

* The sample is in a secure area.

The Accutest facility is defined as a secure facility. Perimeter security has been established, which limits access to authorized individuals only. Visitors enter the facility through the building lobby and must register with the receptionist prior to entering controlled areas. While in the facility, visitors must be accompanied by their hosts at all times. After hours, building access is controlled using a computerized pass-key reader system. This system limits building access to individuals with a pre-assigned authorization status. After hours visitors are not authorized to be in the building. Clients delivering samples after hours must make advanced arrangements through client services and sample management to assure that staff is available to take delivery and maintain custody.

Upon arrival at Accutest, the sample custodian reviews the chain of custody Or Sample Receipt Confirmation form for the samples received to verify that the information on the form corresponds with the samples delivered. This includes verification that all listed samples are present and properly labeled, checks to verify that samples were transported and received at the required temperature, verification that the sample was received in proper containers, verification that sufficient volume is available to conduct the requested analysis, and a check of individual sample containers to verify test specific preservation requirements including the absence of headspace for volatile compound analysis.

Sample conditions and other observations are documented on the chain of custody by the sample custodian prior to completing acceptance of custody. The sample custodian accepts sample custody upon verification that the custody document is correct. Discrepancies or non-compliant situations are documented, flagged and communicated to the Accutest project manager, who contacts the client for resolution. The resolution is documented and communicated to sample management for execution.

9.3 ***Laboratory preservation of Improperly preserved field samples.*** Accutest extends every effort to preserve samples, which were received without proper field preservation.

Field/Equipment negative controls also receive the same amount of preservation as incorrectly preserved samples, and record made in the preservation logbook.

9.4 ***Sample Tracking Via Status Change.*** An automated, electronic LIMS procedure records sample exchange transactions between departments and changes in analytical status. This system tracks all preparation, analytical, and data reporting procedures to which a sample is subjected while in the possession of the laboratory. Each individual receiving samples must acknowledge the change in custody and operational status in the LIMS. This step is required to maintain an accurate electronic record of sample status, dates of analytical activity, and custody throughout the laboratory.

Sample tracking is initiated at login where all chronological information related to sample collection dates and holding times are entered into the LIMS. This information is entered on an individual sample basis

9.5 ***Sample Acceptance Policy***. Incoming samples must satisfy Accutest's sample acceptance criteria before being logged into the system. Sample acceptance is based on the premise that clients have exercised proper protocols for sample collection. This includes sufficient volume, proper chemical preservation, temperature preservation, sample container sealing and labeling, and appropriate shipping container packing.

The sample management staff will make every attempt to preserve improperly preserved samples upon arrival. However, if preservation is not possible, the samples may be refused unless the client authorizes analysis. No samples will be accepted if holding times have been exceeded or will be exceeded before analysis can take place unless the client authorizes analysis.

Sample acceptance criteria include proper custody and sample labeling documentation. Proper custody documentation includes an entry for all physical samples delivered to the laboratory with an identification code that matches the sample bottle and a date and signature of the individual who collected the sample and delivered them to the laboratory.

Accutest reserves the right to refuse any sample which in its sole and absolute discretion and judgement is hazardous, toxic and poses or may pose a health, safety or environmental risk during handling or processing. The company will not accept samples for analysis using methodology that is not performed by the laboratory or for methods that lab does not hold valid accreditation unless arrangements have been made to have the analysis conducted by a qualified subcontractor.

9.6 ***Assignment of Unique Sample Identification Codes***. Unique identification codes must be assigned to each sample bottle to assure traceability and unambiguously identify the tests to be performed in the laboratory.

The sample identification coding process begins with the assignment of a unique alphanumeric job number. A job is defined as a group of samples received on the same day, from a specific client pertaining to a specific project. A job may consist of groups of samples received over multi-day period. The first character of the job number is an alpha-character that identifies the laboratory facility. The next characters are numeric and sequence by one number with each new job.

Unique sample numbers are assigned to each bottle collected as a discrete entity from a designated sample point. This number begins with the job number and incorporates a second series of numbers beginning at one and continuing chronologically for each point of collection. The test to be performed is clearly identified on the bottle label.

Alpha suffixes may be added to the sample number to identify special designations such as subcontracted tests, in-house QC checks, or re-logs. Multiple sample bottles for a specific analysis are labeled Bottle 1, Bottle 2, etc.

9.7 ***Subcontracted Analysis***. Subcontract laboratories are employed to perform analysis not performed by Accutest. The quality assurance staff evaluates subcontract laboratories to assure their quality processes meet the standards of the environmental laboratory industry prior to engagement. Throughout the subcontract process, Accutest follows established procedures to assure that sample custody is maintained and the data produced by the subcontractor meets established quality criteria.

Accutest network laboratories are considered primary subcontractors.

Subcontracting Procedure. Subcontracting procedures are initiated through several mechanisms, which originate with sample management. Samples for analysis by a subcontractor are logged into the Accutest system using regular login procedures. If subcontract parameters are part of the project or sample management has received subcontracting instructions for a specific project, a copy of the chain of custody is given to the appropriate project manager with the subcontracted parameters highlighted. This procedure triggers the subcontract process at the project management level. The Sample Management supervisor contacts an approved subcontractor to place the subcontract order.. Subcontract chain of custody is processed in Sample Management Department and copy is filed with the original CoC. Sample management signs the subcontract chain of custody and ships the sample(s) to the subcontractor. The subcontract COC is filed with the original COC and the request for subcontract. Copies are distributed to the login department, the project manager, and sample management.

Client is verbally notified by Project Manager of the requirement to subcontract to the outside laboratory as soon as need Is identified by the Accutest staff. Client notification must be verified in writing, i.e. by e-mail. Client notification may take place during the initial project set-up, or at the time of sample receipt and login.

Subcontractor data packages are reviewed by the QA Staff to assess completeness and quality compliance. If completeness defects are detected, the subcontractor is

asked to immediately upgrade the data package. If data quality defects are detected, the package is forwarded to the QA staff for further review. The QA staff will pursue a corrective action solution before releasing data to the client.

Approved subcontract data is entered into the laboratory information management system (LIMS) if possible and incorporated into the final report. All subcontract data is footnoted to provide the client with a clear indication of its source. Copies of original subcontract data are always included in the data report whether in hardcopy or PDF file, depending on the data submission requirements.

1.1. *Subcontract Laboratory Evaluation.* The QA staff evaluates subcontract laboratories prior to engagement. As a minimum, the subcontract laboratory must provide Accutest with proof of a valid certification to perform the requested analysis for the venue where they were collected, QC criteria summary (LOD/LOQ, LCS, MS/MSD, %RPD, etc.), copy of the most recent regulatory agency audit report, and a copy of the laboratory's Summary of Qualifications (SOQ). Other beneficial materials are QSM, copies of SOPs used for the subcontracted analysis, a copy of the most recent performance evaluation study for the subcontracted parameter, and copies of the most recent third party accreditor's audit report.

Certification verification must be submitted to Accutest annually. If possible, the QA staff may conduct a site visit to the laboratory to inspect the quality system. Accutest Laboratories Southeast assumes the responsibility for the performance of all subcontractors who have successfully demonstrated their qualifications. When selecting a subcontractor for analysis not performed by Accutest, assure qualifications of the subcontractor through local QA officer.

Qualification process of a subcontract laboratory may be bypassed if the primary client directs Accutest to employ a specific subcontractor

Subcontract Laboratory Database. Accutest Laboratories Inc. maintains centralized database of preferred contractors in order to optimize sample handling and data submission process, as well as obtain competitive priced services of uniform quality throughout the network. Individual Accutest laboratories are assigned "Center of Expertise" status according to unique capabilities.

9.8 ***Sample Storage***. Following sample custody transfer, samples are assigned to various refrigerated storage areas by the sample management staff depending upon the test to be performed and the matrix of the samples. The location (refrigerator and shelf) of each sample is entered into sample location database on the line corresponding to each sample number. Samples remain in storage until the laboratory technician retrieves them into the laboratory for analysis.

Samples for volatile organics analysis are placed in storage in designated refrigerators by the sample management staff and immediately transferred to the organics group control. Sample custody is transferred to the VOC department staff. These samples are segregated according to matrix to limit opportunities for cross contamination to occur.

Organics staff is authorized to retrieve samples from these storage areas for analysis. When analysis is complete, the samples are placed back into storage.

9.9 ***Sample Login***. Following sample custody transfer to the laboratory, the documentation that describes the clients analytical requirements are delivered to the sample login group for coding and entry to the Laboratory Information management System (LIMS). This process translates all information related to collection time, turnaround time, sample analysis, and deliverables into a code which enables client requirements to be electronically distributed to the various departments within the laboratory for scheduling and execution.

The technical staff is alerted to client or project specific requirements through the use of a unique project code that is electronically attached to the job during login. The unique project code directs the technical staff to controlled specifications documents detailing the unique requirements.

9.10 ***Sample Retrieval for Analysis***. It is a responsibility of individual analyst to retrieve samples for analysis. Sample Management employs a program to facilitate sample placement and retrieval. Sample is traced around the laboratory using Status feature of LIMS.

After sample analysis has been completed, the analyst places the sample back into the storage and updates sample status.

9.11 ***Sample Disposal***. Accutest retains all samples under proper storage for a minimum of 30 days following completion of the analysis report. Longer storage periods are accommodated on a client specific basis if required. Samples may also be returned to the client for disposal.

Accutest disposes of all laboratory wastes following the requirements of the Resource Conservation and Recovery Act (RCRA). The Company has obtained and maintains a waste generator identification number, FLR00001263309002 (FLR designates State of Florida).

Sample management generates a sample disposal dump sheet from the LIMS tracking system each week, which lists all samples whose holding period has expired. Data from each sample is compared to the hazardous waste criteria established by the Florida Department of Environmental Protection (FDEP).

Samples containing constituents at concentrations above the criteria are labeled as hazardous and segregated into six separate waste categories for disposal as follows:

* Organic extracts: Chlorinated solvents (methylene chloride, chloroform)
* Mixed non-chlorinated (flammable) solvents (hexane, acetone, toluene, acetonitrile, methanol, ether)
* Oily waste
* Soil (solids)

* Cyanide waste
* Corrosive waste

Non-hazardous aqueous samples are diluted, neutralized, and disposed directly into the laboratory sink.

Non-hazardous solids are drummed and disposed of by waste company. Sample bottles are disposed of as recyclable waste in order to crush the bottles and destroy the labels.

Laboratory wastes are collected by waste stream in designated areas throughout the laboratory. Waste streams are consolidated twice a week by the waste custodian and transferred to stream specific drums for disposal through a permitted waste management contractor. Filled, consolidated drums are tested for hazardous characteristics and scheduled for removal from the facility for appropriate disposal based on the laboratory data.

10.0 LABORATORY INSTRUMENTATION AND MEASUREMENT STANDARDS

Requirement: Procedures, which assure that instrumentation is performing to a pre-determined operational standard prior to the analysis of any samples, must be established by the laboratory. In general, these procedures will follow the regulatory agency requirements established in promulgated methodology. The instrumentation selected to perform specified analysis is capable of providing the method-specified uncertainty and sufficient sensitivity of measurement needed. These procedures must be documented and incorporated into the standard operating procedures for the method being executed. ALSE Equipment List attached as Appendix III.

10.1 ***Mass Tuning – Mass Spectrometers***. The mass spectrometer tune and sensitivity must be monitored to assure that the instrument is assigning masses and mass abundances correctly and that the instrument has sufficient sensitivity to detect compounds at low concentrations. This is accomplished by analyzing a specific mass tuning compound at a fixed concentration. If the sensitivity is insufficient to detect the tuning compound, corrective action must be performed prior to the analysis of standards or samples. If the mass assignments or mass abundances do not meet criteria, corrective action must be performed prior to the analysis of standards or samples.

10.2 ***Wavelength Verification – Spectrophotometers***. Spectrophotometer detectors are checked on a regular schedule to verify proper response to the wavelength of light needed for the test in use. If the detector response does not meet specifications, corrective action (detector adjustment or replacement) is performed prior to the analysis of standards or samples.

10.3 ***Inter-element Interference Checks (Metals)***. Inductively Coupled Plasma Emission Spectrophotometers (ICP) are subject to a variety of spectral interferences, which can be minimized or eliminated by applying interfering element correction factors and background correction points. Interfering element correction factors are checked on a specified frequency through the analysis of check samples containing high levels of interfering elements. Analysis of single element interferent solutions is also conducted at a specified frequency.

If the check indicates that the method criteria has not been achieved for any element in the check standard, the analysis is halted and data from the affected samples are not reported. Sample analysis is resumed after corrective action has been performed and the correction factors have been re-calculated.

New interfering element correction factors are calculated and applied whenever the checks indicate that the correction factors are no longer meeting criteria. At a minimum, correction factors are replaced once a year.

10.4 ***Calibration and Calibration Verification***. Many tests require calibration using a series of reference standards to establish the concentration range for performing quantitative analysis. Method specific procedures for calibration are followed prior to any sample analysis.

Calibration is performed using a linear or quadratic regression calculation or calibration factors calculated from the curve. The calibration must meet method specific criteria for linearity or precision. If the criteria are not achieved, corrective action (instrument maintenance or re-calibration) is performed. The instrument must be successfully calibrated before analysis of samples can be conducted.

Initial calibration for metals analysis performed using inductively coupled plasma (ICP) employs the use of two standards and a calibration blank to establish linearity. The calibration blank contains all reagents that are placed into the calibration standard with the exception of the target elements. Valid calibration blanks must not contain any target elements.

Initial calibrations must be initially verified using a single concentration calibration standard from a second source (i.e. separate lot or different provider). The continuing validity of an existing calibration must be regularly verified using a single concentration calibration standard. The response to the standard must meet pre-established criteria that indicate the initial calibration curve remains valid. If the criteria are not achieved corrective action (re-calibration) is performed before any additional samples may be analyzed.

10.5 ***Linear Range Verification and Calibration*** Linear range verification is performed for all ICP instrumentation and select General Chemistry methods. The regulatory program or analytical method specifies the verification frequency. A series of calibration standards are analyzed over a broad concentration range. The data from these analyses are used to determine the valid analytical range for the instrument.

Some methods or analytical programs require a low concentration calibration check to verify that instrument is sufficient to detect target elements at the reporting limit. The analytical method or regulatory program defines the criteria used to evaluate the low concentration calibration check. If the low calibration check fails criteria, corrective action is performed and verified through reanalysis of the low concentration calibration check before continuing with the field sample analysis.

In accordance with NELAC standards minimum number of calibration points in the absence of method-specific requirements is two calibration points and a blank.

10.6 ***Retention Time Verification (GC/HPLC/IC)***. Chromatographic retention time windows are developed for all analysis performed using gas chromatographs with conventional detectors. An initial experimental study is performed, which establishes the width of the retention window for each compound. The retention time range of the window defines the time ranges for elution of specified target analytes on the primary and

confirmation columns. Retention time windows are established upon initial calibration, applying the retention time range from the initial study to each target compound. Retention times are regularly confirmed through the analysis of an authentic standard during calibration verification. If the target analytes do not elute within the defined range during calibration verification, the instrument must be recalibrated and new windows defined. New studies are performed when major changes, such as column replacement are made to the chromatographic system.

11.0 INSTRUMENT MAINTENANCE

Requirement. Procedures must be established for equipment maintenance. The procedure may include a maintenance schedule if required or documentation of daily maintenance related activities. All instrument maintenance activities must be documented in instrument specific logbooks. All equipment out of service (both analytical and auxiliary) must be clearly marked "Out of Order".

11.1 ***Routine, Daily Maintenance***. Routine, daily maintenance is required on an instrument specific basis. It is performed each time the instrument is used. Daily maintenance traditionally includes activities to insure a continuation of good analytical performance. In some cases, they include performance checks that indicate whether non-routine maintenance is required. If the performance check indicates a need for higher level maintenance, the equipment is taken out of service until maintenance is performed. Analysis cannot be continued until the performance checks meet established criteria. Document return to control. Daily maintenance is the responsibility of the individual assigned to the instrument used for the analysis he is performing.

11.2 ***Non-routine Maintenance***. Non-routine maintenance is reserved for catastrophic occurrences such as instrument failure. The need for non-routine maintenance is indicated by failures in general operating systems, that result in an inability to conduct required performance checks or calibration. Equipment in this category are taken out of service and repaired before attempting further analysis. Analysis cannot continue until the instrument meets all performance check criteria and is capable of being calibrated. Section supervisors are responsible for identifying non-routine maintenance episodes and initiating repair activities to bring the equipment on-line. This may include initiating telephone calls to maintenance contractors if necessary. They are also responsible for documenting all details related to the occurrence and the repair.

11.3 ***Scheduled Maintenance***. Modern laboratory instrumentation rarely requires regular preventative maintenance. Where required, the equipment is placed on a schedule, which dictates when maintenance is required. Examples include annual balance calibration by an independent provider and optical alignment of the ICP. Section supervisors are responsible for initiating scheduled maintenance on equipment that requires scheduled preventative attention. Scheduled maintenance is documented using routine documentation practices.

11.4 ***Maintenance Documentation***. Routine and non-routine maintenance activities are documented in logbooks assigned to instruments and equipment used for analytical measurements. The logbooks contain preprinted forms, which specify the maintenance activities required with each use. Accutest Laboratories Southeast has adopted a problem – action – follow-up format to conduct instrument maintenance. The analyst or supervisor who performs or initiates the maintenance activity is required to check the activity upon its completion, verify complete statement of return to normal conditions and initial the form. Non-routine maintenance (i.e. repairs, upgrades, etc.) is documented in a separate service log.

12.0 QUALITY CONTROL PARAMETERS, PROCEDURES, AND CORRECTIVE ACTION

Requirement: All procedures used for test methods must incorporate quality control parameters to monitor elements that are critical to method performance. Each quality parameter includes acceptance criteria that have been established by regulatory agencies for the methods in use. Criteria may also be established through client dictates or through the accumulation and statistical evaluation of internal performance data. Data obtained from these parameters must be evaluated by the analyst, and compared to established method criteria. If the criteria are not achieved, the procedures must specify corrective action and conformation of control before proceeding with sample analysis. QC parameters, procedures, and corrective action must be documented within the standard operating procedures for each method. In the absence of client specific objectives the laboratory must define qualitative objectives for completeness and representativeness of data.

12.1 ***Procedure***. Bench analysts are responsible for methodological quality control and sample specific quality control. Each method specifies the control parameters to be employed for the method in use and the specific procedures for incorporating them into the analysis. These control parameters are analyzed and evaluated with every designated sample group (batch).

The data from each parameter provides the analyst with critical decision making information on method performance. The information is used to determine if corrective action is needed to bring the method or the analysis of a specific sample into compliance. These evaluations are conducted throughout the course of the analysis. Each parameter being indicative of a critical control feature. Failure of a methodological control parameter is indicative of either instrument or batch failure. Failure of a sample control parameter is indicative of control difficulties with a specific sample or samples.

Sample Batch. All samples analyzed in the laboratory are assigned to a designated sample batch, which contains all required quality control samples and a defined maximum number of field samples that are prepared and/or analyzed over a defined time period. The maximum number of investigative and field QC samples in the batch is 20. Accutest has incorporated the NELAP batching policy as the sample-batching standard. This policy incorporates the requirement for blanks and spiked blanks as a time based function as defined by NELAP. The typical batch contains a blank, laboratory control sample (LCS or spiked blank), matrix spike and matrix spike duplicate. Batch documentation includes lot specifications for all reagents and standards used during preparation of the batch.

12.2 ***Methodological Control Parameters and Corrective Action***. Prior to the analysis of field sample the analyst must determine that the method is functioning properly. Specific control parameters indicate whether critical processes meet specified requirements before continuing with the analysis. Method specific control parameters must meet criteria before sample analysis can be conducted. Each of these

parameters is related to processes that are under the control of the laboratory and can be adjusted if out of control.

Method Blank. A method blank is analyzed during the analysis of any field sample. The method blank is defined as a sample. It contains the same standards (internal standards, surrogates, matrix modifiers, etc.) and reagents that are added to the field sample during analysis, with the exception of the sample itself. If the method blank contains target analyte(s) at concentrations that exceed method or client requirements (typically defined as 1/2 RL concentrations), the source of contamination is eliminated before proceeding with sample analysis. Systematic contamination is documented for corrective action and resolved following the established corrective action procedures. In specific cases, contamination detected in the method blank may be acceptable if the concentrations do not exceed regulatory limits or client defined reporting limits.

Laboratory Control Samples (LCS or Spiked Blanks). A laboratory control sample (spiked blank or commercially prepared performance evaluation sample) is analyzed along with field samples to demonstrate that the method accuracy is within acceptable limits. These spike solutions are derived from different sources than the solutions used for method calibration. The performance limits are derived from published method specifications or from statistical controls generated from laboratory method performance data. Spiked blanks are blank matrices (reagent water or clean sand) spiked with the targeted parameters and analyzed using the same method used for samples. Accuracy data is compared to laboratory experimentally derived limits to determine if the method is in control. Laboratory control samples (LCS) are commercially prepared spiked samples in an inert material. Performance criteria for recovery of spiked analytes is pre-established by the commercial entity preparing the sample. This sample is analyzed in the laboratory as an external reference.

Accuracy data is compared to the applicable performance limits. If the spike accuracy exceeds the performance limits, corrective action, as specified in the SOP for the method is performed and verified before continuing with a field sample analysis. In some cases, decisions are made to continue with sample analysis if performance limits are exceeded; provided the unacceptable result has no negative impact on the sample data.

Marginal exceedance (ME) values are calculated for methods containing more than eleven (11) targeted analytes. The ME is calculated as $\pm$ 4 standard deviations about the mean. MEs are considered for multi-analyte methods because of the increased likelihood of LCS failure as the number of analytes in the method increase. The number of allowable MEs is based on the number of target analytes in the method. Analytes that regularly fall into the ME category are treated as systematic problems, which are resolved using established trend monitoring and corrective action procedures. Marginal Exceedances are not applied to parameters that are detected in field samples. Routine corrective action is initiated for all cases where LCS spike accuracy criteria is beyond the established control limits and the parameter is detected in field samples corresponding to the unacceptable LCS.

Blanks and spikes are routinely evaluated before samples are analyzed. However, in situations where sample analysis is performed using an autosampler, they may be evaluated after sample analysis has occurred. If the blanks and spikes do not meet criteria, sample analysis is repeated.

Proficiency Testing. Performance evaluation samples (PEs) are single or double blind spikes, introduced to the laboratory to assess method performance. PEs may be introduced as double blinds submitted by commercial clients, single or double blinds from regulatory agencies, or internal blinds submitted by the QA group.

A minimum of two single blind studies must be performed each year for every parameter in aqueous and solid matrices for each field of testing for which the laboratory maintains accreditation. Proficiency samples must be purchased as blinds from an A2LA accredited vendor. Data from these studies are provided to the laboratory by the vendor and reported to accrediting agencies. If unsatisfactory performance is noted, corrective action is performed to identify and eliminate any sources of error. A new single blind must be analyzed to demonstrate continuing proficiency.

PE samples performed for accrediting agencies or clients, which do not meet performance specifications, require a written summary that documents the corrective action investigation, findings, and corrective action implementation.

Single or double blind proficiency test samples are employed for self-evaluation purposes. Data from these analyses are compared to established performance limits. If the data does not meet performance specifications, the system is evaluated for sources of acute or systematic error. If required, corrective action is performed and verified before initiating or continuing sample analysis.

Trend Analysis for Control Parameters. Accuracy data for selected spiked parameters from the laboratory control sample (LCS) is statistically evaluated daily for trends. Data from selected LCS parameters and surrogates are pooled on a method, matrix, and instrument basis. This data is evaluated by comparison to existing control and warning limits. Trend analysis is performed automatically as follows:

- Any point outside the control limit
- Any three consecutive points between the warning and control limits
- Any eight consecutive points on the same side of the mean
- Any six consecutive points increasing or decreasing

The results of the trend analysis are printed for supervisory evaluation prior to sample analysis. Trends that indicate the potential loss of statistical control are further evaluated to determine the impact on data quality and to determine if corrective action is necessary. If corrective action is indicated, the supervisor informs the analysts of

the corrective actions to be performed. Return to control is demonstrated before analysis resumes.

12.3 ***Sample Control Parameters and Corrective Action***. The analysis of samples can be initiated following a successful demonstration that the method is operating within established controls. Additional controls are incorporated into the analysis of each sample to determine if the method is functioning within established specifications for each individual sample. Sample QC data is evaluated and compared to established performance criteria. If the criteria are not achieved the method or the SOP specifies the corrective action required to continue sample analysis. In many cases, failure to meet QC criteria is a function of sample matrix and cannot be remedied. Each parameter is designed to provide quality feedback on a defined aspect of the sampling and analysis episode.

Duplicates. Duplicate sample analysis is used to measure analytical precision. This can also be equated to laboratory precision for homogenous samples. Precision criteria are method dependent. If precision criteria are not achieved, corrective action or additional action may be required. Recommended action must be completed before sample data can be reported.

Laboratory Control Duplicate, Spikes & Spiked Duplicates. Spikes and spiked duplicates are used to measure analytical precision and accuracy for the sample matrix selected. Precision and accuracy criteria are method dependent. If precision and accuracy criteria are not achieved, corrective action or additional action may be required. Recommended action must be completed before sample data can be reported.

Serial Dilution (Metals). Serial dilutions of metals samples are analyzed to determine if analytical matrix effects may have impacted the reported data. If the value of the serially diluted samples does not agree with the undiluted value within a method-specified range, the sample matrix may be causing interference, which may lead to either a high or low bias. If the serial dilution criterion is not achieved, it must be flagged to indicate possible bias from matrix effects. *Accutest-SE uses this procedure as opposed to post-digestion spike unless contractual obligations absolutely require latter*

Post Digestion Spikes. Digested samples are spiked and analyzed to determine if matrix interferences are creating biases in the results. It may also be used to determine potential interferences per client's specification. Spike concentration is determined as per analytical method. No action is necessary if the post digestion spike is outside of the method criteria, unless a preparation problem is suspected with the spike, in which case the post digestion spike should remade and reanalyzed.

Surrogate Spikes (Organics). Surrogate spikes are organic compounds that are similar in behavior to the target analytes but unlikely to be found in nature. They are added to all quality control and field samples to measure method performance for each individual sample. Surrogate accuracy limits are derived from published method

specifications or by statistical evaluation of laboratory generated surrogate accuracy data. Accuracy data is compared to the applicable performance limits. If the surrogate accuracy exceeds performance limits, corrective action, as specified in the method or SOP is performed before sample data can be reported.

Internal Standards (Organic Methods). Internal standards are retention time and instrument response markers added to every sample to be used as references for quantitation. Their response is compared to reference standards and used to evaluate instrument sensitivity on a sample specific basis. Internal standard retention time is also compared to reference standards to assure that target analytes are capable of being located by their individual relative retention time.

If internal standard response criteria are not achieved, corrective action or additional action may be required. The recommended action must be completed before sample data can be reported.

If the internal standard retention time criteria are not achieved corrective action or additional action may be required. This may include re-calibration and re-analysis. Additional action must be completed before sample data is reported.

Internal Standards (ICP Metals). Internal standards are used on ICP instruments to compensate for variations in response caused by differences in sample matrices. This adjustment is performed automatically during sample analysis. The internal standard response of replicated sample analysis is monitored to detect potential analytical problems. If analytical problems are suspected, then the field samples are reanalyzed.

12.4 ***Laboratory Derived Quality Control Criteria.*** Control criteria for in-house methods and client specific modifications that exceed the scope of published methodology are defined and documented prior to the use of the method. The Quality Assurance staff identifies the responsibility for control criteria needs. Control parameters and criteria, based on best technical judgement are established using input provided by the operations staff. These control parameters and criteria are documented and incorporated into the method.

The laboratory derived criteria are evaluated for technical soundness on spiked samples prior to the use of the method on field samples. The technical evaluation is documented and archived by the Quality Assurance staff.

When sufficient data form the laboratory developed control parameter is accumulated, the data is statistically processed and the experimentally derived control limits are incorporated into the method.

12.5 ***Bench Review & Corrective Action***. The bench chemists are responsible for all QC parameters. Before proceeding with sample analysis, they are required to successfully meet all instrumental QC criteria. They have the authority to perform any

necessary corrective action before proceeding with sample analysis. Their authority includes the responsibility for assuring that departures from documented policies and procedures do not occur.

The bench chemists are also responsible for all sample QC parameters. If the sample QC criteria are not achieved, they are authorized and required to perform the method specified corrective action before reporting sample data.

Data Qualifiers. An alpha character coding system is employed for defining use limitations for reported data. These limitations are applied to analytical data by the analyst to clarify the usefulness of the reported data for data user. Accutest Laboratories Southeast qualifies data in accordance with program-specific requirements, such as State of Florida DEP, AFCEE, etc., and these qualifiers are hard-coded in the LIMS on project level. Definitions of common qualifiers could be found at the bottom of the sample report form.

12.6 ***QA Monitoring***. The QA staff prior to client release conducts a spot review of completed data packages. This review includes an examination of QC data for compliance and trends indicative of systematic difficulties. If non-conformances are detected, the QA staff places an immediate stop on the release of the data and initiates corrective action to rectify the situation. The data package is released when the package becomes compliant with all quality requirements.

If the review reveals trends indicative of systematic problems, QA initiates an investigation to determine the cause. If process defects are detected, a corrective action is implemented and monitored for effectiveness.

Performance Limits. The Technical Director is responsible for compilation and maintenance of all precision and accuracy data used for performance limits. Quality control data for all test methods are accumulated and stored in the laboratory information management system (LIMS). Parameter specific QC data is extracted annually and statically processed to eliminate outliers and develop laboratory specific warning limits and confidence limits. The new limits are reviewed and approved by the supervisory staff prior to their use for data assessment. The new limits are used to evaluate QC data for compliance with method requirements for a period of one year. Laboratory generated limits appear on all data reports unless method specifies hard-coded limits (mostly General Chemistry and Metals)

12.7 ***Data Package Review***. Accutest employs multiple levels of data review to assure that reported data has satisfied all quality control criteria and that client specifications and requirements have been met. Production departments have developed data review procedures which must be conducted before data is released to the client.

Analytical Review. The analyst conducts the primary review of all data. This review begins with a check of all instrument and method quality control and progresses through sample quality control concluding with a check to assure that the client's

requirements have been executed. Analyst checks focuses on a review of qualitative determinations and checks of precision and accuracy data to verify that existing laboratory criteria have been achieved. Checks at this level may include comparisons with project specific criteria if applicable. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter or nonconformance at this stage of review.

Secondary data reviews are performed at the peer level by analysts who have met the qualification criteria for the method in use. Qualification requirements include a valid demonstration of capability and demonstrated understanding of the method SOP. Section supervisors may perform secondary review in-lieu of a peer review Secondary review is performed on 100% of the data produced by their department. It includes a check of all manual calculations; an accuracy check of manually transcribed data from bench sheets to the LIMS, a check of all method and instrument QC criteria, baseline manipulations (if applicable) and a comparison of the data package to client specified requirements. Also included are checks to assure the appropriate methodology was applied and that all anomalous information was properly flagged for communication in the case narrative. Supervisors have the authority to reject data and initiate re-analysis, corrective action, or reprocessing.

All laboratory data requiring manual entry into LIMS system is double-checked by the analysts performing initial data entry and the section supervisor. Verification of supervisory review is indicated on the raw data summary by the supervisor's initials and date.

Electronic data that is manually edited at the bench by the primary analysts is automatically flagged by the instrument data system indicating an override by the analyst. All manual overrides must be verified and approved by a supervisor who initials and dates all manual changes.

Hard copies of manually integrated chromatographic peaks are printed that clearly depict the manually drawn baseline. The hard copy is reviewed and approved by the reviewer (initialed and dated) and included in the data package of all full tier reports or the archived batch records of commercial report packages.

Electronic data that has been committed to the LIMS can only be edited by a manager or supervisor. These edits may be required if needs for corrections are indicated during the final review. An audit record for all electronic changes in the LIMS is automatically appended to the record.

The group manager performs a tertiary review on a spot check basis. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all analytical requirements and specifications were executed.

Report Generation Review. The report generation group reviews all data and supporting information delivered by the laboratory for completeness and compliance with client specifications. Missing deliverables are identified and obtained from the laboratory. The group also reviews the completed package to verify that the delivered product complies with all client specifications. Non-analytical defects are corrected before the package is sent to the client.

Project Management/Quality Assurance Review. Spot-check data package reviews are performed by the project manager. Project management reviews focus on project specifications. If the project manager identifies defects in the product prior to release, he initiates immediate corrective action to rectify the situation.

The QA Staff reviews approximately 10% of the data produced. The QA review focuses on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification. QA reviews at this step in the production process are geared towards systematic process defects, which require procedural changes to effect a corrective action. However, if defects are identified that can be corrected prior to data release, the QA staff returns the package to the laboratory for corrective action. QA data review cannot be used in lieu of a peer level review or a supervisory review.

Data Reporting. Analytical data is released to clients following secondary departmental review. Data release at this stage of the process is limited to electronic information, which is released to clients through a secure, encrypted, password protected, Internet connection.

Hard copy support data is compiled by the report generation group and assembled into the final report. The report is sent to the client following reviews by report generation, and spot-check by QA staff.

All data reports include specified information, which is required to identify the report and its contents. This information includes a title, name and address of the laboratory, a unique report number, total number of pages in the report, clients name and address, analytical method identification, arriving sample condition, sample and analysis dates, test results with units of measurement, authorized signature of data release, statement of applicability, report reproduction restrictions and NELAC requirements certification. Subcontracted data is clearly identified.

In the event of report revision date of the revision, nature of revision and identity of the person revising the report must be clearly stated in the body of the report. Depending on the level of the deliverables it could be either stated in the Case Narrative or Case Narrative generated specifically for this purpose. Case Narrative must state "supercedes all previous reports".

12.8 ***Electronic Data Reduction.*** Raw data from sample analysis is entered into the laboratory information management system (LIMS) using automated processes or

manual entry. Final data processing is performed by the LIMS using procedures developed by the Company.

All LIMS programs and internally developed software (including Excel spreadsheets) are tested and validated prior to use to assure that they consistently produce correct results. Validation testing is performed by the Information Technology Staff. The testing procedures are documented in an SOP. Programs are not approved for use until they have demonstrated that they are capable of performing the required calculations.

12.9 ***Representativeness***. Data representativeness is based on the premise that qualitative and quantitative information developed for field samples is characteristic of the sample that was collected by the client and analyzed in the laboratory. The laboratory objective for representativeness defines data as representative if the criteria for all quality parameters associated with the analysis of the sample are achieved.

12.10 ***Comparability***. Analytical data is defined as comparable when data from a sample set analyzed by the laboratory is representatively equivalent to other sample sets analyzed separately regardless of the analytical logistics. The laboratory will achieve 100% comparability for all sample data which meets the criteria for the quality parameters associated with its analysis using the method requested by the client.

13.0

14.0 CORRECTIVE ACTION SYSTEM

Requirement. The laboratory must have polices and procedures for correcting defective processes, systematic errors, and quality defects, which enables the staff to systematically improve product quality. The system must include procedures for communicating items requiring corrective action, corrective action tracking procedures, corrective action documentation, monitoring of effectiveness, and reports to management. The system must be documented in a standard operating procedure.

14.1 ***Procedure***. Corrective action is the step that follows the identification of a process defect. The type of defect determines the level of documentation, communication, and training necessary to prevent re-occurrence of the defect or non-conformance.

Routine Corrective Action. Routine corrective action is defined as the procedures used to return out of control analytical systems back to control. This level of corrective action applies to all analytical quality control parameters or analytical system specifications.

Bench analysts have full responsibility and authority for performing routine corrective action. The resolution of defects at this level does not require a procedural change or staff re-training. The analyst is free to continue work once corrective action is complete and the analytical system has been returned to control. Documentation of routine corrective action is limited to bench logbook or maintenance logbook comment.

Process Changes. Corrective actions in this category require procedural modifications. They may be the result of systematic defects identified during audits, the investigation of client inquiries, failed proficiency tests, product defects identified during data review, or method updates. Resolution of defects of this magnitude requires formal identification of the defect, development and documentation of a corrective action plan, and staff training to communicate the procedural change.

Technical Corrective Action. Technical corrective action encompasses routine corrective action performed by bench analysts for out of control systems and corrective actions performed for data produced using out of control systems. Technical corrective action for routine situations is conducted using the procedures detailed above.

Non-routine corrective actions apply to situations where the bench analysts failed to perform routine corrective action before continuing analysis. Supervisors and Department Managers perform corrective action in these situations. Documentation of all non-routine corrective actions is performed using the corrective action system.

Sample re-analysis is conducted if sufficient sample and holding time remain to repeat the analysis using an in-control system. If insufficient sample or holding time remains,

the data is processed and qualifiers applied that describe the out of control situation. The occurrence is further documented in the case narrative and in the corrective action response. The corrective action must include provisions for retraining the analysts who failed to perform routine corrective action.

14.2 ***Documentation & Communication***. Routine corrective actions are documented as part of the analytical record. Notations are made in the comments section of the analytical chronicle or data sheet detailing the nonconformance. Continuation of the analysis indicates that return to control was successful.

Corrective actions for process changes are documented, tracked and monitored for effectiveness. Corrective actions may be initiated by any supervisor or senior staff member by completing the corrective action form in Corrective Action database

The corrective action database is an Access application. The initiator generates the corrective action investigation form, which is documented, tracked, distributed to responsible parties and archived through the application. The application assigns a tracking number initiation data and due date to each corrective action initiated and copies the corrective action form to the corrective action database. The application also distributes an E-mail message containing the form to the responsible parties for resolution.

Corrective Action system employs Deficiency – Root Cause – Immediate Fix – Corrective action approach, further divided into categories of Analytical Error, Omission Error, Random Error, Systemic Error and Training Issue.

The responsible party develops and implements the procedural change. Existing documentation such as SOPs are edited to reflect the change. The affected staff is informed of the procedural change through a formal training session. The training is documented and copies are placed into individual training files. The corrective action form is completed and closed in CA database.

Initial and completed corrective action forms are maintained in the Corrective Action directory. This information is archived daily. Copies of training records describing corrective actions are appended to the involved individuals training files.

Monitoring. The QA Staff monitors the implemented corrective action until it is evident that the corrective action has been effective and the systematic deficiency has been eliminated. The corrective action database is updated by QA to reflect closure of the corrective action. The QA staff also assigns an error code to the corrective action for classification of the type of errors being committed.

If QA determines that the corrective action procedure has not effectively remedied the deficiency, the process continues with a re-initiation of the corrective action. Corrective action continues until the defective process is eliminated. If another procedural change is required, it is treated as a new corrective action, which is documented and monitored using established procedures.

Client Notification. Defective processes, systematic errors, and quality defects, detected during routine audits may have negative impacts on data quality. In some cases, data that has been released to clients may be affected. If defective data has been released for use, Accutest will notify the affected clients of the defect and provide specific details regarding the magnitude of the impact to their data.

15.0 PROCEDURES FOR EXECUTING CLIENT SPECIFICATIONS

Requirement. Systems must be established for evaluating and processing client specifications for routine and non-routine analytical services. The systems must enable the client services staff to identify, evaluate, and document the requested specifications to determine if adequate resources are available to perform the analysis. The system must include procedures for communicating the specifications to the laboratory staff for execution and procedures for verifying the specifications have been executed.

15.1 ***Client Specific Requirements***. The project manager is the primary contact for clients requesting laboratory services. Client specifications are communicated using several mechanisms. The primary source of information is the client's quality assurance project plan (QAPP) which details analytical and quality control specifications for the project. In the absence of a QAPP, projects specifications can also be communicated using contracts, letters of authorization, or letters of agreement, which may be limited to a brief discussion of the analytical requirements and the terms and conditions for the work. These documents may also include pricing information, liabilities, scope of work, in addition to the analytical requirements. QAPPs include detailed analytical requirements and data quality objectives, which supersede those found in the referenced methods. This information is essential to successful project completion.

The client services staff provides additional assistance to clients who are unsure of the specifications they need to execute the sampling and analysis requirements of their project. They provide additional support to clients who require assistance in results interpretation as needed, provided they possess the expertise required to render an opinion.

The project manager is responsibility for obtaining project documents, which specify the analytical requirements. Following project management review, copies are distributed to the QA staff and the appropriate departmental managers for review and comment. The original QAPP is numbered with a document control number and filed in a secure location.

15.2 ***Requirements for Non-Standard Analytical Specifications***. Client requirements that specify departures from documented policies, procedures, or standard specifications must be submitted to Accutest in writing. These requirements are reviewed and approved by the technical staff before the project is accepted. Once accepted, the non-standard requirements become analytical specifications, which follow the routine procedure for communicating client specifications. Departures from documented policies, procedures, or standard specifications that do not follow this procedure are not permitted.

Exception Policy: With respect to the quality system, incoming non-conforming product refers to received samples that do not meet requirements of custody documentation, are improperly packaged or stored or are contaminated. An internal non-conformance

refers to a problem, caused internally due to improper handling of samples, improper sampling methods, and equipment malfunction or data management errors. The individual who identifies the incoming non-conformance is responsible for notifying the project manager. The project manager resolves the issue with the client. The individual who recognizes an internal non-conformance is responsible for initiating corrective action

Departures from standard practices, policies and specifications are reviewed and approved by Technical Director, QA Officer and by Project Manager of the project affected.

Corrective & Preventative Action: Once a quality problem has been identified, the analytical or review process stops, until the reason is identified. Primary responsibility for identifying the cause of the problem rests with the instrument operator. Other staff may be called on to assist in reaching the root cause. The problem prevention tracking system, using Corrective Action Tracking Records, provides a method to track systemic problems until resolved/removed. The QA Officer is responsible for the record management with respect to the disposition of problems.

Deviations that do not limit themselves to a single department and/or client are cited on Corrective Action Record. This may include but not limited to: sample arrival outside of EPA specified holding time, analysis completion outside of EPA specified holding time (with explanation of the reason), inconsistencies between chain of custody and cooler contents, including labeling errors, improper preservation, etc.

Deviations from analytical methods' SOP's are reported by the Analyst to the Section Leader. Single occurrences warrant completion of Corrective Action Tracking record, repetitive occurrences may indicate that either an additional training session is in order, or the SOP does not reflect proper laboratory practice. Training session is conducted by the Technical Director or by QA Officer. In case where SOP does not reflect current laboratory practice, SOP review and correction process may be initiated.

15.3 ***Evaluation of Resources.*** A resource evaluation is completed prior to accepting projects submitted by clients. The evaluation is initiated by the client services staff receives project requirements (usually in the form of QAPjP) and distributes these requirements to the laboratory departments affected. The specifications are evaluated by the department managers from a scheduling and hardware resources perspective. The project is not accepted unless the department managers have the necessary resources to execute the project according to client specifications.

15.4 ***Documentation***. New projects are initiated using a project set up form, which is completed prior to the start of the project. This form details all of the information needed to correctly enter the specifications for each client sample into the laboratory information management system (LIMS, see example). The form includes data reporting requirements, billing information, data turnaround times, QA level, state of

origin, and comments for detailing project specific requirements. The project manager is responsible for obtaining this information from the client and completing the form prior to sample arrival and login.

Sample receipt triggers project creation and the login process. The information on the set-up form is entered into the LIMS immediately prior to logging in the first sample. The set up form may be accompanied by a quotation, which details the analytical product codes and sample matrices. These details are also entered into the LIMS during login.

Special information is distributed to the laboratory supervisors and login department in electronic or hardcopy format upon project setup. All project specific information is retained by the project manager in a secure file. The project manager maintains a personal telephone log, which details conversations with the client regarding the project.

14.5 ***Communication***. A pre-project meeting is held between client services and the operations managers to discuss the specifications described in the QAPjP and/or related documents. Project logistics are discussed and finalized and procedures are developed to assure proper execution of the client's analytical specifications and requirements. Questions, raised in the review meeting, are discussed with the client for resolution. Exceptions to any requirements, if accepted by the client, are documented and incorporated into the QAPjP or project documentation records.

Non-standard specifications for individual clients are documented in the LIMS at the client account level. Once entered into the LIMS, these specifications become memorialized for all projects related to the client account. Upon sample arrival, these specifications are accessed through a terminal or printed as a hard copy and stored in a binder for individuals who require access to the specification. Specifications that are not entered into the LIMS are prohibited unless documented in an interdepartmental memo, which clearly identifies the project, client and effective duration of the specification.

14.6 ***Operational Execution***. A work schedule is prepared for each analytical department on a daily basis. Analytical specifications from recently arrived samples have now been entered into the LIMS database. The database is sorted by analytical due date and holding time, into product specific groups. Samples are scheduled for analysis by due date and holding time. The completed schedule, which is now defined as a work list, is printed. The list contains the client requested product codes and specifications required for the selected sample(s). Special requirements are communicated to the analyst using the comments section or relayed through verbal instructions provided by the supervisor. The bench analyst assumes full responsibility for performing the analysis according to the specifications printed on the work sheet.

14.7 ***Verification***. Prior to the release of data to the client, laboratory section managers and the report generation staff review the report and compare the completed product to the

client specifications documentation to assure that all requirements have been met. Project managers perform a spot check of projects with unique requirements to assure that the work was executed according to specifications.

15.0 CLIENT COMPLAINT RESOLUTION PROCEDURE

Requirement. A system for managing and reconciling client complaints must be implemented in the laboratory. The system must include procedures for documenting client complaints and communicating the complaint to the appropriate department for resolution. The system must also include a quality assurance evaluation to determine if the complaint is related to systematic defects requiring process changes.

15.1 ***Procedure***. Client complaints are communicated to client services representatives, quality assurance staff, or senior management staff for resolution. The individual receiving the complaint retains the responsibility for documentation and communicating the nature of the complaint to the responsible department(s) for resolution. The responsible party addresses the complaint. The resolution is communicated to quality assurance (QA) and the originator for communication to the client. QA reviews the complaint and resolution to determine if systematic defects exist. If systematic defects are present, QA works with the responsible party to develop a corrective action that eliminates the defect.

Documentation. Client's complaints are documented by the client service representative receiving the complaint. A record of the telephone conversation is maintained by client services. Client service staff enters the complaint into Data challenge system, which is also cross-linked with corrective action database – see sec. 13. Complaint is communicated to the production departments concerned via e-mail. The complaint resolution is documented on the e-mail by the responsible party and returned to the originator. QA Officer is copied on the correspondence.

15.2 ***Corrective Action***. Responses to data queries are required from the responsible party. At a minimum, the response addresses the query and provides an explanation to the complaint. Corrective action may focus on the single issue expressed in the complaint. Corrective action may include job case narrative generation, reprocessing of data, editing of the initial report, and re-issue to the client. If the QA review indicates a systematic error, process modification is required. The defective process at the root of the complaint is changed. SOPs are either created or modified to reflect the change. The party responsible for the process implements process changes.

15.3 ***QA Monitoring***. Process changes, implemented to resolve systematic defects, are monitored for effectiveness by QA. If monitoring indicates that the process change has not resolved the defect, QA works with the department management to develop and implement an effective process. If monitoring indicates that the defect has been resolved, monitoring is slowly discontinued. Continued monitoring is incorporated as an element of the annual system audit.

16.0 CONTROL OF NONCONFORMING PRODUCT

Requirement: Policies and procedures have been developed and implemented that describe the procedures employed by the laboratory when any aspect of sample analysis or data reporting do not conform to established procedures or client specifications. These procedures include steps to ensure that process defects are corrected and affected work is evaluated to assess its impact to the client.

Procedure. Nonconforming product is identified through routine internal review and audit practices or through client inquiry. The individuals who identify the nonconformance or receiving a nonconformance inquiry immediately inform the Laboratory Director and the QA Officer. The Laboratory Director initiates an evaluation of the nonconformance through the QA Officer and takes full responsibility for managing the process and identifying the course of action to take, initiating corrective action and mitigating the impact of the nonconformance to the client.

Non-conformances and their significance are explained in case narrative and sample report footnotes. Case narrative comments and sample repot footnotes must state the impact on data quality.

16.1 ***Corrective Action.*** The outcome of the evaluation dictates the course of action. This may include at a minimum client notification, but may also include corrective action. Immediate corrective action is performed using the SOP-specified procedures. However, additional action may be required including cessation of analysis and withholding and/or recalling data reports. If the evaluation indicates that nonconforming data may have been issued to clients, the client is immediately notified and data may be recalled following the procedures specified in respective SOPs. If work has been stopped because of a nonconformance, the Laboratory Director is the only individual authorized to direct a resumption of analysis.

Nonconformances caused by systematic process defects require retraining of the personnel involved as an element of the corrective action solution.

17.0 CONFIDENTIALITY PROTECTION PROCEDURES

Requirements: Policies and procedures are required to protect client data from release to unauthorized parties or accidental release of database information through accidental electronic transmission or illegal intrusion. These policies must be communicated to clients and staff. Electronic systems must be regularly evaluated for effectiveness.

17.1 ***Client Anonymity***. Information related to the Company's clients is granted to employees on a "need to know" basis. An individual's position within the organization defines his "need to know". Individuals with "need to know" status are given password access to systems that contain client identity information and access to documents and document storage areas containing client reports and information. Access to client information by individuals outside of the Company is limited to the client and individuals authorized by the client.

Individuals outside of the Company may obtain client information through subpoena issued by a court of valid jurisdiction. Clients are informed when subpoenas are received ordering the release of their information.

17.2 ***Documents***. Access to client documents is restricted to employees in need to know positions. Copies of all client reports are stored in secure archive with restricted access. Reports and report copies are distributed to individuals who have been authorized by the client to receive them. Documents are not released to third parties without verbally expressed or written permission from the client.

17.3 **Confidential Business Information (CBI).** Operational documents including SOPs, Quality Manuals, personnel information, internal operations statistics, and laboratory audit reports are considered confidential business information. Strict controls are placed on the release of this information to outside parties.

Release of CBI to outside parties or organizations may be authorized upon execution of a confidentiality agreement between Accutest and the receiving organization or individual. CBI information release is authorized for third party auditors and commercial clients in electronic mode as Adobe Acrobat .PDF format only. See also Sec. 6.5.

17.4 ***Electronic Data***.

Database Intrusion. Direct database entry is authorized for employees of Accutest only on a need to know basis. Entry to the database is restricted through a user specific multiple password entry system. Direct access to the database outside of the facility is possible through a VPN connection. A unique password is required for access to the local area network. A second unique password is required to gain access to the database. The staff receives read or write level authorization on a hierarchical privilege basis.

Internet Access. Access to client information is through an HTTP Web application only. It does not contain a mechanism that allows direct access to the database. Clients can gain access to their data only using a series of Accutest assigned, client and user specific passwords. The viewable data, which is encrypted during transmission, consists of an extraction of database information only.

Client Accessibility. Accessibility to client data delivered via electronic means follows strict protocols to insure confidentiality. Clients accessing electronic data are assigned a company account. The account profile, which is established by the MIS staff, grants explicit access to explicit information pertaining to the clients project activity. Passwords are assigned on an individual basis within a client account. These accounts can be activated or deactivated by the MIS staff only.

17.5 ***Information Requests***. Client specific data or information is not released to third parties without verbally expressed or written permission from the client. Written permission is required from third parties, who contact the Company directly for the release of information. Verbal requests will be honored only if they are received directly from the client. These requests must be documented in a record of communication maintained by authorized recipient.

17.6 ***Transfer of Records***. Archived data, which has previously been reported and transmitted to clients, is the exclusive property of Accutest Laboratories. In the event of a cessation of business activities due to business failure or sale, The Company's legal staff will be directed to arrange for the final disposition of archived data.

The final disposition of archived data will be accomplished using the approach detailed in the following sequence:

1. All data will be transferred to the new owners for the duration of the required archive period as a condition of sale.

2. If the new owners will not accept the data or the business has failed, letters will be sent to clients listed on the most recent active account roster offering them the option to obtain specific reports (identified by Accutest Job Number) at their own expense.

3. A letter will be sent to the NELAC accrediting authority with organizational jurisdiction over the company offering them the option to obtain all unclaimed reports at their own expense.

4. All remaining archived data will be recycled using the most expedient means possible.

18.0 QUALITY AUDITS AND SYSTEM REVIEWS

Requirement: The quality assurance group will conduct regularly scheduled audits of the laboratory to assess compliance with quality system requirements, technical requirements of applied methodology, and adherence to documentation procedures. The information gathered during these audits will be used to provide feedback to senior management and perform corrective action where needed for quality improvement purposes.

18.1 ***Quality Systems Review***. Quality system audits are performed annually by the Quality Assurance Director for the Company President. In this audit, the laboratory is evaluated for compliance with the Laboratory Quality Systems Manual (LQSM) and the quality system standards of the National Environmental Laboratory Accreditation Conference. Findings, which indicate non-compliance or deviation from the LQSM, are flagged for corrective action. Corrective actions require either a return to compliance or a plan change to reflect an improved quality process. The QA Officer is responsible for making and documenting changes to the LQSM. These changes are reviewed by the Laboratory Director and Technical Director prior to the approval of the revised system.

18.2 ***Quality System Audits.*** Quality system audits are conducted to evaluate the effectiveness and laboratory compliance with individual quality system elements. These audits are conducted on an established schedule. Audit findings are documented and communicated to the management staff and entered into the corrective action system for resolution. If necessary, retraining is conducted to assure complete understanding of the system requirements.

18.3 ***Technical Compliance Audits***. Technical compliance audits are performed throughout the year following the established schedule. Selected analytical procedures are evaluated for compliance with standard operating procedures (SOPs) and method requirements. If non-conformances exist, the published method serves as the standard for compliance. SOPs are edited for compliance if the document does not reflect method requirements. Analysts are trained to the new requirements and the process is monitored by quality assurance. Analysts are retrained in method procedures if an evaluation of bench practices indicates non-compliance with SOP requirements.

18.4 ***Documentation Audits***. Documentation audits are conducted periodically. This audit includes a check of measurement processes that require manual documentation and non-analytical logbook review. It also includes checks of data archiving systems and a search to find and remove any inactive versions of SOPs that may still be present in the laboratory and being accessed by the analysts. Non-conformances are corrected on the spot. Procedural modifications are implemented if the evaluation indicates a systematic defect.

18.5 ***Corrective Action Monitoring***. Defects or non-conformances that are identified during client or internal audits are shared with management and entered into CA

database for attention by the responsible party. Audit findings are corrected through process modifications and/or retraining. Once a corrective action has been designed and implemented, it is monitored for compliance on a regular basis by the QA staff. Monitoring of the corrective action continues until satisfactory implementation has been verified.

18.6 ***Preventive Action.*** Laboratory systems or processes, which may be faulty and pose the potential for nonconformances, errors, confusing reports or difficulties establishing traceability may be identified during internal audits. These items are highlighted for systematic change using the corrective action system and managed to resolution using appropriate procedures for corrective action.

18.7 ***Client Notification.*** Defective processes, systematic errors, and quality defects detected during routine audits may have negative impact on data quality. In some cases, data that has been released to the client may be affected. If defective data has been released for use, Accutest will immediately notify the affected clients of the defect and provide specific details regarding the magnitude of the impact to their data.

18.8 ***Management Reports***. Formal reports of all audit activities are prepared for the management staff. These reports are prepared annually. The report details the status of the Quality System

The formal report also addresses the following topics:

- Status and results of internal and external audits,
- Status and results of internal and external proficiency testing,
- Identification of quality control problems in the laboratory,
- Discussion of corrective action program issues,
- Status of external certifications and approvals,
- Status of staff training and qualifications,
- Discussion of new quality system initiatives.
- Recommendations for further action on listed items are included in the report.

19.0 HEALTH AND SAFETY

Requirement. The company operates a formal health and safety program that complies with the requirements of the Occupational Health and Safety Administration. The program consists of key policies and practices that are essential to safe laboratory operation. All employees are required to receive training on the program elements. Job specific training is conducted to assure safe practices for specific tasks. All employees are required to participate in the program, receive initial and annual training, and comply with the program requirements. All plan and program requirements are detailed in the Health and Safety Program Manual.

19.1 Policy. Accutest Laboratories will provide a safe and healthy working environment for its employees and clients while protecting the public and preserving the Company's assets and property. The company will comply with all applicable government regulations pertaining to safety and health in the laboratory and the workplace.

The objective of the Accutest Health and Safety Program is to promote safe work practices that minimize the occurrence of injuries and illness to the staff through proper health and safety training, correct laboratory technique application and the use of engineering controls.

19.2 Responsibilities. The Health and Safety Program assists managers, supervisors and non-supervisory employees in control of hazards and risks to minimize the potential for employee and client injuries, damage to client's property and damage or destruction to Accutest's facility.

The Health and Safety Officer is responsible for implementing the Program's elements and updating its contents as necessary. He also conducts periodic audits to monitor compliance and assess the program's effectiveness and is also responsible for creating and administering safety training for all new and existing employees.

The employee is responsible for following all safety rules established for their protection, the protection of others and the proper use of protective devices provided by the Company. The employee is also expected to comply with the requirements of the program at all times. Department Managers and Supervisors are responsible for ensuring the requirements of the Safety Program are practiced daily. The Company President retains the ultimate responsibility for the program design and implementation.

19.3 Program Elements. The Accutest Health and Safety Program consists of key program elements that compliment the company's health and safety objective. These elements form the essence of the health and safety policy and assure that the objectives of the program are achieved.

Safety Education and Training and Communication. Training is conducted to increase the staff's awareness of laboratory hazards and their knowledge of the safety

practices and procedures required to protect them from those hazards. It is also used to communicate general safety procedures required for safe operation in a chemical laboratory.

Initial health and safety training for new employees is conducted during orientation. The training focuses on the Accutest Safety and Health Program and includes specific training for the hazards that may be associated with the employees' duties. Training is also conducted for all program elements focusing on general, acceptable, laboratory safety procedures. Targeted training is conducted to address hazards or safety procedures that are specific to individual employee's work assignments. All training activities are documented and archived in individual training folders. A health and safety training inventory is maintained in the training database.

Accutest Laboratories Southeast maintains personnel trained in HAZWOPER, DOT and HazMat operations, as well as respirator certified.

Safety Committee. The safety committee provides the employee with an opportunity to express their views and concerns on safety issues in a forum where those concerns will be addressed. This committee meets monthly to assure that the interests of the company and the well being of the employee are protected. They also serve as a catalyst for elevating the level of safety awareness among their peers.

Hazard Identification and Communication. The hazard communication program enables employees to readily identify laboratory hazards and the procedures to protect themselves from those hazards. This program complies with OSHA's Hazard Communication Standard, Title 29 Code of Federal Regulations 1910.1200 that requires the company to adopt and adhere to the following key elements:

- Material Safety Data Sheets (MSDS) must be available to any employee wishing to view them,
- The Company must maintain a Hazardous Chemicals Inventory (by location), which is updated on an annual basis,
- Containers are properly labeled,
- All employees must be provided with annual Personal Protection, Hazard Communication and Right to Know training,

Chemical Hygiene Plan. The Chemical Hygiene Plan complies with the requirements of the Occupational Safety and Health Administration's Occupational Exposure to Hazardous Chemicals in the Laboratory Standard, 29 CFR 1910.1450. This plan establishes procedures, identifies safety equipment, personal protective equipment, and work practices that protect employees from the potential health hazards presented by hazardous chemicals in the laboratory if properly used and/or applied.

Emergency Action & Evacuation Plan. The Emergency Action and Evacuation Plan details the procedures used to protect and safeguard Accutest's employees and property during emergencies. Emergencies are defined as fires or explosions, gas leaks, building collapse, hazardous material spills, emergencies that immediately threaten life and health, bomb threats and natural disasters such as floods, hurricanes or tornadoes. The plan identifies and assigns responsibility for executing specific roles in situations requiring emergency action.

Lockout/Tagout Plan. Lockout/tagout procedures have been established to assure that laboratory employees and outside contractors take steps to render equipment inoperable and/or safe before conducting maintenance activities. The plan details the procedures for conducting maintenance on equipment that has the potential to unexpectedly energize, start up, or release energy or can be operated unexpectedly or accidentally resulting in serious injury to employees. The plan ensures that employees performing maintenance render the equipment safe through lock out or tag out procedures.

Personal Protection Policy. Policies have been implemented which detail the personal protection requirements for employees. The policy includes specifications regarding engineering controls, personal protective equipment (PPE), hazardous waste, chemical exposures, working with chemicals and safe work practices. Safety requirements specific to processes or equipment are reviewed with the department supervisor or the Health and Safety Officer before beginning operations.

Emergency Preparedness Plan. This plan identifies the actions to be taken by Accutest Laboratory's staff in the event of terrorism or terrorist actions, to ensure the safety of the employees and the facility. The plan describes the building security actions coinciding with the "Alert Condition", designated by the Department of Homeland Security.

Appendix I

Glossary of Terms

GLOSSARY OF TERMS

Acceptance Criteria: specified limits placed on characteristics of an item, process, or service defined in requirement documents.

Accreditation: the process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one.

Accuracy: the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Audit: a systematic evaluation to determine the conformance to quantitative *and qualitative* specifications of some operational function or activity.

Batch: environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

Blank: a sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

Blind Sample: a sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

Case Narrative: a statement of non-conformances associated with particular data report

Calibration: to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements.

Calibration Curve: the graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.

Calibration Method: a defined technical procedure for performing a calibration.

Calibration Standard: a substance or reference material used to calibrate an instrument.

Certified Reference Material (CRM): a reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body.

Chain of Custody: an unbroken trail of accountability that ensures the physical security of samples and includes the signatures of all who handle the samples.

Clean Air Act: the enabling legislation in 42 U.S.C. 7401 *et seq.*, Public Law 91-604, 84 Stat. 1676 Pub. L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended, empowering EPA to promulgate air quality standards, monitor and to enforce them.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/Superfund): the enabling legislation in 42 U.S.C. 9601-9675 *et seq.*, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. 9601*et seq.*, to eliminate the health and environmental threats posed by hazardous waste sites.

Confirmation: verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors or, additional cleanup procedures.

Conformance: an affirmative indication or judgement that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.

Corrective Action: the action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: the process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form.

Demonstration of Capability: a procedure to establish the ability of the analyst to generate acceptable accuracy.

Document Control: the act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

Duplicate Analyses: the analyses or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

Federal Water Pollution Control Act (Clean Water Act, CWA): the enabling legislation under 33 U.S.C. 1251 *et seq.*, Public Law 92-50086 Stat. 816, that empowers EPA to set discharge limitations, write discharge permits, monitor, and bring enforcement action for non-compliance.

Field of Testing: NELAC's approach to accrediting laboratories by program, method and analyte. Laboratories requesting accreditation for a program-method-analyte combination or for an up-dated/improved method are required submit to only that portion of the accreditation process not previously addressed (see NELAC, section 1.9ff).

Holding Times (Maximum Allowable Holding Times) the maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes from a source independent of the calibration standards or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

Matrix: the component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: any aqueous sample that has been designated a potable or potential potable water source. Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt-water source such as the Great Salt Lake. Non-aqueous Liquid: any organic liquid with <15% settleable solids.

Biological Tissue, Biota: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: includes soils, sediments, sludges and other matrices with >15% settleable solids.

Chemical Waste: a product or by-product of an industrial process that results in a matrix not previously defined.

Air: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device.

Matrix Spike (spiked sample or fortified sample): a sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of Target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): a second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method Blank: a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: the minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

National Institute of Standards and Technology (NIST): an agency of the US Department of Commerce's Technology Administration that is working with EPA, States, NELAC, and other public and commercial entities to establish a system under which private sector companies and interested States can be accredited by NIST to provide NIST-traceable proficiency testing (PT) to those laboratories testing drinking water and wastewater.

National Environmental Laboratory Accreditation Conference (NELAC): a voluntary organization of State and Federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of NELAP.

National Environmental Laboratory Accreditation Program (NELAP): the overall National Environmental Laboratory Accreditation Program of which NELAC is a part.

NELAC Standards: the plan of procedures for consistently evaluating and documenting the ability of laboratories performing environmental measurements to meet nationally defined standards established by the National Environmental Laboratory Accreditation Conference.

Performance Audit: the routine comparison of independently obtained *qualitative and quantitative* measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

Preservation: refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

PT Fields of Testing: NELAC's approach to offering proficiency testing by regulatory or environmental program, matrix type, and analyte.

Proficiency Testing: a means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source.

Proficiency Test Sample (PT): a sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.

Quality Assurance: an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality Control: the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

Quality Manual: a document stating the management policies, objectives, principles, oganizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.

Quality System: a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

Quantitation Limits: the maximum or minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be quantified with the confidence level required by the data user.

Range: the difference between the minimum and the maximum of a set of values.

Raw Data: any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted.

Reagent Blank (method reagent blank or method blank): a sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.

Reference Material: a material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Reference Method: a method of known and documented accuracy and precision issued by an organization recognized as competent to do so.

Reference Standard: a standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived.

Replicate Analyses: the measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval.

Requirement: denotes a mandatory specification; often designated by the term "shall".

Resource Conservation and Recovery Act (RCRA): the enabling legislation under 42 USC 321 *et seq.* (1976), that gives EPA the authority to control hazardous waste from the "Cradle-to-grave", including its generation, transportation, treatment, storage, and disposal.

Safe Drinking Water Act (SDWA): the enabling legislation, 42 USC 300f *et seq.* (1974), (Public Law 93-523), that requires the EPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations.

Sample Duplicate: two samples taken from and representative of the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variance of the total method including sampling and analysis.

Spike: a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: the document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies.

Toxic Substances Control Act (TSCA): the enabling legislation in 15 USC 2601 *et seq.*, (1976), that provides for testing, regulating, and screening all chemicals produced or imported into the United States for possible toxic effects prior to commercial manufacture.

Traceability: the property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.

United States Environmental Protection Agency (EPA): the federal governmental agency with responsibility for protecting public health and safeguarding and improving the natural environment (i.e., the air, water, and land) upon which human life depends.

Validation: the process of substantiating specified performance criteria.

Verification: confirmation by examination and provision of evidence that specified requirements have been met.
NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment. The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

Work Cell: A defined group of analysts that together perform the method analysis. Members of the group and their specific functions within the work cell must be fully documented. A "work cell" is considered to be all those individuals who see a sample through the complete process of preparation, extraction, or analysis. The entire process is completed by a group of capable individuals, each member of the work cell demonstrates capability for each individual step in the method sequence.

Appendix II

Analytical Capabilities

NELAC-Accredited Fields of Testing

Method Type	Method Number	Regulatory Program
Organics		
EDB and DBCP	EPA 504.1	Drinking Water
Metals		
ICP: General	EPA 200.7, 1994	Drinking Water
Cold Vapor Mercury	EPA 245.1, 1994	Drinking Water
Inorganic WetChem		
Perchlorate by Ion Chromatography	EPA 314.0	Drinking Water
Organics		
EDB and DBCP	EPA 504, SW846 8011	Non-Potable Water
Volatile Organics	EPA 624, SW846 8260	Non-Potable Water
Semi-Volatile Organics	EPA 625, SW846 8270	Non-Potable Water
Semi-Volatile Organics	SW846 8270 SIM	Non-Potable Water
Purgeable Aromatics	EPA 602, SW846 8021	Non-Potable Water
Chlorinated Pesticides & PCBs	EPA 608, SW846 8081A, 8082	Non-Potable Water
Poly-Aromatic Hydrocarbons	EPA 610, SW846 8310	Non-Potable Water
Nitroaromatics	SW846 8091	Non-Potable Water
Explosives	SW846 8330A, 8332	Non-Potable Water
Chlorinated Herbicides	SW846 8151A	Non-Potable Water
Organophosphorus Pesticides	SW846 8141B	Non-Potable Water
Dissolved Gases	RSK SOP 147-175	Non-Potable Water
Alcohols	SW846 8015B	Non-Potable Water
Gasoline Range Organics	SW846 8015B	Non-Potable Water
Diesel Range Organics	SW846 8015B	Non-Potable Water
Total Petroleum Hydrocarbons	FLPRO	Non-Potable Water
Tennessee EPH	TN-EPH	Non-Potable Water
Tennessee GRO	TN-GRO	Non-Potable Water
Wisconsin DRO	WI-DRO	Non-Potable Water
Petroleum Hydrocarbons	Iowa OA-1	Non-Potable Water
Petroleum Hydrocarbons	Iowa OA-2	Non-Potable Water
Volatile Petro. Hydrocarbons	Massachusetts VPH, 1998	Non-Potable Water
Extractable Petro. Hydrocarbons	Massachusetts EPH, 1998	Non-Potable Water
Metals		

Method Type	Method Number	Regulatory Program
ICP: General – EPA WW	EPA 200.7, 1994; SW-846 6010B	Non-Potable Water
Cold Vapor Mercury – EPA WW	EPA 245.1, 1994; SW-846 7470A	Non-Potable Water
Inorganic WetChem		
Alkalinity	EPA 310.1*	Non-Potable Water
Alkalinity	SM2320B	Non-Potable Water
CBOD	SM 5210B	Non-Potable Water
COD	EPA 410.1*	Non-Potable Water
COD	SM5220C	Non-Potable Water
BOD	EPA 405.1*	Non-Potable Water
BOD	SM5210B	Non-Potable Water
Color, Apparent	EPA 110.2*	Non-Potable Water
Color, Apparent	SM2120B	Non-Potable Water
Ion Chromatography (Bromide, Fluoride, Chloride, Sulfate, Nitrite, Nitrate,) – Aqueous	EPA 300.0, SW846 9056	Non-Potable Water
Total Kjeldahl Nitrogen	EPA 351.2	Non-Potable Water
Ammonia	EPA 350.1	Non-Potable Water
Oil & Grease, Gravimetric – AQ	EPA 1664, SW846 9070	Non-Potable Water
Orthophosphate	EPA 365.3	Non-Potable Water
pH by electrode (Waters)	EPA 150.1*, SW846 9040	Non-Potable Water
pH by electrode (Waters)	SM4500H+B	Non-Potable Water
Specific Conductance	EPA 120.1	Non-Potable Water
Sulfide	EPA 376.1*	Non-Potable Water
Sulfide	SM4500S=F	Non-Potable Water
Total Dissolved Solids	EPA 160.1*	Non-Potable Water
Total Dissolved Solids	SM2540C	Non-Potable Water
Total Organic Carbon	EPA 415.1*	Non-Potable Water
Total Organic Carbon	SM5310B, SW846 9060	Non-Potable Water
Total Phosphorus	EPA 365.3	Non-Potable Water
Total Solids	EPA 160.3*	Non-Potable Water
Total Solids	SM2540B	Non-Potable Water
Total Suspended Solids	EPA 160.2*	Non-Potable Water
Total Suspended Solids	SM2540D	Non-Potable Water
Turbidity	EPA 180.1	Non-Potable Water
Total CN	EPA 335.4, SW846 9012	Non-Potable Water
Un-Ionized Ammonia - calculation	FDE SOP10/03/83	Non-Potable Water
Perchlorate	EPA 314	Non-Potable Water
Calcium Hardness by Calculation	SM18 2340B	Non-Potable Water
Hardness, Total by Calculation	SM18 2340B	Non-Potable Water
MBAS (Anionic Surfactants as)	EPA 425.1*	Non-Potable Water
MBAS (Anionic Surfactants as)	SM5540C	Non-Potable Water
Corrosivity & pH – aqueous	SW846 9040	Non-Potable Water

Method Type	Method Number	Regulatory Program
Hexavalent Chromium	SW846 7196A	Non-Potable Water
Organics		
EDB and DBCP	SW846 8011 Mod	Solid and Chemical Material
Volatile Organics	SW846 8260B	Solid and Chemical Material
Semi-Volatile Organics	SW846 8270C	Solid and Chemical Material
Semi-Volatile Organics	SW846 8270C SIM	Solid and Chemical Material
Gasoline Range Organics	SW846 8015B	Solid and Chemical Material
Diesel Range Organics	SW846 8015B	Solid and Chemical Material
Alcohols	SW846 8015B	Solid and Chemical Material
Polynuclear-Aromatic Hydrocarbons	SW846 8310	Solid and Chemical Material
Explosives	SW846 8330A, 8332	Solid and Chemical Material
Organochlorine Pesticides	SW846 8081A	Solid and Chemical Material
Polychlorinated Biphenyls	SW846 8082	Solid and Chemical Material
Chlorinated Herbicides	SW846 8151A	Solid and Chemical Material
Organophosphorus Pesticides	SW846 8141B	Solid and Chemical Material
Total Petroleum Hydrocarbons	FLPRO	Solid and Chemical Material
Tennessee EPH	TN-EPH	Solid and Chemical Material
Tennessee GRO	TN-GRO	Solid and Chemical Material
Wisconsin DRO	WI-DRO	Solid and Chemical Material
Petroleum Hydrocarbons	Iowa OA-1	Solid and Chemical Material
Petroleum Hydrocarbons	Iowa OA-2	Solid and Chemical Material
Volatile Petro. Hydrocarbons	Massachusetts VPH	Solid and Chemical Material

Method Type	Method Number	Regulatory Program
Extractable Petro. Hydrocarbons	Massachusetts EPH	Solid and Chemical Material
Metals		
ICP: General – EPA WW	SW846 6010B	Solid and Chemical Material
Cold Vapor Mercury – EPA DW	SW846 7471A	Solid and Chemical Material
Inorganic WetChem		
Ion Chromatography (Bromide, Fluoride, Chloride, Sulfate, Nitrite, Nitrate,) – Aqueous	SW846 9056	Solid and Chemical Material
Oil & Grease, Gravimetric – Solid	SW846 9071	Solid and Chemical Material
Total CN	SW846 9012	Solid and Chemical Material
Total Organic Carbon	SW846 9060	Solid and Chemical Material
Ammonia	EPA 350.1	Solid and Chemical Material
Total Kjeldahl Nitrogen	EPA 351.2	Solid and Chemical Material
Total Phosphorus	EPA 365.3	Solid and Chemical Material
Waste Ignitability	SW846 1010	Solid and Chemical Material
Hexavalent Chromium/soils	SW846 7196A	Solid and Chemical Material
Corrosivity & pH – aqueous	SW846 9040B	Solid and Chemical Material
Corrosivity & pH – solid	SW846 9045B	Solid and Chemical Material
Waste Corrosivity	SW846 1110	Solid and Chemical Material
Organics		
Volatile Organics	TO-3	Air and Emissions

Method Type	Method Number	Regulatory Program
Preparation Methods		
Liquid/Liquid Extraction, Water	SW846 3510C	
Solid Phase Extraction, Water	SW846 3535A	
Solids Extraction by Sonication	SW846 3550B	
Acid/Base Partitioning	SW846 3650B	
Sulfur Cleanup of Extracts	SW846 3660B	
Sulfuric Acid Cleanup	SW846 3665A	
Purge & Trap - Aqueous	SW846 5030B	
Purge & Trap – Solids	SW846 5035A	
Total Recoverable Metals Digestion	EPA 200.7	
Non-Pot. Water Digest: ICP	SW846 3010A	
Digestion of Soils for ICP	SW846 3050B	
TCLP	SW846 1311	
SPLP	SW846 1312	

* Indicates methods which are no longer approved by EPA for Drinking and Non-Potable water analysis but temporarily retained by the State of Florida for a transition period. For further information, please, refer to EPA MUP (March 2007) and joint Memo of FLA DEP and DOH (August 2007)
** Preparation methods are not listed on Primary NELAC Accreditation per State of Florida DOH rules. However, for the benefit of other accrediting authorities, these methods are inspected during FDOH visits. Listing of surveyed and approved preparation methods is available from on-site inspection report.

Non-NELAC-Accredited Fields of Testing

Method Type	Method Number	Regulatory Program
Organics		
Thiodiglycol	Accutest in-house method (HPLC)	Solid and Chemical Material
Volatile Petroleum Hydrocarbons	Missouri Gasoline Range Organics	Solid and Chemical Material
Extractable Hydrocarbons	Missouri Diesel Range Organics	Solid and Chemical Material
Extractable Hydrocarbons	Missouri Oil Range Organic	Solid and Chemical Material
Inorganic WetChem		
Oxidation-Reduction Potential	ASTM D1498-76, mod. for solids	Solid and Chemical Material
Percent Ash (dry basis)	ASTM D2974-87, D482-91	Solid and Chemical Material
Grain Size (hydrometer)	ASTM D422-63	Solid and Chemical Material
Sieve Testing	ASTM D422-63	Solid and Chemical Material
Specific Gravity	ASTM D1298-85	Solid and Chemical Material
Acidity	EPA 305.1	Non-Potable Water
Dissolved Oxygen	EPA 360.1	Non-Potable Water
Mineral Suspended Solids	EPA 160.2/160.4	Non-Potable Water
Organophosphonic Acids	Accutest in-house method (IC)	Solid and Chemical Material
Perchlorate	EPA 314MOD	Solid and Chemical Material
Percent Solids	EPA 160.3 MOD	Non-Potable Water
Settleable Solids	EPA 160.5	Non-Potable Water
Total Mineral Solids	EPA 160.4	Non-Potable Water
Total Residual Chlorine	EPA 330.5	Non-Potable Water
Total Volatile Solids	EPA 160.4	Non-Potable Water
Volatile Suspended Solids	EPA 160.2/160.4	Non-Potable Water
CÑ Amenable to Chlorination	EPA 335.4	Solid and Chemical Material
Bicarbonate, Carbonate, CO2	SM18 4500 CO2D	Non-Potable Water
Ferrous Iron	SM18 3500 FE-D	Non-Potable Water
Salinity - calculation	SM18 2520B	Non-Potable Water

Method Type	Method Number	Regulatory Program
Paint Filter Test	SW846 9095	Solid and Chemical Material
Sulfide/Cyanide Reactivity	SW846 Chapter 7	Solid and Chemical Material
Corrosivity & pH – aqueous	SW846 9040B	Solid and Chemical Material

Appendix III

Equipment List

Organics			
Instrument	**Model**	**Serial #**	**Year**
GC/MS	Agilent 5975C MSD/OI 4551/4660	US83120965	2008
GC/MS	Agilent 5975N MSD/Agilent 7683 AS	US82311290	2007
GC/MS	Agilent 5975N MSD/Agilent 7683 AS	US62724401	2006
GC/MS	Agilent 5975N MSD/Agilent 7683 AS	US53921303	2005
GC/MS	Agilent 5973 MSD/OI 4660/4552 Archon	US41746628	2004
GC/MS	Agilent 5973 MSD/OI 4660/4552 Archon	US41746633	2004
GC/MS	Agilent 5973 MSD/OI 4560/4552 Archon	US21843765	2002
GC/MS	Agilent 5973 MSD/OI 4560/4552 Archon	US21844034	2002
GC/MS	Agilent 5973 MSD/OI 4660/4552 Archon	US02440350	2000
GC/MS	Agilent 5973 MSD/OI 4560/4552 Archon	US94240108	1999
GC/MS	Agilent 5973 MSD/Agilent 7683 AS	US82311290	1998
GC/MS	Agilent 5973 MSD/Agilent 7683 AS	US81211109	1998
GC/MS	Hewlett-Packard 5970 MSD/OI 4560/4552 Archon	3034A12782	1989
GC/MS	Hewlett-Packard 5970 MSD/OI 4560/4552 Archon	2905A11904	1987
GC/MS	Hewlett-Packard 5970 MSD/OI 4560/4552 Archon	2716A10454	1987
GC	Agilent 7890A/Dual ECD/7683B AS	CN10842133	2008
GC	Agilent 6890/NPD-FPD/7683B AS	US10643024	2006
GC	Agilent 6890/Dual FID/7683B AS	CN10641049	2006
GC	Agilent 6890/Dual ECD/7683B AS	CN10641081	2006
GC	Agilent 6890/Dual ECD/7683B AS	US10613003	2006
GC	Agilent 6890/PID/PID/OI 4560/4552 Archon	CN10421047	2004
GC	Agilent 6890/PID/FID/ENTECH 7032A-LB	US10239007	2002
GC	Agilent 6890N/Dual FID/HP 7683 AS	CN10425061	2004
GC	Agilent 6890N/Dual ECD/HP 7683 AS	US10333015	2003
GC	Agilent 6890/Dual ECD/HP 7683 AS	US00036916	2000
GC	Agilent 6890/Dual ECD/HP 7683 AS	US00028304	1999
GC	Hewlett-Packard 5890/Dual FID/HP 7673 AS	3336A61096	1995
GC	Hewlett-Packard 5890/PID/FID/ OI 4560/4552 Archon	3336A60617	1995
GC	Hewlett-Packard 5890/Dual FID/HP 7673 AS	3336A59489	1995
GC	Hewlett-Packard 5890/PID/FID/ OI 4560/4552 Archon	3336A51045	1995
GC	Hewlett-Packard 5890/PID/ELCD/OI 4560/4552 Archon	3203A41646	1992
GC	Hewlett-Packard 5890/Dual FID/HP 7673 AS	3126A51085	1991
GC	Hewlett-Packard 5890/Dual ECD/HP 7673 AS	2921A24618	1990
GC	Hewlett-Packard 5890/PID/FID/ dual MPM 16	3029A29748	1990
GC	Hewlett-Packard 5890/FID	2843A20183	1988
GC	Hewlett-Packard 5890/Dual ECD/HP 7673 AS	2728A14096	1987

Organics			
HPLC	Agilent 1100 Automated LC System	DE91606857	1999
HPLC	Agilent 1100 Automated LC System	DE83700740	1998
HPLC	Agilent 1100 Automated LC System	DE01608404	2000
HPLC	Agilent 1100 Automated LC System	DE40522115	2004
HPLC	Agilent 1100 Automated LC System	DE03000863	2003
O-Prep	ESSA LM2-P Ring and Puck mill	215090-004	2008
O-Prep	TurboVap 4 units		2001
O-Prep	TurboVap 3 units		2004
O-Prep	TurboVap 1 unit		2007
O-Prep	Sonicator 2 units		2004
O-Prep	Sonicator 3 units		2007
O-Prep	Midi-Vap 2000 Kontes	479200-2000	2000
Data System	Hewlett-Packard/MS ChemStation		1999

Inorganics			
Instrument	**Model**	**Serial #**	**Year**
ICP	TJA EnviroTrace 61E Simultaneous	348490	1994
ICP	TJA EnviroTrace 61E Simultaneous	470790	1997
Mercury Analyzer	Leeman Hydra AA	HA-2022	2002
Mercury Analyzer	Leeman Hydra AA	HA-6007	2005
TOC Analyzer	Shimadzu	H51404235007	2004
IC	Dionex DX-500	99030664	1999
IC	Dionex	04070250	2004
Digestion block	DigiPrep	3 units	2005
Centrifuge	CentraCL2	42613052	2003
Spectrophotometer	Milton-Roy Spectronic 200		2000
MicroDistillation Block	Lachat	2 units	2005
Auto Analyzer	QuickChem 8500	050500000130	2005

LIMS		
Instrument	**Model**	**Year**
LIMS	HP True 64	1999

Appendix IV

Certification Summary

Certifying Authority	Certification Program	Registration No.
Arkansas	Solid/Hazardous Wastes, Non-Potable Water	88-0620
California (NELAP)	Potable Water, Solid/Hazardous Waste	04226CA
Florida (NELAP)	Potable, Non-Potable, Solid Waste, UST, Air Toxics	E83510
Georgia	Potable Water	934
Georgia	Solid/Hazardous Wastes	Not Applicable
Iowa	UST, Solid/Hazardous Wastes, Non-Potable Water	IA366
Kansas (NELAP)	Solid/Hazardous Wastes, Non-Potable Water	E-10327
Kentucky	Underground Storage Tank Program	0065
Louisiana (NELAP)	Solid/Hazardous Wastes	38582
Massachusetts	Non-Potable Water	M-FL946
Mississippi	Potable Water	Not Applicable
Nevada	Non-Potable Water, Solid/Hazardous Wastes	FL009462008A
New Jersey (NELAP)	Solid/Hazardous Wastes, Non-Potable Water	FL002
North Carolina	Solid/Hazardous Wastes, Non-Potable Water	573
Oklahoma	Non-Potable Water, Solid/Hazardous Waste	9959
South Carolina	Solid/Hazardous Wastes, Non-Potable Water	96038001
Texas (NELAP)	Non-Potable Water, Solid/Hazardous Waste	T104704040-08-TX
US Army Corps of Eng.	HTRW, Solid/Hazardous Waste	Not Applicable
US Dept. of Agriculture	Foreign Soils Permit	S-56027
US Navy NFESC	NFESC Validated Solid/Hazardous Waste	Not Applicable
Utah (NELAP)	Potable, Non-Potable, Solid/Chemical Materials	FL009462008A
Washington	Potable, Non-Potable, Solid/Chemical Materials, Air	C2046
Texas (NELAP)	Non-Potable Water, Solid/Hazardous Waste, Air Toxics	T104704234-08-TX
Wisconsin	Solid/Hazardous Wastes, Non-Potable Water	399043370

Appendix V

SOP List

SOP #	TITLE
	Organic Preparation Department
OP002	SOP for Glassware Cleaning and Storage
OP003	SOP for Reagent Prep
OP006	SOP for the Extraction of Semi-volatile Organics (BNAs) from Aqueous Samples
OP007	SOP for the Extraction of Semi-volatile Organics (BNAs) from Solid Samples
OP008	SOP for the Extraction of Pesticides/PCBs from Aqueous Samples
OP009	SOP for the Extraction of Pesticides/PCBs from Solid Samples
OP010	SOP for the Extraction of Diesel Range Organics (DRO) from Aqueous Samples
OP011	SOP for the Extraction of Diesel Range Organics (DRO) from Solid Samples
OP012	SOP for the Extraction of Petroleum Related Organics (FL-PRO) from Aqueous Samples
OP013	SOP for the Extraction of Petroleum Related Organics (FL-PRO) from Solid Samples
OP014	SOP for the Extraction of PAHs from Aqueous Samples (HPLC)
OP015	SOP for the Extraction of PAHs from Solid Samples (HPLC)
OP016	SOP for the Extraction of EDB/DBCP from Aqueous Samples
OP017	SOP for the Extraction of EDB/DBCP from Solid Samples
OP018	SOP for the Extraction of Explosives from Aqueous Samples
OP019	SOP for the Extraction of Explosives from Solid Samples
OP020	SOP for Sample Introduction via SW846-5035
OP021	SOP for Sample Introduction via SW846-5030B
OP022	SOP For The Extraction Of Nitroglycerine And Pentaerythritoltetranitrate (PETN) From Water Samples (HPLC Analysis)
OP023	SOP For The Extraction Of Nitroglycerine And Pentaerythritoltetranitrate (PETN) From Solid Samples (HPLC Analysis)
OP024	Standard Operating Procedure For The Extraction Of Nitroaromatics From Water Samples
OP025	SOP For Sample Preparation For Dissolved Gases In Aqueous Samples
OP026	SOP For The Extraction Of Extractable Petroleum Products (OA-2) From Water Samples
OP027	SOP For The Extraction Of Extractable Petroleum Products (OA-2) From Solid Samples
OP028	SOP For The Extraction Of Diesel And Oil Range Organics From Water Samples
OP029	SOP For The Extraction Of Diesel And Oil Range Organics From Solid Samples
OP030	SOP For The Extraction Of Extractable Petroleum Hydrocarbons From Water Samples (Tennessee EPH)
OP031	SOP For The Extraction Of Extractable Petroleum Hydrocarbons From Solid

SOP #	TITLE
	Samples (Tennessee EPH)
OP032	SOP For The Extraction Of Volatile Petroleum Hydrocarbons From Soil Samples
OP033	SOP For The Extraction Of PCBs From Wipes
OP034	SOP For The Extraction Of Diesel Range Organics (DRO) From Aqueous Samples WI-DRO
OP035	SOP For The Extraction Of Massachusetts Extractable Petroleum Hydrocarbons From Water Samples
OP036	SOP For The Extraction Of Massachusetts Extractable Petroleum Hydrocarbons From Solid Samples
OP037	SOP For The Extraction Of Chlorinated Herbicides From Water Samples
OP038	SOP For The Extraction Of Chlorinated Herbicides From Soil Samples
OP039	SOP For The Solid Phase Extraction (SPE) Cartridge Cleanup Of Pesticide Extracts
OP040	SOP For SPLP Leaching Of SVOC And Metals
OP041	SOP For TCLP Leaching Of VOC
OP042	SOP For SPLP Leaching Of SVOC And Metals
OP043	SOP For SPLP Leaching Of VOC
OP044	SOP For The Extraction Of Organophosphorus Pesticides From Water Samples
OP045	SOP For The Extraction Of Organophosphorus Pesticides From Soil Samples

Gas Chromatography/ HPLC SOPs

GC002	Analysis Of 1,2-Dibromoethane (EDB) And 1,2-Dibromo-3-Chloropropane (DBCP) By Gas Chromatography, Electron Capture Detector
GC004	Aromatic Volatiles By Gas Chromatography Using PID Detectors EPA 602
GC005	Analysis Of Organochlorine Pesticides By Gas Chromatography, Electron Capture Detector EPA 608
GC006	Analysis Of Polychlorinated Biphenyls By Gas Chromatography, Electron Capture Detector EPA 608
GC007	Analysis Of Polynuclear Aromatic Hydrocarbons By Gas Chromatography, Flame Ionization Detector EPA 610
GC008	Analysis Of Petroleum Range Organics By Gas Chromatography Using Flame Ionization Detector
GC009	Analysis Of 1,2-Dibromoethane (EDB) And 1,2-Dibromo-3-Chloropropane (DBCP) By Gas Chromatography, Electron Capture Detector SW-846 8011
GC010	Analysis Of Gasoline Range Organics By Gas Chromatography Using Flame Ionization Detector
GC011	Analysis Of Diesel Range Organics By Gas Chromatography Using Flame Ionization Detector
GC014	Analysis Of Polychlorinated Biphenyls By Gas Chromatography, Electron Capture Detector SW-846 8082

SOP #	TITLE
GC015	Analysis Of Organochlorine Pesticides By Gas Chromatography, Electron Capture Detector SW-846 8081
GC016	Analysis Of Nitroaromatics And Nitramines By HPLC
GC017	Aromatic Volatiles By Gas Chromatography Using PID Detectors SW-8021
GC018	Analysis Of Polynuclear Aromatic Hydrocarbons By HPLC SW-846 8310
GC019	Analysis Of Dissolved Gases By Gas Chromatography, Flame Ionization Detector
GC020	Analysis Of Nitroglycerine And PETN By HPLC
GC021	Analysis Of Volatile Petroleum Hydrocarbons By Gas Chromatography
GC022	Analysis Of Extractable Petroleum Products By Gas Chromatography Using Flame Ionization Detector OA-2
GC023	Analysis Of Diesel And Oil Range Organics By Gas Chromatography Using Flame Ionization Detector
GC024	Analysis Of Petroleum Hydrocarbons By Gas Chromatography Using Flame Ionization Detector (Tennessee EPH)
GC025	Analysis Of Nitroaromatics By Gas Chromatography Using Electron Capture Detector
GC026	Method For Determination Of Volatile Petroleum Hydrocarbons By GC-PID/FID
GC027	Analysis Of Non-Halogenated Organics By Gas Chromatography Using Flame Ionization Detector
GC028	Analysis Of Gasoline Range Organics By Gas Chromatography Using Flame Ionization Detector TDEC GRO
GC029	Analysis Of Diesel Range Organics By Gas Chromatography Using Flame Ionization Detector Wi DRO
GC030	Analysis Of Extractable Petroleum Hydrocarbons By Gas Chromatography Using Flame Ionization Detector MA-EPH
GC031	Analysis Of Chlorinated Herbicides Using GC-ECD
GC032	Analysis Of Organophosphorus Pesticides Using GC-NPD Or FPD
GC033	Air Analysis By GC-PID/FID
GC034	Analysis Of Nitroaromatics, Nitramines And Nitrate Esters By HPLC Method 8330b
GC035	Screening Of Volatile Organics By GC-PID/FID

Mass-Spectrometry SOPs

MS003	Analysis of Volatile Organics by EPA Method 624
MS004	Analysis of Semi-volatile Organics by EPA Method 625
MS005	Analysis of Volatile Organics by EPA Method 8260B
MS006	Analysis of Semi-volatile Organics by EPA Method 8270C
MS008	Analysis of Semi-volatile Organics by EPA Method 8270C SIM
MS009	Analysis of Volatile Organics by GC/MS
MS010	Analysis of Volatile Organics by GC/MS SIM

SOP #	TITLE
	Quality Assurance SOPs
QA001	Preparation, Approval, Distribution & Archiving Of Standard Operating Procedures (SOPs)
QA002	Calibration Of Thermometers
QA003	Personnel Training And Analyst Proficiency
QA004	Temperature Monitoring
QA005	Calibration Of Analytical Balances
QA006	Eppendorf Pipette Calibration
QA007	Sample Batching Procedure
QA008	Creating New Accounts
QA009	Creating New Projects
QA010	Confidentiality Protection Procedures
QA011	Signature Authority
QA012	Employee Technical Ethics Responsibilities
QA013	Client Complaint Resolution Procedure
QA014	Procedures For The Purchase Of Laboratory Supplies
QA015	Procedures For The Preparation, Distribution, Use And Archiving Of Laboratory Logbooks
QA016	Corrective Action Procedure
QA017	Standards Traceability Documentation Procedure
QA018	Procedure For Login, Management, Handling, And Reporting Of Proficiency Test (Pt) Samples
QA019	Quality System Review
QA020	Procedure For Developing Method Performance Criteria And Experimental Method Detection Limits
QA021	Subcontracting Procedures
QA022	Internal Audit Procedure
QA023	Fume Hood Inspection
QA027	Review Of Inorganics Data
QA028	Review Of Organics Data
QA029	Manual Integration Of Chromatographic Peaks
QA030	Procedure For The Development And Use Of in-house Quality Control Criteria
QA031	Air Quality Monitoring Of Extraction Laboratory
QA032	Routine Maintenance For Major Analytical Instrumentation
QA033	Laboratory Safety
QA034	Sample Homogenizing
QA035	Solvent Testing And Approval
QA036	Data Package Generation
QA037	Deionized Water Quality Control Procedure
QA038	Data Integrity Training Procedure
QA039	Data Integrity Monitoring Procedure
QA040	Procedure For Conducting Data Integrity Investigations

SOP #	TITLE
QA041	Procedure For The Confidential Reporting Of Data Integrity Issues
QA042	Basic Calculations For General Chemistry Methods
QA043	Data Qualifier SOP
QA044	Calibration Of Micro-Distillation Tubes
QA045	Estimation of Uncertainty
QA046	Document Control
QA047	Management of Client Project

General Chemistry SOPs

GNSOP: 101	Acidity (pH 8.2)
GNSOP: 102	Alkalinity, Total (pH 4.5)
GNSOP: 103	Ammonia – Distillation Procedure
GNSOP: 104	Nitrogen, Ammonia
GNSOP: 105	Bicarbonate, Carbonate, Free Carbon Dioxide
GNSOP: 106	Chemical Oxygen Demand
GNSOP: 109	Color, Apparent
GNSOP: 110	Chromium, Hexavalent (Water)
GNSOP: 113	Cyanide Distillation/Aqueous And Solid Samples
GNSOP: 115	Cyanide, Total
GNSOP: 116	Dissolved Oxygen
GNSOP: 121	Ignitability
GNSOP: 122	Anionic Surfactants As MBAS
GNSOP: 126	Ortho Phosphate
GNSOP: 127	Paint Filter Liquids Test
GNSOP: 128	Phenols Distillation, Soil And Water Samples
GNSOP: 130	Phenols, Total Recoverable
GNSOP: 133	Settleable Solids
GNSOP: 134	Total Suspended Solids (Non Filterable Residue)
GNSOP: 135	Total Dissolved Solids (Total Filterable Residue)
GNSOP: 136	Reactive Sulfide And Reactive Cyanide
GNSOP: 137	pH By Electrode - Water
GNSOP: 140	Sulfide
GNSOP: 144	Total Phosphorus
GNSOP: 145	Turbidity
GNSOP: 147	Winkler Titration For DO Standardization
GNSOP: 161	Percent Solids
GNSOP: 163	Specific Conductance At 25 C.
GNSOP: 166	pH By Electrode – Soil
GNSOP: 167	Biochemical Oxygen Demand (BOD)
GNSOP: 171	Hexachromium In Soils
GNSOP: 179	Corrosivity (Soil pH By Electrode)
GNSOP: 182	Total Kjeldahl Nitrogen

SOP #	TITLE
GNSOP: 189	Corrosivity Toward Steel
GNSOP: 190	Total Nitrogen, Organic Nitrogen
GNSOP: 192	Carbonaceous Biochemical Oxygen Demand (CBOD)
GNSOP: 193	Oxidation-Reduction Potential
GNSOP: 194	Ferrous Iron
GNSOP: 196	Glassware Cleaning
GNSOP: 197	Anions By Ion Chromatography
GNSOP: 211	Oil & Grease And PHC By 1664
GNSOP: 212	Fractional Organic Carbon
GNSOP: 213	Walkley-Black Total Organic Carbon
GNSOP: 214	Particle Size By Sieve
GNSOP: 215	TOC In Water
GNSOP: 216	Particle Size By Hydrometer
GNSOP: 218	Perchlorate
GNSOP: 219	Bulk Density
GNSOP: 222	Un-Ionized Ammonia Calculation
GNSOP: 224	Hardness By Calculation
GNSOP: 225	Cation Exchange Capacity Of Soils (Sodium Acetate)
GNSOP: 226	TOC In Soil
GNSOP: 227	Oil And Grease – Gravimetric Analysis (Soils)
GNSOP: 228	Anions By Ion Chromatography - IC 2000
GNSOP: 229	Determination Of Nitrocellulose In Water
GNSOP: 230	Determination Of Nitrocellulose In Soil

Metals SOPs

MET 100.10	Metals By Inductively Coupled Plasma
MET 103.8	Digestion Of Water Samples For Flame And ICP Analysis
MET 104.7	Digestion Of Soils For ICP Analysis
MET 105.4	Cold Vapor Analysis Of Mercury For Soils
MET 106.4	Cold Vapor Analysis Of Mercury For Water Samples

Sample Management SOPs

SAM101.13	Sample Receipt And Storage
SAM102.6	Procedure For Sample Bottle Preparation And Shipment
SAM104.4	Sample Container Quality Control
SAM108.7	Sample And Laboratory Waste Disposition

Sample and Laboratory Waste Disposition

Prepared by: Svetlana Izosimova Date: 04/18/2007

Reviewed by: Aaron S. Ben David Date: 04/18/2007

Annual Review

Reviewed by: Svetlana Izosimova Date: 07/16/2008

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TITLE: **Sample and Laboratory Waste Disposition**

Summary of changes: Added PCB HazWaste handling procedure – sec. 4.1.5 and 4.2.4.

REFERENCES: Florida DEP Hazardous Waste; 40 CFR, Part 261

1.0 Scope and Application

The disposal of samples and lab waste adhering to Florida State and Federal Regulations.

2.0 Summary

This SOP describes the procedures used by Accutest Laboratories to properly and safely dispose of samples and laboratory wastes; hazardous and non-hazardous; domestic and foreign.

3.0 Definitions

3.1 Foreign sample: Samples from sites that are outside the continental United States.

3.2 Hazardous Sample or Waste: A material is considered hazardous if it is listed in the Code of Federal Regulations, 40 CFR, Part 261 or it demonstrates any of the hazardous characteristics including, ignitability, corrosivity, reactivity, or has demonstrated toxicity.

4.0 Procedure

Sample Disposal: Samples are kept in appropriate storage for a minimum of 30 days after the report is sent to the client unless otherwise specified by client. The samples are divided into three categories: Aqueous, Soil, and Non-aqueous liquid.

4.1 Aqueous Samples

4.1.1 A disposal list is generated by computer, based on either reporting dates or sample number range. The disposal list consists of Job #, Sample #, Matrix, Storage Location, Received date, Released date, Account, Project and Hazard Status. (See attached)

4.1.2 Samples are then removed from the refrigerators and/or cabinets, and are separated as non-hazardous (non-detected or normal) and hazardous (positive result) samples.

4.1.3 Non-hazardous samples are neutralized in the sink in Sample Receiving department and flushed down the drain with tap water. Final volume and pH of the sample disposed is recorded in logbook.

4.1.4 ALSE contract disposal company segregates hazardous aqueous samples into the appropriate waste drums for disposal.

4.1.5 Samples containing PCB in excess of 50 ppm are automatically flagged by LIMS on disposal list. These samples are labeled with distinct PCB label and segregated from the rest of waste samples to be disposed of in LabPak.

4.1.6 Some samples, on a case by case basis, are returned to the client for disposal.

4.2 Soil Samples

4.2.1 Domestic Soil Samples (DSS) are placed in drums after the storage period, either in a hazardous or non-hazardous drum per the samples' status on the disposal sheets.

4.2.2 When the drums are full, they are then sampled and analyzed to determine their hazardous constituents (Full TCLP, RCI, and PCBs).

4.2.3 Based on the results of analysis, the drums are then either disposed of as hazardous or non-hazardous by our contract disposal company.

4.2.4 Samples containing PCB in excess of 50 ppm are automatically flagged by LIMS on disposal list. These samples are labeled with distinct PCB label and segregated from the rest of waste samples to be disposed of in LabPak.

4.2.5 Some samples, on a case by case basis, will be returned to the client for disposal.

4.2.6 Foreign soil samples (FSS) come in vials (volatile organic analysis) or jars. After minimum 60-day hold period, but not to exceed 6 months, these FSS are disposed of in the following manner.

4.2.6.1 FSS vials: Vial samples are preserved either with methanol or DI water. Vials with water are decontaminated by removing the caps, placing the vials in racks and heating the vials to 154.5 to 192.5°C (310 to 379°F) for 30 minutes in an oven. Timing starts when the entire mass reaches the desired temperature. The cooled soil is placed into a drum per the hazard status on the disposal sheets. Vials with methanol must be filtered. The filtrate(methanol) is disposed of in the non-chlorinated solvent waste drum. The soil is then drummed per the hazard status on the disposal sheets.

4.2.6.2 FSS Solids: FSS in jars are emptied into aluminum trays. They are heat-treated, along with the jars and caps in pans, in

the oven for 30 minutes at 154.5 to 192.5°C (310 to 379°F). Afterwards the soil is placed in the appropriate drum.

4.3 Non-aqueous liquid samples

4.3.1 Non-aqueous samples are placed in drums after the hold period.

4.3.2 When the drums are full, they are then sampled and analyzed to determine their hazardous constituents (PCBs). Drums have a 6 month expiration time. If the drum is not full by then it is analyzed and picked up by our contract disposal company.

4.3.3 Based on the results of analysis, the drums are then either disposed of as hazardous or non-hazardous by our contract disposal company.

4.3.4 Samples, on a case by case basis, will be returned to the client for disposal.

4.4 Sample Containers

4.4.1 Containers from samples deemed Non-Hazardous are immediately disposed of into a waste container provided by waste management services specifically for Accutest Laboratories Southeast direct use. A lock and key has been installed to keep the containers use limited to Accutest only.

4.4.2 Containers from samples deemed hazardous are disposed of into the Hazardous waste solids drum.

4.4.3 Waste Management services picks the container up on a weekly basis and brings to the local sort facility where contents are destroyed - recycled.

4.5 Laboratory Waste Disposal:

4.5.1 All materials determined to be hazardous are containerized in appropriate vessels (i.e.: drums). A waste is considered hazardous if it is listed in the Code of Federal Regulations, 40 CFR, Part 261 or it demonstrates any of the hazardous characteristics including, ignitability, corrosivity, reactivity, or has demonstrated toxicity. Our contract disposal company disposes of the drums.

4.5.2 WASTE DRUMS are separated by type:

4.5.3 Chlorinated Waste (Closed Top Steel)- Methylene Chloride

4.5.4 Non-Chlorinated Waste (Closed Top Steel)- Hexane, Methanol, and mixed solvents

4.5.5 Sodium Sulfate/Used Charcoal (Open Top Steel)- Charcoal and paper filters used in the filtering of samples.

4.5.6 Non Hazardous Aqueous Vials (Open Top Poly)- Pimarily Acid Vials

4.5.7 Hazardous Flammable Vials (Open Top Poly)- Methylene Chloride, Hexane.

4.5.8 Hazardous Aqueous waste (Closed Top Poly)- High Odor Samples, Lachate Waste.

4.5.9 Non Hazardous Soil (Open Top Steel)- Soils

4.5.10 Hazardous Solid Waste- (Open Top Steel)

4.5.11 Non-Aqueous/Oil Samples- (Closed Top Steel)

4.5.12 Disposal is done as conscientiously as possible following guidelines set forth by both the State of Florida and our contract disposal company. Management and proper handling is necessary to void any violation. The guidelines change depending on how much waste is generated on a monthly basis:

4.5.12.1 Less than 220 pounds (100 kilograms or about half a drum) is a "Conditionally Exempt Small Quantity Generator".

4.5.12.2 A "Small Quantity Generator" generates 220-2,200 pounds (100-1,000 kilograms or about half a drum to 5 drums)

4.5.12.3 More than 2,200 pounds (100-1,000 kilograms or more than about 5 drums) is a "Large quantity Generator".

4.5.12.4 Accutest Laboratories SE is considered a "Small Quantity Generator".

4.6 Waste Containers and Storage

4.6.1 Containers must be maintained in good condition at all times. Care must be taken to prevent leaks, ruptures, and the accumulation of rainwater on tops of the drums.

4.6.2 Waste containers must be kept closed at all times, except when waste is being transferred to drum.

4.6.3 The containers must be compatible with the waste being stored (i.e. acids should not be stored in metal drums). Never store incompatible wastes in

the same container (i.e. acids and bases). Containers must be stored in such a way to accommodate inspection for leaks and damage from all sides

4.6.4 Each waste container must be labeled with the following information.

4.6.4.1 Type and nature of waste (soil, oil, hazardous, non-hazardous)

4.6.4.2 Waste generator's name and address

4.6.4.3 Manifest document number

4.6.4.4 Proper DOT shipping name and identification number

4.6.4.5 Accumulation start date (change to storage date when container is full)

4.6.4.6 In addition, a hazardous waste must have the words "HAZARDOUS WASTE. FEDERAL LAW PROHIBITS IMPROPER DISPOSAL. IF FOUND, PLEASE CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY" prominently displayed on the container.

4.6.5 Inspection and Records

4.6.5.1 Containers must be inspected weekly. All records must be kept on file for three years. The records, which must be kept on file, include:

4.6.5.1.1 A written log of the inspections
4.6.5.1.2 Manifests and shipping receipts
4.6.5.1.3 Results of laboratory analyses of the wastes
4.6.5.1.4 Land Disposal Restriction form

5.0 Health and Safety

5.1 All employees who handle waste materials should wear full protective clothing including safety glasses &/or face shield, gloves, boots, lab coat or a Tyvek suit, and air-purifying respirator. Direct skin contact with waste materials should be avoided.

5.2 If an employee has accidentally been exposed to a hazardous waste, the individual should rinse the affected areas thoroughly under a safety shower for at least 15 minutes. If the individual begins to exhibit any adverse effects from the exposure, he should be immediately transported to the nearest hospital

emergency room. Employees are referred to the Material Safety Data Sheets for specific instructions on exposure to hazardous substances.

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Appendix B – ALS Laboratory Quality Assurance Manual

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Laboratory Quality Assurance Plan (LQAP)

ALS Laboratory Group, Environmental Division – Fort Collins, CO

Laboratory Quality Assurance Plan (LQAP)

Revision 13

March 18, 2010

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Approved by: *(see page following)*

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Summary of 2010 LQAP Changes

- All additions and deletions are incorporated through tracked changes in accordance with ALS SOP 926r10.
- New text is noted in blue and deleted text is red strikethrough.
- Change sections are also designated with a bar in the left margin.

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1. INTRODUCTION

This Laboratory Quality Assurance Plan (LQAP) describes the policies, procedures and accountabilities established by the Environmental Laboratory of ALS Laboratory Group, Environmental Division (Ft Collins, CO) (ALSLG-FC) to ensure that the environmental test results reported from the analysis of air, water, soil, waste, and other matrices are reliable and of known and documented quality. This document describes the quality assurance and quality control procedures followed to generate reliable analytical data.

This LQAP is designed to be an overview of ALS operations. Detailed methodologies and practices are written in ALS Standard Operating Procedures (SOPs). Where appropriate, ALS SOPs are referenced in this document to direct the reader to more complete information. A list of current SOPs is found in Appendix H.

ALS maintains certifications pertaining to various commercial and government entities; these are listed in Appendix I. Each certification requires that the laboratory continue to perform at levels specified by the programs issuing certification. Program requirements can be rigorous; they include semiannual performance evaluations as well as annual audits of the laboratory to verify compliance.

The State of Utah has primacy in administering certification of this laboratory to perform EPA methods. Thus, the Utah State Health Department certifies ALS to perform EPA methods under Utah Rule R444-14. For that reason, reference is made to Utah Rule R444-14 in this QAPP.

ALSLG-FCis a full service environmental and radiochemistry laboratory, performing analyses for organic, inorganic, and radiological constituents in a variety of matrices. ALSLG-FC specializes in serving the Department of Energy (DOE), Department of Defense (DoD), and architect-engineering firms. ALSLG-FC routinely provides hardcopy data packages and electronic data deliverables that are easily validated by external validators.

The management team at ALS Laboratory Group, Fort Collins applies an integrated approach to quality assurance, client service, and efficient operations, that enables ALSLG-FC to produce compliant data that meet or exceed all technical and service requirements as prescribed by our clients. This Laboratory Quality Assurance Plan (LQAP) defines ALSLG-FC's quality assurance (QA) program, and communicates ALSLG-FC's goals, values and policies regarding quality, ethical conduct, data integrity, and optimized operations.

\

1.1 MISSION STATEMENT

To provide analytical services to help our customers make informed decisions.

1.2 VISION STATEMENT

To be recognized as a global market leader.

1.3 QUALITY POLICY

ALS is committed to producing legally defensible analytical data of known and documented quality acceptable for its intended use and in compliance with the Safe Drinking Water Act, the Clean Water Act, and the Resource Conservation and Recovery Act. This QAPP is designed to satisfy the applicable requirements of the State of Utah and other state certification programs. ALS complies with the National Environmental Laboratory Accreditation Conference (NELAC) standards.

ALS corporate management has committed its full support to provide the personnel, facilities, equipment, and procedures required by this QAPP.

ALS management is committed to improvements of the management systems through compliance with NELAC 2003 and ISO 17025:2005 ALS management is also committed to compliance with project related requirements including DOECAP QSAS and DoD QSM 4.1 Gray Boxes.

ALS management reviews its operations on an ongoing basis and seeks input from staff and clients to make improvements. See section 12.1.5 of this plan for details.

It is the policy of ALS that all employees shall be familiar with all Quality documentation.

Within this framework, ALSLG-FC performs analyses in strict accordance with promulgated methodologies, including:

- USEPA, SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods;
- USEPA, Methods for Chemical Analysis of Waters and Wastes (MCAWW);
- USEPA, Methods for Determination of Metals in Environmental Samples;
- American Public Health Association (APHA), Standard Methods for the Examination of Water and Wastewater (SM);
- USEPA, Methods for Determination of Organic Compounds in Drinking Water;
- American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Volume 11 – Water and Environmental Technology;

- American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Volume 12 – Nuclear Energy;
- USDOE, Environmental Measurements Laboratory (EML), Procedures Manual (HASL-300);
- USEPA, Eastern Environmental Radiation Facility (EERF), Radiochemistry Procedures Manual;
- USDOE, Radiological and Environmental Sciences (RESL), Procedures Manual;
- USEPA, Prescribed Procedures for Measurement of Radioactivity in Drinking Water; and
- US, Code of Federal Regulations (40 CFR).

1.4 STATEMENT ON WASTE, ABUSE AND FRAUD

ALSLG-FC is committed to achieving our goals in the most efficient and effective manner possible, thus avoiding wasteful use of resources. This is accomplished by assuring the proper utilization of ALSLG-FC's purchased materials and equipment, and time and ability of our personnel. *Any ALS Laboratory Group, Fort Collins employee who has any suggestion or concern regarding ALSLG-FC's practices, is encouraged to discuss his/her idea or question with their Department Manager, the Quality Assurance Manager, and/or the Laboratory Director*. A means of confidentially reporting concerns anonymously is also available. Grievances and allegations of unethical conduct will be fully investigated, and appropriate actions taken.

Training regarding ALSLG-FC's Waste, Abuse and Fraud policies is provided to every new staff member, and to all employees lab-wide as an annual refresher. ALSLG-FC's policies regarding waste, abuse and fraud are included in **Appendix A**.

1.5 CODE OF ETHICS AND DATA INTEGRITY STATEMENTS

ALS Laboratory Group, Fort Collins is responsible for creating a work environment that enables all employees to perform their duties in an ethical manner. *It is ALSLG-FC's expectation that all employees exhibit professionalism and respect for clients and each other in all interactions and tasks.* ALSLG-FC requires that each employee abide by the following guidelines:

- Every ALSLG-FC employee is responsible for the propriety and consequences of his or her actions. Each employee shall conduct him or herself in a professional manner towards all clients, regulators, auditors, vendors, and other employees. Professional conduct relates to honesty, integrity, respect, and tolerance for cultural diversity.

- Every ALSLG-FC employee shall perform all assigned duties in accordance with ALSLG-FC's established quality assurance policies and quality control procedures that have been developed to ensure conformance with contractual and regulatory requirements.

- ALS Laboratory Group, Fort Collins expects all employees to use professional judgment and to document all situations thoroughly. It is the responsibility of each ALSLG-FC employee to consult the Department Manager or Quality Assurance Manager when atypical or unusual situations occur and to disclose and document the decision-making process. Every employee must disclose any instance of noncompliance. ALSLG-FC reports all noncompliance issues affecting data to the client.

- It is the responsibility of each ALSLG-FC employee to report any suspicion of unethical conduct to the Quality Assurance Manager or the Laboratory Director.

Data integrity procedures provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. The following list provides examples of improper, unethical, or illegal practices that ALS Laboratory Group, Fort Collins ***does not*** tolerate:

- Falsification of records to meet method requirements (e.g., sample records, logbooks, sample results, electronic records). This includes intentional misrepresentation of the date or time of analysis (e.g., intentionally resetting a computer system's or instrument's date and/or time to make it appear that a date/time requirement has been achieved); and unwarranted manipulation of computer software (e.g., improper background subtraction to meet ion abundance criteria for GC/MS tuning compounds).

- Improper use of manual integrations performed to meet calibration or method quality control criteria (e.g., peak shaving or peak enhancement performed solely to meet quality control requirements).

- Selective exclusion of data to meet quality control criteria (e.g., eliminating initial calibration points without technical justification).

- Misrepresentation of quality control samples (e.g., adding surrogates or tracers after sample extraction, omitting preparation steps for quality control samples; over- or under- spiking).

- Reporting results without analyses to support the results (i.e., dry-labbing).

- Notation of matrix interference as basis for exceeding acceptance limits in interference-free matrices.

- Intentional plagiarism or willful misrepresentation of another employee's work as one's own (e.g., Initial or Continuing Demonstration of Capability study (IDOC, CDOC) or Proficiency Testing (PT) study.

Strict adherence to ALSLG-FC's Code of Ethics and Data Integrity is essential to the reputation and continued health of our business. All ALSLG-FC employees are required to acknowledge their responsibility and intent to behave in an ethical manner by attesting to the requirements described above upon joining the ALSLG-FC staff, and annually thereafter. Included in **Appendix A** are the ethics documents that every employee is required to review and attest to.

1.6 REVIEW, REVISION, DISTRIBUTION AND HIERARCHY OF QA DOCUMENTS

Current copies of pertinent quality assurance guidance documents, such as ALSLG-FC's LQAP, the TNI Standards, the NELAC standards, ISO 17025:2005, the US DOE Quality Systems for Analytical Services (QSAS), the US DoD Quality Systems Manual (QSM) and others, are posted to the ALSLG-FC network so that they are accessible to every employee. Laboratory Standard Operating Procedures (SOPs) and other method references are also posted to the network for lab-wide employee access. Project-specific requirements are disseminated to the laboratory via Laboratory Information Management Systems (LIMS) program specifications (discussed further below).

ALS Laboratory Group - Fort Collins recognizes a hierarchy of guidance that provides for comprehensive definition, yet flexible coverage, thus enabling both overall program and site-specific needs to be met. An overview explaining this hierarchy is given below. **SOP 926** provides detailed guidance on the review, revision, and distribution of laboratory-generated controlled documents.

1.6.1 LABORATORY QUALITY ASSURANCE PLAN

The LQAP is an encompassing controlled-document that describes ALSLG-FC's quality assurance program and policies. All systems, policies, and procedures have been developed and implemented in accordance with applicable USEPA requirements, regulations, and guidance; the current NELAC standards; and requirements set forth in various client quality assurance documents and contractual specifications. This document has been prepared in accordance with these referenced documents, as well as others, cited in the attached **Bibliography**. The LQAP is intended to provide a 'quality requirements framework', including quality control (QC) procedures to be followed in the absence of project-specific requirements (note that project-specific requirements are communicated to laboratory staff via LIMS program specifications, which are discussed subsequently).

The Quality Assurance Manager (QAM) bears primary responsibility for ensuring that the LQAP meets industry standards. Proposed revisions to the LQAP are approved by key laboratory personnel (i.e., Laboratory Director, Quality Assurance Manager, and every Technical or Department Manager). Following approval, the QAM posts the revised LQAP to the ALSLG-FC network, revised to LQAP document in LIMS. The LIMS notifies personnel of all revised documents. It is the requirement of all employee to read and update reading records for all assigned controlled documents. Archival records of all LQAP iterations are maintained by the Quality Assurance Department.

1.6.2 STANDARD OPERATING PROCEDURES

The second kind of controlled-document in the hierarchy of quality assurance guidance are the Standard Operating Procedures (SOPs). An SOP defines the QA/QC requirements for each method and describes in detail how personnel perform procedures and evaluate data. SOPs pertaining to general practices (e.g., standards, temperature monitoring, etc.), administrative procedures (e.g., procurement of supplies and materials, etc.) and health & safety requirements (e.g., calibration and use of the hand and foot monitor), are also maintained by ALSLG-FC. It is ALSLG-FC's intent that the information contained in our SOPs are both method-compliant, and accurately reflect actual practice. *Suggestions for SOP content clarification or revision are encouraged.* SOPS are published to the network when approved.

The LIMS notifies personnel of all revised documents. It is the requirement of all employees to read and update reading records for all assigned controlled documents

This process of revision, approval and distribution is established in the ALSLG-FC SOP 926.A list of current SOPs is provided in **Appendix H**. The Quality Assurance Department manages the review, revision and controlled distribution of documents and maintains associated records.

1.6.3 LABORATORY MANAGEMENT INFORMATION SYSTEMS (LIMS) PROGRAM SPECIFICATION

The last and most specific controlled-document in this hierarchy is the LIMS program specification. The LIMS program specification is a distillation of client Quality Assurance Project Plan (QAPjP) or contractual requirements, prepared electronically by the ALSLG-FC Project Manager (PM), in collaboration with the QAM and applicable Department Managers. This custom program specification, along with the associated LIMS test code nicknames, contain directives and controls that govern testing and reporting data. The program specification is often limited in scope and addresses only those QA/QC

criteria required for a specific project. *When the client's requirements differ from those stated in the SOPs and/or LQAP, the project-specific LIMS program specification requirements supersede the others.* ***It is the responsibility of all personnel who work with samples or data to consult the applicable LIMS program specification for client-specific requirements prior to initiating handling of the samples or data.***

2. LABORATORY ORGANIZATION AND RESPONSIBILITIES

This section provides an overview of ALS Laboratory Group, Fort Collins organization and defines key personnel, their responsibilities, and the lines of communication between these employees. An organization chart that illustrates reporting relationships is provided in **Appendix B**.

ALS policy is to perform work for clients in the most efficient manner possible, avoiding waste of resources and undue pressure on employees. It is the role of both ALS management and employees to ensure that work for clients is performed most efficiently and effectively by properly utilizing ALS purchased materials, equipment, and the time and ability of personnel..

2.1 GENERAL REQUIREMENTS FOR LABORATORY PERSONNEL

ALSLG-FC maintains sufficient personnel to perform analytical services for our clients. Each employee must have a combination of experience and education that enables him or her to demonstrate a specific knowledge of his or her job function, and a general knowledge of laboratory operations, test methods, QA/QC procedures, and records management. *All personnel are responsible for complying with the requirements that pertain to his/her assigned duties.*

2.2 KEY PERSONNEL

Education, experience and skill requirements for these positions are addressed in job descriptions. Functional responsibilities are further discussed below.

In the event of a temporary absence, key personnel must notify other key staff of their absence and reassign their duties to another employee who is qualified to perform the assigned duties. For example, a PM may assign another PM to cover his or her duties; a Department Manager may assign a senior chemist to cover his or her duties within the Department; and the Laboratory Director may assign a Manager to cover his or her duties.

2.2.1 LABORATORY DIRECTOR

The Laboratory Director (and/or designee) is responsible for:

- All laboratory operations, including: business functions such as marketing, sales and financial issues; technical functions such as sample control, preparation, analysis, data management; and quality assurance;

- Providing input and support to proposal processes, including interacting with the Sales, Technical and Quality Assurance staff, to ensure that the laboratory is capable of complying with client and regulatory requirements;
- Supervising all personnel through Management staff, who ensure that QA/QC procedures are being performed and that any nonconformances or discrepancies are documented and remedied properly and promptly;
- Ensuring that corrective actions relating to Findings from internal and external audits are completed in a timely fashion;
- Ensuring that the laboratory has the appropriate resources and facilities to perform analytical services;
- Ensuring that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory;
- Defining the minimum level of education, experience, and skills necessary for all positions in the laboratory;
- Ensuring that only those vendors and supplies that are of adequate quality are used; and
- Directing the performance of the annual Managerial Review.

2.2.2 QUALITY ASSURANCE MANAGER

The Quality Assurance Manager reports to the Laboratory Director and is independent of daily operation and production requirements. Therefore, the QAM is able to evaluate data objectively and perform assessments without production influence. *The QAM has authority to stop work if systems are sufficiently out of control to compromise the integrity of the data generated.*

The QAM shall have documented training and/or experience in QA/QC procedures; knowledge of quality systems as defined by NELAC; and a general knowledge of the analytical test methods for which data review is performed.

The QAM (and/or designee) is responsible for:

- Defining and implementing the quality system;
- Developing and maintaining a pro-active program for prevention and detection of improper, unethical, or illegal

practices (e.g., single- or double-blind proficiency testing studies, electronic data audits, maintaining documents that identify appropriate and inappropriate laboratory and data manipulation practices);

- Ensuring continuous improvement of laboratory procedures via training, control charts, proficiency testing studies, internal audits, and external audits;
- Coordinating the laboratory's participation in state and Federal certification programs;
- Scheduling the review and distribution and maintaining distribution records of controlled documents, including plans (e.g., LQAP, etc.) and SOPs;
- Reviewing Requests For Proposal (RFPs) to ensure compliance with required QA/QC practices;
- Facilitating external audits;
- Overseeing or conducting internal audits of the entire operation annually (technical, system, data, electronic);
- Coordinating, preparing and approving external and internal audit responses and corrective actions;
- Managing the laboratory's participation in proficiency testing (PT) studies;
- Reviewing nonconformances and approving corrective actions;
- Reviewing QC limits per established procedures;
- Ensuring that Method Detection Limit (MDL) studies are performed and documented per requirements;
- Managing the reference standards used in the calibration and/or verification of support equipment (e.g., weights, thermometers, balances);
- Revising the LQAP annually in accordance with industry standards;
- Maintaining an archival system for data records; and

- Maintaining technical and quality assurance training records, including employee demonstrations of capability (DOCs).

2.2.3 HEALTH & SAFETY MANAGER/RADIATION SAFTETY OFFICER (RSO)

The Health & Safety Manager/Radiation Safety Officer (RSO) reports to the Laboratory Director. This Manager is responsible for establishing and monitoring adequate systems, procedures and training to ensure that the laboratory staff, facilities and operational activities conducted, function in a manner that minimizes employee risk of illness and injury, is compliant with all applicable regulations pertaining to matters of safety and health, and that limits the financial liability of the corporation as it relates to these matters. As RSO, this Manager is also responsible for discharging the duties and requirements prescribed by ALSLG-FC's Radioactive Materials License.

Key responsibilities of the Health & Safety Manager/RSO (and/or designee) include:

- Ensuring that all employees have sufficient training to perform their job without unnecessary risk of illness or injury, providing health and safety, including radiation safety, training for new employees, and maintaining health and safety-related training records;

- Providing procedural guidance in the form of the Chemical Hygiene Plan (CHP), Radiation Protection Plan (RPP), Respiratory Protection Plan (ResPP), Emergency and Contingency Plan (ECP) and Health and Safety SOPs, and ensuring that these guidances are reviewed by laboratory staff;

- Ensuring that the laboratory facilities are maintained and operated in a safe manner, including:

  (a) Performing routine safety inspections of all operational areas;

  (b) Performing routine radiation surveys and managing the radiation dosimetry program; and

  (c) Performing personal monitoring, as indicated, for chemical and other exposures.

- Maintaining the laboratory's Colorado Radioactive Materials License and ensuring compliance with the terms of the license. Included in this responsibility are:

(a) Procuring and managing radioactive sources and standards;

(b) Maintaining the laboratory's radioactive materials inventory, which also includes directing prescreen analyses that provide initial characterization of potential sample radioactivity;

(c) Overseeing permitted low level radioactive materials releases to the sanitary sewer; and

(d) Ensuring that radioactive materials waste are transported in accordance with all Federal and state regulations, and are transferred only to facilities that possess a radioactive materials license.

2.2.4 FACILITIES/WASTE COMPLIANCE MANAGER

The Facilities/Waste Compliance Manager, reports to the Laboratory Director. This Manager is responsible for day-to-day management of the building and serves as the primary point of contact for all matters related to waste collection and disposal.

The Facilities/Waste Compliance Manager (and/or designee) is responsible for:

- Coordinating heating, ventilation, and air-conditioning (HVAC) systems operation and maintenance;
- Maintaining the uninterruptible power supply (UPS) and coordinating maintenance and repairs to the electrical system;
- Maintaining the in-house vacuum system;
- Coordinating repairs to the building (e.g., doors, locks, windows, cabinetry);
- Maintaining the building's security and fire alarm system;
- Interfacing with fire inspectors; and responding to security and fire alarms on a 24-hour basis;
- Implementing waste reduction procedures;
- Managing the accumulation of radioactive waste in the laboratory;

- Developing and maintaining Satellite Accumulation Areas (SAAs) and 90-Day Storage Areas;

- Overseeing all waste disposal operations performed by ALSLG-FC, including (1) ensuring compliance with Federal, state, and local regulations for waste handling and disposal in accordance with RCRA, TSCA, and radioactive waste disposal regulations; (2) managing hazardous waste shipments to Temporary Storage and Disposal Facilities (TSDFs); (3) managing sanitary sewer releases; and (4) managing sample archives and the return of samples and sample residues to clients;

- Training personnel on proper techniques for sample handling and waste disposal, according to standards implemented by Federal, state, and local authorities and maintaining associated training records; and

- Supervising the Sample Receiving Department.

2.2.5 INFORMATION SYSTEMS MANAGER

The Information Systems (IS) Manager reports to the Laboratory Director. This Manager is responsible for administering the network, maintaining data recovery systems, and for managing personal computing (PC) equipment and peripherals, thus supporting instrumentation and LIMS. The IS Manager (and/or designee) is responsible for:

- Managing and maintaining the laboratory computer system. This function includes determining and purchasing appropriate hardware and verifying that its function meets intended objectives, establishing network server structure, and developing and implementing proper maintenance and backup procedures;

- Procuring, configuring and maintaining all printers and copiers;

- Serving as a technical resource on computer-related issues;

- Documenting related operating procedures through SOPs, manuals or other proprietary documentation;

- Supervising recovery of all systems in the event of a disaster;

- Along with the Laboratory Information Systems Manager, analyzing information flow in the laboratory and suggesting the most effective hardware, applications software, and/or programming changes as solutions to meet long-term customer requirements; also, implementing those changes in data acquisition and management by purchasing hardware or software, where software is not developed internally; and

- Maintaining and implementing existing and future communications systems, including all internet and telephone systems.

2.2.6 LABORATORY INFORMATION MANAGEMENT SYSTEMS MANAGER

The Laboratory Information Management Systems (LIMS) Manager reports to the Laboratory Director, and bears the primary responsibility for the LIMS, which serves the needs of the technical, business, and management functions of the laboratory.

Key responsibilities of the LIMS Manager (and/or designee) include:

- Designing and developing information systems that relate to data capture and reporting;

- Maintaining and supporting applications that access LIMS and maintaining and supporting database back-end applications used for LIMS;

- Documenting changes and procedures through SOPs, manuals or other proprietary documentation;

- Developing software, as needed, using the appropriate tools, and per industry standard methodologies and validations;

- Overseeing and assisting with the implementation, testing and verification of upgrades made to instrument software;

- Coordinating all efforts to automate and improve electronic systems and processes throughout the laboratory;

- Developing interfaces necessary to achieve the requirements for client-specified electronic data deliverables (EDDs), and managing all deliverable formats provided to clients (hardcopy, electronic); and

- Providing training, as applicable, for all LIMS-related applications.

2.2.7 PROJECT MANAGER

Project Managers report to the Laboratory Director. *The Project Manager serves as the primary point of contact between clients and ALSLG-FC.* Each PM (and/or designee) is responsible for:

- Managing and coordinating the laboratory's performance after contract award, by defining technical and service requirements for personnel via LIMS, and interacting with clients and laboratory personnel to ensure that technical criteria and client service needs are met, including monitoring holding times (if appropriate) and deliverable deadlines, for all project sample analyses;

- Reviewing and approving any nonconformances reported by the laboratory and notifying the client, if appropriate, and communicating with clients pro-actively to ensure that all client service and technical concerns are resolved promptly;

- Reviewing all final reports for completeness, compliance with project requirements, clerical accuracy, and reasonableness;

- Generating, as directed by prompts provided in ALSLG-FC's proprietary EDD generator, and transmitting EDDs to their clients as required; and

- Communicating to the Laboratory Director any potential need for new or improved capabilities based on clients' feedback.

2.2.8 TECHNICAL OR DEPARTMENT MANAGER

Technical and Department Managers report to the Laboratory Director. These Managers exercise day-to-day supervision of laboratory personnel, procedures, and reporting of results. They maintain technical expertise in their area of specialization (e.g., organics, inorganics, radiochemistry).

Technical Managers and Department Managers (and/or their designee) are responsible for:

- Providing technical education and training to personnel, certifying that personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited, and providing documentation of

employee capability and training to the QA Department, and ensuring that training and documentation are up to date;

- Assigning job tasks and prioritizing analyses;
- Developing and implementing a preventive maintenance program for instrumentation in their laboratory, and ensuring that all equipment is maintained, serviced, and properly calibrated;
- Monitoring QA/QC standards of performance, including ensuring that corrective actions are developed, documented, and implemented for all external and internal audit Findings, PT study failures, and other corrective actions;
- Monitoring the validity of the analyses performed and data generated in the laboratory to ensure the production of compliant data, including, contributing to and/or overseeing data review processes;
- Ensure that SOPs are compliant with promulgated methodologies and reflect current practice;
- Maintaining current, compliant MDL studies for all methods, matrices, analytes, columns, and instruments;
- Coordinating and approving the purchase of reagents, standards, glassware, and equipment that meet requirements;
- Providing input to the Laboratory Director regarding methodologies, personnel resources, software, and instrumentation; and assisting in the evaluation and/or development of new methods and technologies that improve ALSLG-FC's ability to meet clients' needs;
- Reviewing RFPs and assisting in the preparation and submission of proposals; and
- Interacting with the Quality Assurance, Information Systems, and Health and Safety Departments to ensure that the laboratory is capable of complying with client and regulatory requirements.

2.3 GENERAL TECHNICAL PERSONNEL

A chemist (analyst) or technician reports to a Technical or Department Manager. This employee performs work in accordance with ALSLG-FC's controlled

documents (e.g., SOPs, LQAP, etc.) and project-specific requirements as defined by the applicable LIMS specification. *ALSLG-FC believes that quality begins at the bench.* Accordingly, these employees are key contributors to ALSLG-FC's success.

A chemist or technician is responsible for:

- Demonstrating proficiency in the analyses for which they are responsible ***before*** analyzing samples (e.g., performing acceptable Initial Demonstration of Capability, IDOC studies), and documenting this demonstration of proficiency;
- Performing analyses, recording all data accurately, directly, and promptly, and interpreting and reviewing data according to established procedures;
- Read and understand all assigned SOPs and plan documents;
- Complying with all QA/QC requirements that pertain to their job function;
- Complying with all health, safety, and waste disposal requirements, as applicable;
- Maintaining and repairing instrumentation;
- Demonstrating good house-keeping practices;
- Disclosing all instances of nonconformances promptly and in writing using the NCR process (**SOP 928**); and
- Participating in training sessions.

3. QUALITY ASSURANCE INDICATORS AND OTHER MEASUREMENT PARAMETERS

ALS Laboratory Group, Fort Collins' objective is the development and implementation of policies and procedures that provide results of known, documented, and appropriate quality. This LQAP defines general policies for the analysis, documentation, evaluation, validation, and reporting of data. Specific, detailed procedures for chain-of-custody, calibration of instruments, analysis, reporting, quality control, audits, preventative maintenance, and corrective actions, are provided in SOPs as listed in **Appendix H**.

In order to produce data of known, documented, and appropriate quality, ALSLG-FC:

- maintains an effective quality assurance program that measures and verifies laboratory performance;

- provides for a Quality Assurance Department that is independent of the operational groups and that has stop-work authority, and that has the responsibility and authority to audit the laboratory and develop and enforce corrective actions;

- evaluates technical and service requirements of all analytical services requests before accepting samples from a client/project. This evaluation includes a review of facilities, instrumentation, staffing, turnaround times, and any project-specific quality control or reporting requirements;

- provides sufficient flexibility to allow controlled changes in routine methodology in order to achieve client-specific data requirements as prescribed in client documents and contracts;

- documents initial demonstration of capability (IDOC) and continuing demonstration of capability (CDOC) for all methods according to Appendix C of the NELAC standards;

- performs all analyses according to promulgated methods or methods developed and validated by ALSLG-FC and documented in SOPs;

- recognizes as soon as possible and discloses and corrects any factors that adversely affect data quality; and

- maintains complete records of sample submittal, raw data, laboratory performance, and completed analyses to support reported data.

3.1 DATA QUALITY INDICATORS

Data Quality Indicators (DQIs) are qualitative and quantitative statements developed by data users that specify the quality of data from field and laboratory data collection activities in order to support specific decisions or regulatory actions. The DQIs describe *what* data are needed, *why* the data are needed, and *how* the data will be used to address the problem being investigated. DQIs also establish qualitative and quantitative goals that allow the data user to determine whether the data are of sufficient quality for the intended application.

The principal DQIs are **precision**, **accuracy** (bias), **representativeness**, **completeness**, and **comparability** (i.e., the PARCC parameters). The following sections define and describe the application of these parameters. The QA/QC protocols used for the majority of analyses are adopted from SW-846 and 40 CFR methodologies, the USEPA Organics and Inorganics CLP SOWs, and various radiochemistry guidances, which contain detailed descriptions of the quality control measures routinely employed.

3.1.1 PRECISION

Precision is an expression of the reproducibility or degree of mutual agreement among independent measurements as the result of repeated

application of the same process under similar conditions. Precision refers to the distribution of a set of reported values about the mean, or the closeness of agreement between individual test results obtained under prescribed conditions. Precision reflects random error and may be affected by systematic error. Precision characterizes the natural variation of the matrix and the contamination that may vary within that matrix. For chemical parameters that do not allow homogenization prior to analysis (e.g., volatile organics analysis), one must review precision values carefully.

Analytical precision is a measurement of the variability associated with duplicate or replicate analyses of the same sample in the laboratory. Analytical precision is determined by the analysis of matrix spike/matrix spike duplicates (MS/MSD), laboratory control sample pairs (LCS/LCSD), or by unspiked duplicate samples (DUPs). Total precision is a measurement of the variability associated with the entire sampling and analysis process, and is determined by analysis of duplicate or replicate *field* samples, thus incorporating the variability introduced by both the field and laboratory operations.

Precision is independent of bias or accuracy, and reflects only the degree to which the measurements agree *with one another*, not the degree to which they agree with the true or accepted value of the parameter measured. Precision for stable chemistry analyses is typically expressed as relative percent difference (RPD), as defined below:

$$RPD(\%) = \frac{X_1 - X_2}{(X_1 + X_2)/2} \quad (100)$$

where:

RPD = Relative Percent Difference

X_1, X_2 = analyte value of sample 1 and sample 2

Precision, for radiochemical analyses, is typically measured in terms of Duplicate Error Ratio (DER), calculated as follows:

$$DER = \frac{|S - D|}{2 * \sqrt{\sigma^2{}_S + \sigma^2{}_D}}$$

where:

DER = Duplicate Error Ratio

S, D = analyte values of (S)ample and (D)uplicate

σ = One Sigma error value associated with sample result

RPDs or DERs are compared to the control limits established for the analysis method, or other quality control criteria as prescribed in the applicable LIMS program specification. Precision objectives vary per analytical method. Sample homogeneity/non-homogeneity is an important factor that influences the precision of duplicate sample results.

3.1.2 ACCURACY

Accuracy is an expression of agreement between the measured and known or accepted reference values. Accuracy is the measure of the closeness of an observed value to the "true" value (e.g., theoretical or reference value or population mean). Accuracy is influenced by random error and systematic error (bias) that occur during sampling and analytical procedures; therefore, accuracy reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ significantly from the known concentration of the spike or standard.

Accuracy is typically measured by determining the percent recovery of known target analytes (i.e., a surrogate or matrix spike) that are spiked into a field sample or reagent water or simulated solid matrix (laboratory control sample). Surrogate recovery is reported and is used to assess method performance for each sample analyzed for volatile and semivolatile organic compounds. For organic and inorganic parameters, the stated accuracy objectives apply to spiking levels at or near the midpoint of the calibration curve. For radiochemical analyses, the spiking levels for the control spikes may vary from five to fifty times the method reporting limit.

Percent recovery is calculated as:

$$R(\%) = \frac{(C_1 - C_2)(100)}{C_3}$$

where:

R% = Spike amount recovered
C_1 = Concentration of analyte in spiked sample
C_2 = Concentration of analyte in unspiked sample
C_3 = Concentration of spike added

Acceptance limits are usually based upon established laboratory performance for similar samples. Other quality control criteria may be prescribed in the applicable LIMS program specification. Recoveries outside the established limits may indicate some assignable cause other than normal measurement error, and the need for corrective action. This corrective action may include reanalysis of the quality control

sample, recalibration of the instrument, reanalysis of the affected samples in the batch, re-preparation of samples in the batch, or flagging and qualifying the data as suspect if the problem cannot be resolved. For contaminated samples, recovery of matrix spikes may depend on homogeneity, matrix interference, and dilution requirements for quantitation.

Both accuracy and precision are calculated for each batch and the associated sample results must be interpreted by considering theses specific measures. The quality assurance objectives for precision and accuracy are to achieve the quality control acceptance criteria specified in the appropriate analytical procedure.

For organic analyses, precision and accuracy are determined by using matrix spike and matrix spike duplicate samples and/or surrogate spike compounds and laboratory control samples. For inorganic analyses, precision and accuracy are determined by using duplicate samples or matrix spike duplicate samples (precision) and matrix spike and laboratory control samples (accuracy). For radiological analyses, precision and accuracy are determined from the results of duplicate samples or matrix spike duplicate samples (precision), laboratory control sample duplicates (precision) and laboratory control samples (accuracy).

Samples identified as field blanks cannot be used for duplicate or matrix spike sample analyses.

QC limits for accuracy and precision may be developed from intra-laboratory historical data or adopted from prescribed limits required by the client. If quality control acceptance criteria do not exist for a given method, then the laboratory may establish advisory control limits derived from a minimum of four data points. Until verified by a statistically significant data population, the control limits will be considered as advisory limits only, and the laboratory will not automatically initiate reanalysis if these limits are not achieved. See Section 9.3 for further discussion of control limits and control charts.

Bias describes the systematic error of a measurement process that causes errors in one direction from the true value. Sources of bias include incomplete homogenization before subsampling and incomplete extraction of target analytes. Calibration drift, which is the nonrandom change in a measurement system over time, is another example of systematic error, and is detectable by the periodic measurement of calibration check standards. *Bias is **not** equivalent to accuracy.*

3.1.3 REPRESENTATIVENESS

Representativeness is a qualitative element. It expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Sample handling protocols (e.g., holding times, storage, preservation and transportation) have been developed to preserve the representativeness of the samples. Proper documentation establishes that quality control protocols have been followed, and sample identification and integrity are ensured. *ALSLG-FC makes every attempt to ensure that the aliquots taken for analysis are homogenous*

and representative of the samples received.

3.1.4 COMPARABILITY

Comparability is a qualitative expression of the confidence with which one data set can be compared to another. Comparability is achieved by:

- following established, standardized, and approved sample collection techniques and analytical methods;
- achieving holding times;
- reporting results in common units;
- using consistent detection levels; and
- reporting data according to consistent rules.

See Chapter 10 of this LQAP for further discussion of standard units typically used to report various analytical parameters.

3.1.5 COMPLETENESS

Completeness is an expression of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Completeness is the percentage of measurements that are judged to be usable (i.e., that meet project-specific requirements). Completeness goals are defined in the site sampling and analysis plan, QAPjP or contract, and vary with the size and complexity of the project. Completeness goals of 80-95% are traditionally accepted as realistic. ALSLG-FC's objective is 100% completeness for samples unaffected by matrix interferences.

It is recognized that some samples are highly contaminated with target and/or non-target compounds, which necessitate cleanups, multiple analyses, and/or extensive dilutions. In these instances, the internal QC results for a sample help to demonstrate the impact upon recoveries and detection limits due to these atypical situations.

Factors that adversely affect completeness include:

- receipt of samples in which chain-of-custody or sample integrity is compromised in some manner (e.g., broken containers, improperly preserved);
- receipt of insufficient volume to perform initial analyses or repeat analysis if initial efforts do not meet QC acceptance criteria;

- receipt of samples for which more than 50% of the holding time has expired; and
- receipt of samples that contain high levels of contamination that can cause persistent effects on instrumentation designed for trace-level analyses.

The equation used to calculate completeness is:

$$C\% = \frac{S}{R} (100)$$

where:

C = completeness
S = number of successful analyses
R = number of requested analyses

The USEPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test as a result of random error, assuming the confidence interval is established at 95% (preamble to 40 CFR Part 136, Vol. 49, No. 209, October 26, 1984). As the number of compounds measured increases in a given sample, the probability for realizing statistical error also increases. The number of compounds present in various methods (e.g., GC/MS Methods SW8260B and SW8270C, ICAP Method SW6010B and Gamma Spectroscopy Method EPA 901.1), increases the probability that one or more analytes will not meet acceptance criteria, to significantly more than the 5% per analyte frequency. The number of target analytes included in these methods can be used to show that a minimum of four to seven target analytes will exceed the control limits established for these methods as a result of the statistical probability for random error. *Establishing quality control criteria that are not consistent with the measurement of the quality objectives for which they are intended is discouraged.*

3.2 TRACEABILITY

Traceability is the extent to which results can be substantiated by hard-copy documentation, electronic or computer-generated data calculations, computer software, and data generation. Traceability documentation exists in two forms: (1) that which links final numerical results to authoritative measurement standards, and (2) that which explicitly describes the history of each sample from collection to analysis. Measurement traceability is further discussed in Chapter 7 of this LQAP.

3.3 SENSITIVITY

The term sensitivity is used in a broad sense to describe the various limits that enable a laboratory to meet project-specific data quality objectives (DQOs). These limit types include: instrument detection limit (IDL), method detection limit (MDL), method quantitation limit (MQL) or method reporting limit (RL), contract-required detection limit (CRDL), and contract-required quantitation limit (CRQL).

3.3.1 IDL AND MDL

The IDL is a minimum value that addresses the detection capability of the instrument *only*, hence IDL studies are performed on a per analyte per instrument basis. IDL studies are particularly important to metals analyses. These IDL studies must be conducted on a quarterly basis, per method requirements, or whenever there is a significant change in instrument components or reagents.

The MDL is a minimum value that addresses the detection capability for the sample preparation procedures and the instrument. Hence, ALSLG-FC performs MDL studies for each preparatory and determinative method combination, matrix, instrument, and analytical column. MDL studies are performed with a frequency that's prescribed by the method, at minimum, annually. Some Wet Chemistry methods require MDL studies to be performed every 6 months. MDL studies are also required for method validation, and whenever the basic chemistry of a procedure changes.

MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. MDLs are determined from replicate analysis (minimum of seven) of a sample in a given matrix containing the analyte(s). 40 CFR Part 136 Appendix B defines the MDL is defined as:

$$MDL = t(n-1, 1-\alpha, = 0.99) \times \sigma$$

where:

σ = Standard deviation of the replicate analyses

$t(n-1, 1-\alpha, = 0.99)$ = Student's t-value appropriate to a 99% confidence level

An MDL check sample, at a concentration about half that spiked for the MDL study and approximately twice the calculated MDL, is also analyzed with the MDL study (immediately following), to demonstrate that the MDL is valid. Performance criteria is that the MDL check is acceptable if it yields a confident positive detection (i.e., all analytes in the check sample can be identified by method-specified criteria). If MDL check sample results do not support the determined MDL,

appropriate corrective actions must be taken (e.g., repeat MDL check sample analysis, repeat MDL study, raise MDL).

An MDL study is not performed for radiological analyses, or any components for which spiking solutions are not available or relevant (e.g., pH, ignitability, etc.). Reporting limits for these kinds of parameters, where applicable, are established based on the laboratory's knowledge of extraction efficiency, instrument sensitivity, and experience with the procedure. **SOP 329** provides additional information about MDL studies.

Although the QA Department provides oversight, each Department Manager is responsible for ensuring that all IDL and MDL studies are conducted and documented as needed.

Results calculated between the MDL and the MQL (RL), see section following, contain a significant amount of error (approximately ±100%). Therefore, values reported between the MDL and MQL (RL) are qualified as estimated – 'J' flagged for organic parameters, 'B' flagged for inorganic parameters. Also, IDL and MDL values are based on an interference-free matrix, and cannot evaluate the effects of sample matrix on the calculated IDL or MDL. Therefore, established IDLs and MDLs may not be achievable in environmental matrices.

3.3.2 MQL, RL

ALSLG-FC defines MQL (RL) as the analyte concentration at or above which the laboratory's precision and accuracy requirements can be routinely demonstrated and achieved. The statistical error associated with this region of a calibration curve is significantly smaller than that associated with the region near the MDL. The MQL (RL) values for most analytes reported by ALSLG-FC are numbers that are approximately 3 to 5 times the values of the MDL for those analytes. It is ALSLG-FC's policy to analyze a calibration standard at or below the MQL (RL) when performing an initial calibration.

The MQL or RL is the lowest level that can be reliably measured by a laboratory with defined limits of precision and accuracy. The USEPA CLP SOW uses the terms CRDL and CRQL to describe *contractually-required* levels of reporting. These reporting terms do not describe instrument sensitivity.

3.4 MINIMUM DETECTABLE CONCENTRATION

The minimum detectable concentration (MDC) is used for radiochemical procedures and is defined as the concentration at which there is a 95% confidence that an analyte signal will be distinguishable from an analyte-free sample.

The general formula for calculating the MDC is based on calculations derived by Curie (Curie, L.A., "Limits for Qualitative Detection and Quantitative Determination," Analytical Chemistry 40(3); pp. 586-693; 1968) and is calculated as follows:

$$MDC = \frac{(4.65\ X\ \sigma_b) + 2.71}{T * K}$$

where:

MDC = Minimum Detectable Concentration

σb = Standard deviation of the measurement background

T = Sample count time

K = Factor for incorporating efficiency, abundance, aliquot yield, ingrowth and decay, and activity conversion factors

3.5 TOTAL PROPAGATED UNCERTAINTY

Total propagated uncertainty (TPU), is a summation of the various uncertainties present in a measurement process, and is an integral part of every reported radiochemical value. TPU, reported as ±TPU, is the expressed estimated measure of the total uncertainty inherent in that reported radiochemical result.

The components of the TPU are classified as either random or systematic. Random uncertainties, also called counting uncertainties (CU), derive from the statistically random (normally distributed) nature of radioactive decay, and are estimated as the square root of the total number of counts acquired during analysis. In cases where the chemical yield is determined by the analysis of a radioactive tracer, the yield uncertainty (YU) is also a random uncertainty, and is estimated as the square root of the total number of tracer counts acquired. CU and YU are calculated in activity units to afford comparability to the sample result.

Systematic uncertainties are attributable to actual errors in the measurement of a physical quantity. For example, if a balance has an accuracy of ±0.1%, the results of those gravimetric measurements are not normally distributed, but rather are assumed to be biased by that amount. Estimates of systematic uncertainties in laboratory processes are somewhat subjective, but should be supported by empirical data whenever possible. Systematic uncertainties associated with the preparation of a sample are called preparation uncertainties (PU), and are defined based on the number of volumetric and gravimetric measurements, quantitative transfers, etc. Systematic uncertainties associated with the analysis, called instrument uncertainties (IU), include biases associated with sample positioning, standard values, calibration coefficients, etc. PU and IU are typically provided as a percentage of the final result. To afford comparability to sample results, PU and IU are expressed in activity units by multiplying the percentage by the sample activity (A).

All contributions to TPU are considered to be independent of each other, and the individual contributions are combined as the square root of the sum of the squares

(see equation below). The final TPU result is expressed in activity units, such as pCi/g or pCi/L.

$$TPU = \sqrt{CU^2 + YU^2 + (A * PU)^2 + (A * IU)^2}$$

TPU is expressed as a value at a specific confidence interval. The default convention at ALSLG-FC is to provide the TPU at the 2-sigma confidence interval. This asserts approximately a 96% confidence level that the actual sample value is within the reported uncertainty range of the calculated result. **SOP 708** provides more information about the calculation and use of TPU.

3.6 QUALITY ASSURANCE PROJECT PLAN (QAPjP) EXCEPTIONS

As a result of the unknown nature of environmental samples prior to analysis, ALS Laboratory Group, Fort Collins has minimal control over analytical and quality control complications that result from sample matrix conditions. These conditions may include highly concentrated samples that contain target compounds of interest and/or non-target components; high organic content (both natural and synthetic); and extremes in pH, viscosity, solubility, etc. Each of these conditions may require a different approach.

Analysis for some samples may be achieved through the use of reduced aliquot sizes. Some sample matrices may require the laboratory to use cleanup and/or dilution techniques in order to analyze the sample by the desired protocol. Unfortunately, reduction of analysis aliquot or diluting a sample necessitates raising reporting limits (RLs) or MDCs, and often adversely impacts the calculation of surrogate, tracer, and matrix spike compound recoveries.

ALSLG-FC has the responsibility to identify matrix interferences that preclude the generation of 'compliant' data. This determination may be made by demonstrating reproducibility (i.e., reanalysis of the affected sample) to show that the quality control measurement failure resulted from sample matrix conditions beyond the laboratory's control and not as a result of analytical error. For example, if the surrogate or tracer recoveries are outside of control limits, then samples may be re-extracted and/or reanalyzed. Repeated non-compliant results indicate that sample matrix probably prevented the laboratory from reporting results deemed compliant.

Analytical projects containing particularly "dirty" samples (i.e., highly contaminated with target compounds and/or matrix co-extractives) will often fail to meet pre-established completeness goals (set forth in the QAPjP), when prior site history does not reveal the matrix constituents issues. Although the laboratory performs all analytical testing and cleanup procedures by the prescribed protocols, the results obtained may not meet validation criteria as a result of elevated reporting limits or the frequency at which surrogate, internal,

tracer, or matrix spike recoveries fail to meet acceptance limits. In cases where the laboratory is unable to meet quality control criteria as a result of sample matrix complications, results that are qualified by data validation guidelines may still be useful to the end user of the data.

ALSLG-FC is committed to adhering to the method requirements and quality control procedures prescribed by our clients. ALSLG-FC strives to produce compliant data, however, uncertainties associated with environmental samples may preclude the laboratory's ability to generate fully compliant data. ALSLG-FC will not assume responsibility for conditions beyond our reasonable control, that directly impact the "validity" versus the usability of the associated analytical data generated by the laboratory.

4. SAMPLE CONTAINERS, PRESERVATION, HANDLING, HOLDING TIMES

Defining the magnitude and nature of an environmental problem, and developing an appropriate solution, requires the collection of representative samples for laboratory analysis and data evaluation. The objective of field sampling is to remove a small portion of an environment that is representative of the entire body. *Analytical methods have been standardized, but the results of analyses are only as good as the sampling protocol and the sample preservation and handling methods.* Defining sampling procedures and the quality elements applicable to environmental testing is beyond the scope of this document, and beyond the responsibility of the laboratory.

Although the laboratory is not responsible for sample collection, it is responsible for maintaining the integrity of the sample after receipt. After the sample has been collected, the constituents of the sample must remain as close as possible to the field condition (i.e., degradation must be prevented). The length of time that these constituents will remain stable is related to their character and the preservation method used. Preservation is accomplished by the addition of chemical preservatives and/or storage at a controlled temperature, and by the strict observation of prescribed maximum holding time allowances. **Appendix C** lists sample container types, preservation requirements, and holding times.

4.1 FIELD SUPPORT

Unless not required by the client, sample kits are prepared at the laboratory to provide the client with all of the sample containers, preservatives and documentation needed for the analyses needed for a project. ALSLG-FC provides shipping containers, custody documents, custody seals, clean sample bottles, labels, applicable high-purity chemical preservatives for water samples, trip blanks, and, upon request, "blue ice" packs to support field-sampling events. Hard-sided, insulated, "picnic" coolers are typically used to transport samples from the field to the laboratory. These coolers meet or exceed all protocol requirements (i.e., USDOT, USEPA, ASTM) for shipping. ALSLG-FC **SOP 205** provides further information on sample kits.

4.2 SAMPLE CONTAINERS

ALS Laboratory Group, Fort Collins provides certified clean (I-Chem 300™,

Eagle Pitcher Level 1, or equivalent) sample bottles for sample collection. Used sample bottles are never used by the laboratory. The Sample Receiving Department maintains certificates of cleanliness that are provided by the vendor for all sample bottles. These certificates are provided to the client upon request. Containers are stored in clean areas, away from laboratory processes, to prevent exposure to fuels, solvents, and other contaminants.

4.3 SAMPLE PRESERVATION AND HOLDING TIMES

ALSLG-FC provides the required chemical preservatives for water samples and, upon request, "blue ice" packs, for thermal preservation during transport. Typically, high quality reagent grade chemical preservatives (i.e., acids, solutions, etc.) are added to individual sample bottles, as appropriate per method and US Department of Transportation (DOT) requirements. Only trace metals grade nitric acid is used for preservation of metals or radiochemical samples, as applicable. It is the responsibility of those collecting the samples to properly use these materials (e.g., don't rinse or overfill container such that the preservative is washed out), and to ensure that chemical preservation requirements are met, and proper preservation techniques (chilling) are performed. Holding times begin with the collection of samples and continue until analysis is complete. See **Appendix C** for a summary of container, preservation and holding time requirements specific to various analyses and matrices.

4.4 SAMPLE RECEIPT SCHEDULE

ALSLG-FC receives samples six days of the week, Monday through Saturday. ALSLG-FC requests that clients ship samples for delivery within one day of collection, and give advance notice to the laboratory regarding shipment of RUSH samples or samples with short hold time requirements. Shipping containers received at the laboratory on holidays or after business hours are placed in a walk-in refrigerator and opened on the next business day, unless other arrangements are made in advance.

4.5 CHAIN-OF-CUSTODY

Chain-of-custody (COC) documentation begins with field sampling and continues through laboratory analysis and disposal. A chain-of-custody record that identifies all individuals who handle the sample is used to establish an intact, continuous record of the physical possession, storage, and disposal of collected samples, including their aliquots, extracts or digestates. The chain-of-custody record is initiated in the field by field personnel who complete a COC form listing all samples. This form contains the following information and remains with the samples during transport:

- client project name and project location;
- field sample number/identification;
- date and time of sample collection;

- matrix;
- container type and number of containers for each sample;
- preservative;
- analysis requested;
- sampler's remarks and signature;
- signature of person relinquishing samples and date and time relinquished;
- custody seal number (if applicable); and
- designation of matrix spike/matrix spike duplicate (MS/MSD) samples (optional).

  Note that contingent upon the sample matrix and analysis to be performed, additional sample volume may need to be submitted to accommodate MS/MSD analyses.

All transfers of samples, except directly between commercial couriers, must be recorded on the chain-of-custody form via the "relinquished" and "received by" sections. All information, except signatures, should be clearly printed.

The USEPA National Enforcement Investigations Center (NEIC) defines evidence of custody as:

- in one's actual possession, or
- in one's view, after being in one's physical possession, or
- having been in one's possession and then locked or sealed to prevent tampering, or
- kept in a secure area, restricted to authorized personnel only.

To ensure that sample custody objectives of traceability are achieved for every project, the chain-of-custody initiated in the field, is continued and maintained internally throughout the laboratory per the requirements specified in **SOP 318.** Internal chain-of-custody begins with sample acceptance and login (**SOP 202**), is maintained as samples are distributed for use throughout the laboratory (further discussed in LQAP Section 4.10), and concludes with final sample disposition (i.e., return to the client or disposal). ALSLG-FC applies a unique barcode to each sample bottle received, and maintains several scanners and PCs throughout the laboratory to document and assist with sample, aliquot, extract and digestate movement throughout the facility. This electronic process is accomplished through LIMS, which retains records of all sample and fraction transactions made.

4.6 SAMPLE ACCEPTANCE POLICY

ALS Laboratory Group, Fort Collins' sample acceptance policy requires that a

sample meet the following conditions:

- The sample shall be completely documented (sample identification, location, date and time of collection, collector's name, preservation type, sample type, any special remarks concerning the sample);
- The sample shall be identified by a unique identifier using durable labels completed in indelible ink;
- The sample shall be collected in adequate volume;
- The sample shall be collected in an appropriate container;
- The sample shall be delivered to the laboratory with at least one-half the holding time remaining;
- The sample shall not exceed allowed radioactivity levels; and
- The sample shall not show signs of contamination, breakage, or leakage.

Sample receipt discrepancies are documented by Sample Receiving Department personnel on the Condition of Sample Upon Receipt, Form 201 (**Appendix D**), which is forwarded to the Project Manager as part of the workorder folder. Where samples do not meet the criteria stated above, the Project Manager requests information from the client before proceeding. If the client can provide the information and, in cases of compromised sample integrity, directs the laboratory to proceed, then data acquired from the sample(s) analysis is reported and the problems noted during sample receipt are disclosed in the narrative of the final data report.

In support of the protection of employee health and of ALSLG-FC's radioactive materials license, ALSLG-FC observes prescreening protocols that designate or determine samples with radioactive content. Detailed procedures for conducting radiological survey of incoming sample packages are given in **SOP 008**, further details regarding prescreening protocols are given in **SOP 703**.

4.7 SAMPLE RECEIPT PROTOCOLS

Upon receipt of the field samples at the laboratory, personnel ensure that sample bottles are maintained according to storage requirements, and in a manner that does not contaminate the samples (see section 4.9 for further details).

Ascension numbers that increment serially each month of the year are applied as workorder number assignments. Following sample arrival and initial screen for USDOT compliance and removable radioactivity, sample receiving personnel inspect the sample and record any discrepancies using Form 201 (**Appendix D**). The following information is documented:

- client and project name, as applicable;
- presence/absence and condition of (i.e., intact, broken) custody seals on

the shipping containers;

- presence/absence of chain-of-custody and completeness;
- sample condition (intact, broken, leaking);
- presence/absence of removable sample tags;
- agreement/non-agreement between the sample labels, tags, chain-of-custody, and any other client documentation;
- receipt of adequate sample volume;
- sample temperature, where applicable;
- presence/absence of headspace in VOA and ^{222}Radon vials; and
- chemical preservation, where applicable.

Sample temperature is verified upon receipt by measuring the temperature of the temperature blank (if available) or by measuring the temperature of a representative samples(s) with an infrared (IR) temperature device. See **SOP 210** for instructions and procedures related to IR temperature guns. Samples that require thermal preservation are considered acceptable if the temperature upon arrival is between just above freezing to 6°C. Samples that require thermal preservation but are hand-delivered to the laboratory immediately after collection, may not meet the temperature requirement. If the hand-delivered sample is packed in ice, then Sample Receiving personnel record its temperature and note that the chilling process was initiated.

4.8 SAMPLE LOGIN POLICIES AND PROCEDURES

After completing sample receipt procedures, the following sample information and analytical requests are entered into LIMS under the unique workorder number assigned:

- client name, contact, address, phone number;
- ALSLG-FC Project Manager;
- date and time of sample receipt;
- unique laboratory identifier for each sample;
- sample description, including date/time of collection;
- analyses requested (LIMS calculates holding times for each analysis);
- program specification or other special instructions, if applicable; and
- due date.

In general, a group of received samples is assigned one workorder number in LIMS. Each sample container is assigned a unique ALSLG-FC identifier

(barcode) that is placed on each container. This unique identification includes all samples, subsamples, and subsequent extracts and/or digestates.

See **SOPs 201 and 202** for additional information about sample login and distribution.

4.9 SAMPLE STORAGE

Samples requiring thermal preservation are stored in designated refrigerated storage areas that are maintained just above freezing to 6°C, centered at 4±2°C. Freezer storage areas are maintained at freezing to ¯20°C, centered at ¯15±5°C. The temperature of refrigeration units is monitored continuously using electronic min/max thermometers and recorded each business day, near to the beginning of the work shift. If the temperature exceeds the prescribed range, then corrective action is taken and documented immediately, and the client notified, if appropriate; see **SOP 326** for further details. Directives for corrective action pertaining to catastrophic failure of cooling units (as well as laboratory ovens, etc.) are included in ALSLG-FC's Emergency and Contingency Plan (ECP).

Samples are stored away from all standards, reagents, food and other sources of contamination. Samples are stored in such a manner as to prevent cross-contamination. For example, pure product or potentially contaminated samples are tagged as "hazardous" and stored within a secured area, separate from other samples. ALSLG-FC provides designated sample storage areas according to the following parameter groups: metals, inorganics (WetChem), semivolatile organics, volatile organics, fuels, and radiochemical analyses.

Samples having suspected radioactive activity and scheduled also for stable chemical analyses are refrigerated. Samples to receive tritium analyses are refrigerated. Samples designated for radiochemistry analyses *only*, with the exception of tritium, are segregated and maintained at ambient temperature.

To effectively monitor the storage and potential contamination of volatile organic samples, ALSLG-FC observes a refrigerator blank program (detailed in **SOPs 511, 512**).

To provide for the safe containment of sample material that could be released as a result of sample container failure, all samples are stored in secondary containment bins. These secondary containment bins are of a sturdy and inert nature, and are sufficient in size to fully contain the sample(s) in the event of a spill, leak or breakage. The bin(s) may be uniquely identified (labeled) to assist in locating samples via the chain-of-custody system. The bins are thoroughly cleaned between uses.

4.10 SAMPLE ACCESS

It is ALSLG-FC's policy that neither samples nor data may be released to unauthorized personnel. In order to ensure that this policy is maintained, the

laboratory facilities are maintained under controlled access and are restricted to authorized personnel only (see **SOP 132** for further details pertaining to building security).

As discussed previously in this section, ALSLG-FC personnel follow strict sample handling and internal chain-of-custody procedures to ensure the integrity of all data generated. Limited access electronic controls in LIMS further protect the validity of the data results. Samples are scanned and transacted in LIMS when they are removed from a storage area for preparation or analysis. The sample ID, analyst, date, time, and location are recorded with each transaction. Likewise, the samples are scanned and transacted in LIMS upon their return to the storage unit. Barcode scanning and LIMS transaction is also observed for the return of sample remainders to the client, and for disposal (see LQAP Section 4.13). ALSLG-FC **SOP 318** contains internal chain-of-custody details; procedures for sample return to the client are described in **SOP 027**.

4.11 SAMPLE HOMOGENIZATION AND SUBSAMPLING

Obtaining a representative aliquot of sample for testing is critical to the representativeness of the analytical results obtained. Proper subsampling techniques, particularly for solid matrices, are a component of each bench employee's technical instruction. Sample homogenization procedures prior to radiochemical analysis are prescribed in **SOP 721**. Representative subsampling procedures for stable chemistry analyses, may be discussed in individual preparatory SOPs, and additional guidance, "Subsampling Soils and Sediments", is also posted to the ALSLG-FC network for ready reference. Client-specified procedures for homogenization or aliquotting may also be defined in the applicable LIMS program specification.

4.12 SUBCONTRACTING ANALYTICAL SERVICES

ALS Laboratory Group, Fort Collins strives to identify the need to subcontract specific analytical procedures during the bid response process. Analyses may also need to be subcontracted, however, in cases of emergency where the ability to meet sample holding time criteria is endangered. In these instances, ALSLG-FC compiles a list of qualified subcontract laboratories that are suitable to perform the needed analyses, then submits the list to the client for selection and approval. If NELAC certified analyses are to be subcontracted, the subcontract laboratory must also hold NELAC certification for the analyses that are to be conducted. The same concept regarding subcontract laboratory qualifications may apply for other program samples (e.g., DOD laboratory approval status is required for the analyses to be conducted in the case of DOD samples that must be subcontracted for analysis). Note that for subcontracted DOD sample analyses, the subcontract laboratory must receive project-specific approval from the DOD client before any samples are analyzed.

ALSLG-FC's Project Manager must receive permission from the client, in writing, before the subcontract laboratory can be procured and samples forwarded

to the laboratory. At a minimum, the specific terms of the subcontract laboratory agreement must include:

- analytical method required (e.g., SW-846, 40 CFR, etc.);
- number and type of samples expected;
- project-specific quality control requirements;
- deliverables required (hardcopy, electronic);
- laboratory certifications required;
- price per analysis; and
- turnaround time requirements.

See **SOP 103** for guidance on evaluating a subcontract laboratory's qualifications. Detailed procedures pertaining to submitting samples to a subcontract laboratory are provided in **SOP 103**.

4.13 SAMPLE DISPOSAL

After completion of sample analysis and submission of the project report, unused portions of samples are retained by the laboratory for a minimum of 90 days from date of invoice. Samples are disposed or returned to the client according to the nature of the samples and the client's specifications. ALSLG-FC documents and retains all conditions of disposal and correspondence between all parties concerning the final disposition of the sample.

Samples, digestates, leachates, extracts, and process waste that are characterized as hazardous, radioactive, or mixed waste are disposed in accordance with Federal and state laws and regulations. ALSLG-FC maintains records to demonstrate that all disposal efforts were conducted in compliance with these laws and regulations. This documentation includes the unique sample identity, date of disposal, nature of disposal (e.g., sample depleted, sample disposed in hazardous waste facility, sample disposed in mixed waste facility, sample returned to client); and name of the individual responsible for disposal.

5. LABORATORY FACILITIES

Appendix E contains a diagram of the ALS Laboratory Group, Fort Collins laboratory facility. ALSLG-FC maintains constant and consistent test conditions throughout the facility (e.g., temperature, air purification, lighting). All entrances and exits are wired to a laboratory-wide security system that is monitored continuously. Access to the laboratory area from the front offices is restricted by means of keypad locks requiring numeric security code entry. Visitors must sign in at the front desk and must be escorted at all times (some vendors are allowed access without continuous escort, in order to facilitate repairs or deliveries). Further details pertaining to building security are provided in **SOP 132**.

The following sections highlight areas of the laboratory that are involved with sample

receipt, handling, preparation, and analysis of samples.

5.1 SAMPLE RECEIPT AREAS

ALSLG-FC's sample receiving area consists of a large dedicated room of more than 500 ft^2. It contains two fume hoods and radiation survey equipment to safely handle incoming radioactive and mixed waste samples. There is an outside access door to facilitate sample delivery and shipping of sample kits. Adjacent to the sample receiving area is the bottle storage room and the radioactivity prescreening lab.

5.2 SAMPLE STORAGE AREAS

ALSLG-FC's sample receiving area has a walk-in cooler and a freezer that are used for temporary storage of samples that require thermal preservation. In addition, there are several designated sample storage locations throughout the laboratory that are used to store samples scheduled for specific analyses (see section 4.9 for further details).

5.3 SAMPLE PREPARATION AREAS

The laboratory has nine sample preparation/extraction/digestion areas. These areas are divided as follows: six radiochemistry preparation laboratories; two organics extraction laboratories; and one metals digestion laboratory. The total floor space of these six laboratories is approximately 4500 ft^2.

Laboratory preparation procedures are segregated as much as possible to minimize the potential for contamination, maximize processing efficiency, and maintain analytical integrity. Rigorous cleaning of glassware (**SOPs 334** and **720**) and apparatus ensures that cross-contamination is minimized. Each laboratory area has a dedicated or locally shared HVAC system that continuously exchanges the laboratory air with filtered and conditioned outside air. There are 34 laboratory hoods in the six sample preparation areas, and each sample preparation area has at least one hood that is capable of maintaining an average face velocity of 100 feet per minute.

5.4 STANDARDS PREPARATION AREAS

A dedicated radiochemical standards preparations room, and an organics standards preparation area are maintained. Metals and inorganic standards are stored independently from sample storage areas and are prepared in their respective laboratory areas.

5.5 ANALYTICAL LABORATORIES

The ALSLG-FC facility houses a volatile organics analysis (VOAs) laboratory that is on an upper level of the building, away from all other laboratory operations. The ALSLG-FC facility also houses one general chemistry (WetChem) laboratory, two radiochemical counting rooms, a total organic carbon (TOC) laboratory area, two gas chromatograph (GC)/high performance liquid

chromatography (HPLC) labs, a semivolatile organic compounds (SVOCs) laboratory, and a metals laboratory that contains separate inductively coupled plasma (ICP), mercury, and inductively coupled plasma/mass spectrometry (ICP/MS) rooms.

5.6 OTHER LABORATORY AREAS

Other areas of the ALSLG-FC facility include a tank room for compressed gasses, several waste management areas, telephone and computer storage rooms, staff offices, Reporting Group and Reports Management data processing rooms, and various scanning/reproduction and supply storage areas.

5.7 DEIONIZED WATER SYSTEM

Within the laboratory, there are two main deionized (DI) water distribution systems available for glassware cleaning, bulk reagent preparation, and general use. One system is located in the janitor's area and serves the radiochemistry side of the facility (ASTM Type II water generated). The other system is located adjacent to the metals laboratory area and serves the stable chemistry side of the facility (ASTM Type I water generated). These DI water systems are capable of continuously delivering water that meets the requirements specified for the ASTM water type, and are monitored and documented each business day to ensure that the water meets these criteria. ALSLG-FC also maintains a third treated water system that is used to support washing of stable chemistry laboratory glassware.

DI water is defined as municipal tap water that has been treated by passing it through a particulate filter, activated carbon unit, cation exchange resin, anion exchange resin, mixed bed resin, and a final "polishing" cartridge. This water contains no detectable heavy metals or inorganic compounds of interest, and is free of organic compounds of analytical interest above ALSLG-FC's routine reporting limits. Additionally, a benchtop Millipore Synergy 185™ unit is available for laboratory use should further finishing be desired.

SOP 319 provides detailed information pertaining to ALSLG-FC's DI water systems, including discussions of independent monthly testing to verify that electronic readouts of water quality are accurate, maintenance by a vendor contractor, and corrective measures to be taken should water quality degrade to below acceptable limits.

6. ANALYTICAL PROCEDURES

ALS Laboratory Group, Fort Collins is capable of analyzing various matrices, including surface and groundwater, drinking water, soil, sediment, vegetation, tissue, filter and aqueous and solid wastes. ALSLG-FC does not routinely perform analyses on air (non-particulate), however, analysis of these matrices may be available through our sister laboratories. Analyses are performed using promulgated methodologies as requested by the client and their regulators, and as required by ALSLG-FC's certifying authorities. *New iterations of established methodologies are evaluated on an ongoing basis and implemented as client needs dictate.* Analytical procedures are conducted in strict adherence with SOPs

that describe the preparation, analysis, review and reporting of samples. In some cases, these SOPs may also describe proprietary methods developed by ALSLG-FC and used per the client's request. A list of ALSLG-FC's analytical capabilities is presented in **Appendix C.** A list of ALSLG-FC's SOPs is provided in **Appendix H**. References for analytical procedures used are presented in the attached **Bibliography**. ALSLG-FC also, upon request, develops and validates procedures that are more applicable to a specific client objective.

6.1 ANALYTICAL METHODS

Selection of the appropriate method is dependent upon data usage and regulatory requirements. ALSLG-FC may modify existing methods in order to:

- achieve project-specific objectives;
- incorporate modifications or improvements in analytical technology;
- address unusual matrices not covered in available methods; and
- provide analytical capabilities for an analyte for which there are no promulgated methodologies.

ALSLG-FC discloses method modifications to our clients by providing the appropriate SOP for review.

6.2 METHOD COMPLIANCE

Compliance is the proper execution of recognized, documented procedures that are either approved or required. Strict adherence to these procedures is necessary to provide data acceptable to a regulatory body of competent jurisdiction in a specific regulatory context.

Compliance is, however, separate from, but not inconsistent with, technical scientific quality. ALSLG-FC understands that the expectations of our clients commonly include the assumption that data and reports will satisfy a regulatory purpose and will be found acceptable and compliant with regulatory requirements.

6.2.1 UNDERSTANDING THE REGULATORY FRAMEWORK

Compliance is not likely to be achieved in the absence of an understanding of the regulatory framework. Upon receipt of a statement of work (SOW), ALSLG-FC attempts to ascertain, prior to accepting samples:

- what regulatory jurisdiction pertains to a project (USEPA, State Department of Health, etc.)
- within the regulatory jurisdiction, what body of regulations has primacy (RCRA, SDWA, CWA, etc.); and

- within this context, what QA/QC protocols are required (DOE, DoD -- AFCEE, NFESC, etc.).

ALSLG-FC works with our clients to achieve a mutual understanding of all requirements and makes the following commitments:

- ALSLG-FC will proactively attempt to identify and understand the regulatory context of client's needs.
- ALSLG-FC will strive to be expert in understanding and executing the regulatory requirements for compliance.
- ALSLG-FC will ensure that we have the capabilities, resources and facilities to perform the requested analyses.
- ALSLG-FC will identify and disclose to clients instances of non-compliance in a forthright and timely fashion.

6.2.2 RESOLVING COMPLIANCE CONTRADICTIONS

Multiple regulatory jurisdictions may overlap for a specific project, which may cause uncertainty or contradictions to arise. Similarly, methods and protocols may be prescribed in a scope of work or QAPjP that either will not achieve stated or implied DQOs, or that conflict with the regulatory requirements. ALSLG-FC will attempt to detect these inconsistencies and contradictions and will disclose them to clients in a timely fashion. ALSLG-FC voluntarily accepts a responsibility to provide information to our clients; however, the primary responsibility for resolving inconsistencies with regulators remains with the client.

6.2.3 DISCLOSURE OF NON-COMPLIANCE

As previously stated, it is ALSLG-FC's policy to disclose in a forthright manner any detected non-compliance that may affect the usability of data produced by ALSLG-FC. It is not within our expertise to predict the manner in which a specific regulator or regulatory body will interpret the rules governing analysis; therefore, ALSLG-FC is unable to guarantee compliance. It is ALSLG-FC's policy that our responsibility begins with a bona-fide and competent attempt to evaluate potential compliance issues, and ends with disclosure of any findings that may enable our clients to make an informed decision.

Procedures for documenting non-compliances and applying corrective actions are given in **SOP 928**. A copy of ALSLG-FC's Nonconformance Report (NCR) is provided in **Appendix F**.

6.3 NON-STANDARD METHOD VALIDATION

When a non-promulgated method (i.e., methods other than EPA, ASTM, etc.) is required for specific projects or analytes of interest, or when the laboratory develops a procedure, the laboratory must establish the validity of the method prior to extracting or analyzing a client's samples. *Validity is established by meeting criteria for precision and accuracy.* Method development and validation must include the following:

- Initial Demonstration of Capability (IDOC) for each analyst performing the method;
- MDL studies or MDC determination, as applicable, for every analyte, matrix, instrument, and column (if applicable);
- validated extraction and analytical criteria; and
- SOP generation and approval per established processes.

7. MEASUREMENT TRACEABILITY AND CALIBRATION

ALS Laboratory Group, Fort Collins follows a well-defined calibration routine for all instruments and equipment. Calibration may be performed by laboratory personnel using certified reference materials traceable to NIST or equivalent certified materials, or by external calibration agencies or equipment manufacturers. The discussion in this section of the LQAP is general in nature because the requirements for calibration are instrument or equipment and method specific. Details of calibration procedures and requirements can be found in ALSLG-FC's standard operating procedures (SOPs), analytical methods and operations manuals.

A list of all major instrumentation available at ALSLG-FC is provided in **Appendix G**. The Quality Assurance Department maintains this list.

7.1 TRACEABILITY OF CALIBRATION

ALSLG-FC's program of calibration and/or verification and validation of equipment must ensure that, wherever possible, measurements performed by the laboratory are traceable to national standards of measurement. ALSLG-FC requests and maintains calibration certificates (e.g., weights, thermometers, balances) that demonstrate traceability to national standards of measurement. If traceability to national standards of measurement is not available or applicable, then ALSLG-FC provides evidence of correlation of results (e.g., verifying an in-line resistivity meter by reading the system's output with a conductivity meter; participating in a PT studies).

7.2 REFERENCE STANDARDS OF MEASUREMENT

ALSLG-FC uses reference standards of measurement (such as Class S weights or NIST-traceable thermometers) for calibration verification purposes only (i.e., these reference standards are not available to laboratory staff for general use). Reference standards of measurement are calibrated or verified by a qualified

vendor that must provide, where possible, traceability to a national standard of measurement. Thermometer Masters are independently recertified annually, weight masters are independently recertified every five years. Certificates of vendor calibration/verification for the reference standards recertifications are maintained by the Quality Assurance Department.

The certified reference standards are then used to annually verify other measurement devices (e.g., laboratory thermometers, laboratory weight sets) in-house. The in-house verification efforts are managed by the Quality Assurance Department. All items so verified are tagged with a sticker indicating the unique identity of the device, the date of verification and the initials of the technician who performed the verification, and the date the verification is valid through. Procedures for the in-house verification of thermometers are given in **SOP 923**. Procedures for the verification of weight sets are given in **SOP 901**.

7.3 TRACEABILITY OF STANDARDS, SOLVENTS AND REAGENTS

ALSLG-FC purchases the highest quality standards, solvents, and reagents appropriate to the analytical methodologies employed. The vendor must supply a Certificate of Analysis, Certificate of Purity, or equivalent. These certificates are maintained by the Department who uses the materials.

With the exception of extraction solvents, each Department documents the date of receipt, date opened and an expiration date for all standards and reagents by labeling the original container, or certificate and/or by entering this information into ALSLG-FC's Standards and Reagents database. Because of the quantity of solvents consumed in a short time frame, solvents are labeled only with the date received.

Each Department is responsible for the preparation, documentation, storage and disposal of its chemicals. Standards preparation information is documented by entry in a ALSLG-FC's Standards and Reagents database. The following information, needed to maintain traceability of the standard, is recorded for each standard:

- date of receipt of reference standard;
- unique internal identification number and traceability to purchased stock or neat compounds, as applicable (i.e., vendor/lot numbers; unique ALSLG-FC identifier);
- date of preparation;
- name of preparer;
- amount of reference material used;
- volume/identity of reagents and solvents used;
- final volume;

- concentration;
- expiration date of the stock and prepared standards.

See **SOP 300** for additional information about standards preparation, storage, and expiration. Verification (re-verification) of radiochemical standards is also addressed in SOP 300.

7.4 GENERAL REQUIREMENTS FOR CALIBRATION

Each calibration is dated and documented to ensure that it is traceable to the method, instrument, date of analysis, analyte, concentration, and response. Sufficient information must be documented to permit reconstruction of the calibration. Acceptance criteria for calibrations must comply with method requirements.

7.5 INSTRUMENT CALIBRATION

This section defines the essential elements of initial instrument calibration (ICAL) and continuing instrument calibration verification (CCV). These procedures ensure that the data will be of known, documented, and appropriate quality for a given application. *Samples yielding concentrations that exceed the upper limit of the calibration curve shall be diluted and reanalyzed, if possible, to bring the results within the calibrated range. Results of samples outside the known calibration range, above or below, must be reported as qualified values and discussed in the case narrative.*

Initial instrument calibration is used for quantitation and continuing instrument calibration verification is used to confirm the validity of the initial calibration. The following items are required of both initial and continuing instrument calibrations:

- The details of the instrument calibration procedures, including evaluation and acceptance criteria, and corrective measures to be taken in the event that these acceptance criteria are not met, must be included or referenced in the test method SOP.

- Sufficient raw data records must be retained to allow reconstruction of the instrument calibration (e.g., calibration date, test method, instrument, date of analysis, name of analyst, concentration of standard(s), response, response factor).

Additional essential elements of initial as well as continuing instrument calibrations are discussed below.

7.5.1 INITIAL INSTRUMENT CALIBRATION

The following items are essential elements of initial instrument calibration:

- Samples must be quantitated from the ICAL, unless the reference method states otherwise.

- The initial calibration range must consist of at least the minimum number of calibration points specified by the reference method. If the reference method does not specify the number of calibration standards, then the minimum number is two, not including blanks or a zero standard. Exception: multi-component analytes, such as chlordane, toxaphene or Aroclors, may be analyzed using a one-point calibration, per SW-846 guidance, if so requested by the client.

- The lowest calibration standard must be above the detection limit (MDL) and at or below the RL (i.e., the method reporting limit must be within the calibrated range of the method).

- Calibration standards must include concentrations at or below the regulatory limits, if these limits are known to the laboratory.

- Criteria for the acceptance of an initial instrument calibration must be established (e.g., RSD, correlation coefficient, etc.).

- If ICAL results are outside acceptance criteria, then corrective action must be performed, and the instrument recalibrated before analyzing samples.

- Exclusion of initial calibration points without technical justification is not allowed (poor injection or power failure are valid reasons to exclude a calibration point).

- All reported target analytes and surrogates must be included in the initial calibration.

- The ICAL must be verified (see section 7.5.3) before samples can be analyzed.

7.5.2 CONTINUING INSTRUMENT CALIBRATION

A continuing calibration verification (CCV) standard must be analyzed with the frequency prescribed in the reference method, or as dictated by the applicable LIMS program specification (typically within every 12hr time period). For example:

- When an ICAL is not performed on the day of analysis, then validity of the initial calibration must be verified with an

acceptable CCV prior to sample analysis.

- A CCV must be repeated at the beginning and end of each analytical sequence. (For GC/MS methods that use an internal standard, only one CCV must be analyzed before each analytical sequence). Some methods additionally prescribe that a CCV must be analyzed after every 10 (or 20) samples analyzed.

The following items are essential elements of continuing instrument calibration:

- With the exception of multi-component analytes, all reported target analytes must be included in the continuing instrument calibration standard.

- Criteria for the acceptance of a CCV must be established (e.g., %D, %Drift, from the initial calibration).

- If the CCV results exceed acceptance criteria, then corrective actions must be performed. If routine corrective action procedures do not produce a second consecutive CCV within acceptance criteria, then a new calibration must be performed and successfully verified.

Additional aspects of calibration verification are discussed below.

7.5.3 CALIBRATION VERIFICATIONS

All ICALs must be verified with a ***second source*** standard obtained from a different manufacturer/vendor and traceable to a national standard, when available. If a different manufacturer/vendor is not available, the laboratory must request a different lot number of the standard.

In most cases, a second-source initial calibration verification (ICV) standard is analyzed immediately after the ICAL and before any samples are analyzed. However, analysis of an ICV is not required, if the continuing calibration verification (CCV) standard is from a second source.

The concentrations of the calibration verification standards must be varied within the established calibration range. At least one of the standards must fall below the middle of the calibration range. ALSLG-FC usually accomplishes this criterion by analyzing the ICV at a different and lower concentration than the CCV. Acceptance criteria for an ICV are usually the same as those for a CCV.

Sample data associated with an unacceptable calibration verification standard may be reported as qualified data in the following cases:

- When the acceptance criteria for the CCV is exceeded high (i.e., high bias), and only non-detects were determined for the affected analyte(s) in associated samples, then those non-detects may be reported.
- When the acceptance criteria for the CCV is exceeded low (i.e., low bias), then these sample results may be reported if they exceed a maximum regulatory limit.
- When the acceptance criteria for the CCV are exceeded (high or low), and the effect on the system from previous sample analysis is substantiated (e.g., by reanalysis or sample response characteristics on a different detector), then the sample results may be reported.

Other levels of concentrations and frequencies of analysis for calibration checks (ICVs, CCVs) may be required by specific client programs. These requirements, which supercede method, SOP or LQAP requirements otherwise stated, are communicated to the laboratory staff via LIMS program specifications.

8. PREVENTIVE MAINTENANCE AND REPAIR OF EQUIPMENT

ALSLG-FC maintains an organized maintenance program that is broader than the particular instruments or devices a specific employee may operate or is familiar with. The objective of ALSLG-FC's equipment maintenance program is to provide a structure of care that prevents quality control failures and minimizes lost productivity that results from equipment malfunction or failure. Within this program are provisions for corrective actions, maintaining spare parts, and a contingency plan in the event of catastrophic failure (e.g., loss of power for a significant period of time).

See Appendix G for a comprehensive list of ALSLG-FC's equipment.

ALSLG-FC's maintenance program is based on equipment manufacturer's recommendations, operator training guidance, and other considerations (e.g., sample throughput). The established maintenance program applies to all laboratory primary instrumentation, as well as support equipment (see Section 8.6 for a definition of what constitutes support equipment). Provisions for documenting all routine and non-routine instrument equipment maintenance and repairs is also established within the maintenance program.

Responsibilities for applying ALSLG-FC's maintenance program rests with the Department that utilizes the equipment, the Quality Assurance Department bears responsibility for

certain support equipment such as balances, ovens, refrigerators, freezers, and temperature measurement devices. Only authorized personnel are permitted to perform maintenance.

Culturally, ALSLG-FC makes a distinction between 'operational' and 'routine' maintenance, that external parties generally do not. ALSLG-FC considers the normal/typical things that operators do to keep the equipment functioning properly (e.g., septum replacement, reagent refill, etc.), as 'operational' maintenance, and does not generally view these tasks as routine maintenance events that require specific documentation in a dedicated maintenance log. ALSLG-FC's view is that the fact that the equipment is performing properly and yielding acceptable QC results, evidences that these maintenance tasks were performed as needed. ALSLG-FC's maintenance system does, however, provide for attestations that this maintenance was performed, where applicable. In contrast, ALSLG-FC defines routine maintenance as those things done in-house only periodically (i.e., that are beyond what is performed as usual 'operational' maintenance), that are short of vendor repair (e.g., annual GFPC drawer evaluation).

Documentation requirements are discussed further in Section 8.4 below.

Note that ALSLG-FC does not consider 'priming', or analysis of solvent blanks, which generally get recorded in the instrument run log, as maintenance.

8.1 MAINTENANCE SCHEDULES

With the exception of certain support equipment that is maintained by the QA Department, each Department Manager is responsible for developing procedures and schedules for maintaining the equipment utilized within their Department, and for delegating specific maintenance responsibilities to employees.

In general, ALSLG-FC performs maintenance as needed (including preventive considerations). Certain aspects of routine maintenance are considered to be 'operational', and are performed each time the instrument is run. Other maintenance is performed 'periodically' (e.g., roughly monthly, contingent upon sample throughput). Each instrument operator is responsible for the performance of their own instrument, and may perform maintenance duties at their discretion. For these reasons, ALSLG-FC's culture is not one of 'scheduled' maintenance, in the traditional (calendar) sense. Consequently, although the Department Manager provides oversight, it is not necessary or practicable to create formal maintenance schedules, or to have maintenance performance synchronized within the Department.

ALSLG-FC maintains service contracts for most major analytical equipment, including gas and high-performance liquid chromatographs, mass spectrometers, liquid scintillation counters, and cold vapor atomic absorption and inductively coupled plasma spectrophotometers. Preventive maintenance is included in most of these service contracts. Service contracts that include preventive maintenance are also retained for ALSLG-FC balances and the DI water system.

8.2 SETTINGS

ALSLG-FC's equipment list (Appendix G) depicts the following information: a) the identity and type (i.e., manufacturer and model number) of equipment (including its configuration) and its software; b) the equipment's serial number or other unique identification; c) the current location; d) the date received and date placed in service (if available); and e) the condition when it was received (e.g., new, used, reconditioned).

While it is true that some settings (e.g., detector wavelength) may be stipulated in reference methods, most instrument settings are not specifically prescribed, as they are instead, dictated by acceptable outcome (e.g., peak resolution, etc.). In a similar vein, ALSLG-FC provides typical instrument settings in the associated determinative SOP, but actual settings may vary contingent upon instrument performance and contributing factors, such as ambient conditions and operator subjectivity.

For the most part (i.e., not applicable to some types of equipment), instrument configuration and settings information is captured electronically by the instrument's 'method' files. Typically there is an 'acquisition' method file and a 'quantitation' method file that together, control the manner in which the data are obtained and subsequently calculated. These instrument files are archived via established laboratory electronic backup protocols (Form 159 – IS / LIMS Policy Statement), and are retrievable, thus providing for the reconstruction of data. The utilization of proper settings is evidenced by analytical data and QC results that meet performance criteria.

8.3 TRENDS

The dominant focus of trending contained in pertinent guidance documents relates to the generation of acceptable 'at on-set' and 'continuing' method QC checks. Concurrent with these requirements, ALSLG-FC's culture for trending observation labwide consists of ensuring that acceptable instrument checks are generated, and that the system is not producing any artifacts at levels of concern, prior to analyzing sample sets.

The expertise of the operator is a major component in effective equipment operation. Experienced operators develop an intuitive sense as to how their instrument is performing. Generally this sense is not based on a specific indicator, as there may be many contributing factors to that particular indicator, but rather on an accumulation of ques (similar to those factors that would be considered during the troubleshooting process). Because this type of expertise does not lend itself well to documentation, ALSLG-FC emphasizes cross-training to ensure consistent data generation, and the retention of 'corporate knowledge'.

8.4 EQUIPMENT DOCUMENTATION REQUIREMENTS

Analysts are responsible for maintaining calibration/verification and maintenance records of all instruments and equipment involved in the creation of the analytical

data they generate. Considerations of maintenance, settings and trends, and their documentation, vary widely contingent upon the type of equipment, how automated it is, and the degree of sample throughput. Documentation can be accomplished by various means, electronically and via hardcopy. For example, ICP, ICP/MS and CVAA routine maintenance is entered into the instrument's PC and printed out in the raw data header, while service contract maintenance and repair are documented in hardcover logbooks. Labwide, dedicated hardcover maintenance logbooks are assigned to each piece of major ALSLG-FC instrumentation, however, the manner is which equipment documentation is recorded, is at the discretion of the Department Manager. It is not ALSLG-FC's intent to unify or centralize maintenance information.

Although the manner of record keeping varies, in order to provide a clear and complete history of repairs and maintenance associated with the instrument, each entry must include the following elements:

- the date of the maintenance or repair:
- the reason for the maintenance or repair (e.g., was this action taken to correct a problem or was this action routine instrument maintenance);
- a full description of the maintenance or repair conducted;
- the name of the analyst or vendor who performed the maintenance or repair;
- reference that it was verified that the equipment is operating properly before being placed back in service (SOP 317), and where this information can be found; and
- the initials of the analyst making the entry and date of entry.

Where applicable, the identity of the reference material used as an instrument check must also be recorded, and where applicable, a statement as to the calibration's expiration must also be made.

Details regarding equipment documentation are also provided in SOP 303. Note that maintenance logs are included in monthly logbook review.

Table 8.1 (Maintenance Snapshot) following provides a brief summary of laboratory equipment, an overview of associated maintenance performed, and comments regarding how associated maintenance documentation is accomplished.

8.5 CORRECTIVE ACTIONS, SPARE PARTS, CONTINGENCY PLAN

8.5.1 CORRECTIVE ACTIONS

Corrective measures for failed QC checks are given in the associated determinative SOP. General procedures for removing equipment from service and placing new or repaired equipment into service, are provided in SOP 317. Detail regarding corrective measures and repair for support equipment failures (e.g., ovens, cooling units, pipets, DI water system), are discussed in SOPs 320, 326, 321 and 319, respectively. Actions to be taken in the event of catastrophic failure are discussed in Section 8.5.3 below.

ALSLG-FC maintains service contracts (preventive maintenance, repair) for most major analytical equipment. Some equipment (particularly some support equipment) does not lend itself to repair and would likely be replaced instead, per requirements given in SOP 127.

8.5.2 SPARE PARTS

An adequate inventory of spare parts is required to minimize equipment downtime. This inventory should include those parts and supplies that:

- are subject to frequent failure;
- have limited useful lifetimes, or
- cannot be obtained in a timely manner should failure occur.

Department Managers are responsible for maintaining an adequate inventory of necessary spare parts for all major instruments and equipment items. Examples of spare parts maintained for major instrumentation include: septa, inserts, columns, tube fittings, filaments, source parts, and traps.

8.5.3 CONTINGENCY PLAN

In the event of a catastrophic instrument failure, ALSLG-FC will make every effort to analyze samples within holding times by alternate means. If the redundancy in instrumentation is insufficient to handle the affected samples, then the Department Manager will notify the Project Manager immediately. In turn, the PM will notify the client to discuss options that will ensure successful completion of the project.

ALSLG-FC will also take appropriate mitigating steps and notify the client should significant power, cooling unit, etc. failures occur that create circumstances which could adversely impact the client's sample results. An automated system is in place to notify the IS Manager and Laboratory Director should a power outage of significant duration occur. However, any employee who notes an outage or unit failure is responsible for contacting the Department Manager or Laboratory Director, who will in turn direct the necessary actions. The specific

course of action taken is dependent upon the nature and extent of the failure. General procedures to be followed in the event of catastrophic failure are provided as an appendix to ALSLG-FC's Emergency and Contingency Plan (ECP).

8.6 SUPPORT EQUIPMENT

ALS Laboratory Group, Fort Collins defines support equipment as all those devices which are not the primary determinative instrument defined by the analytical method, which support laboratory operations. Support equipment includes balances, ovens, refrigerators, freezers, water baths, temperature measurement devices, and mechanical (e.g., Eppendorf ™ pipets. Per ALSLG-FC's definition, support equipment also includes: desiccators; centrifuges; vortex mixers; sonicators; homogenizers (including ball mills, riffle splitters and shatter boxes); pressure filters; vacuum pumps; zero headspace (ZHE) extractors; tumbling devices; platform shakers; water baths; chillers; heating blocks, mantles, hot and stir plates; evaporators; muffle furnaces; kilns and cleanup apparati.

Additionally, ALSLG-FC's deionized (DI) water systems (SOP 319) and health physics equipment (Appendix G) and are also considered to be support equipment.

Requirements pertaining to glassware are given in SOPs 334 and 720. Procedures for maintaining computers and other electronic devices (e.g., printers, backup devices, etc.) are developed, implemented and maintained by the IS Department (Form 159, et. al.)

Support equipment must be calibrated or verified, typically annually, within the applied range of use. NIST-traceable references must be used when available, and the results of the calibration/verification must be documented and within the specifications required of the application for which the equipment is intended.

All support equipment must be maintained in proper working order, and records must be retained to document the equipment's performance, maintenance, and repair. *Each business day, near to the beginning of the work shift, the proper functioning and calibration of the following equipment must be verified: balances, ovens, refrigerators, freezers*. Water bath temperatures must be verified each day of use. Additional monitoring must also be performed and documented, if so prescribed by a test method (e.g., recording the temperature of a water bath during digestion).

Per **SOP 321**, the volumes dispensed from mechanical pipets are verified prior to each use, as these volumes are critical measurements. Because automatic dispensing devices used to deliver solvents or reagents (e.g., for sample preservation and extractions) are not used to deliver critical volumes, these devices are exempt from daily verification.

Where necessary, in-house verifications are performed to document the capability of graduated laboratory glassware (e.g., records are on file in the Quality Assurance Department that document the capacity of the cyanide Midi-Dist sample tube glassware).

Certificates of Accuracy are acquired from the manufacturer and are retained on file within each Department for glass microliter syringes.

The following SOPs provide additional information about calibration and verification of support equipment:

- **SOP 305** -- balance calibration and verification
- **SOP 320** -- monitoring and recording of oven temperatures
- **SOP 326** -- monitoring refrigerator and freezer temperatures.

9. QUALITY CONTROL PROCEDURES

ALS Laboratory Group, Fort Collins' quality control program provides a systematic process that enables the laboratory to evaluate and control the validity of analytical results, by measuring and monitoring accuracy and precision by method and matrix; by developing control limits and using these limits to detect errors or out-of-control events; and by requiring corrective actions to prevent or minimize the recurrence of these events. ALSLG-FC observes QC procedures to ensure that sample data meet laboratory and client quality objectives.

The purpose of preparing and analyzing QC samples is to demonstrate accuracy and precision of the sample data and efficacy of the method for the target analytes being investigated. Acceptance criteria may be dictated by reference methods or by project requirements. All assessments of QC data are performed after all rounding and significant figure truncations have been performed.

For all analyses performed by ALSLG-FC, the QC concepts and samples described in the following sections are mandatory. Determinative SOPs contain a Table that summarizes the types and frequency of QC samples, acceptance criteria, and corrective actions required. Observation of maximum holding time allowance is discussed in LQAP Chapter 4.

9.1 DEFINITION OF BATCH

9.1.1 PREPARATION BATCH

A preparation batch consists of as many as 20 field samples of the same or similar matrix, that are prepared together by the same analyst(s) within a limited or continuous time period, following the same method, and using the same kind of equipment and same lots of reagents. Each batch must contain the appropriate number and kind of method control

Table 8.1 Maintenance Snapshot

Extractions - GPC (Gel Permeation Cleanup) Apparatus Column flow 5.0 (+/-0.1)mL/min (stipulated in SOP) SOP 841. Maintenance discussed sufficiently in SOP (adequate MeCl2 supply, proper flow rate; no leaks, all connections tight). Maintaining hardcover log.	**Extractions - Ignitability Apparatus** SOP 629. Operation and checks discussed sufficiently in SOP (Procedures). If not functioning properly, most likely replace. No maintenance log required.
Extractions Support - Kilns Desired setting given in SOP. Unit either works or doesn't. Vendor repair possible contingent upon problem, most likely replaced. No maintenance log required.	**Extractions Support - Recirculating Chillers** Setting = sufficient water flow, stated in SOP. Either works or doesn't. Vendor repair possible contingent upon problem, most likely replaced. No maintenance log required.
'Extractions Support - Lunar Lander Pressure Filter SOP 608, 609, 666. No special considerations, either works or doesn't. Most likely replace rather than repair. No maintenance log required.	**Extractions Support - Rotary Tumbler** SOPs 603, 608, 609, 666, 668. Desired setting given in SOP. Device either works or doesn't. Vendor repair contingent upon problem (replaced). No maintenance log required.
'Extractions Support - Mixer, Homogenizer No special considerations, either works or doesn't. Most likely replace rather than repair. No maintenance log required.	**Extractions Support - Sonicators** (handheld) (bath, hand-held) - SOPs 665, 673. Temperature requirement and recording directives given in SOPs, as applicable. Specific setting does not need documented (aside from temperature which is evidenced by acceptable reading, setting not critical). Maintenance log not required, unit either works or doesn't (replaced).
'Extractions Support - Nitrogen Evaporator SOPs 637, 665. Desired setting given in SOP. Unit either works or doesn't. Vendor repair not likely, replaced. No maintenance log required.	**Extractions Support - Steam Generator & Evaporator** SOPs 607, 672. Desired setting given in SOP (i.e., value open & flowing). Unit either works or doesn't. Vendor repair not likely, replaced. No maintenance log required.
Extractions Suppot - RapidVap Concentrator Various SOPs. Unit either works or doesn't. Vendor repair not likely, replaced. No maintenance log required.	**Extractions Support - Zero Headspace Extractors** SOPs 608, 669. Detailed operation/maintenance contained in SOP. Benchsheet attestation.
Metals - ICP Analyzer, Autosampler, includes ICP/MS SOPs 807, 827, 834. Maintenance tasks are discussed sufficiently in the SOPs (check gas pressures and supply; for ICP/MS, verify that cooling water for instrument is flowing; check filters on rear of instrument and vacuum monthly; check pump tubing (replace when necessary); check drainage bottle (empty if necessary). Routine maintenance is documented via run data headers, which are e-files maintained on the instrument PC. Settings are included in calibration report printout. Hardcover maintenance logs are being kept for repair documentation.	**Metals - Mercury Analyzer (CVAA)** SOP 812; does not presently contain maintenance text in Procedures Section, SOP will be revised accordingly per established publication schedule (make sure lamp life is adequate; clean window; replace Nafion cartridge as necessary; check adequate reagent supply; replace tubing, tighten fittings as necessary). Routine maintenance is documented via run data header, which is an e-file maintained on the instrument PC. Settings are included in calibration report printout. Hardcover maintenance log is being kept for repair documentation.
Organics - Gas Chromatograph, (Autosampler), Purge & Trap (includes sample heaters); all detectors (including MS) GC SOPs: 402, 406, 407, 409, 424, 425, 434, 438, 444 GC/MS SOPs: 506, 525. ECDs (SOP 016 for leak/wipe tests), FPD (detector considerations), FIDs (periodic cleaning, jet replacement - indicated by instrument performance), PIDs (adequate lamp, clean window), others?. Instrument injection port and seal maintenance (liner cleaning/replacement, septum replacement, etc.); front portion of column clipped off; splitter cleaned, where applicable; check adequate gas flow and reserves (columns & detectors); replace traps (including Vocarb) as needed; use of column and trap bake cycles; tubing clean; fittings tight. Autosampler maintenance essentially means operate with adequate flushes. Maintaining maintenance logs/headers.	**Organics - TOC Analyzer, Autosampler** SOP 670. Routine maintenance discussed as Section 8.1 (check adequate gas pressure and supply; make sure 8-port valve connections are tight; check adequate reagent supply; check halogen scrubber and gas/liquid separator; check mist trap and drain if necessary). Maintaining hardcover log.

Table 8.1 Maintenance Snapshot

Organics - HPLC & Components, includes LC/MS-MS SOPs 404, 408, 439, 446, 447, 336 Maintenance discussed sufficiently in SOPs (check that eluent supply and pressure are adequate; replace column frits/guard columns/columns as necessary; all fittings tight; empty and refill HPLC water supply; replace detector lamp as necessary). Maintaining hardcover log.	
RAD - Alpha Spectrometer (towers & octetes) Operationally discussed sufficiently in SOP. Certain practices, like detector segregation (U/Th vs Am/Pu) could be considered preventive maintenance; also, use of the 'thin film' method for Polonium. Daily vacuum pressure check; weekly cleaning. Periodic maintenance provided for in established instrument training modules. Detectors are placed 'off-line' rather than repaired (either cleaned or changed out). Some repair can be done in-house (replace octet tubing, check connections), otherwise via vendor. Hardcover maintenance log is being kept. Detectors are tracked so that trend information can be ferreted out if needed.	**RAD - Liquid Scintillation Counters** SOP 704. Operationally discussed sufficiently in SOP. LSC operation is more about being optically clean. Instrument is checked annually (alignment, etc.) under service contract. In-house repair is really not applicable. Hardcover maintenance log is being kept.
RAD - Gamma Spectrometers SOP 713. Operationally discussed sufficiently in SOP. Check N2 tank and fill as necessary; hose and fittings checks; clean detectors, shields weekly. Periodic maintenance provided for in established instrument training modules. Some repair can be done in-house, otherwise maintenance is provided under contract. Hardcover log being maintained.	**RAD - Scaler w/ Lucas Cell Counter** Operationally discussed sufficiently in SOP, although a lot of expertise is involved and that expertise/knowledge is primarily obtained by demonstration, not via an operator's manual (each use, make sure cell and tubing are clean and that fittings are tight). Cells are good for 20 runs, then CCV checked. If not acceptable, run CCV again. If still not acceptable, take cell out-of-service per SOP 317. Photomultiplier is cleaned monthly. Plateau is verified annually. Periodic maintenance provided for in established instrument training modules. Hardcover log is being maintained.
RAD - Gas Flow Proportional Counter (Counting Room, PreScreen) SOP 724. Operationally discussed sufficiently in SOP (daily tank pressure check and flow to instrument). Periodic puck maintenance; planchet holder and slides cleaning also performed; provided for in established instrument training modules. Detectors are put 'off-line' rather than repaired. A drawer evaluation is conducted annually. Paragon is considering putting the GFPCs under a maintenance contract. A hardcover log is being maintained.	
RAD Support - Ball Mill SOP 336. Operation/maintenance defined sufficiently in SOP. Device either works or doesn't. Since performance doesn't vary, no maintenance log required.	**RAD Support - Riffle Splitter** SOP 336. Operation/maintenance defined sufficiently in SOP. Device either works or doesn't. Since performance doesn't vary, no maintenance log required.
RAD Support - Platform Shakers SOP 336. Operation/maintenance defined sufficiently in SOP. Device either works or doesn't. Since performance doesn't vary, no maintenance log required.	**RAD Support - Shatterbox** SOP 336. Operation/maintenance defined sufficiently in SOP. Device either works or doesn't. Since performance doesn't vary, no maintenance log required.
Support - Balances SOP 305. Vendor serviced (cleaned, certified) annually (records maintained by QA Dept.). Daily use checks (e.g., level, pan/chamber clean, etc.) and calibration verification defined in SOP (performed by Department). Logbooks (Form 301) that contain acceptance limits and corrective action directives are kept & subject to monthly review.	**Support - Ovens & Muffle Furnaces** SOP 320. Assigned verified thermometers (muffle furnaces rough-checked with thermistor). Daily performance check defined in SOP, performed by Department. Logbooks (Form 312) that contain acceptance limits and corrective action directives kept & subject to monthly review. Problems usually thermometer-related (managed by QA Dept.), when necessary, appliance vendor contacted for servicing (records maintained by Facilities or QA). Departmental staff make minor setting adjustments when necessary (documentation of setting not required, proper setting evidenced by acceptable readings). 'Return to Service' actions defined in SOP, recorded in logbook.

Table 8.1 Maintenance Snapshot

Support - Centrifuges Desired setting given in SOP, but performance not critical. Unit either works or doesn't (vendor repaired if possible, replaced).	**Support - Thermometers** (glass, electronic, IR) - SOP 923. Annual verification and records managed by QA Dept. Directives to notify QA if malfunction given in SOPs 320, 326, 210. Corrective measures, return to service discussed in SOP 923.
Support - Cooling Units (Refrigerators, Freezers) SOP 326. Assigned verified thermometers. Continuous electronic monitoring discussed in SOP. Logbooks (Form 347) that contain acceptance limits and corrective action directives kept Departmentally & subject to monthly review. Problems usually thermometer-related (managed by QA Dept.), or defrost needed (managed by Dept.). When necessary, appliance vendor contacted for servicing (records maintained by Facilities or QA). Departmental staff make minor setting adjustments when necessary (documentation of setting not required, proper setting evidenced by acceptable readings). 'Return to Service' actions defined in SOP, recorded in logbook	**Support - Vacuum Pumps** (instrument, independent) - Organic, Inorganic, RAD. Those affiliated with instruments are included in instrument maintenance practices/documentation. Potential oil change for stand-alones. Managed by Facilities. Not capital equipment. No maintenance log required.
Support - Dessicators Tight seals on unit, for indicating DrieriteTM, replace when pink (can be 'recharged'). SOP directives are sufficient.	**Support - Vortex Mixers** No real setting, technique driven (training). Device either works or doesn't. Vendor repair not likely, replaced. No maintenance log required.
Support - Heating Mantles / Hot Plates / Stir Plates Desired setting given in SOP, not critical, so long as monitored temperature can be sustained. Unit either works or doesn't. Vendor repair unlikely, replaced. No maintenance log required.	**Support - Water/Sonic Baths** Complete unit, or device on top of hot plates. Temperature requirement and recording directives given in SOPs. Specific setting does not need documented (evidenced by acceptable temperature). Should not leak. Maintenance log not required, unit either works or doesn't (vendor repaired if possible, replaced).
Support - Millipore Water System SOP 319. Monitoring (Departmental), acceptance criteria, corrective actions discussed in SOP. Context with larger resin units also discussed. Logbooks (Form 712) subject to monthly review maintained. Independent monthly check also discussed. If needed, unit repair may be attempted in-house, most likely unit would be replaced (discussed in SOP); SOP 127 requirements. Documentation of setting not required, proper setting evidenced by acceptable readings. 'Return to Service' criteria = acceptable readings must be maintained.	
WetChem / Metals - pH Meter / ISEs / Conductivity Meter SOP 1126, 1128, several others. Care & feeding of probes is adequately addressed as Procedures in SOPs. Probe/instrument manuals are listed in the SOPs Reference Section.	**WetChem - Ion Chromatograph, Autosampler** SOPs 1113, 1125. Maintenance considerations need to be added to the beginning of SOP Section 9 (check that eluent supply and pressure are adequate; replace column frits/guard columns/columns as necessary; check that gas supply and pressure are adequate; all fittings tight; empty waste container as necessary). Consider adding detector maintenance detail as well. Settings are included in calibration report printout. Instrument is not networked, still subject to IS backup protocols. Hardcover repair log is being maintained.
WetChem - Cyanide Distillation Apparatus SOP 1110. Necessary detail already in SOP.	**WetChem - UV Spectrophotometer** Various SOPs. Performance mostly involves optically clean and matched cuvettes. Sufficient operational maintenance detail is given in the SOPs. Hardcover maintenance log kept.
WetChem - Flow Injection Analyzer SOPs 1127, 1129, 1123. Sufficient operational detail in Sections 11-14 of SOP)adequate reagent supply; clean, unclogged tubing; fittings tight). Software methods stored in instrument PC, subject to IS back-up protocols (no printout). Hardcover repair log is maintained.	

samples (e.g., MB, LCS) and matrix-specific QC samples (e.g., MS/MSD, DUP). Cleanup procedures may be included as part of the preparation batch. All field and QC samples in the batch should be subjected to the same preparation and cleanup procedures.

9.1.2 ANALYSIS BATCH

The analysis batch (or sequence) consists of samples that are analyzed together within the same or continuous time period, on the same instrument, and processed using the same calibration. Each analysis sequence must contain the appropriate number and kind of standards and samples as defined by the method. If samples from a preparation batch are analyzed in multiple analysis batches, extended method control and matrix-specific QC samples need not be analyzed with every analysis batch.

Where no sample pre-treatment (such as extraction or digestion) is required prior to analysis (e.g., analysis of volatile organic compounds, anions analysis by ion chromatography, etc.), the preparation batch and analysis sequence are equivalent.

9.2 PREPARATION BATCH QC SAMPLES AND STANDARDS – DEFINITION AND USE

The results of quality control samples provide an estimate of accuracy and precision for the preparation and analysis steps of sample handling. The following sections describe the QC information provided by each of these analytical measurements.

9.2.1 METHOD BLANK

A method blank (MB) consists of an aliquot of well-characterized, controlled, or certified matrix (e.g., reagent water, Ottawa sand, solid reference material, boiling chips) that is processed through the entire sample preparation, cleanup, and analysis procedure. For radiochemical analyses, a suitable blank solid matrix has not been identified; therefore, reagent water is routinely used for the blank for most solid matrices. The volume or weight of the blank must be approximately equal to the sample volume or weight processed for sample analyses.

The purpose of the MB is to demonstrate that interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware, are known and minimized. A method blank should not contain target analytes at or above the reporting limit, unless otherwise permitted in the method. Other maximum blank contamination control criteria may apply, as indicated in the associated LIMS program specification.

While some methods may require background correction, sample results are typically not corrected for blank contamination.

9.2.2 LABORATORY CONTROL SAMPLE

A Laboratory Control Sample (LCS) consists of an aliquot of well-characterized, controlled, certified matrix (e.g., reagent water, sand, solid reference material, Teflon™ chips) that is spiked with analytes of interest and processed through the sample preparation, cleanup, and analysis procedure.

The purpose of the LCS is to provide an estimate of bias based on recovery of the compounds from the clean, controlled matrix, and to demonstrate that the laboratory is performing the method within accepted guidelines without potential non-matrix interferences.

Where sample pretreatment is not required, such as with ion chromatography or gamma spectroscopy analysis, or the analysis of volatile organic compounds, the ICV standard or other appropriate control standard may be employed as the LCS.

An LCS for methods with extensive lists of analytes that may interfere with one another may include a limited number of analytes, but the analytes included must be representative of as many analytes as is practical.

Other client-specific QC requirements may be prescribed in the applicable LIMS program specification. The requirements set forth in the LIMS program specification supercede those stated in the method, SOP or LQAP.

9.2.3 MATRIX SPIKE/MATRIX SPIKE DUPLICATE

A matrix spike (MS) or matrix spike duplicate (MSD) is a field sample to which known concentrations of target analytes are added before the sample is processed. The purpose of MS/MSD samples is to assess the performance of the method for a particular matrix and to provide information about the sample's homogeneity. Results of the MS/MSD samples are evaluated in relation to the method QC samples to determine the effect of the matrix in regards to accuracy and precision. Sample results are not corrected for MS/MSD excursions.

To generate MS/MSD pairs for any analysis, there must be an adequate volume/weight of field sample available. Inadequate sample volumes preclude the possibility of generating this pair of QC samples. ALSLG-FC asks clients to designate the sample to be used for MS/MSD analysis to ensure that adequate sample volumes are collected.

For some analyses, changing the composition of the sample in any way invalidates the analysis to be performed (e.g., hardness, alkalinity, pH). Therefore, an MS/MSD pair cannot be generated for these analyses. Normally, duplicate sample aliquots are analyzed in order to generate an estimate of the method's precision.

Other client-specific quality control requirements may be prescribed in the applicable LIMS program specification. The requirements set forth in the LIMS program specification supercede those stated in the method, SOP or LQAP.

9.2.4 SAMPLE DUPLICATE

A sample duplicate (DUP) is a second representative portion of sample that is carried through the preparation, cleanup and analysis process. Results for the duplicate sample are compared to the initial sample analysis results as a means of evaluating precision. For organic analyses, the MS/MSDs fulfill this function. The degree of sample homogeneity directly impacts the integrity of the sample duplicate analysis.

Precision criteria for sample duplicate analyses are those prescribed in the reference method and/or SOP, unless otherwise superceded by client-specific requirements contained in the applicable LIMS program specification.

9.2.5 SURROGATES

Surrogates are organic compounds that are similar to the target analytes, but are unlikely to be present in actual field samples. They are introduced into all field and QC samples in a batch prior to sample preparation, and provide an estimate of bias based on recovery of similar compounds, for a given extraction technique and analysis method combination. Sample results are not corrected for surrogate recoveries.

Acceptance criteria for surrogates are those prescribed in the reference method and/or SOP, unless otherwise superceded by client-specific requirements contained in the applicable LIMS program specification.

9.2.6 CHEMICAL YIELD MONITORS OR ISOTOPIC TRACERS

Chemical yield monitors are used in radiochemical analyses and provide information similar to the surrogate spikes discussed above. The primary difference between a chemical yield monitor and a surrogate is that sample results are corrected for chemical yield recoveries and not corrected for surrogate recoveries. A chemical yield monitor is a substance that has similar chemical characteristics as the parameter being measured. It is introduced into all field and QC samples in a batch during the preparation procedure. Chemical yield

monitors provide information regarding the performance of a method on a sample-by-sample basis.

Chemical yield monitors are evaluated against established laboratory control limits. These ALSLG-FC default control limits may be superceded by other quality control criteria specified in the applicable LIMS program specification.

9.3 CONTROL CHARTS

Control charts are a tool that can assist the laboratory in evaluating process control and trends. Control charts are used as a visual queue giving warning before a measurement system drifts into an out-of-control situation. Information such as radiochemical calibration parameters, results of daily efficiency checks, etc. can be documented in control charts. Accuracy control charts, discussed further below, that contain method LCS (and surrogate, as applicable) performance information, are managed through LIMS. Although the QAM is responsible to annually reviewLCS information, and determine is significant change to a method or process has occurred. The QAM then notifies technical management is the mean and standard deviation of LCS data show significant change (>10%). QC limits can be updated after review by technical personnel as appropriate.LCS information is accessible to *all* bench personnel **for their consideration**, through LIMS.

Further discussions of control charts and control limits and other considerations such as outlier rejection and trend evaluation follow below.

9.3.1 ACCURACY CONTROL CHARTS

Accuracy (recovery) for a batch can be evaluated by plotting the individual percent recovery points for analytes on a control chart and comparing the values against the current control limits. If the spike recovery values for the current analytical batch meets the acceptance criteria for that method, then the data point (and batch) are accepted. **If not, and re-preparation/analysis is possible, the batch is generally reprocessed. At minimum, the failure(s) is considered a non conformance and is narrated in the laboratory data package. See the QC Table of each determinative SOP for further details as to the appropriate corrective actions to be taken for controlled failures.**

Accuracy control charts are generally maintained for each method that utilizes an LCS. For methods that cannot use LCS samples (e.g., pH, flashpoint, conductivity), other tools, **such as periodic participation in 3rd party Performance Test sample analysis,** are used to assess method control.

If fewer than 20 data points for a method, matrix, and analyte combination are acquired, then control charts yield scant information.

9.3.2 CONTROL LIMITS

Control limits for each controlled analyte are calculated, and can be updated, using ALSLG-FC's LIMS. The recovery values from all data processed within a specified date range, are used to calculate the control limits and compile the control chart. **Standard outlier tests, based on the population number evaluated (e.g., Dixon n=<20; Grubbs n=3-147; etc.), per their restrictions/requirements, may be applied.**

The upper and lower control limits of the control chart are designated as the value equal to the average recovery plus or minus three times the standard deviation (i.e., 99% confidence interval).

The upper and lower warning limits for the control chart are designated as the value equal to the average recovery plus or minus two times the standard deviation (i.e., 95% confidence interval).

The average recovery, standard deviation, minimum value, maximum value, and population are displayed on each control chart.

Control limits are updated as needed (e.g., acquisition of a sufficient number of data points to establish meaningful control limits for a newly implemented method; if deemed appropriate as a result of a corrective action investigation; etc.). The frequency with which control limits are updated may vary for different methods. Generally, intra-laboratory historical control limits are not updated more than once per year.

9.3.3 OUTLIER REJECTION

For the generation of control charts, and other quality control data that monitor the laboratory's performance, it is essential to prevent spurious or erroneous data from being incorporated. It may be necessary to reject data as an outlier to prevent an adverse effect on the values being calculated. **Only established statistical approaches may be used, such as application of the Grubbs, Dixion, etc., tests, to identify and handle outliers. Any data point meeting established outlier criteria is justified to be rejected, however, the analyst has the discretion to reaccept the data point where it is technically sound to do so.** In every case, the cause of the outlier rejection must be clearly understood before any data point is ~~**manually**~~ rejected.

For the purposes of statistically determining whether a data point is an outlier or not, ALSLG-FC may use the procedures discussed in the Dixon Rank Sum Test, the Grubbs Test, **or other established appropriate statistical treatment.** If a data point is determined to be

an outlier, it **generally** will not be incorporated into the dataset when updating QC limits.

See SOP 329 for further details regarding the processing of MDL studies and evaluation of outliers.

9.3.4 TREND EVALUATION

Trend analysis techniques can be applied to control charts as a preventive tool to help indicate conditions that could cause an analysis to become out of control. In evaluating control charts, a trend is recognized if one or more of the following situations exist:

- A series of seven successive points occur on the same side of the mean;
- A series of five successive points occur going in the same direction;
- Two consecutive points occur between the warning and control limits;
- A single value occurs outside of control limits.

Corrective action investigation should be employed for every trend identified. Items to be considered upon investigation may include, but are not limited to, the following:

- Has there been a change in instrumentation or personnel?
- Has instrument maintenance been properly performed?
- What conditions have changed since the trend began?
- Have standard or spike solutions changed?

9.4 SECOND COLUMN OR SECOND DETECTOR CONFIRMATION

Second column or detector confirmation is performed for several GC and HPLC methods. Whenever two dissimilar chromatography columns or two detectors of a different nature are available for a given method, the laboratory performs second column or second detector confirmation analysis to confirm the identity of target analytes in field samples. When second column analysis is performed for any chromatography technique, the following policies apply:

- Every attempt will be made to calibrate the second (confirmatory) column in the same manner as the quantitative (primary) column. The same initial and continuing calibration standards will be analyzed on the confirmation column in the same manner as the quantitation column.

The purpose of this dual calibration requirement is to allow the possibility of reporting quantitative results from the confirmation column if interferences on the primary column prevent accurate target analyte quantitation.

- For chromatographic techniques, the determination of target analytes in a sample depends solely on peak retention times observed in both primary and secondary column chromatograms. If target analyte peaks are present at the proper retention times in both confirmation and quantitation column chromatograms at levels above the MDL, then ALSLG-FC considers this analyte to be confirmed.

- In general, ALSLG-FC reports the higher value of the two columns per SW8000C guidance (e.g., 8011, 8081, 8082, 8141, 8151, 8021). It is also ALSLG-FC's policy to report the higher value of the two columns for other EPA methods (e.g., 608, 615).

  If no interferences are present, and an analyte's value from either the primary or secondary column is greater than the reporting limit but between the MDL and the reporting limit on the other column, then ALSLG-FC reports the higher value that is greater than the reporting limit for that analyte.

- ALSLG-FC customarily reports the value from the primary column for methods SW8330 and SW8332. Co-elutions or interferences are frequently observed on the secondary column for these HPLC methods.

- Other reporting rules may apply as dictated in the applicable LIMS program specification. The rules of the LIMS program specification supercede standard ALSLG-FC policy.

9.5 MANUAL RE-INTEGRATION POLICIES AND PROCEDURES

Many data collection systems allow the analyst to reprocess data, thereby allowing for the manual re-integration of analyte peaks. ALSLG-FC makes every attempt to optimize peak integration parameters; however, manual reprocessing of data must be performed to correct a data system's integration error (e.g., incorrect or missed peak assignment, over- or under-integration of area). Manual re-integrations may not be performed solely to meet initial or continuing calibration criteria or any QC criteria (e.g., tuning, or surrogate or spiking compound recovery).

Whenever a manual integration is performed, the analyst performing this process must include a hardcopy of the original and re-integrated peak in the final data report. In addition, the analyst must initial and date the re-integrated page and document the reason for re-integration on the printout. The re-integration must be documented in the case narrative.

Further details regarding manual integration procedures are given in **SOP 939**.

10. DATA REDUCTION, VALIDATION AND REPORTING

Data transfer and reduction are essential functions in summarizing information to support conclusions. It is essential that these processes are performed accurately and are followed by multiple reviews before data are submitted to the client. All analytical data generated by ALSLG-FC are extensively reviewed for accuracy and completeness. The data validation process consists of data generation, reduction, and multiple levels of review, as described below.

10.1 DOCUMENTATION OF RAW DATA

Where possible, raw data are captured and processed electronically using verified software programs (see **SOPs 709 and 1400** for further information regarding software verification).

To facilitate manual documentation of raw data (where suitable LIMS benchsheet interfaces do not yet exist), ALSLG-FC creates custom logbooks comprised of forms or benchsheets that are tailored to contain the information required to adequately document the process being performed, and the associated data. The Quality Assurance Department controls these forms and benchsheets, and issues bound and paginated logbooks to the laboratory as needed via controlled distribution.

As applicable, hardcover, bound laboratory notebooks (most frequently used for instrument maintenance logs or Project Manager notebooks) are also issued via controlled distribution to laboratory staff as needed.

The manually recorded raw data are entered into the laboratory logbook directly, promptly, and legibly in indelible ink. All raw data entries must, at a minimum, contain the following information:

- the initials of the individual who performed the process;
- the date the process was performed;
- the methodology used; and
- the identity of all samples or standard solutions that were employed in carrying out the process.

Raw data must be maintained as part of the laboratory's records. Raw data not only includes instrument outputs, but sample preparation, standard materials documentation, and equipment maintenance information as well. Raw data may be archived electronically or as hardcopy.

10.2 CORRECTION OF ERRORS IN DOCUMENTS

During the course of processing and reviewing sample preparations and analysis results, it may be necessary to correct documentation errors. Detailed requirements for the correction of manual documentation errors are prescribed in **SOP 303**; the correction of electronic information is governed by LIMS controls and audit trails. In summary, manual entries may not be obliterated by erasure, use of correction fluid, or other means. In order to maintain the integrity of the documentation generated by the laboratory, changes to hardcopy documentation must be made in the following manner:

- A single line must be struck through the error so that the original text remains legible;
- As applicable, a corrected entry must be made adjacent to the error; and
- The person making the change must initial and date the corrective entry.

If not clearly evident, the reason for the data change must be indicated.

10.3 DATA REDUCTION

ALS Laboratory Group, Fort Collins analysts perform data reduction. This process consists of interpreting instrument results and verifying calculated concentrations in samples from the raw data. The complexity of the data reduction is dependent on the specific analytical method and the number of discrete operations involved in obtaining a measurement (e.g., digestions, dilutions, cleanups, concentrations). The analyst calculates the final reportable values from raw data or enters all necessary raw data into the LIMS so that the LIMS can calculate the final reportable values.

Data are reduced according to protocols described in SOPs and method-specific review checklists. Computer software used for data reduction is validated before use and verified regularly by manual calculations. All information used in calculation is recorded in order to facilitate reconstruction of the final results (e.g., raw data, calibration files, tuning records, results of standard additions, interference check results, sample response, and blank or background-correction protocols). Information about the preparation of the samples is maintained in order to facilitate reconstruction of the final results (e.g., weight or volume, percent moisture for solids, extract volume, dilution factor).

Copies of all raw data and the calculations used to generate the final results, as recorded in hardbound laboratory notebooks, spreadsheets, electronic data files and LIMS record files, are retained in the project file to allow reconstruction of the data reduction process.

10.4 REPORTING OF SAMPLE RESULTS

Sample results are reported either on an "as-received" basis, or in units of dry-weight measure. The number of significant figures reported is consistent with the limits of uncertainty inherent to the analytical method. In most cases, results are

reported to no more than two or three significant figures. Analytical problems, and/or any modifications of referenced methods are noted in the data package case narrative.

Standard units appropriate to the analytical method are used to report all sample results. Measurements for radiochemical analyses are reported in units of activity such as:

- picocuries per liter (pCi/L), aqueous; or picocuries per gram (pCi/g), solid matrix samples.
- disintegrations per minute per liter (dpm/L) or disintegrations per minute per gram (dpm/g).
- Becquerels per liter (Bq/L) or Becquerels per gram (Bq/g).

It should be noted that one (1) Curie is equal to 2.22×10^{12} dpm; and is also equal to 3.7×10^{10} Bq.

Standard units for inorganic and organic analyses are units of mass per volume (aqueous samples), or mass per weight (solid matrix samples). For example, Wet Chemistry parameters such as hardness, total organic carbon (TOC), etc., are typically reported in milligrams per liter (mg/L) or milligrams per kilogram (mg/kg). Metals results for liquid samples may be reported as mg/L or as micrograms per liter (µg/L). Some methods have specific reporting units mandated by their analysis technique. For example, pH is reported as pH units, and specific conductance is reported as milli-Siemens (mmho/cm) or micro-Siemens (µmho/cm).

10.5 DATA REVIEW

ALSLG-FC employs multiple levels of data review. All data generated and reduced follow review protocols specified in laboratory SOPs (such as **SOPs 052** and **715**), and method-specific checklists. The preparatory technician and analyst who generates the analytical data perform a **Level 1** review of the data for correctness and completeness. This data review verifies that:

- the appropriate SOPs have been followed;
- any special sample preparation or analytical requirements that were communicated to the laboratory via the LIMS program specification have been met;
- all sample preparation information is correct and complete;
- all analysis information is correct and complete;
- QC samples meet criteria for frequency, accuracy and precision;

- all calculations, conversions, and data transfers are accurate;
- all documentation is present and complete, including benchsheets and/or run logs, any applicable NCRs, and documentation and presentation of manual integrations per SOP 939, as applicable.

Procedures for handling unacceptable data are discussed subsequently (LQAP Section 10.6).

Following completion of the Level 1 Review, the analyst then forwards the data to the Department Manager or another qualified reviewer whose function is to provide an independent **Level 2** review of the data. In addition to the elements evaluated in the Level 1 review described above, the Level 2 reviewer verifies that:

- the calibration data are scientifically sound, appropriate to the method, and completely documented;
- qualitative identification of target analytes is correct;
- quantitative results are correct.

The Level 2 reviewer selects a sample and verifies it to the benchsheet. If no errors are found, then the review is considered complete. If any problems are discovered, then additional samples are verified to the benchsheet with the process continuing until no additional errors are found or until the data package has been reviewed in its entirety. The Level 2 review is documented by recording the date and initials of the reviewer on the checklist employed. This sign-off signifies that the data are approved for release and a final report is prepared.

Once the final report is prepared, an additional overall technical review is performed before it is routed to the Project Manager for a **Level 3** review. The intent of this review is to verify that the report is complete and that the data meet the overall objectives of the project.

Each step of the review process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the analysis and/or review. This application of technical knowledge and experience to the evaluation of the data is essential in ensuring that data produced are consistently of known, documented, and appropriate quality.

10.6 PROCEDURES FOR HANDLING UNACCEPTABLE DATA

All QC information is recorded in the same format, with the same units, as that of the associated sample results. It is the analyst's responsibility to evaluate QC data against applicable prescribed limits. When an analysis of a QC sample (e.g., MB, LCS, CCV, etc.), indicates that the associated samples do not meet requirements, the analyst must immediately notify the Department Manager. The Department

Manager then consults with the PM (and QAM, as applicable) to determine whether or not the affected samples must be re-prepped and/or re-analyzed, and/or if specific corrective action needs to be taken before additional analysis may proceed. A Nonconformance Report (NCR) as discussed in Chapter 11 of this LQAP, is initiated per **SOP 928**, as applicable. If the non-compliant data cannot be corrected, then the affected results must be flagged as discussed below, and the discrepancy disclosed in the data package case narrative. The completed NCR Form is included in the data report.

10.7 DATA REPORTING

Data reports contain final sample results, the methods of analysis used and limits of detection, and QC data. The extent of supportive data included (e.g., benchsheets, run logs, calibration data, instrument raw data printouts, etc.), is contingent upon the type of report contracted by the client.

Results of subcontracted data are clearly indicated as subcontract laboratory results when incorporated into the final data package report.

10.7.1 FACSIMILE OR IMAGED REPORTS

For projects that require rapid turnaround of sample analysis results, the laboratory may provide a facsimile or imaged e-mail attachment to the client, followed by the full data report at a later date. If the analysis results provided by facsimile or imaged e-mail attachment have undergone the same review processes followed for final data packages, then this forwarded report indicates that the sample analysis results are final. However, if the accelerated turnaround time requirements preclude a full review/validation of the sample data, then the report is marked as "PRELIMINARY" to indicate that results may change as the review process is completed.

10.7.2 HARDCOPY DATA PACKAGES

The format and content of a data report is dependent upon project specifications, and it is beyond the scope of this document to describe project-specific report requirements. In the absence of client-specified data package deliverables, the following sections describe the items that must be included in all data reports.

10.7.2.1 COVER LETTER

Items contained in the cover letter include:

- the client's name and address;
- ALSLG-FC's name and address, name of contact and telephone number;
- a tabular presentation of field/client sample ID, ALSLG-FC Sample ID, date received, matrix, and date collected. This item is typically

presented as an attachment, the Sample Cross Reference Table;

- a list of each analysis performed and total number of pages for each analytical report;
- identification of all test data provided by a subcontract laboratory;
- a discussion of previously submitted or partial reports that pertain to the samples discussed in the current report; and
- the signature of ALSLG-FC's Project Manager or designee.

10.7.2.2 REPORT FORMAT

Analysis reports are presented in tabular format, and consistent significant figures and units of measurement are used. The following information is included in each report:

- laboratory name, client name, project name and/or number;
- client/field sample ID and ALSLG-FC sample ID;
- date of sample receipt, date and time of sample collection, and date/time of sample preparation and/or analysis;
- sample matrix;
- reporting units and identification of whether the sample results are reported on an "as-received" or dry weight basis;
- method reference for the parameter analyzed and method reporting limits;
- identification of numerical results with values below the method reporting limit;
- case narrative that identifies test methods, describes any deviation from the method or contractual requirements, additions or exceptions to the SOP, and discloses any conditions that may affect the quality of the results;
- identification of sample results that did not meet sample acceptance criteria;

- footnotes or qualifiers referenced to specific data (as applicable) and explanations or keys to flags and abbreviations used;
- surrogate and tracer recoveries, where applicable;
- where applicable, a statement of the estimated uncertainty of the test result; and
- a signature and title, or equivalent electronic identification, of the personnel who accepts responsibility for the content of the report, and the date of issue.

If a report is reissued, the amendments must clearly state that the report is reissued. The cover letter and case narrative must describe why the report has been reissued and which sample results have been reissued.

10.7.2.3 QC REPORTS

Each final report includes QC reports that summarize results from the associated LCS, MB, and matrix QC samples. Additional QC samples may be prepared and reported to comply with project-specific requirements.

10.7.2.4 DATA QUALIFIERS – FLAGGING CODES

Whenever the data quality objectives of the LQAP are not met, the associated sample results must be flagged with the appropriate flagging codes. These codes are applied only in the event that the laboratory cannot generate (through reanalysis) fully compliant data. If sample values are reported outside the calibration range of the method or unreliable interferences exist in the sample, then descriptive codes are applied to the result.

Data qualifiers are added by the laboratory prior to reporting the analysis results. The laboratory appends data qualifiers to each environmental field sample based on an evaluation of all available QC information (e.g., MS/MSD samples, laboratory blanks, LCSs, calibration verification standards, etc.). Analytical batch comments are added to the narrative section of each data report to explain any nonconformance or other issues.

Other flagging practices may be observed if so dictated by the applicable LIMS program specification.

10.7.3 ELECTRONIC DATA DELIVERABLES (EDDS)

The electronic data deliverables generated by the laboratory are project-specific and are produced in a format specified by the client. *Information presented in corresponding fields of the hardcopy report and EDD are identical as both are generated from LIMS.* Before submitting the EDD file, the Project Manager or designee verifies that the EDD is complete and meets the client's format requirements. All EDDs are submitted to the client on computer disks or are transmitted electronically.

10.8 RECORDS AND DATA STORAGE

Records provide the direct evidence and support for the necessary technical interpretations, judgments, and discussion concerning laboratory results. These records, particularly those that are anticipated to be used as evidentiary data, provide the historical evidence needed for later review and evaluation. Records must be legible, identifiable, and retrievable. They must be protected against damage, deterioration, fire, theft, vermin, and loss. Though only 5-year retention

is required by NELAC, ALSLG-FC retains all records for a minimum of seven (7) years, or as otherwise specified per the client's contract.

Laboratory records include the following kinds of documentation:

- personnel qualifications, experience, and training;
- correspondence between ALSLG-FC and clients;
- quality assurance records (e.g., retired SOPs and LQAPs, PT study results, internal and external audit reports and responses);
- contents of laboratory logbooks;
- equipment maintenance records;
- traceability of standards, solvents and reagents;
- instrument checks and calibrations;
- raw data;
- final data reports; and
- sample management records (e.g., sample login, field and internal chain-of-custody, storage, disposal).

10.8.1 ELECTRONIC RECORDS

ALSLG-FC employs a multi-level system that addresses both the frequent backup of sample results (in LIMS) and the periodic backup of raw data (from both networked and non-networked instruments). Additionally, the software that ALSLG-FC uses for these backups, contains a disaster recovery module that allows for the complete recovery of the backup database, in its entirety. In short, ALSLG-FC's LIMS is backed up hourly, and, along with all network servers, is additionally backed up to tape each business day. As indicated in the IS and LIMS Policy Statement (**Appendix A**), instrument backups are performed approximately monthly. Contingent upon the volume of analysis, the frequency of backup might vary.

Backup of the instrument computers is done centrally by the IS Manager if the instrument computer is on the network. It is the responsibility of the operator\user to coordinate a convenient time for both the IS Manager and the user for non-network instrument backup. The instruments that are not on the network are backed up using portable devices. These devices, as well as media, are checked out from the IS Manager, then are returned to the IS Manager for safe storage.

An electronic archive for maintaining final project reports was implemented in 2001. Upon completion of a workorder, all data reports are scanned to create image files that are catalogued and saved

to a dedicated server that is backed up daily as described above. The scanned images remain available on the network for review should any questions regarding the data arise. Retention of hardcopy data reports prior to 2001 is discussed below.

10.8.2 HARDCOPY RECORDS

Prior to electronic compilation and storage, ALSLG-FC created paper copies of project reports. These hardcopy data archives are retained off-site by a records storage contractor. The QAM maintains a database inventory of all records that are stored at the contractor's facility. The contractor is responsible for the maintenance and protection of these records. Access to the records is limited to only designated individuals. If any records need to be retrieved from the storage site, the requestor must fill out an archive request form (Form 136) and submit it to the Quality Assurance Department. E-mail requests directed to the QAM are also acceptable. The QA Department then requests the records from the contractor, who retrieves the records and delivers them to the laboratory on the next business day.

Hardcopy originals of records that have been imaged and verified may be destroyed confidentially (i.e., shredded). Detailed procedures for archiving records and submitting archive requests are provided in **SOP 069**.

As of this writing, no provisions have been made to permanently destroy any records generated by ALSLG-FC. Should ALSLG-FC permanently destroy any records, written notification will be provided to all clients affected.

In the event that the laboratory changes ownership, the responsibility for the retention of records in accordance with the guidelines established in this LQAP, is conferred to the new owner. Should ALSLG-FC go out of business, ALSLG-FC will inform our clients in writing of this business decision, and will transfer records at the client's request.

10.9 CLIENT INQUIRIES/COMPLAINTS

The focal point of contact with the client is the ALSLG-FC Project Manager. If a complaint or any circumstance raises doubt concerning ALSLG-FC's compliance with its policies or procedures, or with the requirement of a method or quality system, it is the Project Manager who initiates investigation and follows through to resolution. The QAM, Department Managers, and Laboratory Director are made aware of, and involved in, the resolution process as needed. Documentation of the complaint and its resolution are maintained as part of the project records. Where resubmission of data is required and/or implementation of preventive measures is necessary, an NCR Form (**Appendix F**) is used and processed (**SOP**

928), through the QAM. ALSLG-FC will respond to all complaints in a timely fashion.

10.10 CONFIDENTIALITY

All laboratory results and associated raw data are confidential and may not be released to or discussed with any party other than the client who requested the analytical services. Access to laboratory records and LIMS is limited to laboratory personnel, on a restricted basis, based on need (i.e., job function). Records are available for an accrediting authority's on-site review, and records specific to the client (as well as quality system records) are available to the client for client audits. ALSLG-FC expects that auditors will honor our clients' and ALSLG-FC's confidentiality requirements, and will not discuss any results, documents, or records viewed during the course of an audit.

Confidentiality is included as a component of ALSLG-FC's ethics training, which is provided to each person as they join the ALSLG-FC staff, and annually, as a refresher training, thereafter.

11. CORRECTIVE ACTIONS

Corrective action is necessary when any measurement system fails to meet the requirements of this LQAP, the appropriate SOP or project-specific instructions, or whenever an error is detected. Items that may need corrective action range from a minor problem such as an analyst failing to initial a form, to a major problem such as a chemist preparing a sample using the wrong reference method.

Corrective actions fall into two general categories: short-term and long-term. Short-term corrective actions are those that can be applied immediately. Examples include: having an analyst initial a form where the initial was missed, or correcting an error in a logbook entry per procedures described in SOP 303. Long-term corrective actions are those that require a clarification of practice or a change in policy in order to effectively resolve the problem. Corrective actions must be completed by the date designated by the QA Department (i.e., within 21 calendar days or less, unless otherwise provided for). Associated SOPs may need to be revised and republished for long-term corrective actions, laboratory staff must be re-trained in accordance with the updated procedures.

11.1 RESPONSIBILITIES FOR CORRECTIVE ACTION INITIATION

The type of corrective action taken is coordinated by the Department, Quality Assurance and applicable Project Managers. A controlled Nonconformance Report (**Appendix F**) is used to document the corrective action. *Any* individual who notes a problem or deviation is responsible for initiating the NCR in a timely manner.

It is the responsibility all personnel who work with samples to note any discrepancies or nonconformances that occur with sample handling. It is the responsibility of the chemists who prepare samples for analysis to document any problems that are noted during sample preparation. It is the analyst's responsibility to monitor the proper functioning of the analytical system prior to,

during and following sample analysis. To accomplish this, various DQIs as discussed in Chapter 3 of this LQAP are monitored and evaluated against laboratory established or project-specific QA/QC requirements. If the evaluation reveals that any of the QC acceptance criteria are not met, then the analyst must immediately correct the problem. When an acceptable resolution cannot be achieved and/or data quality is negatively impacted, the analyst must notify the Department and Project Managers and must initiate an NCR (**SOP 928**) immediately. Per the guidance contained in SOP 928, the laboratory shall notify all affected clients of potential data quality issues in a timely manner, and corrective actions taken to resolve the issue shall be completed in a reasonable timeframe, with documentation submitted to the client.

11.2 ALS LABORATORY GROUP, FORT COLLINS CORRECTIVE ACTION PROCESS

Non-conformances are reported (documented) electronically through a LIMS interface that is available to all staff. The individual who discovered the problem or deviation is responsible for initiating the next sequential NCR in LIMS. Note that in addition to documenting laboratory sample or test issues, NCRs are also used to address client inquiries, and to investigate Performance Test (PT) sample failures.

Documented on the NCR are the initials of the initiator and descriptions of the method, workorder(s) and samples affected; the type, content and extent of the problem noted; the probable cause and the root of the problem (if known); measures taken to prevent recurrence; the specific corrective actions taken and their outcome; and the final disposition/resolution of the data.

As described in **SOP 928**, the processing of the NCR flows from the initiator, to their immediate Supervisor and/or Department Manager and the relevant Project Manager(s), and finally to the Quality Assurance Manager. In this manner, a consensus is achieved as to what specific corrective actions are to be taken. The Project Manager, at his or her discretion, may or may not contact the client to discuss options based on the nature of the nonconformance. Whether or not the client is contacted is noted on the NCR, if the client is contacted, the Project Manager documents who was contacted and when. The Project, Department and Quality Assurance Managers electronically sign and date the NCR, documenting their final approval and verification of the disposition of the data. The LIMS provides for delegation of signature authority as needed to cover key staff outages.

The LIMS, which is subject to ALSLG-FC's frequent backup protocols, maintains an archive of all NCRs generated. In this manner, NCRs are retained as part of the laboratory's electronic records. Also, contingent upon the level of data deliverable specified by the client, a copy of the associated NCR report is included in the analytical data package. Corrective actions that require follow-up, including those initiated by internal or external auditors, are catalogued in a separate LIMS Table that tracks audit findings. This LIMS Audit Findings Table

is managed by the QA Department but is available to all staff on a read-only basis.

12. AUDITS

12.1 INTERNAL AUDITS

Periodic evaluations conducted by the Quality Assurance Department and the analysis of Proficiency Test (PT) samples are two types of internal audits used to assess and document the performance of laboratory staff and processes. Audit documentation constitutes a permanent record of the conformance of ALSLG-FC's measurement systems to quality system requirements.

Internal audits include both technical and systems audits, and are performed periodically per an annual schedule developed and maintained by the Quality Assurance Department. Considerations taken into account in developing the internal audit schedule include, but are not limited to, requests made by the Laboratory Director; the scheduled occurrence of external audits; as needed to support a specific project's requirements; to verify the continued effectiveness of corrective actions previously taken; or in response to an identified need to evaluate compliance in any area of laboratory operations. The intention of the internal audit schedule is to provide for the evaluation of each laboratory area or system at least once annually, thereby providing an overview of laboratory operations. Form 168 or other audit questionnaire may be used as a guide to conduct and document internal audits. Each year, the internal audits conducted are compiled into the annual Quality Systems Audit (QSA), which is discussed subsequently (LQAP Section 12.1.3).

All internal audits are conducted by QA staff or designees who, by experience, are deemed to be knowledgeable in the area assessed. The assigned auditor identifies the scope, time frame and expected duration of the audit, and communicates this information to the applicable Department Manager. The auditor reviews relevant information such as regulations, contract requirements, published procedures, SOPs, etc., prior to the audit. The criteria set forth in these applicable guidances establish the basis of the audit. These reference materials may also be used as auditor's aids.

The audit is conducted in an efficient and professional manner. Findings, Observations and comments are communicated to the Department Manager.

Short-term corrective actions may be taken at the time an item is noted, or an appropriate long-term corrective action plan may be developed. An audit is considered to be closed-out when deficiencies have been satisfactorily corrected.

An audit report summarizing the Determinations made and the corrective actions taken or planned is compiled; the original auditor's notes are customarily included as an attachment of the audit report. The outcome of the audit is communicated to the Laboratory Director. Internal audit corrective actions requiring follow up are

tracked in a LIMS Table that is available for viewing to all laboratory personnel. The QAM oversees satisfactory completion of corrective measures taken. Internal audit records are maintained by the Quality Assurance Department.

See **SOP 937** for additional information pertaining to internal audit procedures.

12.1.1 INTERNAL TECHNICAL AUDITS

Departmental functions that may be reviewed during a technical audit may include, but are not limited to:

- Adherence to SOPs and compliance with promulgated method requirements during sample preparation and analysis;
- Maintenance of internal chain-of-custody;
- Proper preparation, storage, use and documentation of standards;
- Performance and documentation of instrument maintenance;
- Performance and documentation of data review;
- Evaluation of documentation practices pertaining to benchsheet and logbook entries, Nonconformance Report (NCR) generation and analyst demonstration of capability.

12.1.2 INTERNAL SYSTEM AUDITS

Examples of elements that may be reviewed as a system audit may include, but are not limited to:

- An assessment of the SOP process, including procedures for submitting and approving revisions, update and distribution of SOPs, tracking of employee SOP assignments and sign-offs, SOP electronic file management, and archiving of older SOP iterations and records.
- LIMS data capture and reporting processes.
- Sample handling, storage and disposal practices, including maintenance of sample storage areas, sample tracking and internal chain-of-custody documentation, duration of retention, and disposal designation and documentation.
- Use of ALSLG-FC's Standards and Reagents database.
- Performance and documentation of laboratory logbook review.

12.1.3 ANNUAL QUALITY SYSTEMS AUDIT

A lab-wide review of conformance to ALSLG-FC's quality system is conducted annually by the QA Manager or designee(s) as required by Section 5.5.3.1 of the NELAC Standard. The annual Quality Systems Audit (QSA) shall be managed, conducted and reported according to the audit procedures described above. Inputs to the QSA may include, but are not limited to, summaries of the following: Nonconformance Reports (NCRs), Proficiency Testing (PT) study results, deficiencies noted during data review, internal audit Determinations, and Determinations made via external audits.

12.1.4 PROFICIENCY TESTING STUDIES

ALS Laboratory Group, Fort Collins participates in agency studies and/or contracts approved vendors to provide PT samples in accordance with a schedule developed and maintained by the Quality Assurance Department. Participation in PT studies enables ALSLG-FC to demonstrate capability for continued accreditation, competency in a newly developed method, or the effectiveness of corrective actions taken.

ALSLG-FC participates in the following inter-laboratory proficiency testing studies:

- Water Supply (WS) -- twice annually
- Water Pollution (WP) -- twice annually
- Soil/Hazardous Waste and UST -- twice annually
- Radiochemistry -- twice annually
- US Department of Energy (USDOE) Mixed Analyte Performance Evaluation Program (MAPEP) -- twice annually

These PT studies support various regulatory programs (SDWA, CWA, RCRA) and require that the laboratory perform analyses per various methodologies (e.g., EPA 600 series, MCAWW, ASTM, SW-846), matrices and analytes. Analyte lists include: volatile organics, semivolatile organics, organochlorine pesticides, polychlorinated biphenyls, organophosphorous pesticides, phenoxyacid herbicides, high explosives, petroleum hydrocarbons, metals, minerals, nutrients and radionuclides. The analyses of PT samples are conducted in-house, in the manner prescribed by the provider, and within the turnaround time stipulated. The PT samples are distributed to the laboratory and are processed by qualified analysts who routinely perform the analytical method.

PT study results are evaluated by the Quality Assurance Department and the applicable Department Manager as they become available. The NCR and corrective action process as described in Chapter 11 of this LQAP, is used to address any deficiencies that are noted. An archive of PT study reports, maintained by the QA Department, is posted to the network for lab-wide access.

12.1.5 ANNUAL MANAGERIAL REVIEW

A lab-wide Managerial Review is performed annually as required by Section 5.5.3.2 of the NELAC Standard. The Managerial Review assesses operational effectiveness in terms of meeting ALSLG-FC's business goals. It is a tool used to document and facilitate the consideration and introduction of needed operational changes and improvements.

The Managerial Review is performed by a designee under the direction of the Laboratory Director. The general techniques of scoping, assessment interview, reporting and follow-up as described in the internal audit procedures discussed above and outlined in SOP 937, are used to conduct the annual Managerial Review. The contents of the annual Managerial Review are considered to be confidential. A confidential footer must, therefore, appear as a component of the annual Managerial Review report.

Inputs to the Managerial Review may include, but are not limited to the following: a snapshot summary of product generated (i.e., number of samples analyzed and the types of analyses performed), various business assessment reports (e.g., TAT, on- time delivery), output from the annual QSA (i.e., problem areas identified), interview of laboratory staff, and presentation of items discussed during strategic planning sessions and/or Manager's meetings.

12.2 EXTERNAL AUDITS

External audits may be performed by a state or Federal agency or a client as part of an ongoing certification process. Items evaluated by external assessors may include, but are not limited to, reviews of the following: analytical capabilities and procedures; COC procedures; document control; quality systems; and QC procedures. Blind PT samples may be submitted to the laboratory as a form of external audit.

See **Appendix I** for a list of ALSLG-FC's state and Federal certifications. Should

ALSLG-FC drop or lose an accreditation, the PMs must notify all clients that may be affected in a timely manner.

13. PERSONNEL TRAINING

The selection of well-qualified personnel is a factor that contributes to ALSLG-FC's success. Therefore, qualifications of personnel are based upon education and experience. In order to maintain qualified staff, provide personnel advancement within the laboratory, and to provide for personnel's ongoing awareness of potential hazards and protective measures, ALSLG-FC follows a formal documented program of orientation and training. Records of Health & Safety and waste training are maintained by the Health & Safety Manager/RSO and Facilities/Waste Compliance Manager. Technical training records are forwarded to the Quality Assurance Department for retention.

13.1 ORIENTATION

Before working in the laboratory, new employees receive a four-part orientation as described below:

- Human resources -- involves matters of immediate personal concern, such as benefits and company policies

- Quality assurance -- addresses topics related to ethical conduct, good laboratory practices and ongoing documentation of employee capability demonstrations. Required readings (SOPs, LQAP) are assigned at this time.

- Health & safety -- provides for a review of ALSLG-FC's various safety program documents (Chemical Hygiene Plan, CHP; Radiation Protection Plan, RPP; Emergency and Contingency Plan, ECP; Respiratory Protection Plan, ResPP; Waste Management Plan, WMP); as well as other safety and security training.

- Department functional orientation -- focuses on the new employee's basic understanding of their role within the Department and the overall role of Operations within the structure of ALSLG-FC. The Departmental training expands upon the employee's scientific background and work experience to provide the employee with a level of competence that enables the individual to successfully function within the defined responsibilities of his/her position.

Temporary employees receive the same orientation as regular staff, with the exception of the human resources orientation.

SOP 143 details information regarding quality assurance orientation and training for new employees.

13.2 TECHNICAL TRAINING

Chemists (analysts) and technicians are qualified to perform specific analytical procedures and methods. The qualification process, at a minimum, consists of background/theory training, on-the-job training, and demonstration of proficiency. Additional training may include further individualized instruction, programmed learning, conferences and seminars, and specialized training by instrument manufacturers.

Department Managers are responsible for providing documentation of analytical training and proficiency for each employee in their group(s) to the Quality Assurance Department for retention.

13.2.1 INITIAL DEMONSTRATION OF CAPABILITY (IDOC)

New analysts and technicians are trained by Department Managers according to the following guidelines:

- The new employee reads the SOP(s) pertinent to the analytical method being learned, and receives background/theory instruction, as applicable.
- The new employee observes the procedure in which the analytical method and required process documentation is demonstrated by trained personnel. Job requirements are outlined and quality control measurements are defined. For most methods, the trainee performs an Initial Demonstration of Capability (IDOC) by preparing and/or analyzing four (4) blank spike samples under the supervision of the Technical or Department Manager, or an analyst proficient in that method.
- The results of the new employee's preparation and/or analysis are evaluated and problems and corrective actions are discussed. If the blank spike recovery and precision data meet quality control criteria for that method, the employee is deemed to have demonstrated proficiency and is allowed to work on client samples. If the values generated are outside acceptance limits, then training continues until the trainee can consistently meet the acceptance criteria for the method.
- After the certification process has been successfully completed, the Department Manager forwards the documentation to the Quality Assurance Department for retention.

13.2.2 CONTINUING DEMONSTRATION OF CAPABILITY (CDOC)

ALSLG-FC's personnel are required to demonstrate their proficiency upon hire and with each batch of samples. Results from the laboratory control sample (LCS) spike performed by the chemist (analyst) or technician is evaluated ongoing and significant problems are dealt with immediately through the peer review process, non conformance system,

and training. This LCS data is availble to review upon request. Alternately, MDL studies and reports from PT sample analysis may also be used to demonstrate an employee's capability.

13.2.2.1 METHOD DETECTION LIMIT (MDL) STUDIES

Most of the analytical methods employed at ALSLG-FC require the periodic generation of MDL data. The generation of acceptable MDL values requires a thorough understanding of the total analytical process and is a rigorous test of the proficiency of the analytical staff that performs the analysis. An analyst's or technician's performance in an MDL study that generates values that are consistent with past performance may be used to demonstrate initial and/or continuing proficiency in a method. This MDL information may be used in lieu of other demonstrations of proficiency, except where a regulatory promulgated method explicitly requires specific procedures to be followed for the initial demonstration of proficiency.

13.2.2.2 PROFICIENCY TEST (PT) SAMPLES

As discussed in Chapter 12 of this LQAP, ALSLG-FC participates in several proficiency testing programs. These programs typically submit single-blind standards to the laboratory and return a performance summary after results have been evaluated by the sponsoring agency or qualified vendor. Successful participation in these PT study programs by personnel is a rigorous demonstration of the staff's ability to perform routine analytical procedures. Records of successful participation in these programs may be used to demonstrate that an employee has been adequately trained in the methods that he/she performs. This IDOC/CDOC information may be used in lieu of other demonstrations of proficiency, except where a regulatory promulgated method explicitly requires specific procedures to be followed for the initial demonstration of capability.

13.3 TRAINING RECORDS

Technical and quality assurance training records are maintained by the Quality Assurance Department. Health & Safety training records are managed and retained by the Health & Safety Manager/RSO. Waste management training records are managed and maintained by the Facilities/Waste Compliance Manager. Employee training record files may contain, but are not limited to, the following:

- signed annual Ethics training documents

- resume or personnel qualifications form
- transcript or diploma
- QA training and signature/initial on file
- documentation of annual assigned SOP readings
- documentation of annual LQAP reading
- IDOC documentation
- PT study results
- MDL study results
- off-site training certificate

14. GLOSSARY, ACRONYMS AND SYMBOLS

14.1 GLOSSARY

TERM	DEFINITION
Acceptance Criteria:	Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQ)
Accreditation:	The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)
Accrediting Authority, Primary:	The agency or department designated at the Territory, State, or Federal level as the recognized authority with responsibility and accountability for granting NELAC accreditation for a specified field of testing. (NELAC) [1.5.2.3]
Accuracy:	The degree of agreement between a observed value and the accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations. (QAMS)
Aliquot:	A discrete, measured, representative portion of a sample taken for analysis. (EPA QAD)
Ambient:	Usual or natural surrounding conditions, e.g. ambient temperature – the natural, uninfluenced temperature of the surroundings. (NIRP Glossary)
Analyte:	The specific chemicals or components for which a sample is analyzed; may be a group of chemicals that belong to the same chemical family

TERM	DEFINITION
	and that are analyzed together. (DoD QSM)
Audit:	A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity. (EPA-QAD)
Background:	Ambient signal response recorded by measuring instruments that is independent of radioactivity contributed by the radionuclides being measured in the sample. (DOE QSM)
Batch:	Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to twenty environmental samples of the same NELAC-defined matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates, or concentrates) which are analyzed together as a group. An **analytical batch** can include prepared samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)
Bias:	The deviation of a single measured value of a random variable from a corresponding expected value, or a fixed mean deviation from the expected value that remains constant over replicated measurements within the statistical precision of the measurement (Synonyms: deterministic error, fixed error, systematic error). (DOE QSM)
Blank:	A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, or analysis. The blank is subjected to the same analytical and measurement process as the associated samples. Blanks include: Equipment blank: a sample of analyte free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC) Field blank: a blank prepared in the field by filling a clean container with pure deionized water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER) Trip blank: Contaminant free water, or appropriate matrix, which accompanies bottles and samples during shipment to assess the potential for sample contamination during shipment. Trip blanks are not opened in the field, and are required for Volatile Organic Analysis only. (NIRP)

TERM	DEFINITION
	Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)
	Method blank: a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all the steps of the analytical procedures. (NELAC)
	Reagent blank: a sample consisting of reagent(s), without the target analyte(s) or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)
Blind Sample:	A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample, but not the composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process. (NELAC)
Calibration:	To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. See Initial Calibration. (NELAC)
Calibration, Continuing:	The process of analyzing standards periodically to verify the maintenance of calibration of the analytical system.
Calibration Curve:	The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)
Calibration, Initial:	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response, linearity and dynamic range of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a continuing calibration do not conform to the requirements of the method in use or at a frequency specified in the method. See Calibration.
Calibration, Initial Check/Verification (ICV):	Verification of the ratio of instrument response to analyte amount, a calibration check is done by analyzing for analyte standards in an appropriate solvent. Calibration check solutions are made from a stock solution which is different from the stock used to prepare calibration standards. (NIRP Glossary)

TERM	DEFINITION
Carrier:	Carriers are typically non-radioactive (e.g. natural strontium, barium, yttrium) elements. They follow similar chemical reactions as the analyte during processing and are added to samples to determine the overall chemical yield for the analytical preparation steps. The yield of the carrier is typically determined gravimetrically or by ICP and is used to correct radiochemical results for acceptable losses occurring during the preparation process. (DOE QSM)
Chain-of-Custody (COC) Form:	Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers, the mode of collection, preservation, and requested samples. (NELAC)
Confidential Business Information (CBI):	Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. NELAC and its representatives agree to safeguarding identified CBI and to maintain information identified as such in full confidentiality. (NELAC)
Confirmation:	Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second column calibration, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors, or additional cleanup procedures. (NELAC)
Conformance:	An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)
Control Chart:	A graphical plot of test results with respect to time or sequence of measurement, together with limits within which they are expected to lie when the system is in a state of statistical control.
Control Limit:	A range within which specified measurement results must fall to signify compliance. Control limits may be mandatory, requiring corrective action if exceeded, or advisory, requiring that nonconforming data be investigated and flagged.
Corrective Action:	The action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence. (ISO 8402)
Counting Efficiency:	The ratio of the net count rate of a radionuclide standard source to

TERM	DEFINITION
	its corresponding known activity. (DOE QSM)
Counting Uncertainty (Poissonian):	A statistical estimate of uncertainty in a radiochemical measurement due to the random nature of decay. Every radiochemical result is reported with an associated counting uncertainty, usually at the 95% confidence interval.
Data Quality Indicators:	The qualitative or quantitative statements that specify the quality of data required to support decision for any process requiring chemical or physical analysis.
Data Reduction:	The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)
Daughter:	A nuclide formed by radioactive decay of a parent radionuclide.
Deficiency:	An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)
Demonstration of Capability (DOC):	A procedure to establish the ability of the analyst to generate acceptable accuracy. (NELAC)
Detection Limit, Analyte:	The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (NELAC)
Detection Limit, Instrument (IDL):	The concentration of an analyte that produces an output signal twice the root mean square of the background noise, or the parameter determined by multiplying by three the standard deviation obtained of three to five times the desired IDL on three nonconsecutive days with seven consecutive measurements per day. IDL is only required for the metals and analysis. (DOE QSM)
Detection Limit, Method (MDL):	The Method Detection Limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. It may be determined using replicate spike samples prepared by the lab and taken through all steps of the method. The detection limit is calculated using the appropriate student's t-parameter times the standard deviation of a series of spiked samples. (Ref. 40 CFR Part 136, Appx. B)
Digestion:	A process in which a sample is treated (usually in conjunction with heat) to convert the sample into a more easily measured form. (DoD QSM)

TERM	DEFINITION
Dilution Factor:	The factor by which the dilution level of the sample differs from that of a predefined method blank. The method blank is prepared within the prescribed parameters of the method, and has a dilution factor of one. The dilution factor does not include a dryness factor. (DOE QSM)
Document Control:	The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC)
Dry Weight:	The weight of a sample based on percent solids. The weight after drying in an oven at 105±5°C.
Duplicate, Replicate Analysis:	The analyses or measurements of the variable of interest performed identically on two sub samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation, or storage internal to the laboratory. (EPA-QAD) The measurements of the variable of interest performed identically on two or more sub-samples of the same samples within a short time interval. (NELAC)
Duplicate (Replicate) Error Ratio (DER/RER):	A measure of precision used to assess agreement between radiochemical duplicates (replicates) that compares the discrepancy between two measurements to the associated uncertainties.
Duplicate, Replicate Sample:	A second aliquot of the same sample that is treated the same as the original sample in order to determine the precision of the method. A second, separate sample collected at the same time, from the same place, for the same analysis, as the original sample in order to determine overall precision.
Eluent:	A solvent used to carry the components of a mixture through a stationary phase. (DoD QSM)
Elution:	A process in which solutes are washed through a stationary phase by the movement of a mobile phase. (DoD QSM)
Energy Calibration:	The correlation of the multi-channel analyzer (MCA) channel number to decay energy, obtained from the location of peaks from known radioactive standards. (DOE QSM)
False Negative:	An analyte incorrectly reported as absent from the sample, resulting in

TERM	DEFINITION
	potential risks from their presence. (DoD QSM)
False Positive:	An item incorrectly identified as present in the sample, resulting in a high reporting value for the analyte of concern. (DoD QSM)
Finding:	An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding is normally a deficiency and is normally accompanied by specific examples of the observed condition. (NELAC)
Half Life ($T_{½}$):	The time required for 50% of a radioactive isotope to decay. (DOE QSM)
Holding Time (Maximum Allowable):	The maximum times that samples may be held prior to analysis and still be considered valid or not compromised. (40 CFR Part 136)
Homogeneity:	The degree to which a property or substance is evenly distributed throughout a material.
Interference, Spectral:	Occurs when particulate matter from the atomization scatters the incident radiation from the source or when the absorption or emission of an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible. (DoD QSM)
Interference, Chemical:	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte. (DoD QSM)
Internal Standards:	A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. (NELAC)
Isomer:	Generally, any two chemicals with the same chemical formula but with a different structure. (DoD QSM)
Isotope:	A variation of an element that has the same atomic number of protons but a different weight because of the number of neutrons. Various isotopes of the same elements may have different radioactive behaviors, some are highly unstable. (NIRP Glossary)
Lot:	A quantity of bulk material of similar composition processed or manufactured at the same time.
Matrix:	The substrate of a test sample. **Field of Accreditation Matrix:** these matrix definitions shall be used when accrediting a laboratory:
	Drinking Water: any aqueous sample that has been designated a

TERM	DEFINITION
	potable or potential potable water source. Non-Potable Water: any aqueous sample excluded from the definition of Drinking Water matrix. Includes surface water, groundwater, effluents, water treatment chemicals, and TCLP or other extracts. Solid and Chemical Materials: includes soils, sediments, sludges, products, and by-products of an industrial process that results in a matrix not previously defined. Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin. Air and Emissions: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device. (NELAC) Non-aqueous Liquid: any organic liquid with <15% settleable solids.
Minimum Detectable Activity (MDA, Lower Limit of Detection):	The minimum detectable activity is the smallest amount (activity or mass) of an analyte in a sample that will be detected with a probability beta of nondetection (Type II error) while accepting the probability alpha of erroneously deciding that a positive (non-zero) quantity of analyte is present in an appropriate blank sample (Type I error). For the purposes of this standard, the alpha and beta probabilities are both set at 0.05 unless otherwise specified. (ANSI N 13.30 and ANSI N42.23)
Minimum Detectable Concentration (MDC):	The Minimum Detectable Activity expressed in concentration units.
National Voluntary Laboratory Accreditation Program (NVLAP):	A program administered by NIST that is used by providers of proficiency testing to gain accreditation for all compounds/matrices for which NVLAP accreditation is available, and for which the provider intends to provide NELAP PT samples. (NELAC)
Negative Control:	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (NELAC)
Nonconformance:	An indication or judgment that a product or service has not met the requirements of the relevant specifications, contract or regulation, also the state of failing to meet the requirements. (DoD QSM)

TERM	DEFINITION
Performance Based Measurement System (PBMS):	A set of processes wherein the data quality needs, mandates, or limitations of a program or project are specified and serve as criteria for selecting measurement processes which will meet those needs in a cost effective manner. (NELAC)
Positive Control:	Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)
Precision:	The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms. (NELAC)
Proficiency Test Sample:	A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (QAMS)
Qualitative:	Analysis without regard to quantity or specific numeric values. (NIRP Glossary)
Quality Assurance:	An integrated system of activities involving planning, quality control, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)
Quality Control (QC):	The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of the users. (QAMS)
Quality Control Sample:	An uncontaminated matrix spiked with known amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. (EPA-QAD) <u>Laboratory Control Sample (LCS)</u>: (However named, also Laboratory Fortified Blank, Blank Spike, or QC Check Sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias, or to assess the performance of all or a portion of the measurement system. (NELAC) <u>Laboratory Duplicate (DUP)</u>: Aliquots of a sample taken from the same container under laboratory conditions and processed and

TERM	DEFINITION
	analyzed independently. (NELAC) Matrix Spike (spiked sample or fortified sample): A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. (QAMS)
Quantitation Limits, Practical (PQL):	Levels, concentrations, or quantities of a target variable (e.g. target analyte) that can be reported at a specified degree of confidence. (NELAC) The value at which an instrument can accurately measure an analyte at a specific concentration (i.e. a specific numeric concentration can be quantified). These points are established by the upper and lower limits of the calibration range. (DoD clarification) The lowest concentration where the 95% confidence interval is within 20% of the true concentration of the sample. The percent uncertainty at the 95% confidence level shall not exceed 20% of the results for concentrations greater than the practical quantitation limit. (DOE QSM)
Quantitative:	Analysis with regard to quantities or specific numeric values. (NIRP Glossary)
Radioactive Decay:	The process by which a spontaneous change in nuclear state takes place. This process is accompanied by the emission of energy and subatomic particles. (DOE QSM)
Radiation Yield:	The amount of radiation of the type being measured that is produced per each disintegration, which occurs. For gamma spectrometry, this is commonly called gamma abundance. (DOE QSM)
Raw Data:	Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm, or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g. tapes which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted. (EPA-QAD)
Reagent Water:	Shall be water (defined by national or international standard) in which no target analytes or interferences are detected as required by the

TERM	DEFINITION
	analytical method. (NELAC)
Region of Interest (ROI):	In radiochemical analysis, the Multi-channel Analyzer region defining the isotope of interest displayed in terms of energy or channels. (DOE QSM)
Relative Percent Difference (RPD):	A measure of precision between two duplicate (replicate) results expressed as the percent difference between the results relative to the average of the results.
Reliability Check (Daily):	A periodic check of the Continuing Calibration of an instrument used for radiochemical measurements.
Reporting Limit:	The level at which method, permit, regulatory and client specific objectives are met. The reporting limit may never be lower than the statistically determined MDL, but may be higher based on any of the above considerations. Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified.
Retention Time:	The time between sample injection and the appearance of a solute peak at the detector. (DoD QSM)
Rounding Rules:	If the figure following those to be retained is less than 5, the figure is dropped, and the retained figures are kept unchanged. As an example, 11.443 is rounded to 11.44. If the figure following those to be retained is greater than 5, the figure is dropped, and the last retained figure is raised by 1. As an example, 11.446 is rounded to 11.45. If the figure following those to be retained is 5, and if there are no figures other than zeros beyond the five, the figure 5 is dropped, and the last-place figure retained is increased by one if it is an odd number or it is kept unchanged if an even number. As an example, 11.435 is rounded to 11.44, while 11.425 is rounded to 11.42. If a series of multiple operations is to be performed (add, subtract, divide, multiply), all figures are carried through the calculations. Then the final answer is rounded to the proper number of significant figures.
Sample:	A single container or series of containers identified by a unique number comprised of material drawn from a single location or a composite of locations during a fixed period representative of that location (s) and time period(s) for the purpose of analytical testing or physical evaluation. (DOE QSM)
Selectivity:	(Analytical chemistry) The capability of a test method or instrument to respond to a target substance in the presence of non-target substances. (EPA-QAD)

TERM	DEFINITION
Sensitivity:	Capability of method or instrument to discriminate between measurement responses representing different levels (e.g. concentrations) of a variable of interest. (NELAC)
Signal-to-Noise Ratio:	The signal carries information about the analyte, while noise is made up of extraneous information that is unwanted because it degrades the accuracy and precision of an analysis and also places a lower limit on the amount of analyte that can be detected. In most measurements, the average strength of the noise is constant and independent of the magnitude of the signal. Thus, the effect of noise on the relative error of a measurement becomes greater and greater as the quantity being measured (producing the signal) decreases in amplitude. (DoD QSM)
Split Sample:	A portion or subsample of a total sample obtained in such a manner that is not believed to differ significantly from other portions of the same sample.
Standard Operating Procedure (SOP):	A written document which details the method of an operation, analysis, or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing routine and repetitive tasks. (QAMS)
Reference Material:	A certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical method. (EPA-QAD) A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30 – 2.2)
Standard (Spike) Addition:	In radiochemistry, the addition of a known quantity of a radiotracer to a sample and to a split or splits of a sample. Both the sample and split(s) are then processed through the method and the difference in response between the samples used to correct for overall bias resulting measurement bias and from losses during preparation. This method of internal calibration is used in radiochemical determinations where isotopic differentiation between target analyte and tracer is not possible.
Statistical Minimum Significant Difference (SMSD):	The minimum difference between the control and a test concentration that is statistically significant, a measure of test sensitivity or power. The power of a test depends in part on the number of replicates per concentration, the significance level selected, and the type of statistical analysis. If the viability remains constant, the sensitivity of

TERM	DEFINITION
	the test increases as the number of replicates is increased. (NELAC)
Surrogate:	A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes. (QAMS)
Target Analytes:	Identified on a list of project-specific analytes for which laboratory analysis is required.
Tolerance Chart:	A chart in which the plotted quality control data is assessed via a tolerance level (e.g. +/-10% of a mean) based on the precision level judged to be acceptable to meet overall quality/data use requirements instead of a statistical acceptance criteria (e.g. +/- 3 sigma) (applies to radio bioassay laboratories). (ANSI)
Total Propagated Uncertainty (TPU):	An estimate or approximation of the total error associated with a measured value by propagation of individual (preparation, determination) uncertainties.
Traceability:	The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM-6.12)
Tracer:	A traceable internal standard, usually a unique isotope of the element being determined, added to each sample in known amount which enables quantitation of analytes of interest independent of external means of calibration.
Tracer Chemical Recovery:	The percent yield of the recovered radioisotope after the sample/tracer aliquot has undergone preparation and instrument analysis. (DOE QSM)
Tune:	An injected standard required by the method as a check on instrument performance for mass spectrometry. (DoD QSM)
Validation:	Confirmation by examination and provision of evidence that specified requirements have been met. (EPA-QAD)
Verification:	Confirmation by examination and provision of evidence that specified requirements have been met. (NELAC)
	NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.

TERM	DEFINITION
	The result of verification leads to a decision either to restore in service, to perform adjustment, to repair or downgrade, or declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.
Warning Limits:	The limits (typically 2 standard deviations either side of the mean) shown on a control chart within which most results are expected to lie (within a 95% probability) while the system remains in a state of statistical control.

14.2 ACRONYMS

TERM	DEFINITION
AA	Atomic Absorption
AFCEE	Air Force Center for Environmental Excellence
ANSI/ASQ	American National Standards Institute/American Society for Quality
APHIS	USDA Animal and Plant Health Inspection Service
API	American Petroleum Institute
ARAR	Applicable or Relevant and Appropriate Requirement
ASCII	American Standard Code Information Interchange
ASTM	American Society for Testing and Materials
BFB	Bromofluorobenzene
BNA	Base-Neutral and Acid Extractable Organic Compounds
BS	Blank Spike
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
°C	Degrees Celsius
CAS	Chemical Abstract Service
CCC	Calibration Check Compound
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification

TERM	DEFINITION
CDPHE	Colorado State Department of Public Health and the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Calibration Factor
CFR	Code of Federal Regulation
CLLE, CLE	Continuous Liquid-Liquid Extractor
CLP	Contract Laboratory Program
COC	Chain of Custody
CVAA	Cold Vapor Atomic Absorption Spectroscopy.
CWA	Clean Water Act
D	Drift or Difference
DBCP	1,2-Dibromo-3-chloropropane
DCM	Dichloromethane
DENIX	Defense Environmental Management Information Exchange
DER	Duplicate Error Ratio
DFTPP	Decafluorotriphenylphosphine
DI	Deionized
DOC	Demonstration of Capability
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DPM	Disintegrations per Minute
DQI	Data Quality Indicator
DRO	Diesel Range Organics
ECD	Electron Capture Detector
EDB	Ethylene Dibromide
EDD	Electronic Data Deliverable
EERF	Eastern Environmental Radiation Facility

TERM	DEFINITION
EMSL	Environmental Monitoring Systems Laboratory
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FPD	Flame Photometric Detector
GALP	Good Automated Lab Practice
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Graphite Furnace Atomic Absorption
GFPC	Gas Flow Proportional Counting
GPC	Gel Permeation Chromatography
GRO	Gasoline range organics
HECD	(Hall) Electrolytic Conductivity Detector
HEM	Hexane Extractable Material
HDPE	High-Density Polyethylene
HPGe	High Purity Germanium Gamma Spectrometer
HPLC	High-Performance Liquid Chromatography
IC	Ion Chromatography
ICAP-AES	Inductively Coupled Argon Plasma -Atomic Emission Spectroscopy
ICB	Initial Calibration Blank
ICP	Inductively Coupled Plasma
ICP-MS	Inductively Coupled Plasma - Mass Spectrometry
ICS	Interference Check Standard
ICV	Initial Calibration Verification
IDL	Instrument Detection Limit
IPC	Instrument Performance Check
IPN	Incoming Project Notice
IRPIMS	Installation Restoration Program Information Management System

TERM	DEFINITION
IS	Internal Standard
ISO/IEC	International Standards Organization/International Electrotechnical Commission
KD	Kuderna Danish
LCS	Laboratory Control Sample
LD	Laboratory Duplicate
LFB	Laboratory Fortified Blank
LFM	Laboratory Fortified Matrix
LIMS	Laboratory Information Management System
LLRW	Low Level Radioactive Waste
LQAP	Laboratory Quality Assurance Plan
LRB	Laboratory Reagent Blank
LSC	Liquid Scintillation Counting
LUFT	Leaking Underground Fuel Tank
LUST	Leaking Underground Storage Tank
MAPEP	Mixed Analyte Performance Evaluation Program
MCAWW	Methods for Chemical Analysis of Waters and Wastes
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MEK	Methyl Ethyl Ketone (2-Butanone)
MIBK	Methyl Isobutyl Ketone
MSA	Method of Standard Additions
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
MTBE	Methyl tert-butyl ether
N/A	Not applicable

TERM	DEFINITION
NIST	National Institute of Standards
NCR	Nonconformance Report
ND	Non Detect
NEIC	National Enforcement and Investigations Center
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NEPA	National Environmental Policy Act
NFESC	Naval Facilities Engineering Service Center
NIRP	Navy Installation Restoration Program
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Completeness, Comparability
PBMS	Performance Based Measurement System
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PEG	Polyethylene Glycol
PEL	Permissible Exposure Limit
PETN	Pentaerthrite tetranitrate
PID	Photoionization Detector
PM	Project Manager
PNA	Polynuclear Aromatic Hydrocarbon
PQL	Practical Quantitation Limit
psi	pounds per square inch

TERM	DEFINITION
PT	Proficiency Testing
PTFE	Polytetrafluoroethylene
QA	Quality Assurance
QAPjP	Quality assurance project plan
QASS	Quality Assurance Summary Sheet
QC	Quality Control
QIP	Quench Indicating Parameter
r^2	Correlation Coefficient
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RFP	Request for Proposal
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting Limit
ROI	Region of Interest
RPD	Relative Percent Difference
RPM	Revolutions Per Minute
RRT	Relative Retention Time
RSD	Relative Standard Deviation
RSO	Radiation Safety Officer
RT	Retention Time
RTW	Retention Time Window
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMSD	Statistical Minimum Significant Difference
SOP	Standard Operating Procedure
SOW	Statement of Work

TERM	DEFINITION
SPCC	System Performance Check Compound
SPLP, SLP	Synthetic Precipitation Leaching Procedure
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TCMX	Tetrachlorometaxylene
TCL	Target Compound List
TDS	Total Dissolved Solids
TIC	Tentatively Identified Compound
TLV	Threshold Limit Value
TOC	Total Organic Carbon
TPH	Total petroleum hydrocarbon
TPU	Total Propagated Uncertainty
TRPH	Total Recoverable Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
TSS	Total Suspended Solids
TVPH	Total Volatile Petroleum Hydrocarbons
USACE	United Stated Army Corp of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WET	Waste Extraction Test
ZHE	Zero Headspace Extraction

14.3 SYMBOLS

LENGTH	DEFINITION	SYNOMYM
um	micrometer	10^{-6} meter
mm	millimeter	10^{-3} meter
cm	centimeter	0.01 meter
dm	decimeter	0.1 meter
m	meter	

WEIGHT	DEFINITION	SYNOMYM
pg	picogram	10^{-12} gram
ng	nanogram	10^{-9} gram
ug	microgram	10^{-6} gram
mg	milligram	10^{-3} gram
g	gram	
kg	kilogram	10^{3} gram

VOLUME	DEFINITION	SYNOMYM
uL	microliter	10^{-6} Liter
mL	milliliter	10^{-3} Liter
dL	deciliter	0.1 Liter
L	Liter	

CONCENTRATION	DEFINITION
ng/uL	nanograms per microliter
ug/L	micrograms per liter
ug/kg	microgram per kilogram
ug/g	microgram per gram
ug/mL	microgram per milliliter
mg/kg	milligram per kilogram
mg/L	milligram per liter
ug/m^3	microgram per cubic meter
ppb	part per billion
ppm	part per million

TIME	DEFINITION	SYNOMYM
s or sec	second	1/60 minute
m or min	minute	60 seconds, 1/60 h
h	hour	60 minutes

TEMPERATURE	DEFINITION
°C	Degrees Celsius
°F	Degrees Fahrenheit
° K	Degrees Kelvin

ACTIVITY	DEFINITION	SYNOMYM
Bq	Bequerels	Disintegration/s
Ci	Curie	3.7×10^{10} Bq
dpm	Disintegrations per minute	

ELECTRICAL	DEFINITION
V	Volt
A	Ampere
EV	Electron Volt
F	Farad
Ω	Ohm
S or mho	Siemens
W	Watt

PREFIXES	NUMERIC AMOUNT
tera	10^{12}
giga	10^{9}
mega	10^{6}
kilo	10^{3}
hecto	10^{2}
deca	10
deci	0.1
centi	10^{-2}
milli	10^{-3}

micro	10^{-6}
nano	10^{-9}
pico	10^{-12}
femto	10^{-15}

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STATE OF COLORADO
RADIOACTIVE MATERIALS LICENSE

Colorado Department of Public Health and Environment

Pursuant to the *Colorado Radiation Control Act*, Title 25, Article 11, *Colorado Revised Statutes*, and the State of Colorado *Rules and Regulations Pertaining to Radiation Control* (the Regulations) and in reliance on statements and representations heretofore made by the licensee designated below; a license is hereby issued authorizing such licensee to transfer, receive, possess and use the radioactive material(s) designated below; and to use such radioactive material(s) for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, regulations, and orders now or hereafter in effect of the Colorado Department of Public Health and Environment and to any conditions specified below.

1. Licensee: ALS Laboratory Group, Environmental Division (Fort Collins, CO)
2. Mailing Address: 225 Commerce Drive, Fort Collins, Colorado 80524
3. License Number: Colo. 847-02, Amendment Number 13
4. Expiration date: June 30, 2012
5. Authorized Storage/Use Locations: 225 Commerce Drive, Fort Collins, Colorado 80524
6. Designated Radiation Safety Officer: Charles Orchard
7. Radiation Safety Officer Contact Number: (970) 490-1511
8. Fee Category: 3.N
9. Reference Number:

CONDITIONS

10. Authorized Radioactive Material and Uses

A. The licensee is authorized to possess and use Hydrogen-3 in the form of environmental samples, total activity not to exceed 1.85 GBq (50 mCi), for radiochemical analysis or as reference standards in analytical procedures.

B. The licensee is authorized to possess and use any radioactive materials with atomic numbers 3-100 in the form of environmental samples, except as otherwise specified in Condition 10, total activity not to exceed 740 MBq (20 mCi), for radiochemical analysis or as reference standards in analytical procedures.

C. The licensee is authorized to possess and use source material in the form of environmental samples, total activity not to exceed 37 MBq (1 mCi), for radiochemical analysis or as reference standards in analytical procedures.

D. The licensee is authorized to possess and use any radioactive materials with atomic numbers 3-98 in the form of sealed sources, no single source to exceed 1.48 MBq (40 μCi) and total activity not to exceed 187 MBq (5 mCi), for the calibration and checks of analytical equipment.

11. Authorized Radioactive Material Users :

A. Radioactive material authorized shall be used by or under the direct supervision of Renee Gallegos, Charles Orchard, Lance Steere, or Steven Workman.

B. The Radiation Safety Officer shall maintain written records indicating the date and basis of approval of designated users.

12. General Requirements :

A. The licensee shall comply with the provisions of the State of Colorado *Rules and Regulations Pertaining to Radiation Control*: Part 3, "Licensing of Radioactive Material"; Part 4, "Standards for Protection Against Radiation"; Part 10, "Notices, Instructions and Reports to Workers; Inspections"; and Part 17, "Transportation of Radioactive Material".

B. The licensee shall not transfer possession and/or control of radioactive materials or items contaminated with radioactive material except: by transfer of waste to an authorized recipient; by transfer to a specifically licensed recipient; or, as provided otherwise by specific condition of this license pursuant to the requirements of Part 3, Section 3.22 of the Regulations.

C. Radioactive material authorized by Condition 10 of this license shall be stored and used in a manner that will preclude use by unauthorized personnel.

D. The licensee shall ensure that information listed in this license is correct and accurate. The licensee shall notify the Department in writing within ten (10) days whenever the information contained in Items 1 through 7 above is no longer current or determined to be incorrect.

E. The licensee may transport radioactive material or deliver radioactive material to a carrier for transport in accordance with the provisions of Part 17 of the Regulations and the requirements of U.S. Department of Transportation (49 CFR).

13. Occupational Dose Monitoring:

A. All users of radioactive material who are likely to receive an occupational dose exceeding 10% of any applicable limit specified in Part 4 of the Regulations must be equipped with personnel monitoring devices capable of detecting both beta and gamma radiation.

B. If personnel monitoring devices will not be used, the Radiation Safety Officer must maintain written records demonstrating that personnel dose monitoring was not required pursuant to Part 4, Section 4.18 of the Regulations. In addition, the licensee shall include an assessment of individual dose monitoring needs as part of the annual program review required under Section 4.5.

14. Specific Radiation Safety Requirements:

A. Each sealed source containing radioactive material authorized in Condition 10 of this license shall be tested for leakage and/or contamination in accordance with Section 4.16 of the Regulations at intervals not to exceed six months.

B. Wipe tests for contamination must be completed weekly when radioactive materials are used.

C. The analysis of the wipes must be capable of detecting 20 disintegrations per minute (DPM) of alpha emitting radioactive material and 200 DPM of beta/gamma emitting radioactive material on the test sample.

D. If an area survey or wipe test detects the presence of radioactive materials in excess of the limits specified below, then the area and/or affected equipment shall be decontaminated until:

i. the removable contamination is not greater than 20 DPM (alpha) per 100 cm2 and 200 DPM (beta/gamma) per 100 cm2.

ii. the average fixed contamination is not greater than 100 DPM (alpha) per 100 cm2 and 1000 DPM (beta/gamma) per 100 cm2.

iii. the maximum fixed contamination is not greater than 300 DPM (alpha) per 100 cm2 and 3000 DPM (beta/gamma) per 100 cm2.

E. The licensee shall maintain records of surveys and wipe tests for contamination, waste disposal, and the analysis of liquid process wastes disposed of via the sewer.

15. Special License Requirements:

A. The licensee shall maintain in effect a decommissioning financial warranty acceptable to the Department in accordance with the requirements of Part 3, Section 3.9.5 of the Regulations.

16. Licensee Commitments and Reference Documents:

The State of Colorado *Rules and Regulations Pertaining to Radiation Control* shall govern unless the licensee's statements, representations, and procedures contained in the application and correspondence are more restrictive than the Regulations. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Condition 10 of this license in accordance with the statements, representations, and procedures contained in:

A. the application and attachments dated May 21, 2007; and

B. the license correspondence and attachments dated June 7, 2007; August 23, 2007; November 25, 2008; December 3, 2008; April 16, 2009; and

C. the Irrevocable Standby Letter of Credit Number NZS535426, dated January 14, 2005, in the amount of $250,000.00, issued by Wells Fargo Bank, N.A., Trade Services Division, Northern California, One Front Street 21st Floor, San Francisco, California 94111.

FOR THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Date: 4/27/09 By: [signature]

Appendix C – Standard Operating Procedures

WSP ENVIRONMENT & ENERGY

STANDARD OPERATING FIELD PROCEDURES

Standard Operating Field Procedures

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Standard Operating Procedure – 1

Note Taking and Log Book Entries

Materials:

Permanently bound log book (no spiral-bound log books)
Black or blue ballpoint pen (waterproof ink)

Procedure:

1. Use black or blue ballpoint pen with waterproof ink. Felt-tip pens should not be used.

2. Reserve the inside front cover for business cards from key personnel who visit the site (including the person in charge of the log book).

3. On the first page of the log book, place a return for reward notice, WSP's phone number, and the project manager's name.

4. Enter the following on the second page of the log book: project name, project number, project manager's name, onsite contacts, onsite telephone number and address, telephone numbers for all key personnel, and emergency fire and medical telephone numbers.

5. Number each page, initial each page, and put the date at the top of each page. Start a new page for each day. At the end of a day, summarize the day's activities, sign the page, and put a slash through the rest of the blank lines. Start the next day on a new page.

6. Enter the time (in military time, e.g., 0830) in the left column of each page when an entry is recorded in the field notebook.

7. If a mistake is made in an entry, cross out the mistake with one line and initial the end of the line.

8. At all times, maintain the chain of custody on the field log book.

Content:

1. Be sure that log book entries are LEGIBLE and contain accurate and inclusive documentation of project field activities.

2. Provide sufficient detail to enable others to reconstruct the activities observed.

3. Thoroughly describe all field activities while onsite. Be objective, factual, and thorough. Language should be free of personal feelings or other terminology that might prove inappropriate.

4. Describe problems, delays, and any unusual occurrences such as wrong equipment or breakdowns along with the resolutions and recommendations that resulted.

5. Fully document any deviations from or changes in the work plan.

6. Describe the weather and changes in the weather, particularly during sampling events.

7. Sketch a map of the facility or areas onsite where activities are occurring, especially the location of sampling points.

8. During sampling activities, record all information pertaining to the sampling event. Include descriptive locations and diagrams of the sample locations, time, sample media, analysis, sampling procedure, equipment used, sizes and types of containers, preservation and any resulting reactions, sampling identification (especially for duplicate samples), shipping procedures (record airbill numbers), and addresses.

9. Note decontamination or disposal procedures for all equipment, samples, and protective clothing and how effectively each is performed.

10. If possible, photograph all sample locations and areas of interest. Maintain a photographic log in the field log book and include:

    Date, time, photographer, name of site, general direction faced, description of the subject taken, and sequential number of the photograph and the roll number.

11. Record the names and affiliations of key personnel onsite each day.

12. List all field equipment used and record field measurements, including distances, monitoring and testing instrument readings (e.g., photoionization detector (PID), organic vapor analyzer (OVA), pH, conductivity, model numbers, etc.), and calibration activities.

13. Record proposed work schedules and changes in current schedules in the log book.

14. Describe site security measures.

15. Include drum inventory for all investigation-derived waste (IDW) materials generated during site activities. Provide information on how IDW material was labeled.

Standard Operating Procedure - 2

Sample Container, Preservatives, & Holding Times

Scope:

This operating procedure describes the ways and means of selecting the appropriate sampling containers for environmental sampling.

Application:

The purpose of this procedure is to assure that sample volumes and preservatives are sufficient for analytical services required under EPA-approved protocols.

Materials:

Sample containers
Sample container labels
Indelible (waterproof) markers or pens
Clear tape

Procedures:

1. Refer to Table 1 for minimum sample volume and glassware types required for sampling a particular matrix and compound class.

2. Select the appropriate glassware (i.e., bottles or jars) from those provided by the analytical laboratory. Verify that the analytical laboratory has provided the correct number of sample containers and the correct preservatives for the project per the sampling plan requirements.

3. The analytical laboratory should always provide extra sample containers for all analytical parameters in case of breakage or other problems encountered in the field. This is particularly true for VOC sample containers (i.e., 40-ml vials).

4. Report any discrepancies or non-receipt of specific types of sample containers to the Quality Assurance Officer immediately. Arrangements should be made with the laboratory to immediately ship the missing or additional sampling containers to the project site.

5. Apply WSP sample labels to the sample containers.

6. Information on the sample labels should contain the following data:

   Site/Project name
   Project/Task number
   Unique sample identification number
   Sample date
   Time of sample collection (military system, e.g., 0000 to 2400 hours)
   Analytical parameters

Preservative
Sampling personnel

7. Once sample containers are properly labeled, the sample labels should be wrapped with clear tape to prevent deterioration of sample label.

8. Proceed with the sample collection per the sampling plan requirements.

9. Collected samples should be immediately placed in an iced cooler to maintain as close as possible a 4°C atmosphere for shipment to the analytical laboratory. Follow sample shipping procedures detailed in Sample Shipping Standard Operating Procedures.

10. Recommended order of sample collection:

    In-situ measurements (e.g., temperature, pH, specific conductance)
    Volatile organic analytes (VOA)
    Organic analytes
    Inorganic/wet chemistry analytes
    Metals
    Radionuclides

Table 1 – Sample Containers, Preservatives, and Holding Times

Analytical Parameter	Matrix	Sampling Container Size and Type	Preservatives	Maximum Holding Time
Metals, except mercury and hexavalent chromium	Solid	8-oz. glass jar	Cool to 4o C	180 days
Mercury	Solid	8-oz. glass jar	Cool to 4o C	28 days
Hexavalent chromium	Solid	8-oz. glass jar	Cool to 4o C	24 hours
Metals, except mercury and hexavalent chromium	Aqueous	500-ml plastic container with Teflon-lined plastic cap	HNO3, pH<2 Cool to 4o C	180 days
Mercury	Aqueous	500-ml plastic container with Teflon-lined plastic cap	HNO3, pH<2 Cool to 4o C	28 days
Hexavalent chromium	Aqueous	500-ml plastic container with Teflon-lined plastic cap	Cool to 4o C	24 hours
Volatile organics	Solid	4-oz. glass jar with Teflon-lined cap	Cool to 4o C	14 days
Volatile organics	Aqueous	Three 40-ml glass vials with Teflon-lined caps	HCl, pH<2 Cool to 4o C	14 days

Analytical Parameter	Matrix	Sampling Container Size and Type	Preservatives	Maximum Holding Time
Semivolatile organics	Solid	8-oz. amber glass jar with Teflon-lined cap	Cool to 4o C	14 days to extraction 40 days from extraction to analysis
Semivolatile organics	Aqueous	Two 1,000-ml amber glass jars with Teflon-lined caps	Cool to 4o C	7 days to extraction 40 days from extraction to analysis
Cyanide	Solid	8-oz. glass jar	Cool to 4o C	14 days
Cyanide	Aqueous	One 500-ml plastic container	NaOH, pH>12, Cool to 4o C	14 days
Total Dissolved Solids	Aqueous	One 100-ml plastic	Cool to 4o C	7 days
Total Suspended Solids	Aqueous	One 100-ml plastic	Cool to 4o C	7 days
Total Phosphorous	Aqueous	One 100-ml plastic	H_2SO_4 , pH<2. Cool to 4o C	28 days
Total Phosphorous	Solid	One 8-oz. glass jar	Cool to 4o C	28 days
Orthophosphate	Aqueous	One 100-ml plastic	H_2SO_4 , pH<2. Cool to 4o C	28 days
Total Kjeldahl nitrogen	Solid	One 8-oz. glass jar	Cool to 4o C	28 days
Total Kjeldahl nitrogen	Aqueous	One 1,000-ml plastic	H_2SO_4 , pH<2. Cool to 4o C	28 days

Analytical Parameter	Matrix	Sampling Container Size and Type	Preservatives	Maximum Holding Time
Nitrate	Solid	One 8-oz. glass jar	Cool to 4o C	48 hours
Nitrate	Aqueous	1,000-ml plastic or glass	H_2SO_4 , pH<2. Cool to 4o C	28 days
Ammonia	Solid	One 8-oz. glass jar	Cool to 4o C	28 days
Fluoride	Solid	One 8-oz. glass jar	Cool to 4o C	28 days
Fluoride	Aqueous	One 500-ml plastic	Cool to 4o C	28 days
Sulfate	Aqueous	One 500-ml plastic	Cool to 4o C	28 days
Sulfide	Aqueous	One 500-ml plastic	NaOH+Zn acetate, pH<9. Cool to 4o C	7 days
Radionuclides	Solid	One 8-oz. glass jar	Cool to 4o C	28 days
Radionuclides	Aqueous	6 liters	HNO3, pH<2	6 months
TCLP Volatiles	Solid	8-oz. glass jar with Teflon-lined cap	Cool to 4o C	14 days to TCLP extraction 14 days from extraction to analysis
TCLP Semivolatile Organics	Solid	8-oz. glass jar	Cool to 4o C	14 days for TCLP extraction 7 days for preparative extraction 40 days from extraction to analysis

Analytical Parameter	Matrix	Sampling Container Size and Type	Preservatives	Maximum Holding Time
TCLP Metals, except Mercury	Solid	8-oz. glass jar	Cool to 4o C	180 days for TCLP extraction 180 days from preparative extraction to analysis
TCLP Mercury	Solid	8-oz. glass jar	Cool to 4o C	28 days for TCLP extraction 28 days from preparative extraction to analysis
Total Petroleum Hydrocarbons	Solid	4-oz. glass jar with Teflon-lined cap	Cool to 4o C	14 days for extraction 40 days for analysis
Total Petroleum Hydrocarbons (EPA Method 418.1)	Aqueous	1-liter amber glass jar	Cool to 4o C	14 days for extraction 40 days for analysis
Total Petroleum Hydrocarbons (EPA Method 8015 GRO)	Aqueous	2 40-ml glass vials	Cool to 4o C	14 days for extraction 40 days for analysis
Total Petroleum Hydrocarbons (EPA Method 8015 DRO)	Aqueous	2 40-ml glass vials	Cool to 4o C	14 days for extraction 40 days for analysis

Standard Operating Procedure - 3

Groundwater Sampling

Materials:

Bound sampling notebook
Groundwater monitoring data log forms
Well key
Adjustable wrench or manhole wrench
Plastic sheeting
Photoionization detector (PID)
Flashlight or mirror
Electronic water level indicator or interface probe
Bailer (bottom loading)
Pump (for purging)
Nylon or polyethylene rope
Temperature, pH, and conductivity meters
Other field meters, as appropriate (i.e., turbidity meter, DO meter, etc.)
Sample bottles, labels, indelible markers, and clear tape
Peristaltic pump
0.45-micron filter
Teflon tubing
Polyethylene tubing
Pocket knife or scissors
Saranex or Tyvek suit (if required by Health & Safety Plan)
Nitrile gloves
Vinyl gloves

Note: To sample using a low flow submersible pump, see SOP-3b.

Procedure:

1. Verify locations of wells, media to be sampled, and parameters to be analyzed for as specified in the sampling plan.

2. Prepare field log book with description of site, weather, participants, and other relevant observations, including all sampling data necessary to complete the groundwater monitoring data log (Refer to SOP-1). Inspect the well for soundness of protective casing and surface ground seal.

3. With the field personnel in Level C personal protective equipment, unless historical data warrants downgrading to Level D protective equipment, survey around the base of the well and wellhead with a PID; remove well cap, place probe of PID in wellhead, and record PID response in field book. Survey breathing zone to ensure that the level of personal protection is appropriate. Note observations on the groundwater monitoring data log.

4. Check for floating product layer (LNAPLs) and sinking free product layer (DNAPLs). Measure thickness with an oil/water interface probe in accordance with EPA or state

guidance documents or requirements. (If NAPL sampling is required, see the sampling procedures in SOP-3a).

5. Measure the casing inside diameter (CID) and record in inches. From the top of the casing, measure the depth (in feet) to water (DTW) with an electronic water level indicator and record in the field log book. Static water level measurements must be recorded from the surveyor's mark at the top of the casing, if present. If no mark is present, mark a location with a metal file or indelible marker on the casing for future reference. Measure and record the total depth (in feet) (TD) of the well.

6. Monitoring wells should be sampled by starting with the upgradient (or clean wells) and proceeding downgradient (in the order from most to least contaminated wells) for the remaining monitoring wells.

7. Calculate the length of the water column in the well casing:

   length = (TD - DTW)

   Calculate the volume of water in gallons in one well casing:

   For a 2-inch well:

   vol = [(TD - DTW) * 0.16]

   For a 4-inch well:

   vol = [(TD - DTW) * 0.65]

   For a 6-inch well:

   vol = [(TD - DTW) * 1.47]

   or calculate the volume using the formula:

   $vol = (TD - DTW)(CID)^2(0.041)$ CID=casing inside diameter in inches

   or $vol=0.041\ d^2h$

   where: $h = TD-DTW$

   d = diameter of well

8. Remove a minimum of three well volumes before sampling. To determine the number of gallons required to purge the well, multiply the number of gallons in one well volume (calculations above) by three. Record the minimum purge volume in the field log book. Record water color, suspended particulates, discoloration of casing, casing diameter and material, any unusual occurrences during sampling, and any pertinent weather details in the field log book.

9. Place plastic sheeting around the well before beginning purging process. Once plastic is around well, the purging process may begin. Do not allow the bailer rope to come into contact with the ground surface (i.e., keep the rope on the plastic). Keep the plastic as clean as possible.

10. Carefully lower the bailer attached to bailer cord into the well and allow the bottom to sink 1 foot below the water surface to capture surficial water only. Remove bailer and inspect it for LNAPL. If any are found, or if sampling plan requires, secure samples of the LNAPL in accordance with SOP-3a for analysis if sufficient volume is present. Place collected samples on ice. DO NOT PURGE OR SAMPLE GROUNDWATER IN WELL CONTAINING LNAPL.

11. During the purging process, geochemical measurements (e.g., pH, conductivity, turbidity, and temperature) should be collected a minimum of four times (i.e., before purging and after the removal of each well volume). Record these data in the field log book.

12. Continue bailing at a uniform rate. Each time, empty the bailer into a calibrated container for measurement. Dispose of the contents in an appropriate container for later disposal in compliance with federal and state laws.

13. A decontaminated submersible pump may be used in place of a bailer to purge wells when the diameter of the well is large or the purge volume is large. Refer to SOP-16 for submersible pump decontamination procedures.

14. If well is bailed dry before removing three well volumes, allow well to recharge and proceed to sample. Wells shall not be bailed dry if doing so will cause recharge water to enter the well in a cascading fashion but instead will be bailed at a rate which will minimize the agitation of recharged water. If full recovery exceeds 2 hours, sample as soon as sufficient volume is available within 3 hours of purging.

15. After the minimum purge volume has been removed, review the geochemical measurements to ensure that readings have stabilized. Readings should be within 10% of the previous reading. If the geochemical measurements have not stabilized, continue to purge the well until the monitoring parameters do not vary more than 10 percent between two successive well volumes removed.

16. Affix a sample label to each sample container and complete all required information (sample no., date, time, sampler's initials, analysis, preservatives). Place clear tape over the label. Record sample number, well number, date, time, and the sampler's initials in the field book.

17. Collect the groundwater samples after purging is complete. While collecting samples, lower the bailer slowly to avoid agitating the water. Sample first for VOCs, taking care to remove all air bubbles from the vial and minimize agitation. Collect remaining organic samples then inorganic samples.

    The recommended order of sample collection is as follows:

    In field measurements (e.g., temperature, pH, specific conductance, turbidity, dissolved oxygen)
    Volatile organic analytes (VOA)
    Organic analytes
    Inorganic/wet chemistry analytes
    Metals
    Radionuclides

18. Thoroughly decontaminate all equipment used before proceeding to the next well. Discard used bailer cord, plastic sheeting, towels, gloves, etc., in a plastic bag.

19. Complete chain-of-custody forms with appropriate sampling information.

20. Complete both front and back of the groundwater monitoring data log (attachment) for each monitoring well or sampling point upon return from the field, using data from the field log book.

Filtering of Metal Samples:

1. Assemble peristaltic pump per operating manual instructions, which accompany pump.

2. At the pump intake, attach polyethylene tubing to the tubing at the head of the peristaltic pump. The polyethylene tubing should be long enough to extend to the bottom of the bailer. At the pump discharge end, attach a clean 0.45-micron filter (or appropriate sized filter) to the Teflon tubing.

3. Turn on the pump and draw the water from the bailer, through the pump and filter, and into the sample container.

4. Disassemble the pump head and discard the polyethylene and Teflon tubing and filter in a plastic bag.

Attachment 1 – Groundwater Monitoring Data Log
Found on next page

Groundwater Monitoring Data Log

Well No./Designation _____ Date: _____

Site Data

Site Name: _____ WSP Sampling Team _____

Site Address: _____ WSP Project No.: ___

Weather Conditions: _____

Well Description

Well Location: _____

Well Security: _____

Casing Material: Inner _____ Outer _____

Organic Vapors (PID, OVA, TIP): Wellhead _____ ppm

Breathing Zone _____ ppm

Nonaqueous Phase (thickness): _____

Reference Point (e.g., top of PVC casing): _____

Purge Data

Purge Method: _____

(Note: Allow water level to equilibrate after removing well cap)

Total Well Depth (TD): _____ ft Depth to Water (DTW): _____

Casing Inner Diameter (CID): _____ inches

To calculate well volume: Well Vol.(gal)=$(CID)^2(0.04)(TD-DTW)$

Well Volume: _____ gal x 3=Purge Volume _____ gal

Purge Time: Begin _____ End _____

Data: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 1: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 2: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 3: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 4: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 5: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume Purged: _____ Purged Dry: Yes No

Disposal Method for Purgewater: _____

Water Description

Odor: Prepurge _____ Postpurge _____

Color: Prepurge _____ Postpurge _____

Sampling Data

Sampling Method: _____

Sampling Time: Begin _____ End _____

Analytical Parameters (circle appropriate parameters):

VOCs BNA BNE Total (Unfiltered) Metals

Dissolved (Filtered) Metals TPH PCB Cyanide

Other: _____

_____

Comments: _____

_____

_____

Standard Operating Procedure - 3a

Dense Nonaqueous Phase Liquid Sampling

Materials:

Items listed in SOP-3
Interface gauging probe or weighted tape coated with reactive indicator paste
Peristaltic pump, inertial pump, stainless steel double check valve bailer, or fluorocarbon resin double check valve bailer
Stainless steel cable or cable coated with an inert material (e.g., Teflon®)

Procedure:

1. Follow SOP-3 (Groundwater Sampling) procedures 1 through 6.

2. Check for a light nonaqueous phase liquid (LNAPL) layer, and a dense nonaqueous phase liquid (DNAPL) layer. Measure the thickness of the LNAPL and/or DNAPL layer using an appropriate interface gauging probe or a weighted tape coated with the appropriate reactive indicator paste for the suspected NAPL.

3. If no LNAPL is present in the well, proceed to procedure 4. If both LNAPL and DNAPL are detected in the well, slowly lower a bailer to just below the LNAPL layer. Remove the bailer from the well and containerize the LNAPL.

4. Select the appropriate DNAPL sampling device. If the DNAPL layer is of sufficient thickness, a suction-lift pump may be used. DNAPL can be sampled from wells where the water table is less than 25 feet below ground surface (bgs) using a peristaltic pump, and less than 300 feet bgs using an inertial pump. If the DNAPL is not of sufficient thickness or a suction-lift pump is unavailable, use a double check valve bailer to collect the sample. Use a bailer constructed of stainless steel to collect DNAPL samples for organic analyses and a bailer constructed of fluorocarbon resin to collect DNAPL samples for inorganic analyses. The cable used to raise and lower the bailer must be composed of an inert material such as stainless steel or coated with an inert material such as Teflon®.

5. Following removal of the LNAPL, immediately lower the DNAPL sampling device into the well. If using a bailer, slowly lower the bailer to the well bottom and then raise it slowly, causing as little agitation of the sample as possible. Minimize contact of the bailer with the well casing as it is raised.

6. If the sample is collected with a bailer, transfer the DNAPL to the sample container using the bottom check valve, allowing the DNAPL to slowly drain from the bailer.

7. If a suction-lift pump is used to collect the sample, use a low pumping rate to prevent agitation of the sample.

8. Continue following SOP-3 Groundwater Sampling procedures 19 through 21.

Standard Operating Procedure – 3b

Groundwater Sampling Using Low – Flow Submersible Pump

Materials:

Sampling notebook/Field log book
Groundwater monitoring data log forms
Well key
Adjustable wrench or manhole wrench
Photoionization detector (PID)
Flashlight or mirror
Electronic water level indicator
pH, conductivity, temperature meter
Oxidation potential meter (Eh)
Dissolved oxygen meter
Turbidity meter
Sample bottles, sample tags or labels, indelible markers, and clear tape
Appropriate power supply
Redi-Flo 2 submersible pump (or equivalent) and Teflon® tubing
Flow-through cell for pump or appropriate-sized beakers for meters
Buckets or drum for water storage
Pocket knife or scissors
Level C or Level D Personal Protective Equipment
Nitrile or latex gloves

Note: This SOP is only to be used if the applicable state of federal agency approves of purging and sampling groundwater using a submersible pump.

Procedure:

1. Verify locations of wells, media to be sampled, and parameters to be analyzed as specified in the sampling plan.

2. Prepare field log book with description of site, weather, participants, and other relevant observations (Refer to SOP-1)

3. As the following steps are completed, fill-in both front and back of the groundwater monitoring data log (Attachment 1 in SOP-1).

4. With the field personnel in Level D personal protective equipment, unless historical data, information, or suspicious warrants upgrading to Level C protective equipment, survey around the base of the well and wellhead with a PID; remove well cap, place probe of PID in wellhead, and record PID response in field book. Survey breathing zone to ensure that the level of personal protection is appropriate. Note observations on the groundwater monitoring data log. (See Site Health and Safety Plan for appropriate measuring techniques and upgrade requirements).

5. Inspect water surface in the well; use flashlight if necessary. Note any observable floating product and record observations in the field book.

6. Measure and record the extent of the top of the well riser above the ground. If well is a flush mount, measure and record the top of the well riser below the ground. Measure the casing (riser) inside diameter (CID) and record in inches. From the top of the riser, measure the depth (in feet) to water (DTW) with an electronic water level indicator and record on the groundwater monitoring data log. Static water level measurements must be recorded from the surveyor's mark at the top of the riser, if present. If no mark is present, mark a location with a metal file or indelible marker on the north side of the riser for future reference. Measure and record the total depth (TD, in feet) to the bottom of the well.

7. Check for light non-aqueous phase liquids (LNAPLs) and dense non-aqueous phase liquids (DNAPLs). Measure thickness with a oil/water interface probe in accordance with the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (November 1992).

8. Monitoring wells should be purged/sampled by starting with the upgradient (or clean wells) and proceeding downgradient (in the order from least to most contaminated wells) for the remaining monitoring wells.

9. If LNAPL was observed, carefully lower a bailer attached to an appropriate length of new nylon rope into the well and allow the bottom to sink 1 foot below the water surface to capture LNAPL only. Remove bailer and dispose of LNAPL appropriately. Record the quantity of LNAPL removed in the field book.

10. Place plastic sheeting around the wellhead. Carefully lower the pump into the well and place the pump intake in the center of the saturated screen interval, near the top of the well screen if the screen is submerged.

11. Begin purging the well at 0.2 to 0.5 L/min (0.05 to 0.13 gal/min). The water level should optimally be monitored continuously, but at a minimum, every 3 to 5 minutes during purging. Ideally, a steady flow rate should be maintained that results in a stabilized water level (less than 0.3 feet of variation). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. However, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate ad the water level measured immediately after each adjustment.

12. If the recharge rate of the well is very low, care should be taken to avoid loss of pressure in the tubing line, cascading through the sand pack, or pumping the well dry. In these cases, purging should be interrupted before the water in the well reaches a level below the top of the pump. Sampling should commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

13. During purging of the well, monitor the following geochemical parameters every 3 to 5 minutes: turbidity, dissolved oxygen, redox potential (Eh), temperature, specific conductance, and pH. In-line analyzers and continuous readout displays are highly recommended. The well is considered stabilized and ready for sample collection once turbidity, redox potential, and dissolved oxygen in in-line or downhole analyses of groundwater have stabilized within approximately 10% over at least two measurements

– for example, over two successive measurements made three minutes apart. Turbidity should be less than 50 NTUs (decrease pumping rate to lower turbidity measurements). Dissolved oxygen and Eh must be obtained in a manner in which the sample is not exposed to air prior to the measurement. Other parameters may be taken in a clean container, such as a glass beaker.

14. If a well is purged to dryness before removing three well volumes, allow well to recharge and proceed to collect sample. If full recovery exceeds 2 hours, the well should be sampled as soon as sufficient volume is available or within a maximum of 3 hours from purging dry.

15. Collect groundwater samples after purging is completed. Collect the samples using the sampling pump operated at a maximum rate of 0.25 L/min (0.07 gal/min)(or to the rate of the purging activities) to avoid agitating the water. Sample first for VOCs, taking care to remove all air bubbles from the vial and minimize agitation. Collect remaining organic samples then inorganic samples.

    The recommended order of sample collection is as follows:

    In-field measurements (e.g., temperature, pH, Eh, specific conductance, dissolved oxygen, turbidity)
    Volatile organic compounds (VOCs)
    Purgeable organic carbon (POC)
    Purgeable organic halogens (POX)
    Total organic halogens (TOX)
    Total organic carbon (TOC)
    Extractable organics
    Pesticides and herbicides
    Total metals
    Dissolved metals
    Phenols
    Cyanide
    Sulfate and chloride
    Nitrate and ammonia
    Radionuclides

16. Affix a sample tag or label to each sample container and complete all required information (sample no., date, time, sampler's initials, analysis, preservatives). Place clear tape over the tag or label. Record sample designation, date, time, and the sampler's initials on the sample tracking form and in the field book. Complete chain-of-custody forms with appropriate sampling information.

17. Remove the pump and tubing from the well. Inspect the well for soundness of protective casing and surface ground seal. Record water color, suspended particulates, discoloration of casing, any unusual occurrences during sampling, and any pertinent weather details on the groundwater monitoring data log.

18. Thoroughly decontaminate all equipment used before proceeding to the next well. See SOP No. 16 for details on decontamination procedures. Discard used towels, tubing, gloves, etc., in a plastic bag. Refer to the Investigation Derived Waste Management Plan for the site for appropriate storage and disposal methods of these materials.

Standard Operating Procedure - 4

Surface Water and Sediment Sampling (using hand trowel)

Surface Water Sampling

Materials:

Nitrile gloves
Saranex or Tyvek suit
Vinyl gloves
Bulldog boots
Hip-waders
Sample containers
Sample labels and indelible marker
Bound field log book

Procedure:

1. Collection of surface water samples should be completed before collection of the stream sediment samples from the same location. This procedure will eliminate the introduction of sediment and turbulence in the surface water that is to be sampled.

2 The sampler should wear hip-waders or rubber boots and gloves, or Saranex or Tyvek sleeves duct taped onto nitrile gloves, to avoid dermal contact with the surface water.

3. Extreme caution should be exercised when wading into the stream at the sampling location to minimize disturbance of the fine sediments.

4. Because of possible unseen water hazards, two people should be present during the collection of surface water samples.

5. If collecting several surface water samples from the same surface water body, start sampling at the downstream location and progressively move upstream. The sampler should always face upstream (i.e., upcurrent) when collecting the surface water sample.

6. The surface water sample container should be placed into the flowing water and the sample should be collected from just beneath the stream surface.

7. The sample container should be labeled before sample collection. After the sample is collected, the container should be sealed, and placed into a cooler for shipment to the analytical laboratory.

8. The sampling location should be described, including width of stream, depth of stream, water color, and approximate surface flow (e.g., slow, fast moving, etc.).

9. Sampling locations should be marked with a stake or flagged for future reference. Locations should be recorded with respect to a permanent feature, if available.

10. Complete chain of custody form with appropriate sampling information.

11. If collecting sediment samples, proceed to collect the sample from this location.

Sediment Sampling

Materials:

Hand trowels (stainless steel or Teflon)
Nitrile gloves
Vinyl gloves
Tray, mixing pans, Ziploc® plastic bags
Stainless steel or Teflon spoons
Aluminum foil
Saranex or Tyvek suit
Hip-waders of rubber boots
Sample containers
Sample labels and indelible marker
Bound field log book

Procedure:

1. The hand trowel can be used to sample shallow stream bottom sediments, where the depth of water does not exceed 1 foot, using the same procedures specified in the Standard Operating Procedures for Collection of Soils Samples Using a Hand Trowel. The sediment corer or other appropriate sampling device should be used in water deeper than 1 foot (see SOP-6).

2. The sampler should wear hip-waders or rubber boots and gloves, or Saranex or Tyvek sleeves duct taped onto nitrile gloves, to avoid dermal contact with the water.

3. Extreme caution should be exercised when wading into the stream at the sampling location to minimize disturbance of the fine sediments.

4. If collecting several sediment samples from the stream, start sampling at the downstream location and progressively move upstream. The sampler should always face upstream (into the current) when collecting the sediment sample.

5. Insert the trowel into the sediment bed and retrieve sediment. Carefully remove the trowel from the water to avoid washing sediment from the blade. The trowel blade should be tilted at a slight angle, if necessary, to drain excess water from the blade before placing the sediment in the mixing tray.

6. If more sediment is needed to provide sufficient sample volume, reinsert trowel at the sample location and retrieve as before.

7. Examine contents of tray. For volatile organic compound (VOC) samples, do not mix the sediment sample in the tray. Transfer sediment directly into sample containers, choosing your sample from various portions of the tray to simulate homogeneity.

8. After the collection of VOC samples and before filling other sample containers, mix the contents of the tray so a homogeneous texture remains.

9. Transfer the tray contents to the sample containers.

10. The sample container should be labeled before sample collection. After the sample is collected, the container should be sealed, wiped clean of excess sediment material, and placed in a cooler with ice or freezer packs for shipment to the analytical laboratory. Complete chain-of-custody form with appropriate sampling information.

11. The sampling location should be described, including width of stream, depth of stream, water color, and approximate surface flow (e.g., slow, fast moving, etc.).

12. Sampling locations should be marked with a stake or flagged for future reference. Locations should be recorded with respect to a permanent feature, if available.

Standard Operating Procedure - 5

Sediment/Sludge Sampling with Ekman Dredge

Application:

Sediment/sludge samples can be collected with an Ekman dredge, which is normally used when collecting samples from lagoons or other aqueous systems. The dredge consists of a spring-loaded set of jaws with a brass sampling bucket that is lowered to retrieve samples. The dredge can be mounted on a pole or suspended from a line. This may not be used for samples to be analyzed for metals and organics.

Materials:

Ekman dredge
Saranex or Tyvek suit
Overboots or hip-waders
Stainless steel spoons or scoops
Plastic sheeting or garbage bags
Nitrile, surgical, or work gloves
Trays, mixing pans, or Ziploc® plastic bags

Procedure:

1. Sampler should don personal protective equipment as required to prevent dermal contact with sample media.

2. Carefully open jaws of the Ekman dredge and set trip lines to trigger device.

3. Gently lower the Ekman dredge through the aqueous media until it rests on the sediment.

4. To close the jaws of the Ekman dredge, send the messenger down the line; or if the dredge is pole-mounted, strike the spring release button on the top of the pole. The weight will strike the trigger mechanism, causing the spring-loaded jaws to close. This will trap the sludge/sediment inside the sampling bucket.

5. To minimize disturbance and to avoid washing the sample from the dredge bucket, slowly retrieve the dredge through the liquid column above it.

6. The sediment sample should be removed from the dredge bucket with a stainless steel scoop or spoon and transferred directly to the labeled sample container if volatile organic compounds are being analyzed for. The remaining sediment/sludge material should be homogenized in a sampling tray before transferring to the sample container.

7. The sample container should be sealed, labeled, and placed in a cooler with ice or freezer packs for shipment to the analytical laboratory.

8. The sampling locations should be described including width of stream or vessel, depth of stream or vessel, and approximate surface flow rate, if applicable. Locations should be flagged or marked with a stake for future reference.

9. Keep detailed notes in the field log book of the sample location, sample description, sample length, sampler's name, and the requested analytical parameters.

10. Completed chain-of-custody forms with appropriate sampling information.

Standard Operating Procedure - 6

Sediment Sampling Using Hand Corer

Application:

Sampling bottom sediment in shallow surface water bodies and lagoons

Materials:

Hand corer
Extension handle
Analyte-inert core tube liners (glass, Teflon, etc.)
Nitrile, surgical, or work gloves
Protective overboots
Tray, mixing pans, or Ziploc® plastic bags
Stainless steel spoons or trowel
Pipe wrenches
Bound log book

Assembly:

1. Secure the core tube head assembly onto the core tube, as specified by manufacturers instructions.

2. Remove end liner caps and wrapping from a clean core tube liner and insert the liner into the core tube.

3. Insert a clean core retainer into the bottom of the core tube liner so that its convex end points away from the bottom. Plastic materials should not be used if organic analytes are of concern.

4. Screw the shoe (nose cone) onto the bottom of the core tube. The hand corer is now fully assembled for use.

5. If the hand corer is used from a boat or overhead structure, either of the following two attachments can be used:

   a) *5-foot extension handles can be attached to the top of the core head assembly with a threaded adapter fitting, nut, and bolt. The long handle is used to push the corer into bottom sediment.*

   b) *The corer can be lowered to the bottom with a rope. The rope can be tied to a clevis pin that mounts on the core head assembly with a nut and bolt.*

Use:

1. Place nitrile gloves on hands before collecting samples.

2. Sampler should avoid wading into surface water, if possible. If not possible, the sampler should carefully approach the sample location to minimize disturbance of fine sediments.

3. Place the corer in a vertical position perpendicular to the bottom at the desired sample location.

4. The hand corer should be lowered slowly to minimize disturbance of sediments.

5. If using the corer from a wading position push it down into the sediment while turning the handle. The push and twist technique can also be used with the long extension handle attached to the corer.

6. If the corer is attached to a rope, detachable weights can be put on top of the core head assembly by threading the rope through the holes in the center of the weights. The shoe of the corer should not be resting on the bottom before being advanced. Further penetration will be achieved by allowing the corer to fall freely through the water while in a vertical position to strike the bottom. The weights will increase the force of the corer as it strikes the bottom.

7. When sufficient sample has been collected, it is usually necessary to push it back and forth from different angles to loosen the seal between the bottom and the core tube before pulling it up.

8. Slowly retrieve the core tube and place it on a clean surface in a vertical position. Slowly tilt it toward a horizontal position (this can be done immediately following retrieval of the sampling device). This will open the flapper valve and allow water that entered the tube to leak out.

9. Unscrew and remove the core head assembly and shoe from the core tube. Pipe wrenches may be used to unscrew the core tube assembly. Slide the core tube liner out of the core tube.

10. If undisturbed sediment core samples are needed, do not remove the sediment sample from the core tube. Retain the core sample in the core tube liner (i.e., inner sleeve) and place Teflon end caps on each liner end. Label the inner tube and tape the end caps on the tube liner for shipment to the laboratory. Plastic materials, including end cap, should not be used if organic analytes are of concern.

11. To remove sediment from the core tube, place the core tube liner over a sampling tray and remove its contents by inserting the brass rod into the top end of the tube and pushing. The brass rod should be decontaminated and wrapped in clean aluminum foil between each use.

12. If additional sediment is needed to provide necessary sample volume, reassemble the corer using a separate, clean core tube liner and repeat steps 1-11.

13. For volatile organic compound (VOC) samples, do not mix the sample before sampling for VOCs. Transfer sediment from the tray directly into sample containers.

14. Examine the contents of the tray. After the collection of VOC samples and before filling other sample containers, mix the sediment so a homogeneous particle size and texture remain.

15. Using the stainless steel spoon, transfer the tray contents to the sample containers.

16. The sample container should be labeled before sample collection. After the sample is collected, the container should be sealed, wiped clean of excess sediment, and placed in a cooler with ice or freezer packs for shipment to the analytical laboratory.

17. Complete chain-of-custody form with appropriate sample information.

18. The sample location should be described, including depth of the surface water body and approximate surface flow. The location should be flagged or marked for future reference, if possible.

Standard Operating Procedure - 7

Sludge Sampling with Sludge Judge

Application:

The sludge judge is useful for obtaining a core sample of semi-liquid sludge or water and sludge. This instrument is a long, narrow polyethylene tube with a check valve on the bottom. The tube is graduated in 6-inch intervals for easy identification of sampling depth. A sludge judge may not be used for organics.

Materials:

Sludge judge
Saranex or Tyvek suit
Sample containers, labels, and indelible marker
Tray or mixing pans
Aluminum foil
Plastic sheeting or garbage bags
Nitrile gloves
Vinyl gloves
Eye protection
Over boots
Stainless steel scoops, trowels, or spoons

Procedure:

1. Sampling personnel should don the appropriate personal protective equipment based on the type of material being sampled and its historical characteristics.

2. Slowly insert the sludge judge into the material being sampled.

3. When the sludge judge has filled with material, pull back on the sampler to close the check valve and retrieve the sludge sample.

4. If a liquid sample is not required, decant any liquid into a separate container or back into the vessel being sampled. Transfer the remaining sludge sample directly into a labeled sample container by pouring the sludge from the top of the sampling tube. If a liquid sample is required, decant any liquid in the tube directly into sample containers; retrieve the sludge from tube.

5 The sample container should be sealed, labeled, and placed in a cooler with ice or freezer packs for shipment to the analytical laboratory.

6. Keep detailed notes in the field log book of the sample location, sample description, sample depth, sampler's name, and the requested analytical parameters.

7. Complete chain-of-custody forms with appropriate sampling information

Standard Operating Procedure - 8

Sludge Sampling with Coring Tube

Materials:

Field log book
Personal protective equipment (PPE)
Coring tube
Hammer
Plastic tube liners
Hack saw and replacement blades
Mixing tray or bowl
Plastic sheeting
Stainless steel spoon or trowel
Expanding ruler or tape measure

Note: Decontamination is not required for dedicated sampling equipment.

Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Insert a plastic liner into the coring tube to collect an undisturbed sample. A plastic core catcher may be used to improve sample recovery.

3. The sample is collected by pushing or hammering the coring tube into the material to the desired depth, making sure not to exceed the length of the coring tube. Continuous core samples can be obtained from stable coreholes by re-inserting the coring device into the same core-hole. However, a new plastic liner must be placed in the coring device before each sample is collected.

4. Remove the sampler by pulling and twisting the coring tube until it breaks free from the material. This will result in a core that is approximately 2 feet long.

5. If the sample needs to be collected from a depth greater than 2 feet, place a new plastic liner into the tube and re-insert the sampler into the same core-hole and repeat Steps 3 and 4.

6. Remove the plastic liner from the coring tube and decant any excess water above the core.

7. Cut the plastic liner at the desired sample interval using a hack saw with a decontaminated blade. For VOC samples, extrude the sample material directly into a sample container. A closed-system sampler (e.g., Encore Sampler) should be used, if necessary, to collect sludge samples for VOC analysis using EPA Method 5035 for preservation.

8. For all other parameters, a stainless steel spoon or trowel should be used to transfer the sample material into a decontaminated mixing tray or bowl to be homogenized. The

decontaminated stainless steel spoon or trowel can be used to remove gummy or thick sludge from the tube, if required.

9. If necessary, screen the sludge with a PID/OVA or perform a headspace analysis in accordance with SOP 22. Record the reading in the field logbook.

10. Record the sample location, sample description, sample depth, sampler's name, and the requested analytical parameters in the field log book.

11. Label the containers, cover the labels with tape, and immediately place the containers in a cooler maintained at an ambient temperature of 4° Celsius with wet ice. Freezer packs or dry ice should not be used for sample preservation.

12. Complete chain-of-custody forms with appropriate sampling information.

13. Samples should be maintained and shipped in accordance with SOP 20.

14. Properly manage all PPE and investigation-derived wastes in accordance with state and federal requirements.

Standard Operating Procedure – 9

Soil Sampling Using Bucket Auger

Materials:

Field log book
Personal protective equipment (PPE)
Bucket augers
Auger extension rods
Auger handle
Pipe wrenches (for threaded connections)
Push pins (for snap connections)
Stainless steel spoons or trowels
Mixing tray or bowl
Plastic sheeting
Expanding ruler or tape measure

Note: Decontamination is not required for dedicated sampling equipment.

Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Remove all vegetation or other surface material (e.g., gravel) with a hand trowel or other tool (e.g., shovel).

3. Advance the borehole to the desired sampling depth (i.e., the top of the sample interval). Attach a decontaminated auger bucket to collect the soil sample.

4. Place the auger bucket in the borehole. Grip the cross-handle with both hands and twist it clockwise to advance the auger.

5. Withdraw the auger bucket from the borehole and place it on plastic sheeting. For VOC samples, use a decontaminated stainless steel spoon or trowel to transfer the sample material directly into the appropriate sample container. A closed-system sampler (e.g., Encore Sampler) should be used, if necessary, to collect sludge samples for VOC analysis using EPA Method 5035 for preservation.

6. Remove the retrieved soil from the bucket with a decontaminated stainless steel spoon or trowel and place the material in a decontaminated mixing tray or bowl. If additional soil is needed to provide sufficient sample volume, repeat Step 4.

7. If necessary, screen the lead end of the auger with a PID/OVA or perform headspace analysis in accordance with SOP 22. Record the reading in the field logbook.

8. Describe the remaining sample material in accordance with ASTM International Standard D 2488 and the Unified Soil Classification System. Record the sample description in the field logbook.

9. For all other parameters, the sample material should be transferred into a decontaminated mixing tray or bowl. Use the stainless steel spoon to separate large clumps of soil material and mix the contents of the tray to a homogeneous particle size and texture.

10. Examine the contents of the tray and remove coarse gravel, organic material (e.g., roots, grass, and woody material) and any other debris with the stainless steel spoon.

11. Transfer the tray contents to the appropriate sample container using a stainless steel spoon.

12. Label the containers, cover the labels with tape, and immediately place the containers in a cooler maintained at an ambient temperature of 4° Celsius with wet ice. Freezer packs or dry ice should not be used for sample preservation.

13. Measure and record the sample depth in the field logbook, along with the sample location, sampler name, and the requested analytical parameters.

14. Complete the chain-of-custody form with appropriate sampling information.

15. Samples should be maintained and shipped in accordance with SOP 20.

16. Properly manage all PPE and investigation-derived wastes in accordance with state and federal requirements.

Standard Operating Procedure - 10

Split-Spoon Soil Sampling

Application:

To collect soil samples with a split-spoon sampler that is advanced and retrieved with a drill rig.

Materials:

Field log book
Personal protective equipment (PPE)
Split-spoon samplers
Stainless steel spoons or trowels
Mixing tray or bowl
Pipe wrenches
Expanding ruler or tape measure

Note: Decontamination is not required for dedicated sampling equipment.

Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Ensure that the soil boring has reached the desired sample depth and that loose soil in the bottom of the boring has been cleaned out.

3. The drillers will attach a decontaminated split-spoon sampler to the lead drilling rod, lower it to the bottom of the boring, and advance the split-spoon into the undisturbed soil. Record in the field logbook the number of blows for every 6 inches the sampler is advanced.

4. When the split-spoon has reached the desired depth, the driller will retrieve the split-spoon and disconnect the split-spoon from the drilling rod.

5. Remove the head and shoe from the split-spoon and note which end of the sampler is the top and bottom. Separate the split-spoon sampler into two halves keeping all of the soil in one of the halves (if possible).

6. Measure the length of material recovered in the sampler with respect to the penetration depth and record this ratio in the field logbook.

7. If field screening for organic vapors is required, break or cut the soil core every 3 to 4 inches and quickly scan the breaks in the core material with a PID/OVA. Headspace analyses, if required, should be performed in accordance with SOP 22. Record the reading in the field logbook.

8. For VOC samples, transfer the soil directly into the sample containers with a decontaminated stainless steel spoon. A closed-system sampler (e.g., Encore Sampler)

should be used, if necessary, to collect sludge samples for VOC analysis using EPA Method 5035 for preservation.

9. Describe the remaining sample material in accordance with ASTM International Standard D 2488 and the Unified Soil Classification System. Record the information in the field logbook.

   Note: the top of the split-spoon often contains float material, which is not to be included in the soil sample or sample description.

10. If it is necessary to collect soil samples for non-volatile parameters, transfer the recovered soil to a decontaminated mixing tray or bowl with a decontaminated stainless steel spoon. Soil material lodged within the split-spoon shoe should also be placed in the mixing tray or bowl for sampling.

11. Examine contents of the tray and remove pebbles, organic material, (e.g., roots, grass, and woody material), and other debris with the stainless steel spoon. Use the same spoon to chop apart clumps of soil and mix the contents of the tray to a homogeneous particle size and texture.

12. Transfer the soil material to the appropriate sample containers using the stainless steel spoon.

13. Label the containers, cover the labels with tape, and immediately place the containers in a cooler maintained at an ambient temperature of 4° Celsius with wet ice. Freezer packs or dry ice should not be used for sample preservation.

14. Record the sample location, sample depth, sampler name, and the requested analytical parameters in the field log book.

15. Complete the chain-of-custody form with appropriate sampling information.

16. Samples should be maintained and shipped in accordance with SOP 20.

17. Properly manage all PPE and investigation-derived wastes in accordance with state and federal requirements.

BORING LOG WSP Environment & Energy 11190 Sunrise Valley Drive, Suite 300 Reston, Virginia 20191	**PROJECT**	Boring No. Sheet ___ of Date Drilled

Drilling Co. Driller Geologist	Boring Location Ground Elevation TOC Elevation

<u>Boring</u>	<u>Casing/Screen</u>	<u>Sampler</u>
Method	Type	Method
Hole Diameter	Diameter	Length (ft)
Inside Diameter	Screen Length	Hammer (lb)
Total Depth	Screen Slot Size	Fall (in)

Depth	P.I.D. (ppm)	Percent Recovery	Sample Depth	Blows/6"	Well Design	Sample Description

Standard Operating Procedure - 11

Soil Sampling Using Hand Trowel

Application:

To collect surface or shallow subsurface soil samples with a hand trowel.

Materials:

Field log book
Personal protective equipment (PPE)
Stainless steel trowels or spoons
Mixing tray or bowl
Plastic sheeting

Note: Decontamination is not required for dedicated sampling equipment.

Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Remove the resealable plastic bag and aluminum foil from a decontaminated stainless steel trowel or spoon.

3. Remove any vegetation or other surface material (e.g., gravel) from the sample location with a trowel or other tool (e.g., shovel).

4. Push the trowel or spoon into the soil to the desired sampling depth. If sampling a loose gravelly or sandy soil, carefully remove the trowel so that the blade approaches a horizontal position to prevent soil from falling off the blade. If sampling a stiff silty or clayey soil, it may be necessary to remove and reinsert the trowel to loosen the soil. Shallow subsurface soil samples can be collected by digging a hole (e.g., with a shovel or trowel) and collecting a soil sample at the desired depth. A decontaminated stainless steel trowel or spoon should be used for sample collection.

5. Repeat Step 4 if more soil is needed to provide sufficient sample volume.

6. If required, screen the recovered soil with a PID/OVA or perform headspace analyses in accordance with SOP 22. Record the reading in the field logbook.

7. For VOC samples, transfer soil directly into the sample container with the stainless steel trowel. A closed-system sampler (e.g., Encore Sampler) should be used, if necessary, to collect sludge samples for VOC analysis using EPA Method 5035 for preservation.

8. Describe the remaining sample material in accordance with ASTM International Standard D 2488 and the Unified Soil Classification System. Record the sample description in the field logbook.

9. If soil samples will be collected for non-volatile parameters, use the stainless steel spoon to chop apart clumps of soil material and mix the contents of the tray to a homogeneous particle size and texture.

10. Examine contents of the tray and remove pebbles, organic material, (e.g., roots, grass, and woody material), and other debris with a stainless steel trowel or spoon.

11. Transfer the tray contents to the appropriate sample container using a stainless steel spoon.

12. Label the containers, cover the labels with tape, and immediately place the containers in a cooler maintained at an ambient temperature of 4° Celsius with wet ice. Freezer packs or dry ice should not be used for sample preservation.

13. Record the sample location, sample depth, sampler name, and the requested analytical parameters in the field log book.

14. Complete the chain-of-custody form with appropriate sampling information.

15. Samples should be maintained and shipped in accordance with SOP 20.

16. Properly manage all PPE and investigation-derived wastes in accordance with state and federal requirements.

Standard Operating Procedure - 12

Chip, Wipe, and Sweep Sampling

Application:

These methods of sample collection are intended for monitoring surficial contamination of nonvolatile species of analytes on porous surfaces for chip samples and smooth surfaces for wipe samples. Also included is a method for collecting dust samples from porous or non-porous surfaces.

Materials:

Lab-clean sample containers of proper size and composition
Field and travel blanks
Site log book
Sample analysis request forms
Chain of custody forms
Custody seals
Sample seals
Disposable surgical gloves
Sterile wrapped gauze pad (3 in. X 3 in.)
Appropriate pesticide (HPLC) grade solvent
Medium-sized, laboratory-cleaned paint brush
Medium-sized, laboratory-cleaned chisel
Autoclaved aluminum foil
Camera
Distilled/deionized water

Procedure:

Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment. Decontaminate or pre-clean the equipment, and ensure that it is in working order.

3. Perform a general site survey and mark all sampling locations. Measure off the designated area and photo document.

Chip Sample Collection

1. Don a new pair of disposable surgical gloves. Remove aluminum foil wrap from the laboratory-cleaned chisel or equivalent sampling device.

2. Chip the sample area horizontally, then vertically to an even depth of approximately 1/8 inch. Collect the chipped fragments using a decontaminated dustpan and bristle brush and transfer the sample directly into the labeled sample bottle. Cap the container, attach the label and custody seal, and place in a double plastic bag. Store the samples out of direct sunlight and cool to 40 Celsius.

3. Record all pertinent data (sample location, sample description, sample depth, sampling personnel, and the requested analytical parameters) in the site logbook. Complete chain-of-custody forms with appropriate sampling information.

Wipe Sample Collection

1. Don a new pair of disposable surgical gloves. Open a new sterile package of gauze pad. Soak the pad with the appropriate solvent (one in which the contaminant is most soluble). Wipe the marked surface area using firm strokes. Wipe vertically, then horizontally to ensure complete surface coverage.

2. Place the gauze pad in an appropriately prepared sample container with a Teflon-lined cap. Cap the sample container, attach the label and custody seal, and place in a double plastic bag.

3. Record all pertinent data (sample location, sample description, sample depth, sampling personnel, and the requested analytical parameters) in the site logbook. Complete the chain-of-custody forms before taking the next sample.

4. A blank sample should be collected for each sampling event. This consists of a sterile gauze pad, wet with the appropriate solvent, and placed in a prepared sample container. The blank will help identify potential introduction of contaminants via the sampling methods, the pad, solvent, or sample container.

5. Store samples out of direct sunlight and cool to 40 Celsius.

Sweep Sample Collection

1. Don a new pair of disposable surgical gloves. Sweep the measured area using a dedicated brush and collect the sample in a dedicated dustpan (pre-cleaned).

2. Transfer the sample from the dustpan to the sample container. Cap the sample container, attach the label and custody seal, and place in a double plastic bag.

3. Record all pertinent data (sample location, sample description, sample depth, sampling personnel, and the requested analytical parameters) in the site logbook. Complete the chain-of-custody form before taking the next sample.

4. Store samples out of direct sunlight and cool to 40 Celsius.

Standard Operating Procedure - 13

Concrete Core Sampling

Materials:

Concrete corer and drill
Tap water or containers of water
Concrete chisel
Hammer
Aluminum foil
Ionic detergent
Wet/dry vacuum
Stiff-bristled brushes
Sandpaper
Nitrile gloves
Respiratory protection
Tyvek suits
Paper towels
Eye protection
Indelible marker
Kimwipes
Generator (i.e., electrical power)
Extension cord (heavy duty)
Pipe wrenches
Work gloves
Garden hose

Procedure:

1. Clean surface area to be sampled by scrubbing it using ionic detergent (e.g., Whisk solution) and stiff-bristled brush. Rinse the surface with deionized water, then remove the water by vacuuming surface with wet/dry vacuum.

2. Remove any sealant coatings from the surface area using sandpaper or a grinder. Wash, rinse, and vacuum the surface area.

3 Move the drill into position and connect the decontaminated concrete corer to the drill. Connect the water supply and pressure distribution tank.

4. Establish vacuum pressure to hold core drilling rig to the floor.

5. Lower the corer to within 2 inches of the surface, start the drill, and slowly lower the corer to the surface.

6. Keep a steady stream of water flowing through the corer to cool the concrete, prevent the concrete core from splitting, and control fugitive dust. Do not remove corer from the hole until the required depth is reached. However, should the concrete corer become lodged, shut off power immediately to avoid injury.

7. With the drill still operating, remove the corer from core hole and shut off. Observe the hole to see if core was removed. If the concrete core is still in the floor or the core barrel, use a concrete chisel and rubber mallet to break the core loose.

8. When removing the core from the corer, handle the core with clean nitrile gloves.

9. Place a label on the top of the core written with a permanent marking pen. DO NOT WRITE on the core itself, especially if volatile organic compound analysis is requested. Measure the total length of core and record it in the field log book. Wrap the core in aluminum foil and place it in a labeled sample container.

10. Keep detailed notes in the field log book of the sample location, sample description, sample depth, sampling personnel, and the requested analytical parameters.

11. Complete chain-of-custody forms with appropriate sampling information

Standard Operating Procedure - 14

Waste Pile Sampling

Application:

As with soil sampling, waste pile samples can be collected at the surface or at depth, and different equipment is required in each instance. Surface samples can be collected most efficiently with a trowel or scoop. For samples at depth, a decontaminated, clean bucket auger may be required. For a sample core, waste pile samplers may be used. To collect representative samples of a waste pile, composite samples may be required. The objectives of the sampling program will dictate the need to collect composite samples. A grid system set-up on the waste pile may also be used to collect individual or composite samples.

Materials:

Stainless steel trowels or scoops
Stainless steel spoons
Bucket augers
Extension rods
Auger handle
Pipe wrenches
Teflon tape
Work, nitrile, and surgical gloves
Saranex or Tyvek suit
Eye protection
Respirator (if necessary)
Analytical buckets
Tray, mixing pans
Ziploc® plastic bags
Aluminum foil
Stakes and string (grid system)
Plastic sheeting
HNu or other photoionization detector (PID)

Procedure:

1. At the desired sampling location, clear away the accumulated surface debris.

2. The sampler should put on the correct personal protective equipment as dictated by the medium to be sampled and the project. Care should be taken to ensure that contact between the waste material and the skin, eyes, and face of the sampling personnel is prevented.

3. If a grid system is being employed for sampling the waste pile, lay out the grid according to the developed sampling plan.

4. Assemble the sample equipment (e.g., bucket augers) if necessary, and collect the samples at the chosen designations.

5. Collect an adequate volume of waste from a depth of 0-6 inches using the bucket auger, trowel, or scoop at the desired sampling locations. Record the PID measurement in the open borehole.

6. If using a bucket auger, advance the decontaminated bucket auger by turning the bucket auger clockwise into the sample medium. To remove the auger, turn the auger counter-clockwise and pull it from the borehole. This procedure is repeated until sampling is complete. If the sampled waste pile is heterogeneous, a clean, decontaminated bucket must be used every time to collect the sample of the waste material, if necessitated by the objectives of the sampling plan.

7. If composite samples are to be collected, transfer the waste material to a clean tray or mixing pan for compositing. Report the PID measurement of the material in the tray. Use a clean, decontaminated spoon, scoop, or trowel to homogenize the sample. Remove any foreign matter (e.g., rocks, sticks, or other debris) from the tray. Transfer the waste sample directly into a prelabeled sample container. A wide-mouth sampling container is preferable for containing the sample, as it requires less disturbance of the waste sample as the sample is being transferred into the labeled sample container.

8. Keep detailed notes in the field log book of the sample location, details about the grid spacing, sample description, sample depth, PID measurements, sampler's name, and the requested analytical parameters.

9. Complete the chain-of-custody forms with the appropriate sampling information.

Standard Operating Procedure - 15

Decontamination of Drilling Equipment

Materials:

Canvas or plastic tarp(s)
4-mil polyethylene liner
Pressurized steam cleaner (steam jenny)
55-gallon steel drums with bung (closed) tops
55-gallon steel drums with open tops, rings, lids, ring-nut and ring-bolt
Hammer, nails, duct tape, extension cord(s)
Wood boards - 4" x 4", 2" x 4" or 2" x6"
Portable wet/dry vacuum
Shovel, funnel, and squeegee

Construction of Decontamination Basin:

1. Place tarp(s) on flat, firm surface in an accessible area of the site away from areas of surface contamination. Use enough tarp to accommodate the rear of the drilling rig and hollow stem augers and to prevent overspray from the steam jenny from falling onto adjacent soil surfaces. If necessary, place more than one tarp on the ground. Overlap tarp edges and secure with duct tape. Area should be slightly inclined toward one corner so that the decontamination water will pool in one corner for easier pumping to the containment drums.

2. Place a layer of polyethylene liner on top of the tarp(s). If one sheet cannot completely cover the tarp, use another one. Overlap the sheets at the edges and secure with duct tape.

3. Place 4" x 4" boards along the tarp's outer edges to form a square or rectangular basin. Roll each 4" x 4" board toward the center so the tarp and polyethylene wrap completely around it at least once. Secure the tarp and liner to the top of the boards with nails, tacks or heavy-duty staples.

4. Place the drums, steam cleaner, and wet/dry vacuum adjacent to one side of the basin on the outside.

Decontamination Procedure:

1. Unload drilling equipment from the drilling rig and place in one side of the basin.

2. Activate the steam cleaner. Personnel performing steam cleaning should don rubber boots, Tyvek or Saranex suits, rubber gloves, and a hard hat with a face shield for splash protection.

3. Clean each piece of drilling equipment, including auger bits, drill bits, portable power augers, hollow stem augers, auger holders, split spoons, rod lifters, and drilling rods, by holding the nozzle of the steam cleaner a few inches away. Wood 2" x 4"s can be

placed on the basin floor to prevent drilling equipment from coming into contact with solids that will build up beneath it as it is being steam cleaned.

4. After each piece is cleaned, place it on rows of 2" x 4" boards in a separate area of the basin.

5. If space allows, position the rear of the drill rig in the basin and use the steam cleaner to clean off rig surfaces and the hoist and derrick as needed.

6. Reload drilling equipment onto rig and drive it out of the basin.

7. Vacuum up liquids on the basin floor with the flexible hose of the portable wet/dry vacuum. A long-handled squeegee can be used to pool liquid together to aid vacuuming.

8. Remove accumulated solids from the basin floor with a shovel and place in open-top drums. During removal of the accumulated solids, be careful so that the polyethylene liner is not torn, cut, or punctured with the shovel.

9. Empty the canister of the wet/dry vacuum into a bung-top drum using a funnel.

10. Secure and tighten tops of drums and apply appropriate hazardous waste or nonhazardous waste labels to each drum. The accumulation date should be placed on each drum. An inventory of all onsite drums should be entered into the field log book by field personnel. All drums should be marked, numbered, or labeled with an indelible marker for future reference.

11. On completion of onsite work, the properly labeled and inventoried drums should be stored within a newly constructed pad or basin until disposal is arranged. This containment area should be constructed of wooden boards with a polyethylene liner, as described above.

12. Materials used in construction of the decontamination basin or pad should be disassembled and placed into a properly labeled drum for future disposal.

13. All drilling equipment and the drill rig should be decontaminated on arrival onsite and before the start of any drilling activity. On completion of site work, the drilling equipment and rig should be decontaminated by the drilling contractor before departure from the site.

Standard Operating Procedure - 16

Decontamination of Submersible Pumps

Materials:

Field logbook
Personal protective equipment (PPE)
Polyethylene sheeting
Garbage bags
Nonphosphate detergent (e.g., Liquinox or Alconox)
Tap water
Deionized water
Two containers (e.g., garbage cans, buckets, plastic tubs)
Nylon brushes
Isopropanol
Spray bottles
Paper towels

Note: To limit the potential for cross-contamination between wells, wells should be pumped in the order of increasing constituent concentrations whenever possible. This SOP assumes that dedicated tubing is being used at each well. If dedicated tubing is not being used, the tubing should also be decontaminated using the following procedures.

Decontamination Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Prepare a decontamination area by spreading polyethylene sheeting on a firm, flat surface (if possible). Create a berm around the decontamination area to contain inadvertent spillage. A berm can be created by rolling under the edges of the polysheeting or by draping the plastic over a wooden frame, etc.

3. Place two clean containers (e.g., garbage cans, buckets, plastic tubs) on the polysheeting. Place tap water in one container with non-phosphate detergent. Place only tap water in the second container. The containers may also be lined with garbage bags.

4. If an oily film or residue is observed on the pump or leads when they are removed from the well, the pump should be sprayed with isopropanol to remove the oil and then wiped clean with paper towels before proceeding with Step 5 below. The oily rinsate should be contained in a separate container for proper disposal.

5. Place the pump and wire leads in the container of non-phosphate detergent and tap water and scrub the exterior of the pump with a brush. Circulate the soapy solution through the pump for at least 5 minutes. Rinse the exterior of the pump and leads with additional tap water to remove excess soap (if necessary) before proceeding with Step 6.

6. Place the pump and leads in the container of tap water and run the pump for a least 5 minutes. Run water through the pump until all residual detergent has been removed. The soapy solution and rinse water should be changed when it becomes oily or too silty.

7. Remove the pump and leads from the rinse water. Spray off the pump thoroughly with deionized water and wipe it dry with clean paper towels. Wipe off the wire leads with a paper towel soaked with deionized water.

8. Wrap the pump and leads in plastic sheeting or a new plastic garbage bag to prevent possible contamination during transportation. Label the sheeting or bag with the date of decontamination for future reference.

9. Properly manage all PPE and decontamination rinsate in accordance with state and federal requirements (See SOP 26). The spent wash water and rinse water can potentially be placed in the facility's waste water treatment system. However, field personnel should obtain approval from facility personnel and from the local POTW.

Standard Operating Procedure - 17

Decontamination of Water Level Indicators

Materials:

Field logbook
Personal protective equipment (PPE)
Non-phosphate detergent (e.g., Liquinox or Alconox)
Deionized water
Isopropanol
Two buckets
Spray bottles
Paper towels

Note: To limit the potential for cross-contamination between wells, wells should be gauged in the order of increasing constituent concentrations whenever possible.

Decontamination Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. If the groundwater is grossly contaminated (i.e., LNAPL or DNAPL is present), the tape should be pulled out of the well, NOT reeled up, and placed directly into a bucket of nonphosphate detergent and tap water. The tape and probe should be scrubbed with a brush to remove visible contamination. The tape and probe should then be rinsed in a second bucket of tap water before proceeding with Step 3. If persistent stains or oily films remain, apply isopropanol to a paper towel and wipe the tape and probe until clean.

3. Thoroughly wet a paper towel with deionized water from a spray bottle. Fold the paper towel over the tape and wipe it as the tape is reeled up.

4. The water level probe should also be sprayed with deionized water and wiped dry with a clean paper towel.

5. Place water level indicator in the clean carrying case or in a clean plastic bag to prevent contamination during transportation.

6. Properly manage all PPE, used paper towels, and decontamination rinsates in accordance with state and federal requirements (See SOP 26).

Standard Operating Procedure - 18

Decontamination of Interface Probe

Materials:

Field logbook
Personal protective equipment (PPE)
Nonphosphate detergent (e.g., Liquinox or Alconox)
Deionized water
Isopropanol
Two buckets
Spray bottles
Paper towels

Decontamination Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. If the groundwater is grossly contaminated (i.e., LNAPL or DNAPL is present), the tape should be pulled out of the well, NOT reeled up, and placed directly into a bucket of nonphosphate detergent and tap water. The tape and probe should be scrubbed with a brush to remove visible contamination. The tape and probe should then be rinsed in a bucket of tap water before proceeding with Step 3. If persistent stains or oily films remain, apply isopropanol to a paper towel and wipe the tape and probe until clean.

3. Thoroughly wet a paper towel with deionized water from a spray bottle. Fold the paper towel over the tape and wipe it as the tape is reeled up.

4. The interface probe should be sprayed with deionized water and wiped dry with a clean paper towel.

5. Place the interface probe in the clean carrying case or in a clean plastic bag to prevent contamination during transportation.

6. Properly manage all PPE, used paper towels, and decontamination rinsates in accordance with state and federal requirements (See SOP 26).

Standard Operating Procedure - 19

Decontamination of Sampling Equipment

Materials:

Field logbook
Personal protective equipment (PPE)
Deionized water
10% nitric acid solution
Nylon brushes
Containers (e.g., garbage cans, buckets, plastic tubs)
Nonphosphate detergent (e.g., Liquinox or Alconox)
Isopropanol
Aluminum foil
Polyethylene sheeting
Plastic garbage bags
Paper towels
Spray bottles
Duct tape

Note: All sampling equipment must be decontaminated before shipment to the office.

Decontamination Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Prepare a decontamination area by spreading polyethylene sheeting on a firm, flat surface (if possible). Create a berm around the decontamination area to contain inadvertent spillage. A berm can be created by rolling under the edges of the polysheeting or by draping the plastic over a wooden frame, etc.

3. Prepare a solution of nonphosphate detergent and tap water in a container.

4. Wipe sampling equipment with paper towels to remove residual soil or gross contamination. Heavy oils or grease may be removed with paper towels soaked with isopropanol.

5. Disassemble sampling equipment (e.g., split-spoon samplers and bailers). Wash equipment thoroughly in a nonphosphate detergent and hot tap water (if available) solution. Teflon bailers must be disassembled and the inside washed with a long-handled bottle brush or short-handled brush pulled through the bailer with rope.

6. Rinse the equipment with hot tap water (if available).

7. If the equipment will be used to collect samples for metals analysis, follow the tap water rinse with a 10% nitric acid solution rinse. Carbon steel equipment (e.g., bucket augers, split-spoons) should be rinsed with 1% nitric acid solution to reduce the potential for

oxidizing the metal surfaces. Collect the nitric acid rinse in a separate bucket for proper disposal. Rinse the equipment with tap water.

8. Thoroughly rinse the equipment with deionized water.

9. Spray the equipment with isopropanol and allow to completely air dry. The solvent rinse must be collected in a separate bucket. Isopropanol is the recommended solvent for organic contaminants because it is readily available and is not a Department of Transportation hazardous material. However, other solvents (e.g., acetone, hexane, methanol) may be more effective in removing certain contaminants, such as oils or PCBs. Please note that many state programs and USEPA regions specify the solvents to be used for equipment decontamination.

10. Rinse the equipment with deionized water using at least five times the volume of solvent used in the previous step.

11. After the equipment has been allowed to completely air dry, each piece must be individually wrapped with aluminum foil (shiny side out), and then wrapped in plastic.

    Note: Decontamination solvents may introduce contaminants to environmental samples. It is very important to ensure that the equipment has completely dried before use or storage.

12. After the final decontamination event on a project, label each piece of equipment with the date of decontamination, the initials of decontamination personnel, and the type of decontamination solutions used.

13. Note any discrepancies from standard decontamination procedures in the field logbook.

14. Field decontamination presents unique problems in disposal of decontamination solutions. The spent wash water and rinse water can potentially be placed in the facility's waste water treatment system. However, field personnel should obtain approval from facility personnel and from the local POTW. If no wastewater treatment system is present onsite, or if approval cannot be obtained from the facility and local POTW, the wash water should be containerized for offsite disposal in accordance with state and federal requirements. The volume of spent solvent generated during field decontamination should be minimal. Solvents should be collected in separate buckets and allowed to evaporate. See SOP 26 for information on managing investigation-derived wastes.

15. Paper towels soaked with solvent should be allowed to air dry and be disposed of with the general trash. Under no circumstances should any decontamination solution be disposed of on soil surfaces.

Standard Operating Procedure – 20

Sample Shipping Procedures

Materials:

Suitable shipping container (e.g., plastic cooler or lab supplied styrofoam cooler)
Chain-of-custody forms
Custody seals
WSP mailing labels
Strapping, clear packing, or duct tape
Ziploc® plastic bags
Knife or scissors
Permanent marker
Latex or nitrile gloves
Large plastic garbage bag
Wet ice
Bubble wrap or other packing material
Universal sorbent materials
Sample container custody seals (if required)
Federal Express form (with WSP account number)
Vermiculite (or commercially available cat litter)

Procedures:

For shipping purposes, samples are segregated into two classes; environmental samples and restricted articles (i.e., hazardous materials). Environmental samples can also be categorized based on expected or historical analyte levels (i.e., low or high). An environmental sample is one that is not defined as a hazardous material by the Department of Transportation (DOT, 49 CFR Part 171.8). The DOT defines a "hazardous material" as a substance which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Any material of a suspected hazardous nature, previously characterized as hazardous, or known to be hazardous is considered a restricted article.

In general, the two major concerns in shipping samples are protecting the samples from incidental breakage during shipment and complying with applicable DOT and courier requirements for restricted article shipments.

Protecting the samples from incidental breakage can be achieved using "common sense." All samples should be packed in a manner that will not allow them to freely move about in the cooler or shipping container. Glass surfaces should not be allowed to contact each other. When possible, repack the samples in the same materials that they were originally received in from the laboratory. Each container should be cushioned with plastic bubble wrap, styrofoam, or other nonreactive cushioning material. Shipping hazardous materials should conform to the packaging, marking, labeling, and shipping instructions identified in 49 CFR Parts 172 & 173.

Environmental samples shall be packed for shipment using the following procedures:

1. Line the shipping container with a large, heavy-duty plastic garbage bag. Place universal sorbent materials (e.g., sorbent pads) between the cooler and the heavy-duty plastic bag. The amount of sorbent material should be sufficient to absorb the volume of wet ice and aqueous samples. If using a plastic cooler, securely tape the drain plug closed on the outside of the cooler.

2. Place 2-4 inches of bubble wrap or other packing material inside the heavy-duty plastic bag in the bottom of the cooler.

3. The sample packer should wear latex or nitrile gloves when handling the samples during the packing process.

4. Place the bottles in the cooler with sufficient space to allow for the addition of more bubble wrap or other packing material between the bottles. Large or heavy sample containers should be placed on the bottom of the cooler with lighter samples (i.e., VOAs) placed on top to eliminate breakage.

5. Place the "wet ice" inside two sealed heavy-duty zipper-style plastic bags and package the bags of ice on top of or between the samples. Pack enough ice in the cooler to chill the samples during transit. If the cooler is shipped on a Friday or Saturday for Monday delivery, double the amount of ice placed in the cooler (Monday delivery should be used only as a last resort). Fill all remaining space with bubble wrap or other packing material. Securely close and seal with tape the top of the heavy-duty plastic bag.

6. Place chain-of-custody form (and, if applicable, CLP traffic reports) into a Ziploc® plastic bag and affix to the cooler's inside lid, then close the cooler. Securely fasten the top of the cooler shut with tape. Place two signed and dated chain-of-custody seals on the top and sides of the cooler so that the cooler cannot be opened without breaking the seals.

7. Once cooler is sealed, shake test the cooler to make sure that there are no loose sample containers in the cooler. If loose samples are detected, open the cooler and repack the samples.

8. Using clear tape, affix a mailing label with WSP's return address to the top of the cooler.

9. Ship samples via priority overnight express to the contracted analytical laboratory for next morning delivery. If applicable, check the appropriate box on the airbill for Saturday delivery.

10. Declare value of samples on the shipping form for insurance purposes. The declared value should reflect the cost to recollect the samples.

11. Record the tracking numbers from the Federal Express forms in the field notebook and on the chain of custody form. Also, retain the customer's copy of the Federal Express airbill.

Hazardous materials should be packed according to the above procedures with the following additions:

1. Place samples in individual Ziploc® plastic bags and secure with a plastic tie or tape.

2. Place samples in paint cans in a manner which would prevent bottle breakage (i.e., do not place glass against glass).

3. Place vermiculite or other absorbent packing material in the paint can around the samples. The amount of packing material used should be sufficient to absorb the entire contents of the sample if the container is broken during shipment.

4. Secure a lid to the paint can with can clips and label the outside of the can with sample numbers and quantity. Mark the paint can with "This End Up" and arrow labels that indicate the proper upward position of the paint can.

5. Package the paint cans in DOT-authorized boxes or coolers, with appropriate DOT shipping labels and markings on two adjacent sides of the box or cooler.

6. Ship the restricted articles via overnight courier following the courier's documentation requirements. A special airbill must be completed for each shipment. Retain a copy of the airbill for WSP records and tracking purposes, if necessary.

Standard Operating Procedure – 21

Field Quality Assurance/Quality Control Samples

Materials:

Field logbook
Personal protective equipment (PPE)
Sample containers
Sample labels
Clear tape
Laboratory analyte free water
Clean or dedicated sampling equipment

Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Select the appropriate glassware for the field Quality Assurance/Quality Control (QA/QC) samples. Refer to the WSP Standard Operating Procedure for Sample Container, Preservatives, and Holding Times to determine the appropriate bottles to use.

3. Field QA/QC samples include the following:

   trip blanks
   duplicate samples
   equipment blanks

4. Trip blanks should be provided by the analytical laboratory for all projects where samples are being collected for analysis of volatile organic compounds (VOCs). Trip blanks should accompany the sample bottles from the analytical laboratory to the site, accompany the sample containers at all times during the sampling event, and return to the laboratory with the sample containers. One trip blank should be submitted to the analytical laboratory with each shipment containing samples for VOC analysis. The trip blank should be analyzed only for VOCs.

5. One duplicate sample should be collected for every 20 samples of each matrix (e.g., soil and groundwater) collected during each sampling event. Duplicate samples of soil and other solid matrices should be collected by dividing the sample material in half and alternately filling the two sample bottle sets. Duplicate samples of groundwater and other aqueous matrices should be collected by alternately filling the two sample bottle sets from the same sampling vessel (e.g., bailer). The appropriate SOP should be followed for the collection of each sample type (soil, groundwater, sediment, sludge). Duplicate samples should be analyzed for all the analytes that are being analyzed for during the sampling event.

6. One equipment blank should be collected in the field at a rate of one per type of equipment per decontamination event not to exceed one per day. If dedicated sampling equipment is used, the equipment blanks should be prepared in the field before

sampling begins. If field decontamination of sampling equipment is required, the equipment blanks should be prepared after the equipment has been used and field-decontaminated at least once. Equipment blanks should be prepared by filling or rinsing the precleaned equipment with analyte-free water and collecting the rinsate in the appropriate sample containers. The samples should be labeled, preserved, and filtered (if required) in the same manner as the environmental samples. Equipment blanks should be analyzed for all the analytes for which the environmental samples are being analyzed. Decontamination of the equipment following equipment blank procurement is not required.

7. All QA/QC samples should be submitted to the analytical laboratory with unique sample numbers. Therefore, the QA/QC samples should be labeled as separate environmental samples following the same numbering scheme used during that particular sampling event. However, the QA/QC samples should be clearly identified on WSP's copy of the chain-of-custody form and in the field logbook.

Standard Operating Procedure - 22

Soil Head Space Screening (Field Technique)

Materials:

PPE
Field logbook
Photoionization detector (PID) and/or Flame Ionization Detector (FID)
Aluminum foil
Clear 8-oz to 16-oz glass large-mouth containers with lids
Stainless steel spoon
Zipper-style plastic bags

Procedure:

1. Use appropriate PPE as specified in the site-specific health and safety plan.

2. Check PID to ensure that it is working properly.

3. Using WSP's standard operating procedure (SOP) for collecting soil, sludge, or sediment, half-fill a clean glass jar with sample. Place a piece of aluminum foil over the top of the jar and tightly seal the jar. Label the jar indicating the sampling location, depth, and date. Store the jar upside down until the sample is analyzed.

4. If jars are not available, collect the sample using a zipper-style plastic bag (e.g., Ziploc®). Seal and label the bag as specified in item 3.

5. Shake the sample vigorously for approximately 15 seconds.

6. If necessary, warm the sample to room temperature (70°F) by placing the jar in a heated room or vehicle. This step is very important when the ambient temperature is below 32° F.

7. After waiting approximately 15 minutes, carefully unscrew the lid of the jar without disturbing the aluminum foil. Pierce a hole through the aluminum foil using the tip of the PID. If using zipper-style bags, open the bag slightly and place the tip of the probe into the opening. Do not insert the probe into the soil and avoid the uptake of water droplets.

8. Following probe insertion, record the highest meter response. Using the foil seal/probe insertion method, maximum response should occur between 2 seconds and 5 seconds. Erratic PID response may result from high organic vapor concentrations or elevated headspace moisture. If these conditions exist, the headspace data should be qualified or discounted.

9. Record the sample location, depth, soil texture (i.e., clay or sand), and PID reading in the field notebook. Also record the ambient temperature, humidity, and whether moisture was present in the jar or plastic bag. These points are important because on very cold days volatilization of organic compounds is reduced and water vapor present

in the jar may cause the PID to give a false reading. Be consistent in your procedure and in your recording of the data.

10. Duplicate 10 % of the headspace samples by collecting two samples from the same location and following items 2 through 9 above. The headspace screening data from both jars should be recorded and compared. Generally, replicate values should be consistent to plus or minus 20%.

11. Samples collected for headspace screening should not be retained for laboratory analysis. Dispose of the soil and jar appropriately.

Standard Operating Procedure – 23

Underground Utility Locating

Application:

The purpose of this procedure is to ensure that all required and appropriate procedures are followed to locate and mark subsurface utilities (e.g., electrical lines, natural gas lines, communication lines) before initiating any intrusive field activities (e.g., drilling, test pits, trenching). Compliance with this procedure is mandatory before intrusive work can be conducted on a WSP project. This procedure is intended to allow the work to proceed safely and will minimize the potential for damaging underground utilities. Intrusive work includes all activities that require WSP's employees or their subcontractors to penetrate the ground surface. Examples of intrusive work include, but are not limited to probing, drilling, injection, test pit excavations, trenching, and remedial excavations.

Materials:

Record of the communication utility locating form (Attachment 1)
Field logbook
Wooden stakes
Spray paint
Flagging tape
As-built drawings for sub grade utilities (if available)
Hand auger or post-hole digger
Hand-held magnetometer or cable locator (optional, if and only if private utility locator has cleared the area and personnel have been properly trained in the use of the equipment)

Procedure:

Pre-site Mobilization

1. Gather the necessary information to complete the record of communication utility locating form (Attachment 1).

2. Contact the state utility locating service (e.g., One-Call, Miss-Dig). It is imperative to contact the locating service with sufficient lead-time to allow all utility providers to visit the site location. In each case, the state utility locating service will provide the caller with a legal dig date. Under no circumstances will intrusive work begin before the legal dig date provided by the call center. The telephone numbers for the locating service in selected states are listed in Table 1. However, the telephone number is typically listed in the area Yellow Pages. Provide the utility locating service with any information they request concerning the site and work activity in order to locate utilities at the site. Several states, including California, require that the proposed drilling locations be marked with white spray paint before contacting the locating services. The following information provided by the locating service should be documented in a record of communication utility locating form (Attachment 1): utility providers that will be contacted, and a utility clearance ticket number. The ticket number will be used by the

various utility companies to reference the clearance request and to contact the caller with clearance verifications (see note below).

Note 1: Generally, the public utility companies will mark underground lines up to the private property boundary. However, you should request that the utility companies mark their utilities in the work areas on the site. If the utility companies will not provide that service, a private utility locating service **MUST** be contracted.

Note 2:Some utilities (e.g., sewer, water, cable TV) may not be included by the State locating service. The State locating service will provide you with a list of utilities that will be notified based on the information provided regarding the sites location. Compare this list with utilities generally expected at all sites (e.g., sewer, water, gas, communication, electric). If any expected utilities are absent from the contact list, you **MUST** contact the utilities directly for clearance before the start of intrusive activities. Record all contacts on the utility locating record of communication form.

3. Identify a site contact familiar with the utilities on the property (e.g., plant manager, facility engineer, maintenance supervisor), and provide this individual with a site plan showing the proposed locations of all soil borings, monitoring wells, test pits, and other areas where intrusive activities will be conducted. Ask the site contact for all drawings concerning underground utilities in the proposed work areas.

4. No intrusive work should be done before the legal dig date provided by the State utility locating service. No intrusive activities should be conducted along or near public right-of-ways until all utilities have been marked and visually verified in the area of investigation. In addition, **NO** field activities shall be conducted on private property unless the State locating service or a private utility locating service has confirmed the presence or clearance of onsite utilities.

Site Mobilization

1. Locate all proposed drilling and trenching locations, both onsite and offsite, with spray paint, stakes, or other appropriate markers.

2. Verify that **ALL** utility companies listed by the municipal locating service, and any contacted directly by WSP, have either marked the underground lines in the specified work areas or have responded with "no conflict." Document on the utility record of communication form as each utility mark is visually confirmed.

   Note: When receiving verbal clearances by telephone from utility companies, or their subcontractors, it is imperative that you verify which utilities are being cleared, particularly when dealing with subcontractors that may be marking more than one utility.

3. Review all available as-built utility diagrams and plans with the site contact to identify potential areas where underground lines may be present. The review should confirm the locations marked by the locating services and identify utilities that may have been omitted by the locating services. If the as-built drawings do not confirm utilities marked by the locating services, follow instructions in Section 6. If possible, obtain a copy(s) of the utility plans for future reference in the field.

Conduct a site walk with the site contact. During the site walk, attempt to obtain a general knowledge of the types of utilities present in the work areas. Furthermore, survey your surroundings to identify features that require electricity (e.g., parking lot lights, pad-mounted transformers) or suggest the presence of underground utilities, such as linear depressions in the ground. Check these items against the utility locating record of communication form checklist. For example, check to see whether major electrical lines are aboveground, or locate underground sewer lines by using the locations of manholes and storm water grates. Keep in mind that many sewer lines can be offset from catch basins.

4. A minimum of 4 feet clearance should exist between utilities and proposed drilling locations, and a minimum of 6 feet between utilities and proposed trenching locations. A minimum distance of 15 feet should be maintained by heavy equipment (e.g., excavator buckets, drill rig towers and rods) from overhead power lines. A safe distance of 25 feet should be maintained from high tension overhead power lines. In the event that work must be conducted within 25 feet of high tension wires, the lines should be wrapped and insulated by the local utilities. If a utility conflict is identified, adjust the proposed location(s) using the criteria given above. These minimum distances should be increased whenever possible to offer additional assurance that utilities will not be encountered.

5. A private utility locating service **MUST** be used for work on private property in cases where the public utility locating service does not mark utilities on the subject property. It is **NOT ACCEPTABLE** to rely on as-built drawings or verbal utility clearances. A private locator may not be necessary in rare instances; however, these cases must be discussed with the project manager **AND** a partner or executive partner of WSP before work may proceed.

   A listing of several private subsurface utility locating firms is provided in Table 2. In addition, a hand-held magnetometer or magnetic-cable locating device can be used to augment, but not replace, clearance for each work area. Use of this equipment is restricted to employees with proper training on the use of hand-held utility locating equipment. Proper training is defined as having working knowledge of the manufacturer's operating procedures, and the completion of at least one successful location under the supervision of a qualified person.

6. In some cases, state and private locating services may not be able to identify all utilities. In areas where uncertainty still exists concerning the presence of underground utilities after clearance by state and private locating services, a hand auger or post-hole digger can be used to probe the shallow subsurface before using any heavy equipment (drill rig, backhoe). The probe hole should be advanced a minimum of 4 feet below ground surface at each proposed drilling or excavation location. A sufficient number of probe holes should be completed so that the area is cleared for the proposed intrusive activity. For drilling, a minimum of three holes installed in a triangular pattern should be advanced at each location. The use of hand digging methods in **NO WAY** replaces the need State and private utility locating services. Hand digging techniques should only be employed if uncertainty regarding the location of underground lines still exists after clearances by the State locating service and a private locating service.

7. Discuss the site conditions with the subcontractor and recommend that care be used at the start of the intrusive activities. Field personnel should always consider the presence of unidentified utilities at each work area. In addition, field personnel have the authority and responsibility to postpone intrusive activities if insufficient information, as stipulated in this SOP, is available, or if onsite reconnaissance identifies inconsistencies in the findings of utility locators. In these instances, field personnel should contact the project manager or a member of the health and safety committee, and an executive partner or partner of WSP before proceeding with the proposed work. The first priority on every project is to ensure that the work is conducted safely.

   Again, it is the requirement of this SOP to obtain site utility clearances from the State utility locating service. If the State locating service does not provide onsite (i.e., work area) utility clearance, a private locating service must be contracted to clear the work areas before digging, drilling, or probing begins. Although certain instances and site conditions may appear to allow intrusive work without prior clearance, **ALL** deviations from this SOP **MUST** be approved by the project manager and a partner or executive partner **BEFORE** beginning intrusive work.

8. If the scope of the intrusive activity locations changes, the scope of intrusion expands or includes a new onsite or offsite area(s), review the existing information to determine whether the area(s) can be safely cleared of all potential underground utilities. If necessary, contact the state locating service and request another clearance for the new area(s) of investigation and retain a private locator in accordance with Item 5 above. Remember, the new request will provide a new legal dig date before which NO INTRUSVE WORK CAN BEGIN. Additionally, if a clearance ticket will expire while the work is ongoing (typically after 14 days), a new clearance must be requested at before the first ticket expires so that work can continue uninterrupted. Refer to the communication utility locating form for the legal dig date time frame required by the State locating service.

PUBLIC and PRIVATE UTILITY LOCATING FORM

Project:_____ Project Manager:_____

Project Number:_____

Project Start Date:_____ Duration of Project:_____

Project Location (Site Address):_____

Project Site Description (complete the following with all information available *before* calling):

Work Being Done For: (*Company or Individual Name*): _____

State: _____County:_____ City/Place: _____

Street: _____(*Only one street per ticket)* Zip Code:_____

Nearest Intersecting Street: _____

Lat/Long:_____Parcel/Tax map ID:_____

Description of the area to be marked *(Provide the following: Street working on, which side of street, how far in which direction from nearest intersecting street; etc.)*:

_____

_____

Locations for proposed borings or digging identified with paint and/or stakes? (circle one): YES NO N/A

NOW, MAKE THE CALL:

Call Placed to Phone No.: _____

Date of Call:_____Time of Call:_____a.m. / p.m.

Ticket No. Assigned to Location Request:_____

Assigned Legal Dig Date: ___ / ___ / ___ Assigned Legal Dig Time: ____ AM / PM

The Following Table Must Be Completed Before Work Can Begin:

CALL BACK/FAX BACK INFORMATION RECORD						
	Gas	Communication	Electric	Water	Sewer	Other
Responsible Company (provided by OneCall operator)						
Date Notified						
Time Notified						
Notified By						
Phone Number						
Marks Complete						
No Conflict						
No Facilities						

Calls Made By:_____ Form Completed By:_____

Project Manager Notified of Results (initial if completed):_____

Onsite Underground and Overhead Utility Clearance Checklist

Visual Confirmation of Marked Public Utilities:

Utility Type	Visual Cues	Marks Confirmed (initial)	No Markings Seen (initial)
Water	Blue Markings, fire hydrant, manholes; water meter, sprinkler heads, AST, hose bib		
Gas	Yellow Markings, gas meter, manholes; yellow bollards		
Electric	Red Markings, parking lot lights, overhead lines (telephone poles), underground vaults, manholes; conduit on buildings		
Sewer (sanitary/storm)	White or Blue Markings, underground vaults, manholes, drain grates		
Communication	Red or White Markings, red bollards, telephone poles; manholes; conduit on buildings		

Visual Confirmation of Marked Private Utilities (at onsite drilling/digging locations):

Utility Type	Visual Cues	Marks Confirmed	No Markings Seen (initial)	Not Applicable (initial)
Water	fire hydrant, manholes; water meter, ASTs, interior connections, hose bib, valve box			
Irrigation	sprinkler heads, hose bibs			
Gas	gas meter, manholes; yellow bollards, interior connections, valve box			
Electric	parking lot lights, interior connections, overhead lines, underground vaults, manholes, transformers/switchgear; conduit on buildings			
Sanitary/Storm/ Septic System	underground vaults, manholes, drain grates, leach field, sand mound, no evidence of sanitary sewer (for septic system			
Production Equipment	USTs (fill pipes and vent pipes), ASTs (overhead and underground pipelines), manholes/valve pits; pump islands			
Communication	Red/orange bollards, telephone poles, interior connections; manholes; conduit on buildings			

If any Utilities have "No Marking Seen" checked, private locating must be conducted to clear each drilling/digging area.

Site Visit Made By:_____

Form Completed By:_____

Standard Operating Procedure – 24

Soil Sampling Using GeoProbe® System or Equivalent

Application:

To perform depth-discrete soil sampling with 2-foot or 4-foot long samplers using hydraulically-driven soil sampling equipment (GeoProbe® System or Equivalent).

Materials:

Stainless steel soil sampler (2-foot or 4-foot long)
Clear acetate liners
Tape measure or expandable ruler
Utility knife
Photoionization detector (PID)
Stainless steel spoons
Aluminum tray or stainless steel mixing bowl[a]
Nitrile or latex gloves
Field notebook

Procedure:

1. Calibrate the PID in accordance to the manufacturer's instructions. Decontaminate all down-hole sampling equipment and the utility knife, spoons, and mixing bowl per SOP 19 before initiating any boring activities. Ensure that the location is clear of all underground utilities and pipelines.

2. Attach a decontaminated 2-foot or 4-foot long stainless steel sampler fitted with a new, clear acetate liner and a decontaminated removable cutting shoe to small-diameter rods. Lower the stainless steel sampler to the top of the desired sampling depth.

3. Advance the stainless steel sampler through the desired sample interval. Record in the dedicated field notebook the interval through which the sampler was pushed.

4. After the sampler has reached the desired depth, retrieve the sampler by first removing the rods and then disconnecting the sampler. Remove the cutting shoe and acetate liner containing the soil column from the sampler. Measure the length of the material recovered relative to the interval the sampler was advanced, and record this information in the field notebook.

5. Cut the acetate liner using a utility knife to expose the recovered soil. Quickly scan the recovered soil with the PID and if necessary, immediately collect samples for VOC analysis. If the plan indicates the collection of samples for headspace analysis, collect this sample after obtaining the sample for VOC analysis per SOP 22. Record the PID readings in the field notebook.

6. For VOC samples, transfer soil directly from the acetate liner into the sample containers with a clean, stainless steel spoon. Fill the VOC sample container with a representative

sample from the entire length of the recovered sample core, or other designated sample interval[a]. Fill the VOC container completely, leaving no headspace.

7. Describe the recovered soil using the Unified Soil Classification System or standard geological descriptions. Record the sample description in the field notebook.

8. If it is necessary to mix the sample, transfer the soil from the acetate liner to a clean aluminum tray or decontaminated stainless steel mixing bowl with a decontaminated stainless steel spoon[b].

9. Examine contents of the tray/bowl and remove rock fragments and organic debris, such as roots, grass, and woody material, with the stainless steel spoon. Use the same spoon to chop apart clumps of dirt and mix the contents of the tray to a homogeneous particle size and soil texture. Transfer the tray/bowl contents to the appropriate sample containers using the stainless steel spoon.

10. The sample container(s) should be sealed, labeled, and placed in a cooler with ice or freezer packs to maintain 4° Celsius for shipment to the analytical laboratory.

11. Complete the chain-of-custody form with the appropriate sampling information.

    a) *NJDEP's Field Sampling Procedures Manual requires the collection of soil samples for VOC analysis from the 0.5-foot interval that exhibits the highest reading during the field (PID) screening.*

    b) *U.S. Environmental Protection Agency (EPA) Region 4 requires a glass bowl for homogenizing soil for sample collection.*

Standard Operating Procedure – 25

Groundwater Sampling Using Geoprobe® System or Equivalent

Application:

To perform groundwater sampling using hydraulically-driven screen point sampling equipment (GeoProbe® System or Equivalent).

Materials:

Stainless steel probe rods with treads sealed with Teflon® tape or O-rings
Stainless steel screen point sampler
Stainless steel mini-bailer
Teflon®-coated stainless steel wire or thin nylon line
Polyethylene tubing (3/8-inch) fitted with a stainless steel check valve
Silicone tubing
0.45-micron filter
Peristaltic pump
Sample bottles, labels, indelible markers, and clear tape
Nitrile or latex gloves

Procedure:

1. Decontaminate all down-hole equipment before conducting sampling activities at each location. Ensure that the sampling location has been cleared of all underground utilities.

2. Drive the stainless steel point sampler into the subsurface material. The design of the sampler should allow the screen to remain retracted within the probe rods until it is driven to the appropriate sampling depth.

3. After reaching the desired depth, pull back on the stainless steel sheath to expose the screen. The point on the probe rods will be displaced and is not recoverable[a].

4. Purging is not required for probes that are sealed and opened at the target depth for sample collection. Exposed probes that are driven through the soil to the desired water sample depth must be purged of a minimum of three probe-rod volumes of water before sampling is conducted.

5. Groundwater samples can be collected using a mini-bailer lowered on Teflon®-coated stainless steel wire or nylon line inside the probe rods. Another method of sample collection involves the use of a clean section of 3/8-inch polyethylene tubing fitted with a stainless steel bottom check valve. The polyethylene tubing is inserted down the probe rods to the desired sampling depth. Oscillate the polyethylene tubing up and down to drive a column of water to the surface. A peristaltic pump may be attached to the sample tubing and used to pump water to the surface. The peristaltic pump should not be used to collect samples for VOC analysis.

6. Immediately collect samples for VOC analysis, if required. Transfer the groundwater directly form the sampling equipment (mini-bailer, polyethylene tubing) to the sample containers. If analyzing for dissolved metals, the sample must be filtered in the field. See note below with regards to field filtering of metal samples.

7. Seal and label each sample container and place in a cooler with ice or freezer packs to maintain 4° Celsius for shipment to the analytical laboratory.

8. Complete the chain-of-custody form with appropriate sampling information.

   a) *Where samples are collected from depths greater than 15-20 feet below the water table, a water level indicator may be inserted into the rods before exposing the screen to determine whether water is entering through the rod joints or disposable probe point.*

Field Filtering of Metal Samples:

1. Assemble peristaltic pump per operating manual instructions that accompany the pump. Silicone tubing is generally used though the head of the pump.

2. Attach polyethylene tubing to the inflow end of the silicone tubing. The polyethylene tubing should be long enough to extend to the bottom of the screen point. Attach a clean filter to the outflow end of the silicone tubing.

3. Turn on the pump and slowly draw the water from the sampling equipment, through the pump and filter, and into the sample container. If sediment is visible in the sample container, filter break-through has occurred and the sampling and filtering process will need to be repeated.

4. Disassemble the pump head and discard the tubing and filter.

Standard Operating Procedure – 26

Managing Investigation Derived Waste

Application:

The purpose of this SOP is to provide instructions for handling, storing, and sampling Investigation Derived Waste (IDW) pending disposal. *All IDW should be handled as hazardous waste unless information exists which would allow it to be classified as non-hazardous waste.* IDW generated during a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response action must be managed in compliance with applicable or relevant and appropriate requirements (ARARs) to the extent practicable and with applicable requirements of the CERCLA offsite policy. (EPA Guidance Document OERR Directive 9345.3-02)

IDW includes soil cuttings, development water, purge water, drilling fluids, decontamination fluids, personal protective equipment, and sampling equipment.

Materials:

Non-Hazardous and Hazardous Waste Labels
Investigation Derived Waste Log (Figure 1)
Permanent Ink Marking Pen Paint Stick/Pen
Sampling Equipment (Refer to Sampling SOPs)
Sample Jars
Chain of Custody Forms
Cooler

Procedure:

Hazardous IDW

1. All IDW should be handled as hazardous waste unless information exists which would allow it to classified as non-hazardous waste. New or existing site data (i.e., soil and groundwater results) and generator knowledge can be used to classify the IDW.

If site data or generator knowledge indicates that the IDW is determined to be hazardous the following procedures will apply:

- The IDW must be placed in DOT approved containers (55-gallon drum, roll-off container, or temporary storage tank).
- The containers must remain closed except when adding, sampling, or inspecting the material.
- All containers must be labeled with the words "Hazardous Waste".
- An accumulation start date and the contents of the container must be included on the label.
- Investigation Derived Waste Logs (Figure 1) must be completed before leaving the site. One copy of the log should be presented to the site contact and the original provided to the project manager. Once the material has been removed

from the site, the IDW log should be stamped "Removed" and placed in the project file.

- The IDW containers must be stored in a secure onsite location (facility hazardous waste storage area if one exists).
- Disposal of the IDW must be completed within **90 days** of the date the waste was generated. If the facility is a small quantity generator, 180 days is allowed for shipment of the waste offsite.
- Onsite disposal may be allowed or appropriate under certain conditions. Refer to OERR Directive 9345.3-02 for guidance, especially for CERCLA sites.
- WSP personnel should notify the site contact that weekly inspections of the IDW must be conducted and documented.
- WSP personnel should also instruct the site contact that this waste must be included in the facilities annual or biannual reports.

2. If the IDW is presumed to be hazardous and sampling is required to confirm its classification, it should be labeled Hazardous Waste-Pending Analysis. The waste should be sampled before leaving the site (See sampling SOPs). It should be noted that EPA methods 8260 and 8270 may be more cost effective than running the full Toxicity Characteristic Leaching Procedure (TCLP) scan. TSD Facilities will usually specify the required analysis for their waste profiles.

Non-Hazardous IDW

1. If information exists to classify the IDW as non-hazardous waste, the following procedures can be implemented:

Soil Cuttings

- Spread around the borehole or other onsite location with the approval of facility personnel
- Place back in the boring
- Containerize and dispose offsite

Groundwater

- Pour onto ground next to well to allow infiltration
- Containerize and dispose offsite
- Discharge to POTW with approval of facility personnel
- Discharge to onsite wastewater treatment plant with approval of facility personnel

Decontamination Fluids

- Pour onto ground (from containers) to allow infiltration
- Containerize and dispose offsite
- Discharge to POTW with approval of facility personnel
- Discharge to onsite wastewater treatment plant with approval of facility personnel

PPE

- Double bag and deposit in site dumpster
- Containerize and dispose offsite

If the IDW is containerized and is non-hazardous, the following procedures will apply:

- The non-hazardous IDW must be placed in DOT approved containers (55-gallon drum, roll-off container, or temporary storage tank).
- The containers should remain closed except when adding, sampling, or inspecting the material.
- All containers must be labeled with the words "Non-Hazardous Waste".
- An accumulation date and the contents of the container should be included on the label.
- Complete the IDW log (Figure 1). One copy of the log should be presented to your site contact and the original should be given to the project manager.
- The IDW containers must be stored in a secure onsite location.
- Arrangements for disposal *should* be completed within 90 days of the accumulation start date.

Investigation Derived Waste Log

Date:_____

Site Information

Site Name: _____ Site EPA ID #:_____

Site Contact: _____ Site Address: _____

Contact Telephone No:_____

Waste Identification

Type of Waste Generated (check one of the following):

☐ Soil Cuttings ☐ PPE ☐ Decontamination Water

☐ Groundwater ☐ Storm Water ☐ Drilling Fluids

☐ Other (Describe): _____

Field Activities that generated the Waste:

☐ Soil Borings ☐ Well Sampling ☐ Well Installation

☐ Decon ☐ Excavation ☐ Pumping Tests

☐ Other (Describe): _____

Generation Date:_____ ***90-Day Deadline***: _____

Quantity of Waste Generated and Container Type:

_____

_____

Storage Location: _____

Waste Identification (Check One of the Following);

☐ Non Hazardous Waste (pending analysis)
☐ Non Hazardous Waste (based on site information or generator knowledge)
☐ Hazardous Waste (pending analysis)
☐ Hazardous Waste (based on site information or generator knowledge)

If generator knowledge or site information was used for identification, explain:

_____

_____

Type of Label Applied to Containe☐ Non Haz ☐ Hazardous ☐ PCB ☐ Used Oil

WSP Information (Note: One copy to site contact - the original in project file)

Personnel/Contact:_____ Project No.:_____

Telephone:_____

Standard Operating Procedure – 27

Soil Sampling Using a Rotosonic Sampler

Application:

To perform soil sampling with a rotosonic drill rig sampler advanced ahead of the temporary casing.

Materials:

Rotosonic samplers
Rotosonic sample bags (plastic)
Knife
Photoionization detector (PID)
Ziplock plastic bags (quart size)
Nitrile or latex gloves
Sample containers
Field Notebook
Marker

Procedure:

1. Decontaminate all downhole drilling and sampling equipment in accordance with the appropriate procedures before initiating any intrusive work.

2. Ensure that the temporary rotosonic casing has been advanced to immediately above the desired sample depth and loose soil in the bottom of the borehole has been removed.

3. The drillers will attach a decontaminated rotosonic sampler to the drilling rods, lower it to the bottom of the borehole, and advance the sampler through the soil using the rotosonic rig. (Note: the standard rotosonic sampler is capable of collecting a 10-foot long continuous core although 5-foot samplers may also be available. It may be desirable to advance the sampler less than 10 feet to avoid penetrating relatively thin confining layers.)

4. After the sampler has penetrated the desired sample interval, the drillers will retrieve the sampler and disconnect it from the drilling rods.

5. The drillers will place a 4-inch diameter plastic bag over the bottom end of the sampler and vibrate the rotosonic drill head until the sample is extruded from the core barrel and fills the bag. After filling, remove the bag and place it on plastic sheeting for examination and screening. Note the orientation of the sample (i.e., which end is "up") and the depth interval. Be sure the examination/screening area is far enough away from the drilling rig exhaust pipe or other potential sources of contaminants that could effect the screening results.

6. Wearing new gloves, cut the sample bag lengthwise using a decontaminated knife. Immediately scan the recovered soil material with a PID at approximately 2-foot intervals and record the readings in the field notebook.

7. Collect samples for soil headspace analysis using the procedure described in WSP's SOP 22 or other approved method/guidance. Record all headspace readings in the field notebook.[a]

8. If soil samples are being collected for VOC analysis, immediately transfer soil directly from the recovered core into the appropriate sample container(s). Collect the sample from the desired depth based on the sampling plan or field screening results. Label the container(s) with the sample name, depth, date and time of collection, sampler name, and analysis requested. Immediately place the containers in a cooler with ice to maintain a temperature at 4°C.

9. Collect samples for other parameters, as needed, in accordance with the sampling plan.

10. Describe the recovered soil using the Unified Soil Classification System or standard geological descriptions, and include PID measurements, sample number(s) and depth(s), and observations such as staining or odor. Write all descriptive information in the field notebook.

11. Complete the chain-of-custody form with the appropriate sampling information.

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[a] A "background" headspace measurement should also be obtained on an empty bag. Depending on the manufacturer of the bag and ambient temperatures, a background measurement of up to 5 ppm may be present.

Standard Operating Procedure – 28

Sampling of Private Water Supply Wells

Scope:

This procedure describes the method for collecting representative groundwater samples from a domestic or other private water supply well.

Materials:

Business cards
Field notebook
Temperature, pH, and conductivity meter(s)
Sample containers
Cooler
Labels
Indelible markers
Nitrile or latex gloves
Chain of custody forms
Bucket or pail (1 or 2-gallon)
Paper towels or Kimwipes

Pre-Sampling Activities:

1. Verify the location of the well to be sampled and analytical parameters as specified in the sampling plan.

2. Contact the well owner and explain the scope of work. If no information has been obtained about the well, try to obtain information from the owner regarding the exact well location, well construction details, static water depth, well depth, casing diameter, well yield, date drilled and drilling company, previous testing, presence of water treatment components, resource aquifer, and well use. Locate the well on a site or USGS topographic map for future reference.

3. If insufficient well information is obtained from the owner, consider performing a water well survey to obtain the information.

Sampling Procedures:

1. Prepare the field notebook with description of site, well location and owner, weather conditions, sampling personnel, and other relevant observations.

2. Inspect the well to verify construction and other information concerning the well.

3. Identify a cold water tap or spigot for sample collection. The sampling point should be as close to the well as possible, and before the water passes through any treatment systems, heating unit, or storage system. If a suitable sampling point is not available, try to find another well at the site or take steps to minimize the impact of any potential interferences to the sample. Document in the field notebook whether you can or cannot collect a water sample before any treatment or storage components.

4. If sampling from a tap or faucet, try to remove any aerators, filters, or other devices from the tap before purging. If the sampling point is outside, consider removing any hoses connected to the spigot. (However, hoses may be allowed to remain attached during purging to divert large volumes of water from buildings, septic systems, etc).

5. Start to purge the system by running water from a tap or outside spigot. Use a small bucket or pail and watch to determine the purge rate for the system. If the water sample is to be collected from a tap located after a pressurization or holding tank, a sufficient volume should be pumped from the well to allow for the complete exchange of water into the holding tank and the point where the sample is to be collected.[a]

6. Geochemical measurements (pH, conductivity, and temperature) of the water should be collected at regular intervals (every 1-2 minutes) after the start of purging. Record all measurements in the field notebook.

7. Review the geochemical measurements to ensure that readings have stabilized (within 10% of the previous reading). If the geochemical measurements have not stabilized, continue to purge the well until the measurements do not vary more than 10% between two successive measurements (if possible).

8. Collect the groundwater samples after purging is complete. While collecting samples, reduce the water flow to a thin stream. The flow rate should be high enough to deliver a smooth stream of water without splashing but low enough to permit filling of the sample bottles without turning the valve down during sampling. Collect the samples in accordance with the procedures described in WSP's SOP 2 – Sample Containers Preservatives and Holding Times. Label each container with the site name, sample name, date and time of collection, samplers, preservatives (if added), and analyses. Place the sample containers in a rigid cooler with ice maintained at a minimum of 4^0C.

9. Decontaminate all field meters and other non-disposable equipment, and properly dispose of any used paper towels, gloves, etc.

10. Complete chain-of-custody forms with appropriate sampling information.

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[a] It is advisable to open as many inside taps as possible during the purging process to facilitate the exchange of water in holding tanks.

RECORD OF COMMUNICATION
UTILITY LOCATING FORM

Date of Call:_____/ _____/ _____ Time of Call:_____a.m. / p.m.

Name of Utility Service Protection Center Called:_____

Call Placed to Phone No.: (___) ___-_____ Call taken by operator:_____

Ticket No. Assigned to Location Request: [ ]

Co. ID # (*if assigned by Utility Service Protection Center*):_____

Person Calling _____Company Phone: (___) ___-_____

Alternate Contact Name: _____ Alternate Contact Phone: (___) ___-_____

Company Address: _____

Assigned Start Date: _____ / _____ / _____ a.m. (8:00 – 12:00) / p.m. (12:00 – 5:00)

Type of Work: _____Use of Explosives: Y / N

Potential Boring Locations Identified with White Paint and/or Stakes: Y / N / Not Applicable

Work Being Done For: (*Company or Individual Name*):_____

State: _____ County: _____ City/Place: _____

Street: _____*(Only one street per ticket)* Zip Code:_____

Nearest Intersecting Street:_____

Map Page: _____Grid(s):_____

Description of the area to be marked *(Provide the following: Street working on, which side of street, how far in which direction from nearest intersecting street; etc.)*:

_____

_____

Map of the area to be marked faxed to the Utility Service Protection Center: Y / N / Not Accepted

Utility Service Protection Center Fax No.: (___) ___-_____

CALL BACK INFORMATION RECORD

	Gas	Tele.	Elec.	Wtr.	Swr.	Cable TV	Other
Date Notified							
Time Notified							

Notified By							
Phone Number							
Marks Complete							
No Conflict							
No Facilities							

Groundwater Monitoring Data Log

Well No./Designation _____ Date: _____

Site Data

Site Name: _____ WSP Sampling Team _____

Site Address: _____ WSP project No.: ___

Weather Conditions: _____

Well Description

Well Location: _____

Well Security: _____

Casing Material: Inner _____ Outer _____

Organic Vapors (PID, OVA, TIP): Wellhead _____ ppm

Breathing Zone _____ ppm

Nonaqueous Phase (thickness): _____

Reference Point (e.g., top of PVC casing): _____

Purge Data

Purge Method: _____

(Note: Allow water level to equilibrate after removing well cap)

Total Well Depth (TD): _____ ft Depth to Water (DTW): _____

Casing Inner Diameter (CID): _____ inches

To calculate well volume: Well Vol.(gal)=$(CID)^2(0.04)(TD-DTW)$

Well Volume: _____ gal x 3=Purge Volume _____ gal

Purge Time: Begin _____ End _____

Prepurge Data: Temp _____ pH _____ Spec. Cond._____
Turb. _____Other _____

Volume 1: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 2: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 3: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 4: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume 5: Temp _____ pH _____ Spec. Cond._____Turb. _____Other _____

Volume Purged: _____ Purged Dry: Yes No

Disposal Method for Purgewater: _____

Water Description

Odor: Prepurge _____ Postpurge _____

Color: Prepurge _____ Postpurge _____

Sampling Data

Sampling Method: _____

Sampling Time: Begin _____ End _____

Analytical Parameters (circle appropriate parameters):

VOCs BNA BNE Total (Unfiltered) Metals

Dissolved (Filtered) Metals TPH PCB Cyanide

Other: _____

Comments: _____

Standard Operating Procedure – 29
Aquifer Pumping Tests

Scope:
This standard operating procedure (SOP) describes the methods and techniques used to perform aquifer pumping tests on partially- or fully-penetrating test wells.

Objective:
Aquifer tests are generally performed to measure the hydraulic characteristics of a water-bearing zone that has been identified and partially characterized (e.g., total depth of the water-bearing unit, groundwater flow direction, texture of the matrix, etc.) by investigations at the site. The tests generally include four separate phases: a background monitoring phase; a stepped-rate pumping test; a constant-rate pumping test; and a recovery test. Aquifer tests typically include a pumping well where the aquifer is stressed by removing formation water, and at least one observation well where the response to pumping is measured.

This SOP is designed to provide the user with a general outline for conducting each phase of the aquifer test and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), well gauging (SOP 3) and equipment decontamination (SOPs 16 through 19). This SOP does not cover aquifer test planning (e.g., layout of the pumping and observation wells, estimation of pumping rates, selection of pump types, etc.) nor does it cover the analysis of the aquifer test results for determining the characteristics of the water-bearing zone. These topics require a significant amount of planning and are more appropriately addressed in the work plan or a dedicated aquifer test plan.

These procedures are oriented towards *In situ*-brand transducers and data loggers, which are the current state-of-the-art and the brand most often used by WSP. While some specifics may be slightly different for other brands of monitoring equipment, the overall sequence of work should be similar and readily adaptable to any equipment set-up.

Because of the inherent complexity and the number of different tests involved, this SOP is divided into four sections. Each section provides an overview of the objective of the test and a brief description of the methods to be used. The set-up procedures are cumulative; each phase of the aquifer test uses equipment or procedures that were used in the previous phase of the test. The reader is encouraged to read the entire SOP before beginning any onsite activities.

Preliminary Procedures

Materials:

- Field notebook
- Laptop computer with appropriate ports and adapters
- Vented pressure transducer with internal or external data loggers
- Barometric pressure monitoring equipment
- Electronic water level meter or oil/water interface probe (if necessary)
- Photoionization detector (PID)
- Groundwater extraction pump and appropriate tubing
- Power supply
- Water storage tank
- Flow meter(s) and/or flow gauge(s)
- Stopwatch
- Small (1 to 5 gallon) container with known capacity
- Nitrile gloves
- Heat resistant gloves
- Tape measure
- Exacto, pocket knife, or scissors
- Pump lift line (polypropylene rope or other suitable material)
- Duct tape
- Indelible marker or metal file
- Paper towels
- 5-gallon bucket(s)
- Distilled water (decontamination of downhole equipment)
- Plastic sheeting
- Waste labels (if necessary)

1. Review site Health and Safety Plan (HASP) before mobilizing to the field. Discuss groundwater contamination constituents and specific HASP issues with Project Manager and determine the proper level of PPE.

2. Prepare field book (SOP No. 1) daily with site description, weather conditions, participants, and other relevant observations, including all data necessary to complete the hydraulic conductivity tests. Pay careful attention to the weather conditions (e.g., changes in temperature, precipitation, wind, etc.) both locally and regionally as these can adversely affect the data.

3. Survey the ambient (background) air around the base of the well casing and wellhead for organic vapors (if appropriate) using a PID, or equivalent. Record air monitoring measurements in the field book.

4. Inspect extraction well and observation/test wells (e.g., monitoring wells or piezometers) for soundness of protective casing, surface ground seal, and locking mechanism; record findings in the field book.

5. Unlock protective casing or flush mounted curb box. Remove well cap or plug, place PID probe in wellhead, and record PID response in field book. Survey breathing zone to ensure that PPE level is appropriate.

6. Place plastic sheeting around the head of the extraction well or observation well before initiating any down well measurements or testing activities.

7. Allow static water level to equilibrate, as appropriate, before gauging the wells.

8. Measure the inside diameter (ID) of the casing and record in inches. From the top of the casing, measure the depth to water (DTW) and total depth (TD) of the well (in hundredths of a foot with an electronic water level indicator and record in the field book). Water levels should be measured from the surveyor's mark at the top of the casing, or if no mark is present, from the north side of the casing. Be sure to mark a location with a metal file or indelible marker on the north side of the casing if the surveyor mark is absent and record in the field book for future reference.

9. Thoroughly decontaminate (SOP No. 17) the water level indicator cable during retrieval using distilled water and paper towels.

10. **Do not create an airtight seal by replacing the well caps at the locations that will be used during the pumping tests.** It is important that they be open to the atmosphere. Take steps, if necessary, to protect the openings by loosely covering the well opening with the protective steel cover or other material to prevent rain, snow, or debris from entering the well during the test.

Background Monitoring Test

This portion of the aquifer test involves monitoring each of the wells (pumping and observation wells) selected for the aquifer test for a period of time, usually a minimum of 24 hours, to identify any naturally-occurring (e.g., changes in barometric pressure, earth tides, rain events, etc.) or man-made (e.g., artificial recharge, nearby pumping wells, trains, etc.) forces that might systematically alter or potentially mask water level changes during the pumping portions of the aquifer test. Data collected from the background monitoring phase establishes a baseline that can be used to correct the pumping test data by analytically removing the non-pumping trends. Background data can also be used to help determine if the water-bearing unit is confined or unconfined.

The physical placement of the downhole equipment for this portion of the test will be used for the remaining phases of the aquifer test.

1. Assemble all of the monitoring gear (transducers, data loggers, cables, etc.). Verify the transducers have power (for transducers with onboard loggers) and sufficient cable length to reach the intended monitoring zone. Each cable should be fitted with a desiccant cartridge (provided by equipment supplier) to prevent moisture from building up in the transducer vent line. Also, verify that the transducers are rated for the intended water depths; Table 1 provides the criteria for selecting the appropriate transducer. Transducers with the lowest pressure rating appropriate for the anticipated depths should be selected as the device accuracy decreases as the pressure rating increases.

Table 1

Maximum Depth Below Water Table for Pressure Transducer (a)

Pressure Transducer (PSI)	Depth Below Water Table (feet)
10	23
20	46
30	69
50	115

a/ PSI=pounds per square inch

2. Mark each transducer (on the sonde itself) with the well identification number to avoid confusion during data recovery after all phases of the aquifer test have been completed.

3. Familiarize yourself with the data logging software. Transducers with onboard data loggers usually require an interface with a laptop or a hand-held computer running the appropriate proprietary software. Additional cables or adapters (e.g., RS-232 [serial] to Universal Serial Bus [USB]) may be necessary to physically link the computer to the data loggers.

4. Thoroughly decontaminate the pressure transducers using a non-phosphate detergent and distilled water before placement of equipment into the extraction well or observation wells. Decontaminated equipment should be placed on or wrapped in clean plastic sheeting until inserted into the monitoring well or piezometer.

5. Determine the depth below ground surface at which you will be setting the individual transducers for the pumping and observations wells:

    a. The most critical placement will be the transducer installed in the pumping well. This transducer is typically positioned below the pump (which will be installed in the next phase of the aquifer test) to allow water level measurements during periods of significant drawdown. If the well is shallow enough and the depth rating of the transducer is sufficient to withstand the pressure (Table 1), the transducer can simply be lowered to a depth just above the bottom of the well; take care to not allow the transducer to contact the bottom of the well during installation. If the transducer is to be positioned below the pump and above the bottom of the well, measure the length from the transducer bottom up the cable and mark the cable for easy reference when lowering into the well. In either case, be sure the transducer position is such that the bottom of the pump will not contact the top of the transducer.

    b. The placement of transducers in the observation wells is less critical. The units need only be positioned below the level of expected drawdown in each well (you should have some idea of this based on your site characterization and aquifer test design). As with the pumping well transducer placement, the easiest positioning is to place the transducer at a depth just above the bottom of the observation well (see Table 1).

6. Practice defining, running, stopping, and downloading data using the laptop or hand-held computer before installing any of the transducers in the pumping or observation wells. **Be sure that the internal time settings in the transducers, loggers, barometric pressure monitoring equipment, laptop, and/or hand-held computer are synchronized before programming any tests.** This step is critical to ensuring a simultaneous start (and stop) of the test, contemporaneous data collection, and synchronized data logs.

7. Follow manufacturer's specifications to prepare the barometric monitoring equipment. The unit should be placed in the same general area as the pumping well.

8. Program the background monitoring test into each data logger and the barometric pressure monitoring equipment. The background monitoring data is recorded on a linear time scale (e.g., once every 15 minutes). As barometric pressure, tides, and other natural forces typically yield changes in the wells that occur over the space of 1 to 2 hours, data collected on a schedule of once every 15 to 30 minutes should provide a data set that is sufficiently dense to follow any systematic trends. Water levels that can change on more rapid scales (e.g.,

karst terrain) may require shorter sampling intervals. Check the aquifer test plan to verify the appropriate timing.

9. Secure the transducer cable to the wellhead, protective casing, or curb box using duct tape, "S-hooks", or other appropriate methods. The transducers should be secured so that they **do not** move vertically within the water column during the aquifer tests. Be careful not to pinch or kink the cable, which could block the transducer's vent to the atmosphere.

10. Allow the groundwater elevation in the test wells to re-equilibrate with the surrounding formation after the insertion of the transducers. The amount of time required for this step will be dictated by the characteristics of the formation. Wells with recovery times of less than a minute should be allowed to stand a minimum of fifteen minutes before initiating the background test.

11. Run the background monitoring test for a minimum of 24 hours. Do not disturb the pumping or observation wells during the monitoring period. Be sure to record any changes in the weather, especially rain or snow events, and any other environmental or physical changes (e.g., tides, train schedules, etc.) that may potentially alter the water levels in the wells. Aquifer tests conducted in karst terrain should also note regional precipitation events (i.e., within a 20 mile radius) because even distant meteoric water can quickly be transmitted over long distances through infiltration in karstic terrain.

12. **Do not stop the barometric data monitoring equipment at the end of the background monitoring test.** Barometric data should be collected for all phases of the aquifer test.

13. Download the groundwater and barometric pressure data to the laptop or hand-held device and create a back-up copy of the data. It is not necessary to erase the data loggers, as most contain sufficient memory to store millions of data points; leaving data on the loggers provides a secondary back-up system. Verify that all of the data has been transferred to the laptop or another storage media (e.g., compact discs) before erasing the data files from the loggers.

Stepped-Rate Pumping Test

The stepped-rate, or variable-rate, pumping test is designed to stress the aquifer with a series of short-term pumping periods with incrementally higher pumping rates to determine the maximum sustainable pumping rate. The primary purpose of the stepped-rate test is to establish the pumping parameters for a constant-rate test; however, data from the stepped-rate tests can be used, if sufficient data is collected, as support for the constant-rate analysis. The stepped-rate test usually involves a minimum of three pumping periods or "steps" to establish the response of the aquifer.

The following procedures assume that the background monitoring test has been completed and the monitoring equipment remains in place.

1. The groundwater extraction method should be selected based on the depth to water, the anticipated flow rate, and the availability of power. Submersible pumps should incorporate a backflow check-valve(s) that prevents water within the riser pipe from flowing back into the well when the pump is shut off. Check the aquifer test design to verify the pump requirements and appropriate type of tubing.

2. Before installation, measure the length to the pumping intake depth specified in the aquifer test plan; the length includes the lift line and attached submersible pump or the length of tubing for non-submersible pumps (e.g., peristaltic pumps). Accurate measurements are critical to avoid contact with the transducers during installation and when using electric submersible pumps in low yield aquifers. **Dry pumping electric submersible pumps, even for short periods of time, may damage the device.**

3. Install and secure the tubing or submersible pump and tubing in the pumping well to the specified depth.

4. Attach a flow through meter to the discharge/conveyance line. Digital and optical styles are available, depending upon the predicted flow rates. Be sure to check the manufacturer's recommendations for calibration and ensure that the meter is equipped with the properly sized fittings. The flow meter measurements should be periodically verified by manually estimating the time necessary to fill a container of known capacity.

5. Extracted groundwater exiting the flow meter should be piped to a water storage tank with sufficient capacity. The tank should be constructed of materials that are compatible with contaminants that may be present in the groundwater and any applicable state or federal regulations (i.e., Department of Transportation), especially if the material will be managed as investigation-derived waste (SOP 26).

6. Define the stepped-rate tests in each data logger and the barometric pressure monitoring equipment. **Be sure that the internal time settings in the transducers, loggers, barometric pressure monitoring equipment, laptop, and/or hand-held computer are synchronized before programming any tests.** The stepped-rate test is a **logarithmic** test. Data is collected rapidly in the first portion of the test, often several times per second, with the time between

successive water level measurements becoming progressively longer as the test proceeds. This approach yields dense data in the early portion of the test where changes in water levels are occurring rapidly and less data as the water levels approach a steady-state. Most data loggers will convert the logarithmic measurement schedule to a linear schedule at a pre-designated time, which can be programmed during the test set-up. Typical log-linear conversion times range from 1 to 5 minutes for the short-term (i.e., one hour or less) steps; however, the actual conversion time should be estimated based on the aquifer test design and adjusted (for the constant-rate pump phase to follow) in the field based on observations during the individual stepped-rate tests. Table 2 provides typical log-linear conversion times for various test durations.

Table 2

Maximum Log-linear Conversion Times for Various Pumping Test Durations

Duration of Testing (Minutes)	Maximum Log-linear Conversion Time (Minutes)
10-15	1
15-60	5
60-300	30
300-1440	60

7. Gauge the pumping and observation wells prior to beginning the tests to establish the groundwater elevation at static (i.e., non-pumping) conditions (need to ensure that the pumping well has re-established static conditions following insertion of the pump). These data will be used to determine the amount of drawdown during the tests. Wells should be gauged manually and using the transducers. Record the data in the field notebook.

8. Variable-rate tests typically consist of at least three pumping sessions with different pumping rates, one of which is the anticipated maximum extraction rate estimated from the existing site characterization data. Pumping strategies often begin at some fraction of the maximum anticipated rate (i.e., one-half) with increasing steps towards the maximum. An alternate strategy begins with the anticipated maximum pumping rate and adjusts the steps up or down based on the drawdown observed in the pumping well. In either case, it is important that at least one of the pumping sessions be conducted at a rate that is greater than the initial estimate to verify that the maximum sustainable pumping rate has been achieved.

9. Begin the variable-rate test sequence. Careful synchronization of the start of the test and the pump are critical to ensure optimal data capture during the initial drawdown phase. Begin pumping the well 0.5 to 5 seconds **after** the data collection has started; starting pumping before the data loggers begin collecting data will result in the loss of important early drawdown data.

10. Monitor the pumping rate and groundwater elevation frequently during the test. Pumping rates should be maintained within 5 percent of the target extraction

rate. Groundwater elevations in the pumping well should be monitored regularly using both the transducer and an electronic water level meter to ensure that the well is not dewatered during the test. Record discharge rates, meter readings, and manual water level measurements in the field book.

11. Continue each step for the prescribed amount of time, or until the water level in the extraction and observation wells reach stabilization. It is important to run the initial step long enough to establish that the effects of well storage (i.e., water stored in the well casing and surrounding filter pack) have dissipated and formation water is being drawn into the well. If the water levels do not stabilize and the continued operation of the test will expose an electric submersible pump, discontinue the test and reevaluate the pumping rate.

12. Water levels should be allowed to recover to static conditions (i.e., within 95 percent of the initial elevations) between each step. **Do not remove the transducers or the pump from the test wells at the end of the test**.

13. Download the groundwater elevation and barometric pressure data to the laptop or hand-held device and create a back-up copy of the data. It is not necessary to erase the data from the loggers as most contain sufficient memory to store millions of data points; leaving data on the loggers also provides a secondary back-up system. Verify that all of the data has been transferred to the laptop or another storage media (e.g., compact discs) before erasing the data files from the loggers.

Constant-Rate Pumping Test/Recovery Test

The constant-rate pumping phase of the aquifer test is designed to stress the water-bearing zone over an extended period of time to evaluate the hydraulic conductivity and storage parameters of the unit. Typical constant-rate tests are run for 48 to 72 hours using the maximum pumping rate established during stepped-rate tests. The constant-rate test includes a recovery phase which occurs immediately after the pump is turned off. The recovery test is a passive test performed to monitor the response of the water-bearing zone as it recovers from the stress induced by the constant-rate test. Recovery is typically measured for 24 hours.

1. The set-up for the constant-rate test is identical to that of the stepped-rate tests. Groundwater levels should be at static, pre-pumping conditions before starting the constant-rate test.

2. Program the constant-rate test into the loggers and barometric pressure monitoring equipment. **Be sure that the internal time settings in the transducers, loggers, barometric pressure monitoring equipment, laptop, and/or hand-held computer are synchronized before programming any tests.** The constant-rate test is a **logarithmic** test. Caution should be used when setting the conversion time for the test. High sampling frequencies that are important in the early phase of pumping become less desirable as the test proceeds and the water levels stabilize. Typical constant-rate tests performed in low to moderate yield unconsolidated units have conversion times that range between 15 and 60 minutes.

3. Begin the constant-rate test. Careful synchronization of the start of the test and the pump are critical to ensure optimal data capture during the initial drawdown phase. Begin pumping the well 0.5 to 5 seconds **after** the data collection has started; starting pumping before the data loggers begin collecting data will result in the loss of important early drawdown data.

4. Monitor the pumping rate and groundwater elevations periodically during the test. As with the stepped-rate test, pumping rates should be maintained with ± 5 percent of the target extraction rate and the water levels above the pump should be checked to ensure that the well is not being dewatered. Groundwater elevations in the pumping well should be monitored regularly using both the transducer and an electronic water level meter to ensure that the well is not dewatered during the test. Record discharge rates, meter readings, and manual water level measurements in the field book. Monitoring should be more frequent at the beginning of the test with reductions in the monitoring schedule, as appropriate. Once stabilization has been achieved, the monitoring schedule can be reduced further; however, monitoring should be conducted, at a minimum, every two hours after the water levels have stabilized to verify that the pumping rate remains constant, the water levels have not decreased due to changes in the water-bearing unit storage, and other equipment is operating as designed. Record the monitoring intervals and results in the field book.

5. Using the data recorded by the data loggers and barometric monitoring equipment, continue the constant-rate test for the prescribed amount of time or

until the groundwater level in the pumping and observation wells reach stabilization.

6. At the conclusion of the constant-rate pumping test, suspend all data recording but **do not shut off the pump** or remove any equipment from the wells. Download the constant-rate test data from the data loggers.

7. Program a recovery test into each transducer using a laptop or hand-held device. **Be sure that the internal time settings in the transducers, loggers, barometric pressure monitoring equipment, laptop, and/or hand-held computer are synchronized before programming any tests.** The recovery phase is a **logarithmic** test. Log-linear conversion times should be the same for the recovery period as those used for the constant-rate pumping test.

8. Begin the start sequence for the recovery test. Careful synchronization of the start of the data loggers and the pump shutdown is critical for capturing the early response data that occurs as soon as the pumps are shut down (this is the inverse of the drawdown data collected during the pumping phases of the test). The pump should be shut down approximately 0.5 to 5 seconds after the data loggers begin recording the test.

9. Continue the recovery test for the prescribed amount of time or until the water level in the extraction and observation wells has returned to 95 percent of the pre-pumping static water level. **Do not remove the downhole equipment (e.g., pump, transducers) until the completion of the recovery test**.

10. Download the groundwater elevation and barometric pressure data to the hand-held device and create a back-up copy of the data on a laptop computer at the conclusion of the recovery test. It is not necessary to erase the data from the loggers as most contain sufficient memory to store millions of data points; leaving data on the loggers also provides a secondary back-up system. Verify that all of the data has been transferred to the laptop or other storage media (e.g., compact discs) before erasing the data files from the data loggers.

11. Remove the pump, tubing, piping, transducer cables, and transducers from the test wells and place them on plastic sheeting around the well or in a bucket. Replace well cap, locking expandable plug, and secure test wells with locking mechanism.

12. Decontaminate transducers, transducer cables, and pump with distilled water and paper towels (SOP No. 17). Decontaminated equipment should be placed on, in, or wrapped in plastic until further use. Properly dispose of decontamination water, PPE, lift line, and other disposable supplies in accordance with the IDW plan.

Standard Operating Procedures – 30
***In Situ* Single Well Hydraulic Conductivity Test (Slug Test)**

Scope:

This standard operating procedure describes the methods and techniques to be employed for performing *in situ* single well hydraulic conductivity tests, or slug tests, on partially- or fully-penetrating monitoring wells or piezometers.

Objective:

The objective of performing *in situ* single well hydraulic conductivity tests, or slug tests, is to measure the hydraulic characteristics of the aquifer (water-bearing zone) in the immediate vicinity of the monitoring well or piezometer for aquifer characterization. The hydraulic conductivity test is performed by creating an instantaneous change in the water level by either inserting (falling head) or withdrawing (rising head) a slug from a monitoring well or piezometer that is at equilibrium.

Materials:

Field book
Monitoring well lock keys
Hand tools (wrenches), if necessary
Water level indicator
Pressure transducer-internal/external logger (Troll, PDA, or Hermit, see Table 1)
Oil/water interface probe, if necessary
Photoionization detector (PID), if necessary
Closed volume slug (polyvinyl chloride [PVC] pipe filled with sand, cement, or other inert material)
Nitrile or heat resistant gloves
Tape measure
Exacto, pocket knife, or scissors
Rope
Duct tape
Indelible marker or metal file
Paper towels
5-gallon bucket(s)
Distilled water (decontamination of downhole equipment)
Plastic sheeting

Procedures:

1. Review site Health and Safety Plan (HASP) before mobilizing to the field. Discuss groundwater contamination constituents and specific HASP issues with Project Manager.

2. Prepare field book (SOP No. 1) with site description, weather conditions, participants, and other relevant observations, including all data necessary to

complete the hydraulic conductivity tests, or slug tests. Verify monitoring well or piezometer locations.

3. With field personnel in Level D personal protective equipment (PPE), unless historical data warrants upgrading to Level C PPE, survey ambient (background) air around the base of the well casing and wellhead for organic vapors using a photoionization detector (PID) or equivalent. Record air monitoring measurements in field book.

4. Inspect monitoring well or piezometer for soundness of protective casing, surface ground seal, and locking mechanism.

5. Unlock protective casing or flush mounted curb box. Remove well cap or plug, place PID probe at wellhead, and record PID response in field book. Survey breathing zone to ensure that PPE level is appropriate. Record air monitoring measurements in the field book.

6. Place plastic sheeting around the monitoring well or piezometer head before initiating any down well measurement or testing activities. After plastic is placed around the monitoring well covering the ground surface, measurement and testing procedures may commence. If necessary, place tape on well casing to prevent cutting or slicing of rope or cable.

7. Allow static water level to equilibrate, as appropriate, before measuring or determining the presence or thickness of a floating product layer (LNAPL) or a sinking free product layer (DNAPL). Measure thickness using an oil/water interface probe, if necessary, in accordance with EPA RCRA Groundwater Monitoring Technical Enforcement Guidance Document [November 1992], state guidance, or site work plan documents (SOP No. 3a). Record observations in the field book. If LNAPL or DNAPL are present, do **NOT** perform hydraulic conductivity tests in the monitoring well/piezometer.

8. Measure the monitoring well or piezometer casing inside diameter (ID) and record in inches. From the top of the casing, measure the depth (in hundredths of a foot) to water (DTW) with an electronic water level indicator and record in the field book. Static water level measurements must be recorded from the surveyor's mark at the top of the casing, if present. If no mark is present, mark a location with a metal file or indelible marker on the north side of the casing and record in the field book for future reference. Measure and record the total depth (TD), in hundredths of a foot, of the monitoring well or piezometer.

9. Thoroughly decontaminate (SOP No. 17) the water level indicator cable during retrieval from the monitoring well or piezometer using distilled water and paper towels.
10. Thoroughly decontaminate the pressure transducer and closed volume slug using distilled water before placement of equipment into the monitoring well or piezometer. Decontaminated equipment should be placed on or wrapped in clean plastic sheeting until inserted into the monitoring well or piezometer. Record pertinent data logger and pressure transducer information (model or serial number and pressure transducer rating) in field book.

11. Using the tape measure, measure the length from the transducer bottom up the cable to a point where the transducer will be positioned in the monitoring well or piezometer. Mark the transducer cable at the appropriate length for reference. The transducer must be positioned at a depth below the static water level so upon total insertion of the slug into the water column (slug completely enters the water column), the slug bottom does not contact the top of the transducer.

12. Position the transducer in the monitoring well or piezometer below the static water level to the point where mark is aligned with the monitoring well or piezometer survey mark. Allow transducer to equilibrate for a minimum of 10 minutes before starting test.

13. Secure transducer cable to the wellhead, the well casing, protective casing (i.e., duct tape), or the curb box (i.e., "s" hooks). Note, the transducer must be secured such that the transducer can **NOT** move vertically within the water column during performance of the hydraulic conductivity tests. If using an external data logger, connect the transducer cable to the automatic data logger.

14. Power the data logger/transducer and check for proper operation and battery life. Enter monitoring well/piezometer information, transducer reference data, and testing parameters. Generate a test file for each planned individual slug test; the number of tests to be performed should be determined by the Project Manager, but should be no less than three (two falling and one rising) per monitoring well/piezometer. Verify that data logger/transducer collection mode is programmed to record on the logarithmic scale, with a maximum asymptotic interval of 10 minutes.

15. Evaluate water level stabilization by reviewing pressure head readings from the transducer. Once pressure readings have stabilized, record the transducer reference point (zero or reference head).

16. Verify that the slug is full and closed, as applicable. Closed volume slug should be of an appropriate diameter and length to displace an appropriate water volume on insertion into the water column. Secure rope to the top of the closed volume slug; checking knot to be certain rope will not untie during testing process. Using the tape measure, measure the length from the bottom of the closed volume slug up the rope to a point where the slug will be positioned immediately above the recorded static water level. Mark this location.

17. On the rope, mark a second depth measurement corresponding to the depth at which the slug should be lowered into the water column (falling head). The slug must be positioned below the static water level upon total insertion into the water column, but above the level of the transducer. Secure the closed volume slug rope to well head, the well casing, protective casing, or the curb box using duct tape or some other means.

18. In preparation for the first test, lower the closed volume slug into the monitoring well or piezometer so that the slug bottom is suspended immediately above the

static water column. This position should correspond to the first mark (No. 16 above).

19. **Falling-Head Tests**

    Start the test on the data logger and, approximately 0.5 second to 1 second later, smoothly but quickly lower the closed volume slug into the water column (falling- head test, slug in) until the second mark is positioned equal to the wellhead survey mark. Be sure that the slug does not move the transducer cable.

    Rising-Head Tests

    Start the data logger and approximately 0.5 second to 1 second later, smoothly, but quickly, remove the closed volume slug from the water column (rising-head or bail-down test, slug out) until the first mark is positioned equal to the wellhead survey mark (ensuring that the slug is above the original static water level). Be sure that the slug does not move the transducer cable.

20. During each hydraulic conductivity test, monitor (review) the water level data collected on the data logger to ensure proper operation. Record weather changes, heavy equipment movement, or other conditions that may affect water level measurements in the field book. In addition, verification should also be conducted to determine that the volume of the slug is roughly equal to the volume of water displaced, as measured by the data logger. Using the data recorded by the data logger, continue the hydraulic conductivity test, or slug test, until the water level in the monitoring well or piezometer returns to the smaller of either 0.02-foot from the original static water level or within five percent of the change in head.

21. Using the data logger, stop collecting measurements when the static water level stabilizes as described in Step 20.

22. After completion of the testing procedures at a location, remove closed volume slug, transducer cable, and transducer from the monitoring well or piezometer and place on plastic sheeting around the well or in a bucket. Replace well cap, expandable plug, curb box top and secure monitoring well or piezometer with locking mechanism.

23. Decontaminate transducer, transducer cable, and closed volume slug with distilled water and paper towels (SOP No. 17). Decontaminated equipment should be placed on, in, or wrapped in plastic until further use. Properly dispose of decontamination water, PPE, rope, and other disposable supplies in accordance with the investigation-derived waste (IDW) plan.

24. In the field, periodically, and/or before concluding the field activities, download data files from the transducer/logger to a computer diskette or laptop computer.

General Notes:

If groundwater quality data is available for the well(s) being tested, conduct the slug tests in the order of increasing contaminant levels to reduce the potential for cross-contamination.

Single well hydraulic conductivity test, or slug test, data should be analyzed using appropriate aquifer type (unconfined, confined, etc.), method (Bouwer and Rice, Hvorslev, etc.), monitoring well or piezometer construction parameters (fully- or partially-penetrating), pre-testing water level measurements, and HydroSOLV's AQTESOLV for Windows (or equivalent) software package.

Hydraulic conductivity (K) values are calculated (length/time) as centimeters per second (cm/sec), meters per second (m/sec), or feet per second (ft/sec).

Pressure transducer selection criteria:

Table 1

Maximum Depth Below Water Level for Pressure Transducer (a)

Pressure Transducer (PSI)	Depth Below Water Table (feet)
11	23
21	46
31	69
51	115

a/ PSI=pounds per square inch

Standard Operating Procedure - 31

Stream Gaging

Materials:

Current meter
Chest waders or hip waders
Personal floatation device
Wading rod
Stop watch
Tag line(s) or tape measure(s)
Stakes and flagging
Mallet or small sledgehammer
Shovel
Neutrally buoyant object (e.g. small plastic wiffle ball)
Construction level
Polyethylene sheeting
Electronic water level meter
Hand-held calculator
Bound field log book

Application:

Stream gaging is the process of measuring stream flow, or discharge, at a specific location on a stream or river. Stream discharge is a measure of the volume of water flowing through the cross-sectional area of the stream per unit time and is typically reported in cubic feet per second (cfs).

Preparatory Activities

Selection of Technique for Measuring Stream Discharge

There are several methods for measuring stream discharge: velocity-area method, float method, tracer tests, and weirs or flumes. Following is a description of each method and their advantages and disadvantages. The first two methods are covered in more detail later in this SOP.

- The most common and most accurate method is the velocity-area or mid-section method, the standard method used by the U.S. Geological Survey (USGS) for stream gaging stations. The velocity-area method involves using a current meter to measure the stream velocity in each of a number of subsections along a transect perpendicular to the stream flow, calculating the discharge at each subsection and adding each subsection discharge together to calculate the total stream discharge.

- The float method is simpler and less accurate and provides an estimate of stream discharge. Like the velocity-area method, the float method involves measuring the cross-sectional area of the stream, but instead of measuring the velocity with a current meter, the velocity is estimated by measuring the travel

time of a neutrally buoyant object along a specified length of the stream's reach. The stream discharge is calculated by multiplying the cross-sectional area of the stream by the average velocity of the floating object.

- Discharge can also be measured using tracer tests that involve the instantaneous or constant-rate injection of tracers (e.g. fluorescent dyes or salt solutions) and monitoring for the arrival of the tracer at downstream stations. Tracer tests are useful in streams where it is difficult to measure stream velocity with a current meter due to excessive turbulence or debris or where the cross-sectional area of the stream cannot be accurately measured due to irregular or changing streambed morphology (e.g. mountain streams). The use of tracer tests to measure stream discharge is not covered by this SOP. Please refer to guidance documents listed in the references at the end of this SOP.

- Discharge can also be measured using weirs or flumes constructed within the stream channel. Use of these devices is applicable to gaging stations on small streams or irrigation channels where streambed morphology or low stream flows are not conducive to the velocity-area method and where frequent discharge measurements may be required. Weirs are common devices used to measure discharge in streams and irrigation canals and are overflow structures built perpendicular to the flow direction. Weirs are generally easier to install, less expensive, and more accurate for very low flow conditions than flumes but require periodic maintenance to prevent accumulation of sediment and debris on the upstream side and require a greater head loss to operate. General information concerning the use of weirs to measure stream discharge is provided in this SOP. The use of flumes to measure stream discharge is not covered by this SOP. Please refer to guidance documents listed in the references at the end of this SOP for additional information.

Stream discharge measurements are often associated with measurements of stream water level, or stage, measured on a staff gage. The correlation between stage and discharge is used to establish a rating curve for a given gaging station. Survey information (location and elevation) for the staff gage also allows for incorporating surface water elevations into the overall site characterization and understanding of groundwater - surface water interaction.

Current Meter Selection for Velocity-Area Method:

Stream velocity measurements and discharge calculations have historically been made using USGS style mechanical current meters (e.g. Price AA and Pygmy meters) attached to a wading rod. While mechanical current meters are still commonly used, electronic current meters that utilize electromagnetic sensors (e.g. Marsh-McBirney Flo-Mate™), acoustic Doppler technology (e.g. Sontek/YSI FlowTracker ADV™), or calibrated propellers (e.g. Global Water Flow Probe™) are recommended for velocity measurements. The electronic current meters provide handheld computer interface, data storage, automatic discharge calculations, velocity averaging, and applicability in a variety of flow conditions and water depths. With all current meters, consult the user's manual for instructions on setup, calibration, use, data storage/recall, and maintenance. Modified versions of current meters are available for deployment from boats, cableways, and bridges, on ice covered streams or in continuous deployment.

Field Procedures

Velocity-Area Method:

1. Accurate measurement of stream discharge requires selecting a gaging station with appropriate stream morphology. The best site for stream gaging is one where the reach of the stream is relatively straight with parallel banks, and where the streambed is relatively uniform and free of boulders, debris, or protrusions. Stream flow should be relatively uniform and parallel throughout the cross-sectional area of the stream without slack water, eddies, or excessive turbulence. The water depth should be sufficient for proper operation of the current meter without interference from the top or bottom of the water column (minimum depth of approximately 0.3 feet).

2. Field personnel entering the water should wear hip waders or chest waders depending on the depth of the stream. If the water depth is greater than 3 feet, the sampler should also wear a personal floatation device (PFD). Extreme caution should be exercised when wading into the stream and no attempt should be made to enter a stream during high flow or flood conditions. Because of possible hazards, it should be considered to have two people present during stream gaging activities.

3. Describe the stream gaging site on the Discharge Measurement Notes form, noting the distance from established landmarks or gaging stations. Each gaging location should be marked along the bank with a stake or flagged for future reference.

4. String a tag line or measuring tape across the stream perpendicular to the stream flow and secure the tag line or measuring tape to stakes on both side of the stream keeping the line out of the water.

5. Divide the stream into approximately 20 to 30 sections. No individual section should contain more than 10% of the total discharge. This may be impractical for very small streams, but no fewer than 10 sections should ever be used. For each section, note the distance from the bank to the center of the section. Isolate areas of very low flow or no flow adjacent to the bank to their own section. Figure 1 provides an example stream cross-section with sections.

6. Calibrate the current meter before starting to collect field data in accordance with manufacture's User's Manual. Any field deviations should be recorded in the Discharge Measurement Notes.

7. Make sequential measurements of water depth and flow velocity at each station along the tag line/tape using the current meter attached to a standard or top-setting wading rod. Hold the wading rod vertically and stand in a position that produces the least interference with water flow around the current meter, typically downstream and to the side.

8. If water depth is less than 2.5 feet, use the "six tenths" (or "one-point") method for flow velocity measurements at each station. Using this method, one velocity measurement is made at 0.6 of the depth below the surface. (For example, for a water depth of 1 foot, the current meter should be set at 0.6 feet below the surface, or 0.4 feet above the streambed). For water depths greater than 2.5 feet, use the "two-point" method. For this method, two velocity measurements are made at each station, at 0.2 and 0.8 of the depth below the surface. (For example, for a water depth of 4 feet, velocity measurements are made at 0.8 and 3.2 feet below the surface. The average of the two is used as the mean for the section.) Each velocity measurement should be sampled for a minimum of 40 seconds.

9. Record the flow velocity and water depth measurements in the field logbook and on the Discharge Measurement Notes form. If the current meter has data storage capability, save the field measurements (including calculated discharge) for future reference or downloading to a lap-top computer or storage device.

10. Calculate the discharge for each section by multiplying the measured velocity times the cross-sectional area. The total stream discharge is the sum of the individual section discharges.

Float Method:

1. Field personnel entering the water should wear hip waders or chest waders depending on the depth of the stream. If the water depth is greater than 3 feet, the sampler should also wear a personal floatation device (PFD). Extreme caution should be exercised when wading into the stream and no attempt should be made to enter a stream during high flow or flood conditions. Because of possible hazards, it should be considered to have two people present during stream gaging activities.

2. String a tag line or measuring tape across the stream perpendicular to the stream flow and secure it to stakes on both sides of the stream keeping the tape out of the water.

3. For streams less than 20 feet wide, measure the depth every foot, and for steams greater than 20 feet wide, measure the depth every two feet.

4. Calculate the stream cross-sectional area by either of the follow methods.

    a. Method 1 – cross-sectional areas are determined for each measurement interval
    b. Method 2 –average water depth (i.e. sum of all depths divided by the number of measurement intervals) times the stream width.

5. Measure a distance along the bank of the stream to use as the float distance and mark the upstream and downstream points.

6. Pick several points across the stream channel approximately equal distance apart, being sure to avoid areas of slack water with no flow. At each point, drop the neutrally-buoyant object above the upstream point and measure the time it takes to float from the upstream point to the downstream point. Divide the distance floated by the float time to calculate the float velocity. For streams less than 10 feet wide, take three float velocity measurements, and for streams greater than 10 feet wide, take at least four float velocity measurements.

7. Multiply the average float velocity by a correction coefficient of 0.85 to determine the corresponding stream flow velocity.

8. Calculate the total stream discharge by either of the following methods, depending on how cross-sectional area was calculated in step #4 above.

    a. Method 1 - multiply the individual cross-sectional areas calculated in step #4a by the stream velocity calculated for floating runs in that portion of the stream and add the discharges
    b. Method 2 - multiplying a total stream cross-sectional area calculated in step #4b by an average stream velocity for all of the floating runs.

Weir Method

There are two main types of weirs: broad-crested weirs and sharp-edged weirs. A broad-crested weir is a flat topped structure, commonly a horizontal block, which extends across the entire width of the channel. A sharp-edged weir consists of a thin plate with a rectangular or v-shaped notch. V-notch weirs measure low discharges (less than 10 ft^3/sec) more accurately than other weir types. The probable range in discharge and minimum head differences across the weir must be considered when selecting the type and size of the structure to be installed across the stream or canal.

The weir should be constructed in a location that provides an upstream approach that is relatively straight with tranquil flow (i.e. long, straight channel/reach free of tight curves, projections, and waves). Poor approach flow will affect the accuracy of the discharge measurements. It may be necessary to temporarily dam or divert water flow around the selected location during weir installation.

Construction and installation techniques vary with the type and size of weir. Sharp-crested v-notch weirs can be constructed using portable weir plates fabricated with 10- to 16-gauge steel forced firmly into the soft, unconsolidated sediments along the bottom and sides of the stream channel. A construction level should be used to ensure the plate is properly aligned in both the horizontal and vertical directions. The weir should be sealed along the bottom and sides with mud, stones, or polyethylene sheeting to prevent water from flowing beneath or around the side of the weir.

After setting the weir plate, a staff gage is installed in the area of pooled water on the upstream side of the structure. The staff gage is used to collect water level data with respect to the weir.

Field data collected from the stream gaging location consists of measurements of the water depth or head relative to the weir crest, which is the point where water flows over the weir. The head measurements made at the upstream staff gage are used to determine the discharge using either a standard table or equation established for the selected weir geometry. For very low flows at v-notch weirs, the discharge can also be directly measured by observing the time required to fill a container of known capacity.

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US Bureau of Reclamation. 1997. Water Measurement Manual. Third Edition, Revised 2001.

Discharge Measurement Notes

Site _____

Station ID _____ Measurement Number _____

Date _____ Field Crew _____

Station Description

Station Location _____ _____

Nearest Gage _____ feet mile upstream downstream

Gage #_____

Gage Height at start _____ Gage Height at finish_____

Relative Flow Conditions _____

Weather _____

Additional
Comments_____

Equipment and Method

Meter Type _____ Meter #_____

Measurement Method (circle one): six-tenths 2-point both other

Calibration Check Prior _____ Post _____ (zero in bucket for calibration)

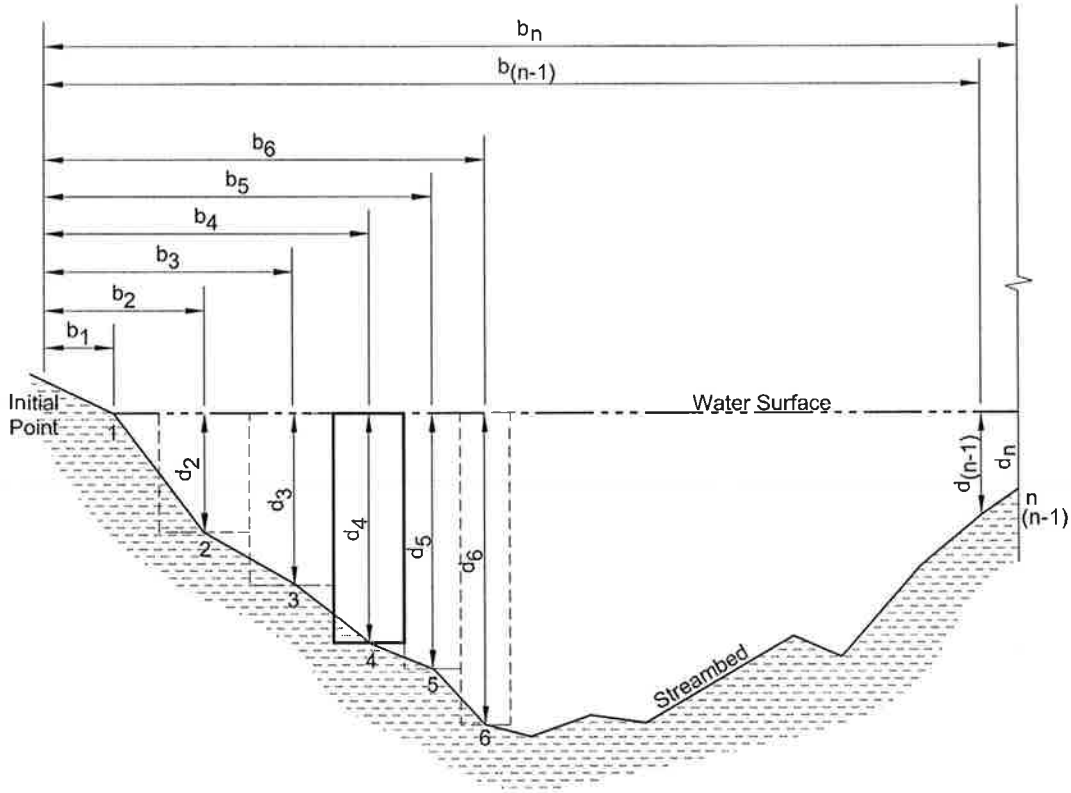
Measurements

Total Stream Width _____ft Number Sections _____

Measurement Rated (circle one) Excellent (<2%) Good (<5%) Fair (<8%) Poor (>8%)

Based on the following conditions: _____

Section	Distance (feet)	Width (feet)	Area (ft^2)	Velocity (ft/sec)	Velocity (ft/sec) 2-point method		Duration of reading (sec)	Discharge (ft^3/sec)	Notes
				0.6 depth	0.2 depth	0.8 depth			
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
Total									



1, 2, 3, 4, 5, 6, n	Observation Point
$b_1, b_2, b_3, b_4, b_5, b_6, b_n$	Distance, in Feet, From Initial Point to Observation Point
$d_1, d_2, d_3, d_4, d_5, d_6, d_n$	Depth of Water, in Feet, at the Observation Point

Total Stream Discharge (Q) is the Sum of Discharges of the Individual Sections (q_x).

$$Q = q_1 + q_2 + q_3 + q_4 + q_5 + q_6 + q_n$$

$$\text{where } q_x = V_x \left[\frac{b_{(x+1)} - b_{(x-1)}}{2} \right] d_x$$

q_x = Discharge through section x

V_x = Mean Velocity in section x

Reference: Buchanan and Somers (1969)

WSP Environment & Energy
11190 Sunrise Valley Drive Suite 300
Reston, Virginia 20191
(703) 709-6500

Figure 3
Discharge Calculation for Stream Gaging

PR001/PR086.DWG

Appendix B – Mann Kendall Test - Well NW-9

State of Idaho
Department of Environmental Quality
Remediation Program

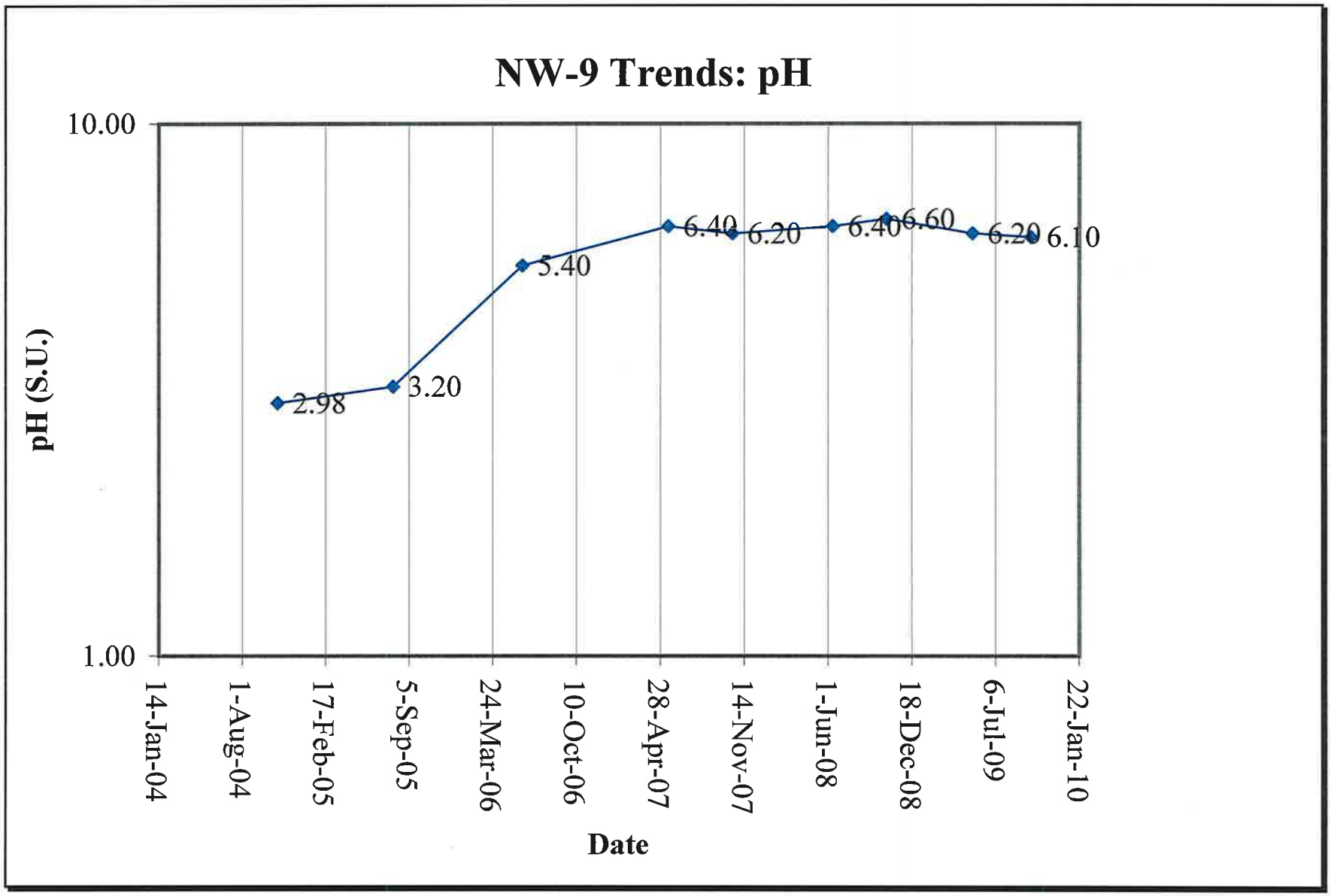
Mann-Kendall Statistical Test
Version 2 10/22/02

Instructions: To use the spreadsheet, provide at least four rounds and up to ten rounds of data. Enter the data in cells with yellow background. Output is presented in blue background cells. Use consistent concentration units. All non-detect values should be assigned a single value, less than the detection limit, even if the detection limit varies over time. The spreadsheet contains several error checks and a data entry error may cause "DATA ERR" to be displayed. Dates that are not consecutive will show an error message and will not display the test results. The spreadsheet tests the data for both increasing and decreasing trends at 80% and 90% confidence levels. If an increasing or decreasing trend is not present, use the additional coefficient of variation (CV) test for stable and non-stable conditions, as proposed by Wiedemeier, et al (2000), *Designing Monitoring Programs to Effectively Evaluate the Performance of Natural Attenuation, AFCEE, San Antonio, Texas, January 2000*. Clicking the PRINT button will print both the data analysis sheet and the plot of concentration trends.

This spreadsheet is adapted from State of Wisconsin DNR, Remediation and Redevelopment Program Form 4400-215 (2/2001), developed by George Mickelson.

Site Name =		City =		Site ID =		Well Number =	
Compound		NW-9 pH					
Event Number	Sampling Date (most recent last)	Concentration (leave blank if no data)	Concentration (leave blank if no data)	Concentration (leave blank if no data)	Concentration (leave blank if no data)	Concentration (leave blank if no data)	Concentration (leave blank if no data)
1	25-Oct-04	2.98					
2	29-Jul-05	3.20					
3	3-Jun-06	5.40					
4	17-May-07	6.40					
5	17-Oct-07	6.20					
6	12-Jun-08	6.40					
7	18-Oct-08	6.60					
8	12-May-09	6.20					
9	29-Sep-09	6.10					
10							
Mann Kendall Statistic	S	16	0	0	0	0	0
Number of Rounds	n	9	0	0	0	0	0
Average		5.50	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Standard Deviation		1.41	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Coefficient of Variation (CV)		0.26	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Trend ≥ 80% Confidence Level		INCREASING	n<4	n<4	n<4	n<4	n<4
Trend ≥ 90% Confidence Level		INCREASING	n<4	n<4	n<4	n<4	n<4
Stability Test, If No Trend Exists at 80% Confidence Level		NA	n<4 n<4	n<4 n<4	n<4 n<4	n<4 n<4	n<4 n<4
Error Check, Blank If no Errors Detected			n < 4	n < 4	n < 4	n < 4	n < 4

Data Entry By =	MT	Date =	5-May-10	Checked By =	MT
Concentration Units =	mg/L ug/L				


NW-9 Trends: pH
10.00
1.00
pH (S.U.)
2.98
3.20
5.40
6.40
6.20
6.40
6.60
6.20
6.10
14-Jan-04
1-Aug-04
17-Feb-05
5-Sep-05
24-Mar-06
10-Oct-06
28-Apr-07
14-Nov-07
1-Jun-08
18-Dec-08
6-Jul-09
22-Jan-10
Date

Appendix C – Health and Safety Plan

Health and Safety Plan

Nu-West Industries, Inc.
Conda Phosphate Operations
Soda Springs, Idaho

Prepared by

WSP Environment & Energy

Revision: 1

Date: May 6, 2010

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Appendix D – Venomous Snakes and Spiders
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Appendix F – NIOSH Pocket Guide to Chemical Hazards
Appendix G – Route to Hospital

1 Introduction

This Health and Safety Plan (HASP) was prepared to address potential health and safety related issues which might arise during implementation of the sampling and analysis work plan (Work Plan) for site characterization at the Nu-West Industries, Inc. Conda Phosphate Operations (CPO) facility. The work is being performed pursuant to an Order on Consent between Nu-West Industries and the U.S. Environmental Protection Agency (EPA).

In this HASP and the associated Work Plan, the term "Facility" is used to denote the entire Nu-West property where CPO conducts operations. The term "Site" is an inclusive term referring to both the Facility and the adjacent properties that will be included in the characterization study. "Main Processing Area" is a term to denote the southeast portion of the Facility where most processing operations occur; this area includes most of the Facility buildings, tank farms, loading and unloading areas, etc. "Main Processing Area" does not include the cooling ponds, gypstacks, or tailings ponds.

The CPO Facility is located at 3010 Conda Road, Soda Springs, Caribou County, Idaho (Figure C-1). The Primary areas of interest at the Facility (Figure C-2) include:

- Main Processing Area,
- former process ponds, conveyance ditches, and intervening land
- holding ponds, adjacent wetlands, and intervening land

The Site also includes certain off-property areas, such as Woodall Spring located north of the Facility.

This HASP provides an overview of conditions at the Site and describes the safety procedures to be employed during implementation of the Workplan. The HASP presents the minimum requirements applicable to all Workplan contractors and subcontractors; all contractors and subcontractors may use more stringent requirements as necessary to fulfill their own corporate requirements.

During the development of this HASP, consideration was given to current safety standards as defined by the EPA, the Occupational Safety and Health Administration (OSHA), the National Institute of Occupational Safety and Health (NIOSH), the Idaho Department of Environmental Quality (IDEQ), and Nu-West Industries, Inc. In addition, the HASP includes information on health effects and standards for known contaminants and the procedures designed to account for the potential for exposure to unknown substances. Specifically, the following references have been consulted:

- 29 CFR 1910.120 and 40 CFR 311
- OSHA/NIOSH/EPA/U.S. Coast Guard Occupational Health and Safety Guidelines for Activities at Hazardous Waste Sites
- NIOSH Pocket Guide to Chemical Hazards
- American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value
- Quick Selection Guide to Chemical Protective Clothing

- Ansell Edmont Industrial Chemical Degradation Guide for Gloves and Protective Clothing.

1.1 GENERAL FACILITY INFORMATION

The Facility occupies approximately 1,012 acres 5 miles north of Soda Springs, Idaho (Figure C-1). The site is situated at the eastern limit of a broad, north-south trending valley, approximately 4 miles wide that has been filled by lava flows. The valley floor is topographically flat with elevations ranging from approximately 6,135 to 6,150 feet above mean sea level. The regional topography slopes gradually to the south. Across the region there are north-northwest trending linear escarpments, typically with 15 to 50 vertical feet of relief. The eastern portion of the site is positioned at the base of the Aspen Mountains.

The Main Processing Area, which occupies the east-central and southeastern portions of the Facility, is approximately 120 acres (Figure C-2) and consists of materials production and storage areas. The facility's tailing ponds, gypsum ponds (gypstacks), and process water cooling ponds are located immediately to the west of the Main Processing Area. The facility's primary surface features include the Main Processing Area, railroad tracks and service roads, a quality control laboratory area, two cooling ponds, three tailings ponds, and two gypstacks.

The main processes include ore crushing and washing, the production of phosphoric acid, super phosphoric acid, sulfuric acid, and chemical compounds via mineral processing. CPO receives approximately 2 million tons of phosphate ore annually, which is delivered to the facility by rail from the CPO Dry Valley Mine approximately 8 months per year. Processes on the north end of the Main Processing Area include ore car roll-over/unloading, ore stockpiles, ore reclaim area, washplant, former calciner, and ball mills to pulverize the ore.

Washed and ground ore is used in the phosphoric and super-phosphoric acid plants. Phosphoric acid is produced by combining phosphate bearing ore with sulfuric acid. A byproduct of the process is gypsum which is pumped to the gypstacks. Additionally, the facility produces sulfuric acid in the East Sulfuric Acid Plant by oxidizing sulfur. Molten elemental sulfur is received on rail cars and is unloaded in molten form to a sulfur pit. The East Plant burns approximately 500 tons of elemental sulfur daily to produce approximately 50% of its sulfuric acid demand. Additional sulfur is purchased from offsite sources and delivered via rail cars. The North Plant, or North Sulfuric Acid Plant, consists of a steam boiler and the sulfuric acid unloading and storage facility. All waste water from the East Sulfuric and North Sulfuric Acid Plants is neutralized in the neutralization tank and then recycled to the ore processing wash plant.

In the Granulation Plant located in the central portion of the manufacturing area, using the phosphoric acid, sulfuric acid, and ammonia, the facility can produce two different grades of granular fertilizer: mono-ammonium phosphate (MAP) and ammonium phosphate sulfate (APS). Once the product is dried, it is transferred to the Dry Product Storage area in the south-central portion of the Main Processing Area for loading onto railcars.

1.2 PREVIOUS SITE INVESTIGATIONS

Results of the following previous studies have been provided to WSP:

- March 1988: Ecology & Environment *Site Inspection Report*
- September 1994: Roy F. Weston *Expanded Site Inspection Report*

- May 2003: Engineers Inc. *Ground Water Assessment Report*
- November 2003: Engineers Inc. *Ground Water Assessment Report*
- June 2004: Engineers Inc. *Ground Water Assessment Report*
- December 2004: Engineers Inc. *Ground Water Assessment Report*
- October 2005: Engineers Inc. *Ground Water Assessment Report*
- August 2006: Engineers Inc. *Ground Water Assessment Report*
- November 2006: Engineers Inc. *Ground Water Assessment Report*
- July 2007: Engineers Inc. *Ground Water Assessment Report*
- December 2007: Engineers Inc. *Ground Water Assessment Report*
- August 2008: Engineers Inc. *Ground Water Assessment Report*
- September 2008: Enercon *Process Water Impacted Soil Remediation Report*
- May 2009: Engineers Inc. *Ground Water Assessment Report*

The results were reviewed to identify the maximum constituent concentrations in various media samples which are presented in Table C-1; the primary constituents of interest are metals and radionuclides.

1.3 WORK ACTIVITIES

This HASP will be used to ensure that adequate safety practices are utilized during performance of the following field activities conducted by project personnel:

- geophysical study
- land survey
- soil boring installation and soil sampling
- surface water and sediment sampling
- groundwater and potable water sampling
- investigation derived waste sampling
- visiting/touring
- operating motor vehicles
- decontamination of sampling and earthwork equipment.

All project personnel performing field activities will be subject to the standards, procedures, and requirements specified in this HASP and will be required to certify review and intended compliance with the document before conducting any activities. An example certification is provided in Section 13.0. All project personnel will be briefed by the Site Health and Safety Coordinator (SHSC) and will be required to become familiar with the following sections of this plan:

- Contingency Plan and Emergency Procedures - Section 10.0

- Safety Rules and Personal Hygiene - Appendix A
- Field Standard Operating Procedures (SOPs) for Use and Decontamination of Personal Protective Equipment (PPE) - Appendix B
- Heat Stress Monitoring and Cold Stress Prevention - Appendix C
- Venomous Snakes and Spiders - Appendix D
- Field Standards and Operating Procedures for Underground Utility Locating - Appendix E

This HASP may be modified if it becomes evident that the provisions specified are not feasible or adequate to protect the health and safety of personnel, or if supplemental activities are implemented that are not addressed herein. All changes to this HASP shall be documented by completing a HASP change form (Section 12.0), which must be signed by the CPO Project Coordinator, and the Health and Safety Officers (HSOs), Radiation Safety Officer (RSO), and Task Managers of the primary contractors. A copy of completed HASP modification forms will be included in each copy of the HASP and will be maintained with the project records. The SHSC will be responsible for informing personnel of all HASP changes during the daily briefing meetings.

Site specific training will be conducted by CPO prior to the beginning of work.

2 Organization Structure

The appropriate technical personnel will be organized into a project team to efficiently and safely perform the task describe in the Work Plan. The successful achievement of the project goals can only be accomplished through the use of appropriate management techniques and personnel.

WSP is the primary contractor responsible for the satisfactory implementation of the Work Plan. In this capacity, WSP will oversee and monitor the work, although other contractors will be responsible for conducting their work in a safe manner and, if necessary, assume the role of incident commander. If it is necessary to change the personnel identified below, CPO will provide timely written notice to the EPA. The WSP Certified Safety Professional (CSP) for the Sampling and Analysis Work Plan is Keith Green, CSP (#19772). The WSP HSOs and RSOs for the Sampling and Analysis Work Plan are Laura Tobin and Keith Green. Mr. James Cagle is the CPO Project Coordinator with overall responsibility for all aspects of the Work Plan. The responsibilities of key technical personnel are described below; emergency contact information is also provided.

Project Manager – James Bulman

The Project Manager is responsible for the day-to-day progress of the project and supervision of field personnel. These responsibilities include organizing field activities, complying with the provisions of the work plan, field documentation and record keeping, and ensuring quality control of field activities. The Project Manager and the HSOs must also ensure that subcontractors and outside observers comply with the HASP and their corporate HASP(s), as appropriate.

HSO and RSO – Laura Tobin and Keith Green (WSP)

The HSO and RSO are responsible for ensuring that this HASP is followed by personnel under the direction of their respective companies. They will ensure that investigations are performed in a safe manner to eliminate hazards and coordinate with personnel and contractors regarding all procedures related to health and safety. The HSO and RSO will report directly to the Project Manager.

Field Team Leader - Varying based on activity

The Field Team Leaders are responsible for the operation of the field teams and coordination of field activities with other contractors. Responsibilities include organization of field activities, compliance with the provisions of the work plans, field documentation and record keeping, quality control of field activities, and communication with the project manager, project engineer, or other designated contact. The Field Team Leaders, along with the SHSC, must ensure that WSP and contractor personnel comply with the HASP.

Site Health and Safety Coordinator – Varying based on activity

The SHSCs are responsible for monitoring daily activities to ensure that personnel are properly implementing the HASP. Specific duties may include performing personal air monitoring (screening), observing activities conducted by WSP personnel and contractors, and maintaining notes concerning activities in relation to personnel safety (e.g., air monitoring results, sampling activities). In the event that unsafe acts conducted by contractors' employees are observed, the SHSC will inform that contractor's HSO. The coordinator has the authority to stop contractors' unsafe work practices until corrective measures are implemented; however, the contractors are

responsible for correcting any unsafe conditions created by their activities or acts by their employees in compliance with their HASP and any applicable regulations. If the unsafe act or condition is not remedied by the contractor, the SHSC will inform the appropriate Project Manager and HSO, and work will cease until such a time that corrective measures are implemented. In the event that unsafe acts conducted by WSP are observed, the SHSCs similarly have the authority to suspend activities until changes in work practices are implemented.

The SHSC will determine if work practices or Site conditions require changes in this HASP including, but not limited to, upgrades or downgrades in personal protection; changes in equipment or methodology to more safely accomplish work tasks or monitoring; and implementation of engineering or administrative controls. These changes must be approved by the HSOs and Project Managers prior to implementation.

Emergency contact information (i.e., cell phone numbers) for key technical personnel is presented below; additional emergency contact information (i.e., police) is presented in Section 10.

Responsibility		**Company**	**Phone**
Project Coordinator:	Jim Cagle	CPO	(208) 547-4381
WSP Project Manager:	James Bulman	WSP	(703) 709-6500
WSP CHP/HSO/RSO:	Keith Green	WSP	(571) 217-3617
	Laura Tobin	WSP	(303) 726-8100

3 Description of Planned On-Site Activities

This section identifies the type of planned assessment activities that will be performed during the project. Site investigation activities will include:

- geophysical survey
- land survey
- soil boring installation and soil sampling
- surface water and sediment sampling
- groundwater and potable water sampling
- investigation derived waste sampling
- decontamination of sampling and earthwork equipment

These field tasks are described briefly below; Section 4 identifies the associated hazards and protective measures to be implemented.

3.1 GEOPHYSICAL SURVEY

A geophysical survey is expected to further characterize the subsurface conditions under portions of the property using electrical or electromagnetic methods (EM). The EM survey will attempt to define the existence of fractures in bedrock beneath the site. The work is anticipated to require a maximum of 2 days to complete. Due to the short nature of the activity, the absence of any intrusive work, the absence of notable potential exposure to any contaminants at unsafe concentrations, the contractor will not be required to have completed the 40-hour OSHA training pursuant to 29 CFR 1910.120(e)(2). All contractor personnel who enter the Facility will receive CPO's required safety training.

Information from the EM survey will be used to finalize the scope of investigation activities.

3.2 LAND SURVEY

A majority of the investigation locations will be surveyed to document horizontal and vertical coordinates. Although no intrusive activities will be performed, it will be necessary for the surveyors to open monitoring wells for the purpose of determining elevations and, work at surface water bodies to locate surface water and sediment sample locations or locate and install staff gauges.

3.3 SOIL BORING INSTALLATION AND SOIL SAMPLING

Soil samples may be collected from borings advanced solely for the purpose of sampling or for the purpose of well installation. The samples will be analyzed for the purpose of chemical or radiochemical characterization, mineralogy, or other physical attributes.

The borings will be advanced using either direct-push or hollow-stem auger drilling methods. In addition, hand augers, shovels, and trowels may be used for collection of shallow soil samples. Collection of samples for laboratory testing with direct-push or hollow-stem auger drilling utilizes

some type of core barrel, whether within the drilling rods themselves or as a separate unit (e.g., split-spoon sampler). Single-use liners will be used when sampling with direct-push methods, thus requiring no decontamination. Split-spoon samplers, hand augers, shovels, and trowels will be decontaminated between each use.

3.4 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples will be collected from the Woodall Spring and Woodall Spring Ditch. The samples will be collected from a secure area along the shoreline. The samples will be collected using a variety of methods that will be selected based on the location, depth of surface water, and intended use of the data. The collection equipment will not be energized, with the possible exception of a battery operated peristaltic pump, which may be used to collect surface water samples from areas in which several feet of water are present. Surface water samples will typically be collected using transfer bottles, bailers, or peristaltic pumps. The bailers will be disposable, and the peristaltic pumps will utilize disposable tubing. Sediment samples will be collected by trowel, shovel, or core barrel; all non-disposable equipment will be decontaminated between locations.

3.5 GROUNDWATER AND POTABLE WATER SAMPLING

Groundwater samples will be collected primarily from monitoring wells, production wells, and residential wells. Potable water samples will be collected from residential wells. Submersible pumps will be used. The submersible pumps will be powered by a mobile generator and utilize disposable tubing or, in the case of sampling production or potable wells, via the existing electrical supply and piping. Non-dedicated submersible pumps will be decontaminated between locations.

Water levels for the monitoring wells will be measured concurrent with groundwater sampling and periodically throughout the project to evaluate groundwater flow and the relationship between groundwater and surface water. Meters used for this purpose will be decontaminated between locations.

3.6 INVESTIGATION DERIVED WASTE HANDLING

Four general types of investigation derived waste will be generated during the project:

- soil from drilling or excavation activities
- rinsate from decontamination of equipment
- purge water
- disposable personal protective and sampling equipment

All disposal referenced below will be in accordance with applicable Federal, State, and local regulations.

Within the property, soil cuttings generated during borehole drilling (or by hand) will be used to backfill the soil borings; excess soil from the borings or soil generated at well locations will be spread on the adjacent ground surface. In areas beyond the CPO property boundary, the soils

will be contained in labeled drums and returned to the property for temporary storage, characterization, and disposal.

Soil generated during activities onsite will be returned to the borehole, except in instances where contaminated material is encountered. Suspect contaminated material will be segregated from clean material, then contained, characterized, and disposed of in accordance with applicable regulations.

A temporary decontamination pad will be constructed on the property to contain wash water generated during cleaning of waste characterization sampling equipment, downhole equipment and, as necessary, the drilling rigs. This water and water generated during other miscellaneous decontamination activities will be placed in labeled drums, stored in a designated area, characterized, and disposed of.

Purge water generated during groundwater sampling will be contained at the point of origin, and transferred to onsite in drums to a designated area.

Disposable Level D PPE and sampling equipment will be disposed of with CPO's general trash. Level C and higher PPE will be drummed, labeled, and stored in a designated area until such time as disposal is arranged.

4 Exposure to Toxic Substances and Hazards

Hazards associated with Site investigation include but are not limited to exposure to toxic chemicals, exposure to radioactive materials, physical hazards and water safety.

4.1 EXPOSURE TO TOXIC SUBSTANCES (CHEMICAL)

Table B-1 summarizes the constituents detected in environmental media samples collected during previous investigations. Information available for many of these constituents from the NIOSH Pocket Guide to Chemical Hazards is presented in Appendix F.

Constituents of interest identified include certain metals (e.g., arsenic, barium, boron, cadmium, chromium, thallium, vanadium), fluoride, and radium-226. Many of these substances are corrosive, and pose immediate risks to skin, tissues, eyes and other body parts.

Soils, sediments, groundwater, and surface water generated during drilling or sampling activities may pose absorption, inhalation, or ingestion hazards for field personnel. Handling of equipment that has been exposed to contaminated media, as well as decontamination fluid generated from the cleaning of equipment, may pose an absorption or ingestion risk. In addition, sample preservatives (e.g., hydrochloric and nitric acids) pose absorption, inhalation, or ingestion hazards for field personnel handling preserved sample containers, and coolers/boxes holding sample containers.

4.2 EXPOSURE TO RADIOACTIVE MATERIALS

As noted above, radium-226 is a constituent of interest at the Site. In addition, there are other radionuclides in the natural uranium decay series that are also present in the area. These radionuclides can produce radiation doses at levels above natural background to Site workers via several potential exposure pathways; namely, external radiation exposure, inhalation of particulates, and incidental ingestion of soil and dust.

4.3 GENERAL PHYSICAL HAZARDS

Field personnel must be aware of their surroundings at all times and be aware of their footing at all times. Slip, trip, and fall hazards associated with investigation activities (e.g., waste characterization sampling) and Site activities (e.g., hoses, ladders) will be assessed at the beginning of a new work phase or the start of a new task within a work phase. Field personnel will be mindful of the potential presence of animals (including wild animals, livestock, and pets), reptiles, arachnids, and insects. Field personnel must be aware of the inherent risk of working near or in the vicinity of heavy equipment (i.e., drill rigs, excavators), and using field equipment (i.e., peristaltic pumps, hand augers, knives).

Line-of-sight need not be maintained for all activities due to the size of the investigation area. During the daily Site briefings (Section 6.1), contractor personnel should:

- discuss the relative locations of the activities to be performed that day such that all personnel are generally aware of the whereabouts of others.
- organize daily activities so that a minimum of two workers are generally within the same area (e.g., in the undeveloped limited-access area west of the property).

- no surface water or sediment sampling activities will be performed with fewer than two workers present.

Before any intrusive activities are initiated, utility clearances will be obtained in accordance with the Appendix E. Specifically, the Project Manager or his designee is to contact Idaho Dig Line (1-800-342-1585) to obtain utility clearance a minimum of 2 business days prior to any intrusive activities, but not more than 10 business days due to time limits on the clearance. The various utilities include but are not limited to water, gas, electricity, sewer, storm drains, and telecommunications; a complete list of participating utilities in the area is provided in Appendix E. Utility clearance will also be verified with facility personnel.

Documentation of the contact (Appendix E, Form 1) will be supplemented by electronic confirmation from One Call and each responding utility. The identified utilities will be temporarily marked or flagged to ensure that obtrusive activities are clear of all subsurface utilities. Due to the size of the study area, the Project Manager or his designee will prepare maps identifying the approximate intrusive locations (where such locations are near or beyond the property boundaries) and provide copies to the CPO offices (before contacting Dig Line) for use by the locators.

It is CPO's responsibility to identify the limited existing underground utilities present within its property.

4.4 WATER SAFETY

When collecting or surveying surface water or sediment samples/locations, work will be performed from shoreline. Wading or other entry into water bodies will not occur. Sampling from flat-bottom boats will not occur.

When collecting samples from shoreline areas, life jackets or buoyant work vests will be worn if topographical features do not allow for sure footing.

When working in dewatered areas, a safety line will be attached to a safety harness worn by the sampler and tied to a fixed object or field vehicle on-shore during all sampling activities. An on-shore observer will be in constant line-of-sight with personnel conducting the sediment sampling in dewatered areas.

5 Hazard Assessment

Site constituents of interest (COI) include metals, acids, and radioisotopes. Table C-1 summarizes constituents present in environmental media samples collected at the Site and identify the highest concentrations reported for these constituents. In addition, a literature review was conducted to find exposure limits for all COIs, and ionization potentials (IP) for volatile organic compounds.

Exposure limits are expressed as 8-hour time weighted averages (TWAs) or ceiling limits. The OSHA and NIOSH TWAs are referred to as permissible exposure limits (PELs) and recommended exposure limits (RELs). The ACGIH adopts values for exposure limits referred to as threshold limit values (TLVs) and further divides some into TWAs, ceiling limits, and short-term exposure limits.

Limits of exposures of workers to radioactive materials on the Site will be the same as limits for members of the public. With this approach, Site workers will not be classified as "radiation workers" and will not have to comply with more extensive training requirements. The exposure limits for members of the public to radiation and radioactive material are specified by the Idaho Department of Quality. Previous radiological characterization data for the Site (discussed below) have shown that potential radiation doses to workers at the Site during the investigations will be less than 100 millirems per year (mrem/yr). Additional radiological characterization data for the Site will be acquired during the investigations to evaluate/verify this conclusion.

5.1 PARTICULATE MONITORING

Non-volatile compounds (i.e., metals) in ambient air are measured with particulate monitoring devices (e.g., Mini-Ram). Particulate monitoring devices pass the ambient air through a beam of light and measure the degree of light scatter produced by the particulate matter. Particulate monitoring is expected to occur during intrusive work (e.g., drilling). The SHSC will determine when particulate monitoring is necessary.

In order to provide adequate PPE for field personnel, continuous particulate monitoring will be performed with a Mini-Ram or similar particulate monitor when working in the Main Plant Area until conditions in these areas can be assessed. A Mini-Ram can only measure total particulate matter; therefore, upgrades to the PPE will be based upon the maximum expected concentrations for expected chemicals (Table C-2). Level D PPE will be used when the dust concentrations are below 2.5 mg/m^3, unless acid mist is present at a location. If sustained Mini-Ram readings greater than 2.5 mg/m^3 are recorded for 5 minutes, the work area will be evacuated and dust control measures put into place. In the interim, field personnel implementing dust control measures will be required to upgrade to Level C PPE. Level C protection includes the donning of a tight-fitting respirator equipped with P-100 cartridges.

In areas where acid mist is present, continuous monitoring will be performed with a Mini-Ram or similar particulate monitor. Upgrades to the PPE will be based upon area specific action levels:

- Phosphate Building/Digester = 1 mg/m^3
- Oxidation Tank Farm/SPA/PPA = 0.5 mg/m^3
- Sulfuric Acid Plant and Tank Farm = 0.5 mg/m^3

- Granulation Area = 1 mg/m^3

5.2 EXTERNAL RADIATION DOSE MONITORING

Based on prior sample results and dosimetry data for the Site, there is no reasonable exposure scenario by which an employee could exceed applicable radiation dose limits while working on the Site during the investigation. Nevertheless, to verify this and to provide useful Site-specific exposure data, several of the personnel that are likely to be performing the bulk of the field work will be assigned a personal radiation dosimeter to measure the external radiation doses and document actual radiation dose rates. Such workers will be required to pick up their assigned dosimeter at the "access control point" (i.e., field office) and return the dosimeter to the control point when leaving the Site. When not being worn by workers, personal dosimeters will be stored in a secure, shielded container with background (control) dosimeters. A certified commercial dosimetry service will be used to analyze the control and personal dosimeters.

6 Site Controls and Decontamination

The following section defines the measures and procedures for maintaining Site control and decontamination. Site control is an essential component in the implementation of the health and safety program; decontamination procedures will ensure that hazardous materials are not removed and that offsite exposure risks are minimized.

6.1 PRE-ENTRY HEALTH AND SAFETY BRIEFING

At the beginning of each work day and before any work starts, a health and safety briefing must be conducted. The Field Team Leader and SHSC will review activities scheduled for the day and the hazards associated with those tasks with the Site workers. A record of the pre-entry health and safety briefing will be documented in the field log books.

6.2 SITE ENTRY

The CPO property is surrounded by a chain link fence. The main entrance is manned 24 hours a day, 7 days a week.

No visitors associated with the project will be permitted to enter the property without permission of the Project Coordinator or his designate. Visitors to the on- or off-property work areas will be permitted, but access to exclusion zones (e.g., drilling locations) will be denied without evidence of training and medical surveillance, and review of the HASP (see Section A.2.1.2). A safe perimeter of 20 feet will be established around all work areas when conducting drilling, soil, surface water and groundwater sampling. Contractors will limit the access of others to off-property work areas by establishing physical barriers (e.g., pylons, caution tape). When working on private property, Site workers will communicate with property owners, homeowners, residents, or tenants regarding safety procedures during activities performed on or in the vicinity of their property.

6.3 SITE COMMUNICATION

A series of three extended car horn blasts will be the emergency signal to indicate that all personnel must evacuate the work area. Electronic communication (e.g., cell phones) will be used to notify personnel outside of the immediate work area. When working on private property, Site workers will establish communication procedures with homeowners and/or residents before conducting any work. Local emergency authorities will be contacted as necessary. In case of evacuation, personnel will follow facility protocols.

6.4 DECONTAMINATION

Decontamination is the process of removing or neutralizing contaminants that have accumulated on non-disposable PPE and equipment that have been in contact with potentially impacted environmental media. Decontamination protects workers from substances that may contaminate and eventually permeate the protective clothing, respiratory equipment, sampling equipment, vehicles, and other equipment used. Proper decontamination protects all Site personnel by preventing the transfer of potentially contaminated materials into clean areas, the

mixing of incompatible materials, and the uncontrolled transportation of contaminants. Decontamination will take two forms: equipment and personnel.

Decontamination of equipment will prevent the removal of constituents from the Site to areas beyond the Site and prevent cross-contamination from dirty to clean areas within the Site. As discussed in Section 4, equipment to be decontaminated includes all down-hole drilling or testing equipment and tools which may come into contact with the potentially contaminated media, as well as reusable sampling equipment.

This HASP specifies the correct level of personal protection to be worn based on the conditions and potential for exposure. Personnel decontamination procedures are provided in Appendix B.

7 Level of Protection

All contractors, excluding the geophysical contractor, will have completed a 40-hour health and safety training course fulfilling the initial instruction requirements specified in 29 CFR 1910.120(e)(2) for activities on a hazardous waste site. Before personnel arrive at the Site, each contractor will provide documentation of 40-hour training, 8-hour refresher training, participation in a medical monitoring program, and fit-test results for the use of tight-fitting respirators for each site worker. Workers will be required to acknowledge that this HASP and any Site-specific HASP that their employer has prepared have been reviewed.

Most activities are expected to be performed in modified Level D PPE. Modifications to this level of PPE are permitted. Levels of protection should be selected based on the following:

- type and concentration of the chemical substance in the ambient atmosphere and its toxicity
- potential for exposure to substances in air, liquids, solids, or other materials personnel may come into contact with during the work
- knowledge of chemicals present along with their properties such as toxicity, route of exposure, and contaminant matrix
-

In situations where the type of chemicals, chemical concentrations, or possibilities of contact are not known, WSP employees will begin the Task in Level C personal protection until the hazards can be better defined. However, if CPO personnel have data or experience in the area containing unknown hazards, the SHSC will discuss the situation with CPO personnel and with the WSP corporate H&S officer.

The current PPE assessment was based on the anticipated hazards of work activities using existing Site characterization data. Proper modifications to the level of PPE to be used will be made as necessary. Types of sampling that may be performed include instantaneous and continuous organic vapor monitoring, instantaneous and continuous particulate matter monitoring, and OSHA and NIOSH reference method sampling. This monitoring would be performed at a frequency and duration adequate to assess potential hazards.

8 Personal Protection Equipment

Personal protective equipment will be used to reduce employee exposure to hazards that may be encountered while performing sampling activities.

8.1 EQUIPMENT

Level D will consist of the following equipment as dictated by actual activity needs:

- steel-toe work boots
- nitrile, viton, neoprene, or butyl gloves
- hard hats and hearing protection
- safety glasses, goggles, or face shields
- Tyvek or coated Tyvek coveralls
- Rubber boots

All employees will don this level of protection before conducting any activity in the work zone. Respirators and coveralls will be available, but not required unless organic vapors and/or particulates exceed established background levels.

Level C PPE will consist of the same items listed for Level D and include a NIOSH-approved air-purifying respirator (APR) with organics, dust, acid gas, and pesticide respirator cartridges (MSA cartridges GMC-P100). Contractors will be responsible and provide appropriate PPE for their employees.

The level of protection will vary by task and location. The person collecting samples will don a coated Tyvek and face shield. The person recording notes will don a Tyvek suit, and keep face shield nearby. Respirators will not be required, but will be available. Table C-2 lists upgrade action levels by location, including the Phosphate Building/Digester, Oxidation Tank Farm/SPA/PPA Areas, Sulfuric Acid Plant and Tank Farm, and Granulation Area. Action levels for areas not listed on Table C-2 are 2.5 mg/m^3 for solid particulate and 1 mg/m^3 for acid mist. If samples are required from inside the Phosphate Unit, all employees will enter in Level C.

The fit of the facepiece-to-face seal of the respirator affects its performance. All personnel required to use APRs will provide up-to-date fit test documentation. After each day's use, the APR will be inspected, cleaned, and stored by the employee.

Damaged PPE will be replaced immediately. WSP and all other contractors will have backup equipment available.

The following protective equipment (if used) will be discarded and replaced daily:

- respirator cartridges
- Tyvek coveralls
- outer booties
- inner surgical gloves
- outer gloves

- safety glasses or equivalent PPE, when working near liquids

Procedures for putting on PPE are provided in Appendix B. Item 15 of Appendix B outlines procedures for containerizing used PPE and personal decontamination wastes.

The level of protection provided by PPE selection may be upgraded or downgraded by the SHSC based on changes in conditions or findings. When a significant condition change occurs, the hazards will be reassessed. Some indicators for hazard reassessment are as follows:

- start of a new work phase (e.g., start of work on a different area)
- a change in job tasks during a work phase
- a change of weather
- encountering contaminants other than those previously identified
- a change in ambient or background levels of contaminants
- a change in work scope that affects the degree of contaminant contact.

8.2 INSPECTION

Proper inspection of PPE features several sequences of inspection depending on specific articles of PPE and its frequency of use. The different levels of inspection are as follows:

- inspection and operational testing of equipment received from the factory or distributor
- inspection of equipment as it is issued to workers
- inspection after use or training
- periodic inspection of stored equipment
- periodic inspection when a question arises concerning the appropriateness of the selected equipment or when problems with similar equipment arise.

The primary inspection of PPE will occur before use and will be conducted by the user. This ensures that the device or article has been checked out by the user and the user is familiar with its use.

9 On-Site Monitoring and Safety Equipment

Several pieces of safety equipment will be provided near the work area. A particulate monitor, PID or both, as appropriate, will be used to monitor conditions within in the breathing zone of workers upwind and downwind of sampling locations in the Main Plant Area. Radiation monitoring equipment will include personal dosimeters for select contractor personnel as described in Section 5.3.

A first aid kit and eyewash will be available during all work conducted at all locations onsite. A first aid kit will be kept in the vehicle during work performed at any locations beyond the property boundary. Awareness of the location of the nearest telephone, potable water supply, and sanitary facility during each field activity will be acknowledged by all appropriate personnel by signing the certification in Section 13.0. Chemical showers and eyewashes are available throughout the plant area.

10 Contingency Plan and Emergency Procedures

During daily Site briefings, personnel will be reminded of provisions outlined in the emergency response plan, communication systems, and evacuation routes. This plan will be reviewed and revised, if necessary, on a regular basis by the SHSC. This will ensure that the plan is adequate and consistent with prevailing conditions.

10.1 PERSONNEL ROLES AND LINES OF AUTHORITY

The Field Team Leader and SHSC have primary responsibility for responding to and correcting emergency situations affecting project personnel. Possible actions may involve evacuation of personnel from the Site. Contractors are responsible for addressing any emergencies resulting from their work, establishing the proper incident command structure, and implementing response actions, as necessary.

10.2 EVACUATION ROUTES AND PROCEDURES

It is possible that an emergency could necessitate evacuation of all personnel. If such a situation should arise, the designated emergency signal of a series of three extended horn blasts shall be sounded and all personnel will move to the designated meeting location. Electronic communication (e.g., cell phone) will be used to alert workers beyond the range of the horns. In case of evacuation, personnel will follow facility protocols.

All available vehicles outside the work area would be used in the evacuation. All personnel would exit the area, making sure to be upwind of smoke, vapors, or spill location(s), and meet at the guard house. A second rendezvous point will be selected by the SHSC in case the guard house would be in appropriate based on wind direction, severity, and type of incident. The coordinator will conduct a head count to insure all personnel have been evacuated safely using the Site log. If someone is missing, the SHSC, or his designated representative, will alert the appropriate CPO personnel and local emergency response personnel.

10.3 EMERGENCY CONTACT AND NOTIFICATION SYSTEM

To obtain medical assistance as soon as possible in the case of an emergency, the following telephone numbers, addresses, and directions for the nearest medical treatment facilities will be posted in each project vehicle:

Nearest Telephone:	Field Team Leader, SHSC	Phone:	task dependent[1]
Ambulance (name):	Ambulance-paramedics	Phone:	911
Hospital (name):	Caribou Memorial Hospital	Phone:	(208) 547-3341 or 911
Police (local or state):	Soda Springs PD	Phone:	(208) 547-3213 or 911

[1] It is the responsibility of the task-specific field team members to communicate contact numbers on a daily or weekly basis as appropriate based on the activity duration and changes in the field teams.

Fire Department (name): Soda Springs FD Phone: (208) 547-3977 or 911

State Poison Control Center: Poison Control Center Phone: (800) 632-8000 or 911

Directions to Hospital:

1.	Start going West on Conda Road	
2.	Turn left onto ID-34	1.2 miles
3.	Turn left onto 3rd St. E/S. ID-34	5.5 miles
4.	Turn right onto E 2nd St. S/ID-34	0.3 mile
5.	Turn left onto 3rd W	0.9 mile
6.	End at Hospital (300 S. 3rd Street W)	0.2 mile

Total Estimated Time: 14 minutes Total Estimated Distance: 8.1 miles

A map showing the route to the hospital is provided in Appendix G.

In an emergency situation, all personnel will take direction from their SHSC. The SHSC will also be responsible for notifying the appropriate emergency organization. The names and phone numbers of all personnel and agencies that could be involved in an emergency response will be determined by the SHSCs present. This information will be readily available at the Site.

10.4 EMERGENCY MEDICAL TREATMENT PROCEDURES

In an emergency, the primary concern is to prevent the loss of life or severe injury to personnel. If immediate medical treatment is required, personal decontamination will be delayed until the condition of the victim has stabilized. If decontamination can be performed without interfering with first aid or if a worker has been contaminated with an extremely toxic or corrosive material that could cause severe injury, decontamination will be performed immediately. If an emergency caused by a heat-related illness develops, protective clothing will be removed from the victim as soon as possible to reduce heat stress.

The following standard emergency procedures will be used during the project. The SHSC shall be notified of any emergencies and will be responsible for ensuring that the appropriate procedures are followed. These procedures shall be rehearsed regularly as part of the overall safety program for the project.

Minor injuries: If the injury or illness is minor, full decontamination should be completed and first aid administered before the injured is transported to hospital.

Major injuries: If the patient's condition is serious, call 911 for ambulance and paramedic support. At least partial decontamination should be completed, but only under the supervision of trained medical professionals. First aid may be administered while awaiting an ambulance or paramedics. The choice of hospital shall be made by the ambulance personnel.

Any person transported to a clinic or hospital for treatment should take a copy of this HASP because it provides information of the chemical or chemicals to which the person may have been exposed.

10.5 MEDICAL EMERGENCIES

Five medical emergencies have been identified as requiring implementation of emergency procedures. These emergencies are cardio-pulmonary emergencies, physical injuries, heat or cold-related injuries, chemical exposures, and snake or spider bite. Heat- and cold-related issues are discussed in Appendix C.

10.5.1 Cardio-Pulmonary Emergencies

Cardio-pulmonary emergencies are life-threatening situations requiring immediate response of trained individuals to prevent death. At no time will these emergencies be considered less than life-threatening. These emergencies include heart attack, cardiac arrest, or respiratory arrest. Response and emergency treatment will be rendered without regard to protective equipment or decontamination procedures. As a precaution, and if necessary, a representative from the Site will accompany the worker to the hospital to advise on matters of decontamination.

10.5.2 Physical Injuries

Physical injuries can range from minor sprains, to internal injuries, to an open compound fracture. Depending on the severity of the injury, treatment may be delayed for decontamination procedures to be performed. If the physical injury is major, decontamination procedures should be supervised by a trained medical professional. The level of decontamination will be directly related to the seriousness of the injury and will be determined by the SHSC or his designee.

Outside garments can be removed (depending on the weather) if they do not cause delays, interfere with treatment, or aggravate the injury. Respiratory masks and chemically-resistant clothing should be removed from the injured person. If the outer contaminated garments cannot be safely removed, the individual should be wrapped in blankets to help prevent contaminating the inside of the ambulance or medical personnel. Outside garments are then removed at the medical facility. One exception would be if it is known that the individual has been contaminated with an extremely toxic or corrosive material which could cause severe injury or loss of life.

If an employee working in a contaminated area is physically injured, appropriate first aid procedures will be followed. Depending on the severity of the injury, emergency medical response may be sought. If the employee can be moved, he/she will be taken to the edge of the work area (on a stretcher, if needed) where contaminated clothing will be removed, additional emergency first aid will be administered, and transportation to a local emergency medical facility will be arranged.

10.5.3 Chemical Exposure

Exposure to chemicals can be divided into two categories:

- injuries from direct contact, such as acid burns or inhalation of toxic chemicals
- potential injury due to gross contamination on clothing or equipment.

For inhaled contaminants, treatment can only be provided by qualified physicians. If the contaminant is on the skin or in the eyes, immediate measures must be taken to counteract the

substance's effect. First aid treatment usually is flooding the affected area with clean water; however, for a select few chemicals, water may cause more severe problems.

When protective clothing is grossly contaminated, the constituents may be transferred to treatment personnel or the wearer and cause injuries. Unless severe medical problems have occurred simultaneously with splashes, the protective clothing should be washed off as rapidly as possible and carefully removed. Portable eye washes will be available to provide a means of flushing and washing such contamination.

If the injury to the worker results from a chemical splash or uncontrolled release, the following first aid procedures are to be instituted:

- Eye Exposure - If contaminated solids or liquids get into the eyes, wash eyes immediately at the emergency eyewash station using large amounts of running or flowing water. Obtain medical attention immediately. **Contact lenses will not be worn at the Site.**
- Skin Exposure - If contaminated solids or liquids get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. Obtain medical attention immediately when exposed to concentrated solids or liquids.
- Breathing - If a person breathes in large amounts of contaminants, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration immediately. Keep the affected person warm and at rest. Obtain medial attention as soon as possible.
- Swallowing - When contaminated solids or liquids have been swallowed and the person is conscious, attempt to obtain information from the person to aid in identifying the substance swallowed. Contact the poison control center immediately. Under their direction, one or two glasses of milk or water may be administered to dilute the swallowed material. The poison control center may direct a responder to induce vomiting. Do not induce vomiting if: the person is unconscious or semiconscious, or convulsing; if a strong corrosive has been swallowed or if a petroleum product has been swallowed. Vomiting is best induced by administering one tablespoon of Syrup of Ipecac. Transport the person to the hospital and monitor the airway constantly.

10.5.4 Snake/Spider Bite

A discussion of snake/spider bites is included here. Additional information, including guidance on the identification of poisonous snakes and spiders that could be encountered in southeast Idaho is included in Appendix D.

Snakes are most likely to bite when they feel threatened, are startled, provoked, and/or have no means of escape when cornered. Encountering a snake is always considered dangerous and it is recommended to leave the vicinity. When dealing with direct encounters it is best to remain silent and motionless; if the snake does not flee it is important to step away slowly and cautiously. To avoid other encounters it is advised not to reach blindly into hollow logs, overturn rocks, or enter unoccupied buildings or other potential snake hiding-places. Sturdy over-the-ankle boots, loose clothing, Kevlar snake chaps, and responsible behavior offer effective protection from snakebites when in the wilderness.

The most common symptoms of all snakebites are panic, fear and emotional instability, which may cause symptoms such as nausea and vomiting, diarrhea, vertigo, fainting, tachycardia, and cold, clammy skin.

If an employee is bitten by a snake, the following first aid procedures will be followed, regardless of the species. Dry snakebites and bites inflicted by a non-venomous species, are still able to cause severe injury to the victim. There are several reasons for this; a snakebite which is not treated properly may become infected, the bite may cause anaphylaxis (i.e., allergic reaction) in certain people, and the saliva and fangs of the snake may harbor many dangerous microbial contaminants. An infection may spread if neglected, and, in the worst cases, even kill the victim.

Protect the patient (and others, including yourself) from further bites. While identifying the species is desirable, do not risk further bites or delay proper medical treatment by attempting to capture or kill the snake. If the snake has not already fled, carefully remove the patient from the immediate area. (Avoid snakes that appear to be dead, as some species will actually rollover on their backs and stick out their tongue to fool potential threats. Additionally, a snake's detached head can immediately reflex and potentially bite; the bite can induce just as bad an effect as a live snake bite.)

Keep the patient calm and call for help (911) to arrange for transport to the nearest hospital emergency room, where anti-venom for snakes common to the area will often be available.

Make sure to keep the bitten limb in a functional position and below the victim's heart level so as to minimize blood returning to the heart and other organs of the body.

Outside garments can be removed (depending on the weather) if they do not cause delays, interfere with treatment, or aggravate the injury. Respiratory masks and chemically-resistant clothing should be removed from the injured person. If the outer contaminated garments cannot be safely removed, the individual should be wrapped in blankets to help prevent contaminating the inside of the ambulance or medical personnel. Outside garments are then removed at the medical facility. One exception would be if it is known that the individual has been contaminated with an extremely toxic or corrosive material which could cause severe injury or loss of life.

Do not give the patient anything to eat or drink. This is especially important with consumable alcohol, a known vasodilator that will speed up the absorption of venom. Do not administer stimulants or pain medications to the victim, unless specifically directed to do so by a physician.

Remove any items or clothing which may constrict the bitten limb if it swells (e.g., rings, bracelets, watches, footwear).

Keep the patient as still as possible.

Do not incise the bitten site.

Many organizations, including the American Medical Association and American Red Cross, recommend washing the bite with soap and water. However, do not attempt to clean the area with any type of chemical.

Some medical professionals, along with the American Red Cross, cautiously recommend two other measures:

If a victim is unable to reach medical care within 30 minutes, a bandage, wrapped two to four inches above the bite, may help slow venom. The bandage should not cut off blood flow from a vein or artery. A good rule of thumb is to make the band loose enough that a finger can slip under it.

Apply a cold compress to the bite area and apply continuous, steady pressure.

10.6 FIRE/EXPLOSION

On notification of a fire or explosion, the designated emergency signal of a series of three extended horn blasts shall be sounded and all personnel will move to the designated meeting location. Electronic communication (e.g., cell phone) will be used to alert workers outside of the work area. The fire department shall be alerted and all personnel moved to a safe distance from the emergency area.

Fire extinguishers will be present at the Site. If a small, localized fire breaks out, chemical fire extinguishers will be used in an attempt to put out incipient-stage fires. If necessary and feasible, a fire blanket, soil, or other inert materials will be placed on the burning area to extinguish the flames and minimize the potential for spreading. Local fire-fighting authorities will be contacted for assistance.

If an uncontrolled fire develops releasing potentially toxic gases, Site personnel and the public in the immediate vicinity will be evacuated. Only personnel trained in fire fighting and outfitted with proper protective equipment will be allowed in the immediate fire area. The Field Team Leader, SHSC, or their designee assistant will alert local fire-fighting companies.

In case of evacuation, personnel will follow facility protocols.

10.7 PERSONAL PROTECTIVE EQUIPMENT FAILURE

If any worker experiences a failure or alteration of protective equipment that affects the protection factor that person and his buddy shall immediately leave the work area. Re-entry shall not be permitted until the equipment has been repaired or replaced.

10.8 OTHER EQUIPMENT FAILURE

If any other equipment fails to operate properly, the Field Team Leader or the SHSC shall be notified to determine the effect of this failure on continuing operations. If the failure affects worker safety or prevents completion of the activity, all personnel shall evacuate the work area until the situation is evaluated and appropriate actions taken.

In all situations when an emergency results in the evacuation of a work area, personnel shall not re-enter the area until the following conditions have been met:

- the conditions resulting in the emergency have been corrected
- the hazards reassessed
- the HASP is reviewed.

Site personnel have been briefed on any changes in the HASP.

11 Training Requirements

Several levels of health and safety training are required for personnel participating in the implementation of field activities. Documentation of this training will be maintained in the WSP project files and at the Site for all personnel who have access to or work at the site.

11.1 INITIAL TRAINING

With the exception of the GPR contractor, all other RI/FS contractors participating in field activities will have received training in accordance with 29 CFR 1910.120. This training shall include, but is not limited to:

- names and responsibilities of site health and safety personnel
- chemical and physical hazards present on the Site
- safe use of PPE, including respiratory protection
- safe work practices
- use of engineering controls and equipment on the Site
- medical surveillance requirements, including right-to-know
- air monitoring program and record keeping
- material handling procedures
- decontamination procedures
- site control procedures
- evacuation and emergency procedures.

These workers must present the following documents to the SHSC overseeing a task before field activities commence:

- 40-hour OSHA training
- current 8-hour refresher certificates
- annual qualitative fit test results for half-face or full-face respirators.

11.2 SITE-SPECIFIC TRAINING

Site-specific hazard training including identification of the protective measures described herein, before beginning work. Attendance records for the meetings will be maintained in the project files.

Pre-entry briefings will be held prior to initiating any Site activity, and at such other times as necessary to ensure that employees are apprised of the HASP and that it is being followed. The information and data obtained during Site characterization activities will be used to prepare and update the HASP.

11.3 VISITOR TRAINING

All visitors to the active work areas will be briefed by the SHSC on health and safety procedures to be followed. The visitors will be provided the HASP to review and will sign a certification that the plan has been provided, reviewed, and understood before visitors enter an active work area.

The SHSC will control visitor entry to the active work areas. No visitor will enter these areas without previously notifying the Field Team Leader/SHSC of the visit and providing documentation of training outlined in Section 11.1. The SHSC will ensure that all visitors have the proper level of PPE for downrange activities and training in the use of the equipment; visitors who do not have the appropriate training will not be permitted in areas where the use of PPE is required.

12 Authorized Changes to the Health and Safety Plan

All changes to the HASP are to be documented by completing a form for Modification of Site Health and Safety Plan (Form C-1). This completed form must be signed by the SHSCs, HSOs, and Project Managers. A copy of all completed forms will be included with each copy of the HASP and maintained with the project files.

13 Certification

This HASP, prepared by Laura Tobin of WSP, which satisfies the requirements of OSHA 1910.120, has been reviewed and approved by the WSP HSOs.

By their signature below, these and all Site personnel certify that they have read the HASP, and are familiar with, and will comply with, its provisions.

NAME	SIGNATURE	EMPLOYER

14 References

American Conference of Governmental and Industrial Hygienists (ACGIH). 1999. Threshold Limit Values and Biological Exposure Indices for 1999. Cincinnati, Ohio.

Ansell Edmont Industrial, Chemical Degradation Guide for Gloves and Protective Clothing.

Forsberg, Krister. 1997. Quick Selection Guide to Chemical Protective Clothing, 3rd Edition. Van Nostrand Reinhold Company, New York.

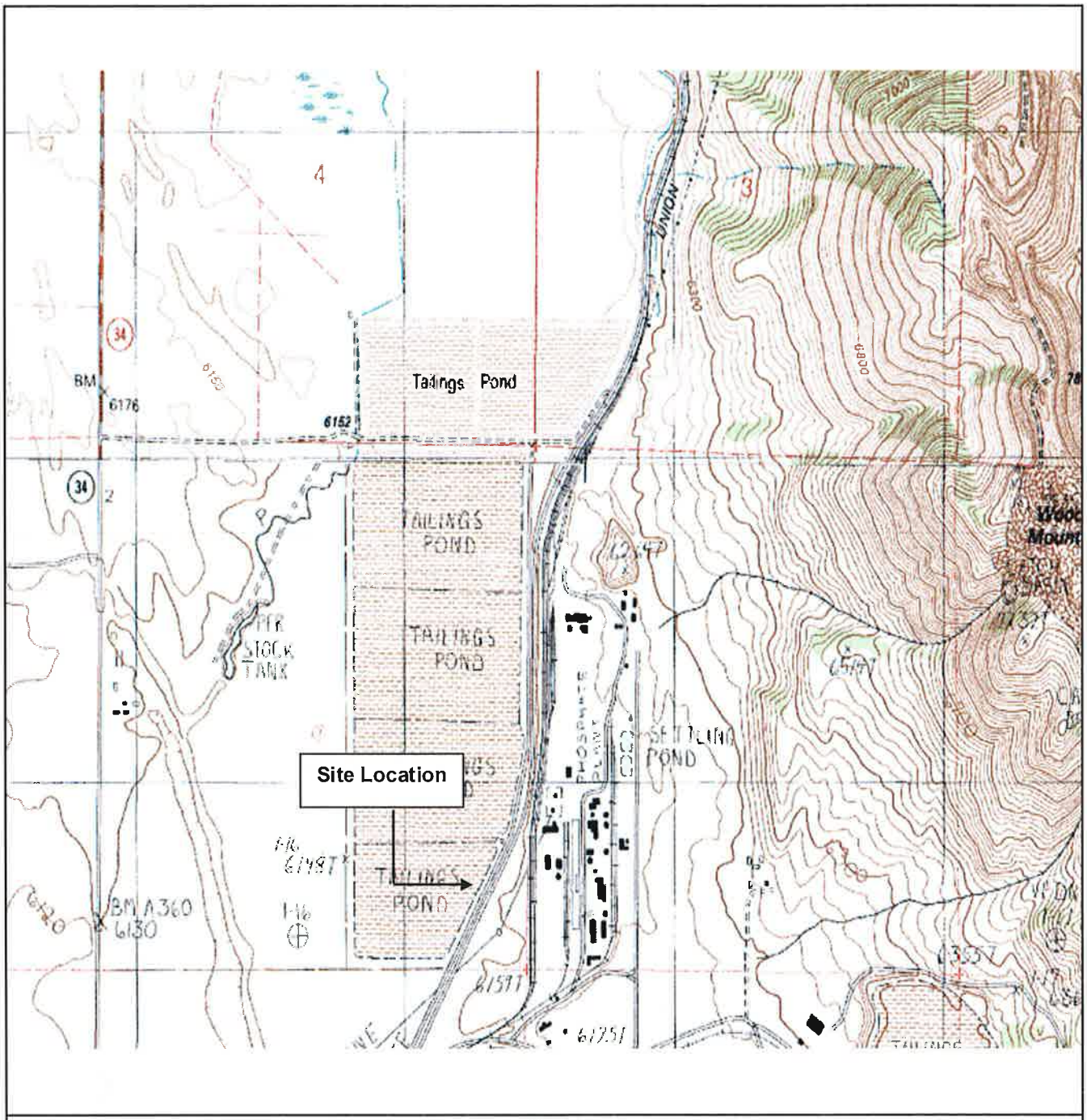
National Institute of Occupational Safety and Health (NIOSH)/Occupational Safety and Health Administration (OSHA). 1985. Pocket Guide to Chemical Hazards.

National Institute of Occupational Safety and Health/Occupational Safety and Health Administration/U.S. Coast Guard/U.S. Environmental Protection Agency. 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.

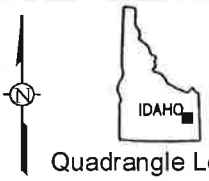
Occupational Safety and Health Administration (OSHA). 1999. OSHA Technical Manual, Section V: Chapter 2.

Rae Systems. 2005. RAE Systems PID Training Outline. San Jose, California.

Figures



Reference
7.5 Minute Series Topographic Quadrangle
Soda Springs, Idaho
Photorevised 1982 Scale 1:24,000



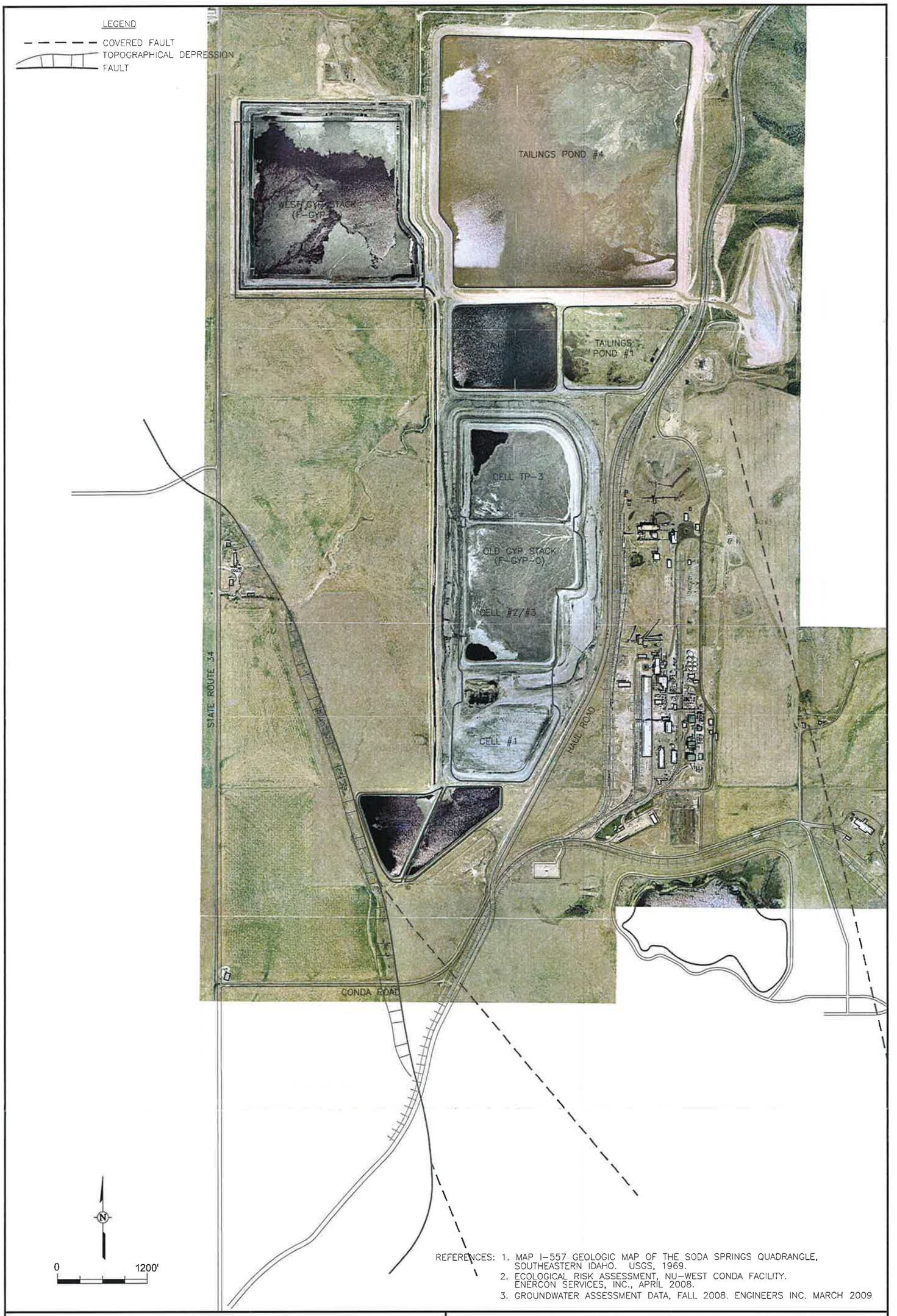
Quadrangle Location

1000 0 2000 4000

Scale in Feet

WSP Environment & Energy
4600 South Ulster Street
Suite 930
Denver, Colorado 80237
303-850-9200

Figure C-1
Site Location
Nu-West CPO
Soda Springs, Idaho



REFERENCES:
1. MAP I-557 GEOLOGIC MAP OF THE SODA SPRINGS QUADRANGLE, SOUTHEASTERN IDAHO. USGS, 1969.
2. ECOLOGICAL RISK ASSESSMENT, NU-WEST CONDA FACILITY. ENERCON SERVICES, INC., APRIL 2008.
3. GROUNDWATER ASSESSMENT DATA, FALL 2008. ENGINEERS INC. MARCH 2009

WSP

WSP Environment & Energy
4600 South Ulster Street Suite 930
Denver, Colorado 80237
(303) 850-9200

Figure C-2
Facility Layout
Nu-West CPO Facility
Soda Springs, Idaho

10002704.DWG

Tables

Table C-1

Maximum Constituent Concentrations by Media
Health and Safety Plan
Nu-West Industries - Conda Phosphate Operations Facility
Soda Springs, Idaho

Parameters	PEL [a]	Sludge Concentration (mg/kg)	Sludge Location	Groundwater Concentration [b] (mg/m^3)	Groundwater Location	Waste Water Concentration [b] (mg/m^3)	Waste Water Location
Metals							
Aluminum	5 mg/m^3	22,000	AGPS-03	0.353	MWB	0.27	AGPS-06
Antimony	0.5 mg/m^3	-	-	0.000042	MWB	0.00012	AGPS-01
Arsenic	0.01 mg/m^3	1.6	AGPS-02	0.000021	MWB	0.00067	AGPS-05
Barium	0.5 mg/m^3	140	AGPS-03	0.000034	MWB	0.002	AGPS-06
Beryllium	0.002 mg/m^3	-	-	0.000013	MWB	-	
Boron	10 mg/m^3 (c)	-	-	-		-	
Cadmium	0.005 mg/m^3	62	AGPS-03	0.000171	MWB	0.0082	AGPS-05
Calcium	5 mg/m^3	80,000	AGPS-03	0.41	A-2A	4	AGPS-05
Chromium	1 mg/m^3	29	AGPS-02	0.00023	NW-9	0.015	AGPS-06
Cobalt	0.1 mg/m^3	-	-	0.00025	MWB	-	
Copper	1 mg/m^3	5.2	AGPS-02	0.000247	NW-5	0.0041	AGPS-05
Iron	10 mg/m^3	2,100	AGPS-03	0.00738	NW-9	0.13	AGPS-06
Lead	0.05 mg/m^3 (b)	32	AGPS-03	0.000006	A-7	0.00069	AGPS-05
Lithium	0.025 mg/m^3	-	-	-		-	
Magnesium	15 mg/m^3	14,000	AGPS-03	0.2397	MWB	0.17	AGPS-06
Manganese	5 mg/m^3	22	AGPS-02	0.0132	MWB	0.0051	AGPS-05
Mercury	0.1 mg/m^3	0.087	AGPS-03	-		0.0000034	AGPS-05
Nickel	1 mg/m^3	14	AGPS-02	0.00127	MWB	0.0041	AGPS-06
Potassium	5 mg/m^3	12,000	AGPS-02	0.098	A-7	0.32	AGPS-06
Selenium	0.2 mg/m^3	2.8	AGPS-02	0.000036	JRS-11	-	
Silver	0.01 mg/m^3	-	-	-		-	
Sodium	NA	21,000	AGPS-02	0.5822	A-7	1.2	AGPS-06
Thallium	0.1 mg/m^3	-	-	0.000003	A-8	0	
Vanadium	0.5 mg/m^3	43	AGPS-02	0.00055	NW-9	0.022	AGPS-06
Zinc	5 mg/m^3	0.124	AGPS-02	0.00371	MWB	0.038	AGPS-06
General Chemistry							
Bromide	NA	-	-	-	-	-	-
Chloride	NA	-	-	0.374	MWA	-	-
Fluoride	NA	-	-	0.706	MWB	17	AGPS-05
Total Phosphate	NA	-	-	-	-	-	-
Orthophosphate	NA	-	-	0.202	NW-9	-	-

Table C-1

Maximum Constituent Concentrations by Media
Health and Safety Plan
Nu-West Industries - Conda Phosphate Operations Facility
Soda Springs, Idaho

Parameters	PEL [a]	Sludge Concentration (mg/kg)	Sludge Location	Groundwater Concentration [b] (mg/m^3)	Groundwater Location	Waste Water Concentration [b] (mg/m^3)	Waste Water Location
Sulfate	NA	-	-	1.558	MWB	-	-
Total Sulfide	NA	-	-	-	-	-	-
Total Dissolved Solids	NA	-	-	8.792	MWB	-	-
Total Suspended Solids	NA	-	-	0.183	NW-9	-	-
Total Organic Carbon	NA	-	-	-	-	-	-
Dissolved Organic Carbon	NA	-	-	-	-	-	-
Dissolved Carbon Dioxide	NA	-	-	-	-	-	-
Nitrate	NA	-	-	0.207	MWA	-	-
Nitrite	NA	-	-	-	-	-	-
Nitrate-Nitrite	NA	-	-	-	-	-	-
Ammonia	35 mg/m^3	-	-	0.114	MWA	-	-
Total Kjeldahl Nitrogen	NA	-	-	0.139	MWA	-	-
Total Alkalinity	NA	-	-	1.495	A-7	-	-
Acidity	NA	-	-	-	-	-	-
pH	NA	-	-	0.008	NW-8	-	-
Total Hardness	NA	-	-	-	-	-	-
Specific Conductance (µS/cm)	NA	-	-	6360	NW-5	-	-
Turbidity (NTU)	NA	-	-	122	A-7	-	-
Radiochemical Parameters							
Gross Alpha (pCi/L)	NA	-	-	9.30	A-4	-	-
Gross Beta (pCi/L)	NA	-	-	99	A-7	-	-

As noted in the title, the concentrations provided in this table represent the maximum levels reported in Site samples; as such, these concentrations are not representative of values typically encountered nor do they represent Site average values.

mg/kg - milligrams per kilogram
mg/m^3 - milligrams per cubic meter
µS/cm - microsiemens per centimeter
NTU - nephelometric turbidity units
PEL - permissible exposure limit
pCi/L - picoCuries per Liter
NA - not applicable
a/ PELs, which are legal exposure limits established by OSHA, are provided as time-weighted averages (TWAs). A TWA is the average exposure over a specified period of time (typically 8-hour work shifts during 40-hour work weeks). This means that, for limited periods, a worker may be exposed to concentrations higher than the PEL, so long as the average concentration over 8 hours remains below the PEL.
b/ Concentrations reported in mg/L. Converted to mg/m^3.
c/ National Institute for Occupational Safety and Health recommended exposure limit (REL).

Table C-2

Action Levels
Health and Safety Plan
Nu-West Industries - Conda Phosphate Operations Facility
Soda Springs, Idaho

Constituent	OSHA ACTION LEVEL / PEL (mg/m3)	NIOSH IDLH (mg/m3)	Maximum Concentration (mg/kg)(a)	**Individual Constituent Dust Level Resulting in PEL (mg/m3)**	Relative Proportion of Contaminant	Weighted Reciprocal Factor	**Individual Constituent Factor of Safety at 2 mg/m3**
Aluminum	5	--	22,000	**227.27**	14.32%	0.004	**90.91**
Antimony	0.5	50	-	-	-	-	-
Arsenic	0.01	5	1.6	**6250**	0.00%	0.000	**2500.00**
Barium	0.5	50	140	**3571.43**	0.09%	0.000	**1428.57**
Beryllium	0.002	4	-	-	-	-	-
Boron	10	9	-	-	-	-	-
Cadmium	0.005	25	250	**20.00**	0.16%	0.050	**8.00**
Calcium	5	25	80,000	**62.50**	52.08%	0.016	**25.00**
Chromium	1	15	2,000	**500.00**	1.30%	0.002	**200.00**
Cobalt	0.1	20	-	-	-	-	-
Copper	1	100	5.2	**192,307.69**	0.00%	0.000	**76,923.08**
Iron	10	2500	2,100	**4,761.90**	1.37%	0.000	**1,904.76**
Lead	0.05	100	32	**1,562.50**	0.02%	0.001	**625.00**
Lithium	0.025	0.5	-	-	-	-	-
Magnesium	15	750	14,000	**1,071.43**	9.11%	0.001	**428.57**
Manganese	5	500	22	**227,272.73**	0.01%	0.000	**90,909.09**
Mercury	0.1	10	0.087	**1,149,425.29**	0.00%	0.000	**459,770.11**
Nickel	1	2	14	**71,428.57**	0.01%	0.000	**28,571.43**
Potassium	5	1	12,000	**416.67**	7.81%	0.002	**166.67**
Selenium	0.2	10	2.8	**71,428.57**	0.00%	0.000	**28,571.43**
Silver	0.01	10	-	-	-	-	-
Sodium	NA	15	21,000	-	13.67%	-	-
Thallium	0.1	15	-	-	-	-	-
Vanadium	0.5	35	43	**11,627.91**	0.03%	0.000	**4,651.16**
Zinc	5	500	0.124	**40,322,580.65**	0.00%	0.000	**16,129,032.26**
Column Totals			153,611		100.00%	0.077	**16,825,806.04**
Allowable Dust (mg/m3)						**2.000**	
Level C Dust Level (mg/m3)						**2.500**	
Factor of Safety						**2.000**	

Constituent	OSHA ACTION LEVEL / PEL (ppm)	NIOSH IDLH (ppm)	Ionizing Potential eV
Ammonia	50	300	10.18

a/ All order of magnitude estimates, except arsenic (ESC Risk Assesment Table 5).

Table C-3

Acid and Metal Action Levels by Location
Health and Safety Plan
Nu-West Industries - Conda Phosphate Operations Facility
Soda Springs, Idaho

Phos Building / Digester

Chemical	Reasonable Max in Solution	Comment	PEL	IDLH	Aerosol @ PEL	APF =
Phosphoric	30%	1st run acid is 10% to 30%	1 mg/m3	1000 mg/m3	3.3 mg/m3	50
Cadmium	0.020%	Max liquid content 200 mg/l	0.005 mg/m3	9 mg/m3	25.0 mg/m3	50
Chromium	0.010%	Max liquid content 100 mg/l	0.001 mg/m3	15 mg/m3	10.0 mg/m3	50
Sulfuric	0.3%	Assumed 99.75% H2SO4 is converted to gypsum precipitate	1 mg/m3	15 mg/m3	400.0 mg/m3	50
HF	1.7%	Cooling pond/gystack water is 17,000 ppm Fluoride max	2.5 mg/m3	24.6 mg/m3	147.1 mg/m3	50
				Aerosol @ PEL of mixture	2.2 mg/m3	
				HASP Upgrade to Level C	**1 mg/m3**	
				F.S.	2.23	
				HASP Evacuate/Level B (based on protection factor)	50 mg/m3	

Oxidation Tank Farm / SPA / PPA Areas

Chemical	Reasonable Max in Solution	Comment	PEL	IDLH	Aerosol @ PEL	APF =
Nitric	38%	Per CPO communication	5 mg/m3	64.5 mg/m3	13.2 mg/m3	50
Cadmium	0.020%	Max liquid content 200 mg/l	0.005 mg/m3	9 mg/m3	25.0 mg/m3	50
Chromium	0.010%	Max liquid content 100 mg/l	0.001 mg/m3	15 mg/m3	10.0 mg/m3	50
Phosphoric	68%	Assume 68% SPA is oxidized	1 mg/m3	1000 mg/m3	1.5 mg/m3	50
HF	1.7%	Cooling pond/gystack water is 17,000 ppm Fluoride max	2.5 mg/m3	24.6 mg/m3	147.1 mg/m3	50
				Aerosol @ PEL of mixture	1.1 mg/m3	
				HASP Upgrade to Level C	**0.5 mg/m3**	
				F.S.	2.22	
				HASP Evacuate/Level B (based on protection factor)	25 mg/m3	

Sulfuric Acid Plant and Tank Farm

Chemical	Reasonable Max in Solution	Comment	PEL	IDLH	Aerosol @ PEL	APF =
Sulfuric	93%		1 mg/m3	15 mg/m3	1.1 mg/m3	50
				Aerosol @ PEL of mixture	1.1 mg/m3	
				HASP Upgrade to Level C	**0.5 mg/m3**	
				F.S.	2.15	
				HASP Evacuate/Level B (based on protection factor)	25 mg/m3	

Other Hazard: Sulfur dioxide may be present in gas form. It converts to sulfuric acid in contact with water (including tears and respiratory system fluids)

Granulation Area

Chemical	Reasonable Max in Solution	Comment	PEL	IDLH	Aerosol @ PEL	APF =
Phosphoric	42%	42% is used in granulator	1 mg/m3	1000 mg/m3	2.4 mg/m3	50
Cadmium	0.020%	Max liquid content 200 mg/l	0.005 mg/m3	9 mg/m3	25.0 mg/m3	50
Chromium	0.010%	Max liquid content 100 mg/l	0.001 mg/m3	15 mg/m3	10.0 mg/m3	50
HF	1.7%	Cooling pond/gystack water is 17,000 ppm Fluoride max	2.5 mg/m3	24.6 mg/m3	147.1 mg/m3	50
				Aerosol @ PEL of mixture	1.8 mg/m3	
				HASP Upgrade to Level C	**1 mg/m3**	
				F.S.	1.76	
				HASP Evacuate/Level B (based on protection factor)	50 mg/m3	

Other Hazard: Ammonia may be present in gas form.

Forms

Form – Modification of the Health and Safety Plan

Nu-West Industries, Inc.
Soda Springs, Idaho

Client: _____

Location: _____

Change Number: _____
Date: _____
Section(s) of HASP Affected: _____

Modification:

Approved:

_____ Site Health and Safety Coordinator
Signature

_____ Health and Safety Officer
Signature

_____ Project Manager
Signature

_____ CPO Project Coordinator
Signature

Appendix A – Safety Rules and Personal Hygiene

Safety Rules and Personal Hygiene

1. Remove all facial hair that interferes with a satisfactory fit of respiratory protective equipment.

2. Do not take prescribed drugs unless specifically approved by a physician. Notify the SHSC that prescription medication is being taken.

3. In the work zone, do not eat, drink, smoke, chew gum or tobacco, or engage in any other practice that increases the probability of hand-to-mouth transfer or ingestion of material.

4. Wash hands and face thoroughly after leaving the work area and before eating, drinking, or any other activities.

5. Thoroughly wash entire body as soon as possible after removing Level C protective garments.

6. Whenever possible, avoid contact with contaminated or suspected contaminated surfaces.

Appendix B – Field Standard Operating Procedures for Use and Decontamination of PPE

Field Standard Operating Procedures for Use and Decontamination of Personal Protective Equipment

1. Park vehicles outside work boundaries.

2. During the pre-work safety meeting, the Site Health and Safety Coordinator will provide the following information:
   A. a description of the Site and known problem areas
   B. the level of protection required
   C. emergency medical information
   D. the locations of the first aid kit and fire extinguisher

3. Use the nearest lavatory. A portable lavatory will be provided at the Site (outside of work areas).

4. Lay out and check safety gear.

5. Check and don modified Level D PPE.

6. For work in Level C PPE, put on safety gear in the following order:
   A. Coveralls
   B. Steel-toed work boots
   C. Connect suit and boots with tape
   D. Outer booties, if used
   E. Air purifying respirators (APRs), if required

7. For work in Level C PPE, put on APRs as follows:
   A. Inspect.
      (1) Inspect before each use to ensure that they have been cleaned adequately.
      (2) Check material conditions for signs of pliability, deterioration, or distortion.
      (3) Examine cartridges and ensure that they are the correct type for the intended use, that the expiration date has not passed, and that they have not been opened or used previously.
      (4) Check face shields for cracks or fogginess.
   B. Loosen all harness strap adjustments.
   C. Place chin in chin cup and draw back evenly on strap adjustments - the two bottom straps first, then the two top straps, and the center top strap last.
   D. Check that the respirator is centered evenly on the face and that the straps are not uncomfortably tight.
   E. Check for leaks or proper facial seals.
      (1) To conduct a negative-pressure test, close the inlet part with the palm of the hand so it does not pass air, and gently inhale for about 10 seconds. Any inward rush of air indicates a poor fit. Note that a leaking facepiece may be drawn tightly to the face to form a good seal, giving a false indication of adequate fit.
      (2) To conduct a positive-pressure test, gently exhale while covering the exhalation valve to ensure that a positive pressure can be built up. Failure to build a positive pressure indicates a poor fit.

8. Put on the rest of the gear in the following order:
   A. Raise hood
   B. Hard hat
   C. Surgical gloves
   D. Outer gloves
   E. Connect gloves and suit with tape

9. Select a buddy to act as a safety backup.

10. Check your buddy's equipment and have your buddy check yours for rips, tears, or malfunctions. Pay special attention to respirators, making sure that seals are good and that cartridges are securely in place.

11. If any equipment or gear gets damaged or if your suit tears badly, GO BACK.

12. If you experience physical discomfort, breathing difficulties, light-headedness, dizziness, or other abnormalities, GO BACK.

13. When you return, have your buddy check for external accumulation of contamination and remove it. Also check gear for damage.

14. Decontamination will be performed in steps as follows (as appropriate for the PPE being utilized):

    Step 1 - Segregated Equipment Drop: Deposit equipment used onsite (tools, sampling devices and containers, monitoring instruments, clipboards, etc.) in different containers with plastic liners. Each may be contaminated to a different degree. Segregation at the drop reduces the probability of cross-contamination. This equipment may be reused if properly decontaminated.
    Equipment: various sizes of containers
    plastic drop cloths

    Step 2 - Boot Cover and Outer Glove Wash and Rinse: (Optional - will be used at the SHSC's discretion.)
    Equipment: pesticide sprayer with nozzle
    two wash basins or tubs
    scrub brush
    water
    Liqui-nox nonphosphate soap solution (1%)

    Step 3 - Tape Removal: Remove tape around boots and gloves, and deposit in container with plastic liner. Remove boot covers, then outer gloves, and place them in the container.
    Equipment: container (30-50 gallons)
    plastic liners
    folding chairs

    Step 4 - Safety Boot Wash and Rinse: (Optional - will be used at discretion of WSP Environmental Strategies field team members.)

Equipment: two wash basins or tubs
scrub brush
water
Liqui-nox solution (1%)

Step 5 - Protective Coverall Removal: With the assistance of a helper, remove protective coverall. Deposit in container with plastic liner.
Equipment: container (30-50 gallons)
folding chairs
plastic liners

Step 6 - Respirator Removal: Remove facepiece. Avoid touching face with gloves. If work is completed for the day, discard cartridges in lined container, and wash and rinse respirator.
Equipment: container (30-50 gallons)
plastic liners

Step 7 - Inner Glove Removal: Remove inner gloves and deposit in container with plastic liner.
Equipment: container (20-30 gallons)
plastic liners

15. Respirators will be cleaned daily by hand washing with MSA cleaner-sanitizer solution followed by a thorough rinse and air drying. NEVER ALLOW A RESPIRATOR TO DRY WITH THE STRAPS PLACED FORWARD ACROSS THE FACESHIELD BECAUSE THIS MAY CAUSE CHANGES IN THE FACE-TO-RESPIRATOR SEAL SURFACE. The specific procedures to be employed are as follows:

A. Remove all cartridges (canisters) and filters plus gaskets and seals not permanently affixed to their seats.

B. Loosen harness adjustment straps.

C. Remove exhalation valve cover.

D. Remove inhalation and exhalation valves.

E. Remove protective faceshield cover.

F. Wash facepiece in MSA cleaner/sanitizer powder mixed with warm water, preferably at a temperature of 120□ F. Wash components separately from facepiece. Heavy soil may be removed from the facepiece surface using a medium-soft handbrush.

G. Remove all parts from the wash solution, and rinse twice in clean, warm water.

H. Air dry all parts in a designated clean area.

I. Pat facepieces, valves, and seats to remove any remaining soap residue, water, or other foreign material with a clean, damp, lint-free cloth.

J. Reassemble respirator.

K. Place respirator in a plastic bag and the respirator box or otherwise store the respirator to prevent exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures, and impact.

16. Remediation waste material will be handled as follows:

A. Expendable material, such as tape, boot covers, inner and outer gloves, coveralls, and expendable sampling items, will be placed in a lined 30- to 33-gallon garbage can. When the container is full, and at the end of every day, the garbage sack will be removed and promptly placed into licensed waste hauler trucks for offsite disposal with excavated soils.

B. Wash and rinse waters from personal and equipment decontamination will be containerized in 55-gallon drums. When the drum is full, and at the end of every day, the water will be pumped into licensed waste hauler trucks for offsite disposal with excavated soils.

Appendix C – Heat Stress Monitoring and Cold Stress Prevention

Heat Stress and Heat Stress Monitoring

Heat is one of the most common (and potentially serious) illnesses at hazardous waste sites where PPE is worn; therefore, regular monitoring and other preventive precautions are vital. Shelter from the sun will be provided during rest periods. Below is a list of the signs and symptoms of heat stress. Initial work schedules will be approximately 90 minutes of work followed by 15 minutes of rest. Work intervals will be adjusted to shorter periods based on the assessment of the SHSC Monitoring for heat stress will be conducted by visual observation by the individual team members.

Signs and Symptoms of Heat Stress

- **Heat rash** may result from continuous exposure to heat or humid air.

- **Heat cramps** are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:
  - muscle spasms
  - pain in the hands, feet, and abdomen

- **Heat exhaustion** occurs from increased stress on various body organs, including inadequate blood circulation caused by cardiovascular insufficiency or dehydration. Signs and symptoms include:
  - pale, cool, moist skin
  - heavy sweating
  - dizziness
  - nausea
  - fainting

- **Heat stroke** is the most serious form of heat stress. Temperature regulation fails, and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms include:
  - red, hot, usually dry skin
  - lack of or reduced perspiration
  - nausea
  - dizziness and confusion
  - strong, rapid pulse
  - coma

First-aid remedies for heat stress and heat stroke include removing the worker to a cool place, providing cool water or a commercial sport drink, loosening tight clothing, and calling for an ambulance if victim vomits or starts to loose consciousness.

Cold Stress Prevention

The types of cold-related stress are frostbite, hypothermia, and immersion or trench foot. Personnel performing field tasks in the winter months should be aware of the signs and symptoms of cold-related stress so they can take precautionary measures to avoid cold-induced injury and illness. The following is a brief synopsis of each type of cold-related stress.

Frostbite results when cells are cooled until ice crystals form inside them. Most injuries from frostbite are localized to the exposed part of the body.

- First degree frostbite or frostnip usually strikes the tips of fingers, toes, ears, nose, and chin or cheeks. It is usually painless, and the victim is often unaware of it. The skin turns pale or white from first degree frostbite.

- Second degree frostbite can occur in skin and its underlying tissue. The skin becomes firm and white, waxy, or translucent. As the third injured areas warm, it will become numb, and then will turn blue or purple and swell. The superficial capillaries have been injured, and edema fluid will leak out into the tissue. Stinging and burning pain and superficial blisters may develop. The throbbing, aching, and burning may last for some weeks, and the body part may become permanently red and be extremely sensitive if again exposed to the cold.

- Third degree frostbite involves freezing not only the skin and subcutaneous tissue but even muscle and bone. This serious injury usually involves the hands and feet. The tissues are cold, pale, and frozen to the touch. The injured area usually turns purple or blue and is extremely painful after thawing. Large blisters and tissue death (gangrene) may occur within the first day or two.

Generalized, severe, progressive body cooling is known as systemic hypothermia. This may occur at outside temperatures above freezing as well as below freezing. It occurs when the core temperature of the body falls below 95°F (35°C) and results when the body temperature controlling mechanism is overwhelmed. At 96.8°F, the body attempts to compensate for the cold. As core temperatures fall below 95°F, the body is unable to rewarm itself without assistance because of the failure of the temperature control system.

Hypothermia may be of acute duration if someone is suddenly immersed in cold water. Subacute hypothermia may occur in otherwise healthy people, such as skiers, mountain climbers, or lost hunters, subject to prolonged cold exposure and physical exertion. Chronic hypothermia may occur in old people or those who are ill.

Hypothermia may be mild to moderate, when the core temperature is between 81°F and 95°F and the patient is conscious, or it may be severe, when the core temperature is below 80°F and the patient is unconscious.

The symptoms of hypothermia depend on the core temperature and become progressively more severe as the core temperature drops. Between 95°F and 98.6°F, the first symptom is shivering, a subconscious attempt of the body to generate more heat through muscular action. In addition, certain semiconscious activities occur, such as stamping the foot and dancing up and down. Below 95°F, difficulty in speaking, lack of coordination, stumbling, falling, and an inability to use the hands occur. It is at this point that the loss of temperature control occurs and the body is unable to rewarm itself. Below 90°F, shivering decreases and the muscles become progressively rigid. Below 85°F, the victim becomes irrational and may fall into a coma. The pulse and respiration slow. Below 80°F, unconsciousness occurs. The pulse is weaker, and cardiac arrhythmia may be noted. Below 78°F, the respiratory and

cardiovascular centers fail, with resulting pulmonary edema and ventricular fibrillation and then cardiac standstill. Ventricular fibrillation is the usual cause of death in these victims.

Even without a thermometer, the level of hypothermia may be noted by observing the victim's mental state. With a few degrees' drop in core temperature, the victim may become withdrawn, discouraged, or mildly depressed. As the temperature drops a few degrees more, to 94°F or below, the victim may become indecisive, confused, or disoriented and may make incorrect decisions. Below 86°F, sleepiness, lethargy, and confusion are obvious. These progressively become more sever until coma occurs. The comatose state, if allowed to continue, results in death. The stages of hypothermia may progress rapidly after the victim's temperature falls below 90°F.

Trench foot of immersion foot occurs from the wet cooling of an extremity over hours or days at a temperature just above freezing while remaining relatively immobile. It used to been commonly in shipwrecked sailors or soldiers forced to remain in trenches for days at a time. The extremity is cold, swollen, waxy, mottled, and may be numb.

Preventive Work Guidelines

1. Exposure to cold will be terminated immediately when severe shivering becomes evident.

2. When air temperature falls below 30°F, dry bulb temperature and wind speed will be measured periodically, and the wind chill factor will be calculated. (Weather radios are an adequate substitute.)

3. All work except for emergencies will be terminated when the wind chill is below -18°F.

4. Metal tool handles will be covered with thermal insulating material at temperatures below 30°F.

5. When work is performed continuously in the cold at a wind chill of below 20°F, heated shelter will be made available. A vehicle can be used for shelter if it is kept idling with the heater on.

6. Work will be arranged in such a way that sitting or standing for long periods of time is minimized.

Keep warm, dry, and keep moving, but do not become overheated while working in the cold. Exercise fingers and toes.

Appendix D – Venomous Snakes and Spiders

Venomous Snakes

(http://www.venombyte.com/venom/snakes/venomous_snakes_by_state.asp),
(http://www.californiaherps.com/snakes/pages/c.o.lutosus.html)

Great Basin Rattlesnake

Jeff Miller photo.

Scientific name: *Crotalus oreganus lutosus*.

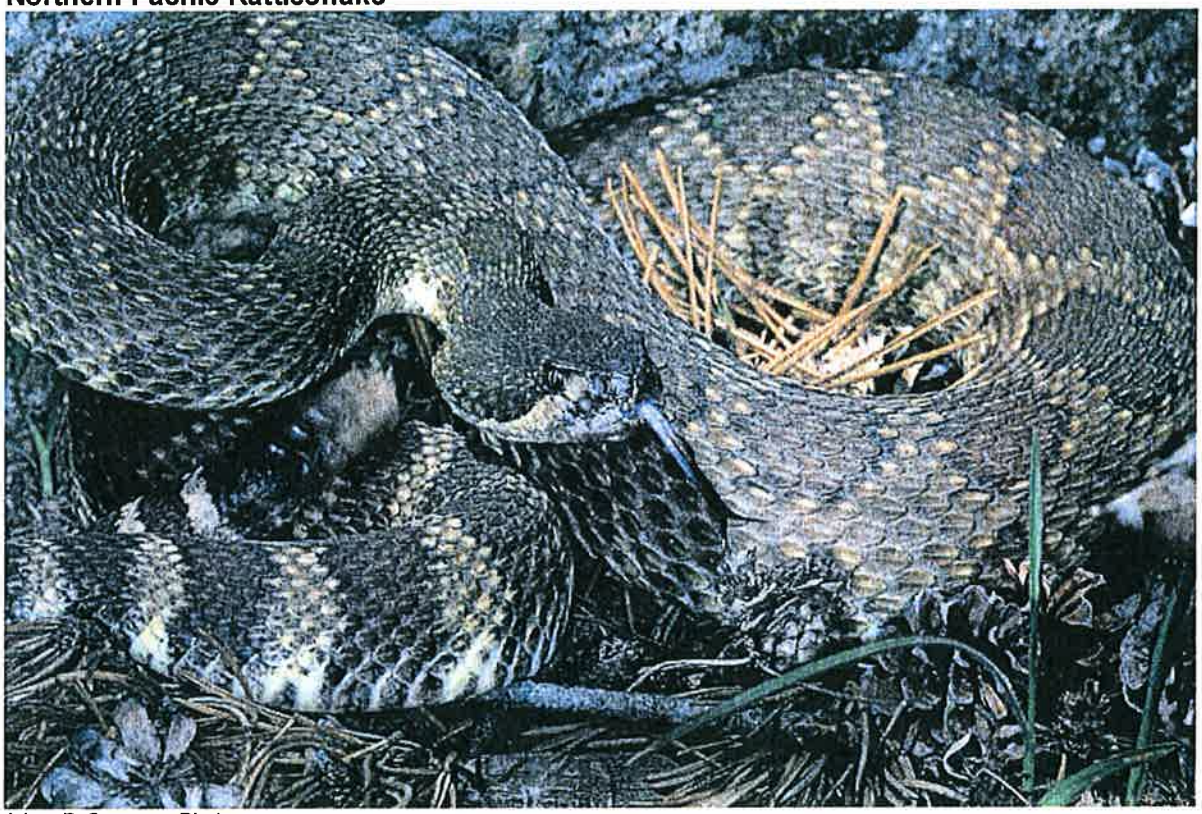
Description: Adult size is 15-65 inches (56-91 cm). A heavy-bodied snake with a thin neck and large, triangular head. Two light stripes extend diagonally across the sides of the head, but are sometimes not evident. Ground color is varied, pale grey, tan, light yellow or buff colored. The back is marked with dark blotches with lighter centers. A rattle extends from the tail.

Behavior: Primarily nocturnal, but active during daylight in periods of moderate heat. When alarmed, a rattlesnake shakes its tail back and forth. The movement rubs the rattle segments together producing buzzing sound which serves as a warning. Juveniles are born with only a silent button at the end of the tail.

Range: In Idaho, this snake inhabits rocky hillsides, barren flatlands, sagebrush, grassy plains, and agricultural areas. Outside Idaho, the species ranges into eastern Oregon, western Utah, most of Nevada, northwest Arizona, and northeast California.

Bites: They can be dangerous to children or older citizens in poor health. As with all venomous snakebites, the victim should seek immediate medical care from a physician or hospital experienced in treating snakebite.

Northern Pacific Rattlesnake



Adam P. Summers Photo

Scientific name: *Crotalus oreganus oreganus*.

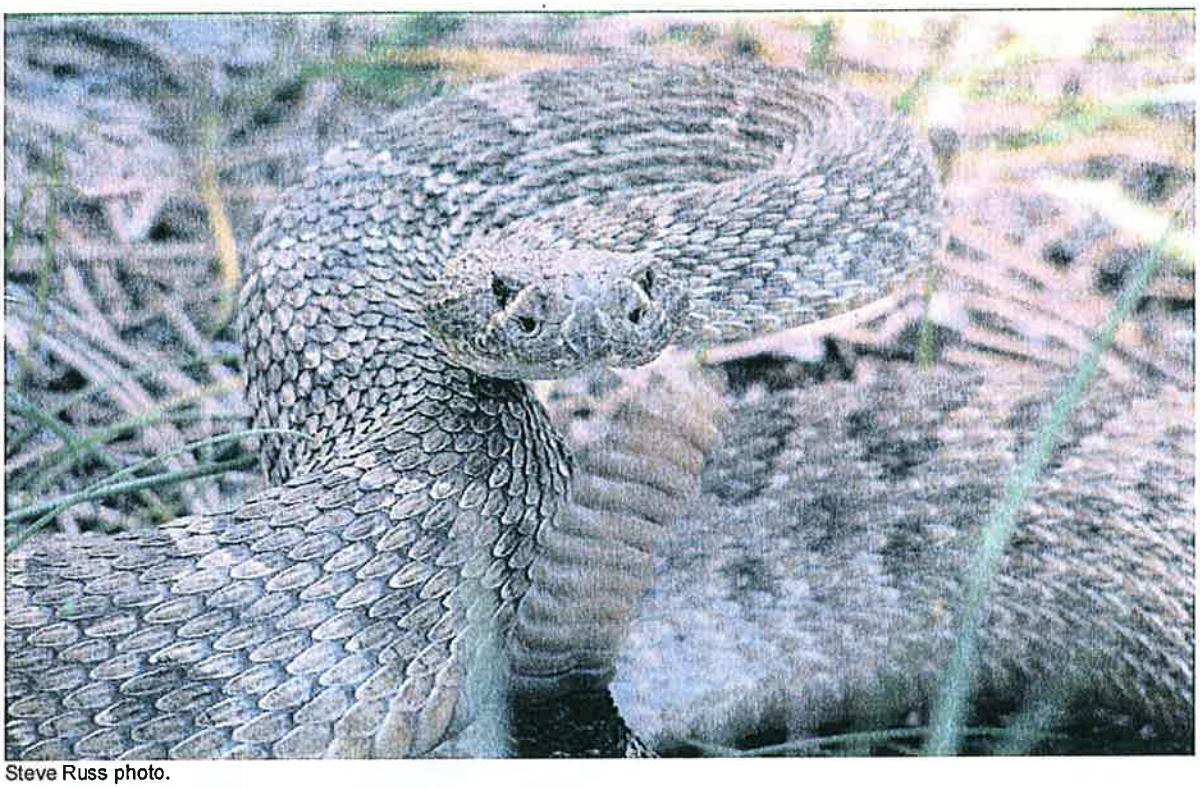
Description: Adult size is 15-60 inches. A heavy-bodied pit viper, with a thin neck and large triangular head. Usually display a light stripe extending diagonally from behind the eye to the corner of the mouth. Ground color is varied, olive-green, gray, brown, golden, reddish-brown, yellowish, or tan. Dorsal blotches on the front 2/3 of the body change to dark bars on the body and dark and light rings on the tail. A rattle extends from the tail.

Behavior: Primarily nocturnal, but active during daylight in periods of moderate heat. In cooler areas, snakes are known to den in burrows, caves, and rock crevices, sometimes in large numbers and with other species. When alarmed, a rattlesnake shakes its tail back and forth. The movement rubs the rattle segments together producing buzzing sound which serves as a warning. Juveniles are born with only a silent button at the end of the tail.

Range: In Idaho, this snake inhabits rocky hillsides, talus slopes and outcrops, rocky stream courses, rocky areas in grasslands, mixed woodlands, montane forests, pinyon juniper, and sagebrush. Range extends up to 11,000 feet above sea level. Outside Idaho, the species ranges into Oregon, western California and Washington (west of the Cascade Range), and into Canada.

Bites: They can be dangerous to children or older citizens in poor health. As with all venomous snakebites, the victim should seek immediate medical care from a physician or hospital experienced in treating snakebite.

Prairie Rattlesnake



Steve Russ photo.

Scientific name: *Crotalus vinidus vinidus*

Description: Adult size is 35-60 inches. A heavy-bodied pit viper, with a thin neck and large triangular head. Ground color is varied, from tan to greenish-brown. Dorsal blotches extend down the back, with smaller blotches on the sides. A rattle extends from the tail.

Behavior: These snakes become active in late April and early May. Primarily diurnal in the spring and fall, primarily nocturnal during summer and winter months. In cooler areas, snakes are known to den in burrows, caves, and rock crevices, sometimes in large numbers and with other species. When alarmed, a rattlesnake shakes its tail back and forth. The movement rubs the rattle segments together producing buzzing sound which serves as a warning. Juveniles are born with only a silent button at the end of the tail.

Range: In Idaho, this snake inhabits rocky hillsides, talus slopes and outcrops, rocky stream courses, rocky areas in grasslands, mixed woodlands, montane forests, pinyon juniper, and sagebrush. Range extends up to 11,000 feet above sea level. Outside Idaho, the species ranges into as far east as Iowa, as far west as California, Oregon and Washington, north into Canada and south into Mexico.

Bites: They can be dangerous to children or older citizens in poor health. As with all venomous snakebites, the victim should seek immediate medical care from a physician or hospital experienced in treating snakebite.

Venomous Spiders

(http://www.desertusa.com/july97/du_bwindow.html) (http://hobospider.com/info/index.html)

Two species of venomous spiders reside in Idaho: the black widow and hobo spiders.

Anyone bitten by a spider should preserve it in rubbing alcohol for positive identification. Most spider bites are not considered dangerous, but if you suspect a black widow or hobo spider, get medical attention immediately.

Black Widow

Bill Schmoker Photo.

Scientific name: *Latrodectus hesperus*

Description: Black widow spiders are 0.5 to 1.5 inches in length. They are brown or more often glossy black. Their legs are long and thin. Females usually have a reddish hourglass shape on the underside of their abdomen.

Behavior: Black widows spin webs that lack shape and form. They are generally shy and nocturnal, and typically stay hidden in their web belly upward during daylight hours. Spiders can emerge if the web is grazed. Webs are often found on the underside of ledges, rocks, and debris.

Range: Hobo spiders are found throughout Idaho and much of the northwest.

Bites: Male and juvenile black widows are not venomous. Females are considered the most venomous spider in North America. Symptoms of bites vary by individual, and include; local pain and swelling at bite location, abdominal pain, muscle cramps, headache, rash, sweating, eyelid swelling, salivation, weakness, nausea, dizziness, chest pain and respiratory difficulties. Bites rarely result in death.

Hobo Spider: Aggressive house spider

Jeb Blakely Photo.

Scientific name: *Tegenaria agrestis*

Description: Hobo spiders measure roughly 12 to 18 mm in length. Their legs show no distinct rings and have short hairs. Males exhibit two large palps that look like boxing gloves, while females have larger abdomen.

Behavior: These spiders create a non-sticky web that trips their prey, but does not trap it. The spider chases it's prey after it encounters a web. As a result, Hobo spiders appear very aggressive to humans. Webs are funnel shaped and are often attached to stationary objects found near ground level.

Range: Hobo spiders are found throughout Idaho and much of the northwest.

Bites: About 50% of Hobo spider bites are dry, with no venom injected into victim. When venom is injected, the victim will experience an immediate redness which develops around the bite and begins to disappear. Appearance of a bite after 24 hours is often similar to a mosquito bite. Bites then begin to blister and break open. Bites take between three weeks and three years to heal, and can cause headaches, nausea, vomiting, flu-like symptoms. In some cases, skin grafts or amputations are necessary.

Appendix E – Field Standards and Operating Procedures for Underground Utility Locating

Field Standards and Operating Procedures for Underground Utility Locating

Application:

The purpose of this procedure is to ensure that all subsurface utilities (e.g., electrical lines, gas lines, telephone lines) are located and marked before initiating any intrusive field activities (e.g., drilling, test pits, trenching). Compliance with this procedure will allow the work to be conducted safely and will minimize the potential for damaging underground utilities.

Materials:

Record of the communication utility locating form (Form 1)
Field logbook
Wooden stakes, spray paint, flagging tape
As-built drawings for subgrade utilities (if available)
Hand auger or post-hole digger
Hand-held magnetometer or cable locator

Procedure:

Pre-Site Mobilization

1. Gather the necessary information to complete Form 1, the record of communication.

2. Contact the local utility service at least 72 hours before the start of the field activities. The telephone numbers for the locating services can be obtained via the Internet. Provide the locator service with any information they request concerning the site and work activity to locate utilities. In California, the proposed drilling locations must be marked with white spray paint before contacting the locating services. The following information provided by the locating service should be documented in a record of communication form: utilities to be located and their corresponding colors, and utility clearance ticket number. The ticket number will be used by the various utility companies to reference the clearance request (see note below). The public utility companies will typically mark their lines up to the property lines unless a junction box or meter is present on the site. However, request that the utility companies mark their utilities in the work areas on the site.

Note: Some utilities (e.g., sewer, water, cable TV) may not be included with the utility locating service and will have to be contacted directly before the start of intrusive activities.

3. If the field activities need to be started before the end of the 72-hour notification period, determine whether the locating service can expedite the request. As a general rule, no intrusive activities should be conducted along or near public right-of-ways until all utilities have been checked and marked in the area of investigation. Field activities may be conducted on private property if sufficient information is available to locate all underground utilities.

4. Identify a site contact familiar with the utilities on the property (e.g., plant manager, facility engineer, maintenance supervisor), and provide this individual with a site plan

showing the proposed locations of all soil borings, monitoring wells, test pits, and other areas where intrusive activities will be conducted.

Site Mobilization

1. Locate all proposed drilling and trenching locations, both on and off site, with spray paint, stakes, or other appropriate markers.

2. Verify that all utility companies listed by there municipal locating service have marked all underground lines in the area and whether the lines have been marked.

3. Review all available as-built utility diagrams and plans with the site contact to identify potential areas where underground lines may be present. If possible, obtain a copy(s) of the utility plans for future reference in the field. Check the drawings to ensure they are as-builts and not design plans.

Note: As-built drawings are not always accurate for locating underground lines.

Conduct a site walk with the site contact and clear each proposed work area using the utility markings and information provided on the as-built plans. During the site walk, attempt to obtain a general knowledge of the types of utilities present in the work areas. Check to see whether major electrical lines are aboveground. Underground sewer lines may be traced using the locations of manholes and storm water grates.

4. A minimum of 4 feet clearance should exist between utilities and proposed drilling locations, and a minimum of 6 feet between utilities and proposed trenching locations. If a utility conflict is identified, adjust the proposed location(s) using the criteria given above.

5. A private utility locating service should be contracted in cases where the public utility locating service does not mark utilities on the subject property and site-specific information concerning the type and location of potential underground lines is poor or nonexistent. Alternatively, a hand-held magnetometer or magnetic-cable locating device can be used to clear each work area.

6. In areas where uncertainty still exists concerning the presence of underground utilities, a hand auger or post-hole digger should be used to probe the shallow subsurface before using any heavy equipment (drill rig, backhoe). The probe hole should be advanced a minimum of 4 feet below ground surface at each proposed drilling or excavation location. A sufficient number of probe holes should be completed so that the area is cleared for the proposed intrusive activity. For drilling, a minimum of three holes should be advanced at each location.

7. Discuss the site conditions with the subcontractor and recommend that care be used at the start of the intrusive activities. Field personnel should always consider the presence of unidentified utilities at each work area. Ensure the work is conducted safely.

8. If the scope of the intrusive activities expands to a new on- or off-site area(s), review the existing information to determine whether the area(s) can be safely cleared of all potential underground utilities. If necessary, contact the municipal locating service and request another clearance for the new area(s) of investigation. Remember, the new

request will require another 72-hour period before all underground utilities can be cleared.

Record of Communication
Utility Locating Form

Date of Call: _____/ _____/ _____ Time of Call: _____a.m. / p.m.

Name of Utility Service Protection Center Called: _____

Call Placed to Phone No.: ( ) - _____ Call taken by operator: _____

Ticket No. Assigned to Location Request: [ ]

Co. ID # (*if assigned by Utility Service Protection Center*): _____

Person Calling _____Company Phone: ( ) - _____

Alternate Contact Name: _____ Alternate Contact Phone: ( ) - _____

Company Address: _____

Assigned Start Date: _____ / _____ / _____ a.m. (8:00 – 12:00) / p.m. (12:00 – 5:00)

Type of Work: _____ Use of Explosives: Y / N

Potential Boring Locations Identified with White Paint and/or Stakes: Y / N / Not Applicable

Work Being Done For: (*Company or Individual Name*): _____

State: _____ County: _____ City/Place: _____

Street: _____(*Only one street per ticket*) Zip Code: _____

Nearest Intersecting Street: _____

Map Page: _____Grid(s): _____
Description of the area to be marked *(Provide the following: Street working on, which side of street, how far in which direction from nearest intersecting street; etc.)*:

_____

Map of the area to be marked faxed to the Utility Service Protection Center: Y / N / Not Accepted
Utility Service Protection Center Fax No.: ( ) - _____

CALL BACK INFORMATION RECORD

	Gas	Tele.	Elec.	Wtr.	Swr.	Cable TV	Other
Date Notified							
Time Notified							
Notified By							
Phone Number							
Marks Complete							
No Conflict							
No Facilities							

Appendix F – NIOSH Pocket Guide to Chemical Hazards

September 2005

NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

Aluminum	**CAS** 7429-90-5
Al	**RTECS** BD0330000
Synonyms & Trade Names Aluminium, Aluminum metal, Aluminum powder, Elemental aluminum	**DOT ID & Guide** 1309 170 (powder, coated) 1396 138 (powder, uncoated) 9260 169 (molten)

Exposure Limits	**NIOSH REL**: TWA 10 mg/m^3 (total) TWA 5 mg/m^3 (resp)
	OSHA PEL: TWA 15 mg/m^3 (total) TWA 5 mg/m^3 (resp)
IDLH N.D. See: IDLH INDEX	**Conversion**

Physical Description
Silvery-white, malleable, ductile, odorless metal.

MW: 27.0	BP: 4221°F	MLT: 1220°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 2.70
Fl.P: NA	UEL: NA	LEL: NA	

Combustible Solid, finely divided dust is easily ignited; may cause explosions.

Incompatibilities & Reactivities
Strong oxidizers & acids, halogenated hydrocarbons [Note: Corrodes in contact with acids & other metals. Ignition may occur if powders are mixed with halogens, carbon disulfide, or methyl chloride.]

Measurement Methods
NIOSH 7013, 7300, 7301, 7303; OSHA ID121
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes) Skin: No recommendation Eyes: No recommendation Wash skin: No recommendation Remove: No recommendation Change: No recommendation	**First Aid** (See procedures) Eye: Irrigate immediately Breathing: Fresh air

Respirator Recommendations Not available.
Important additional information about respirator selection

Exposure Routes inhalation, skin and/or eye contact

Symptoms Irritation eyes, skin, respiratory system

Target Organs Eyes, skin, respiratory system

See also: INTRODUCTION See ICSC CARD: 0988 See MEDICAL TESTS: 0011

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NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

Ammonia

CAS 7664-41-7

NH_3

RTECS BO0875000

Synonyms & Trade Names
Anhydrous ammonia, Aqua ammonia, Aqueous ammonia [Note: Often used in an aqueous solution.]

DOT ID & Guide
1005 125 (anhydrous)
2672 154 (10-35% solution)
2073 125 (>35-50% solution)
1005 125 (>50% solution)

Exposure Limits
NIOSH REL: TWA 25 ppm (18 mg/m^3) ST 35 ppm (27 mg/m^3)
OSHA PEL†: TWA 50 ppm (35 mg/m^3)

IDLH 300 ppm See: 7664417

Conversion 1 ppm = 0.70 mg/m^3

Physical Description
Colorless gas with a pungent, suffocating odor. [Note: Shipped as a liquefied compressed gas. Easily liquefied under pressure.]

MW: 17.0	BP: -28°F	FRZ: -108°F	Sol: 34%
VP: 8.5 atm	IP: 10.18 eV	RGasD: 0.60	
Fl.P: NA (Gas)	UEL: 28%	LEL: 15%	

[Note: Although NH_3 does not meet the DOT definition of a Flammable Gas (for labeling purposes), it should be treated as one.]

Incompatibilities & Reactivities
Strong oxidizers, acids, halogens, salts of silver & zinc [Note: Corrosive to copper & galvanized surfaces.]

Measurement Methods
NIOSH 3800, 6015, 6016; OSHA ID188
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated (solution)
Remove: When wet or contaminated (solution)
Change: No recommendation
Provide: Eyewash (>10%), Quick drench (>10%)

First Aid (See procedures)
Eye: Irrigate immediately (solution/liquid)
Skin: Water flush immediately (solution/liquid)
Breathing: Respiratory support
Swallow: Medical attention immediately (solution)

Respirator Recommendations NIOSH
Up to 250 ppm:
(APF = 10) Any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern*
(APF = 10) Any supplied-air respirator*
Up to 300 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern*
(APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes	inhalation, ingestion (solution), skin and/or eye contact (solution/liquid)
Symptoms	Irritation eyes, nose, throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation; liquid: frostbite
Target Organs	Eyes, skin, respiratory system

See also: INTRODUCTION See ICSC CARD: 0414 See MEDICAL TESTS: 0013

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Antimony	**CAS** 7440-36-0
Sb	**RTECS** CC4025000
Synonyms & Trade Names Antimony metal, Antimony powder, Stibium	**DOT ID & Guide** 1549 157 (inorganic compounds, n.o.s.) 2871 170 (powder) 3141 157 (inorganic liquid compounds, n.o.s.)

Exposure Limits	NIOSH REL*: TWA 0.5 mg/m^3 [*Note: The REL also applies to other antimony compounds (as Sb).]
	OSHA PEL*: TWA 0.5 mg/m^3 [*Note: The PEL also applies to other antimony compounds (as Sb).]

IDLH 50 mg/m^3 (as Sb) See: 7440360 **Conversion**

Physical Description
Silver-white, lustrous, hard, brittle solid; scale-like crystals; or a dark-gray, lustrous powder.

MW: 121.8	BP: 2975°F	MLT: 1166°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 6.69
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but a moderate explosion hazard in the form of dust when exposed to flame.

Incompatibilities & Reactivities
Strong oxidizers, acids, halogenated acids [Note: Stibine is formed when antimony is exposed to nascent (freshly formed) hydrogen.]

Measurement Methods
NIOSH 7301, 7303, P&CAM261 (II-4); OSHA ID121, ID125G, ID206
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 5 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator

Up to 12.5 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.

Up to 25 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 50 mg/m^3:
(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-

pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus **Escape:** (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms Irritation eyes, skin, nose, throat, mouth; cough; dizziness; headache; nausea, vomiting, diarrhea; stomach cramps; insomnia; anorexia; unable to smell properly
Target Organs Eyes, skin, respiratory system, cardiovascular system
See also: INTRODUCTION See ICSC CARD: 0775 See MEDICAL TESTS: 0016

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Arsenic (inorganic compounds, as As)

CAS 7440-38-2 (metal)

As (metal)

RTECS CG0525000 (metal)

Synonyms & Trade Names
Arsenic metal: Arsenia
Other synonyms vary depending upon the specific As compound. [Note: OSHA considers "Inorganic Arsenic" to mean copper acetoarsenite & all inorganic compounds containing arsenic except ARSINE.]

DOT ID & Guide
1558 152 (metal)
1562 152 (dust)

Exposure Limits
NIOSH REL: Ca C 0.002 mg/m^3 [15-minute] See Appendix A
OSHA PEL: [1910.1018] TWA 0.010 mg/m^3

IDLH Ca [5 mg/m^3 (as As)] See: 7440382

Conversion

Physical Description
Metal: Silver-gray or tin-white, brittle, odorless solid.

MW: 74.9	BP: Sublimes	MLT: 1135°F (Sublimes)	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 5.73 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame.

Incompatibilities & Reactivities
Strong oxidizers, bromine azide [Note: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.]

Measurement Methods
NIOSH 7300, 7301, 7303, 7900, 9102; OSHA ID105
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated/Daily
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations (See Appendix E) NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, skin and/or eye contact ingestion

Symptoms Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, [potential occupational carcinogen]

Target Organs Liver, kidneys, skin, lungs, lymphatic system

Cancer Site [lung & lymphatic cancer]

See also: INTRODUCTION See ICSC CARD: 0013 See MEDICAL TESTS: 0017

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Barium nitrate (as Ba)	**CAS** 10022-31-8
$Ba(NO_3)_2$	**RTECS** CQ9625000
Synonyms & Trade Names Barium dinitrate, Barium(II) nitrate (1:2), Barium salt of nitric acid	**DOT ID & Guide** 1446 141

Exposure Limits	NIOSH REL*: TWA 0.5 mg/m^3 [*Note: The REL also applies to other soluble barium compounds (as Ba) except Barium sulfate.]
	OSHA PEL*: TWA 0.5 mg/m^3 [*Note: The PEL also applies to other soluble barium compounds (as Ba) except Barium sulfate.]

IDLH 50 mg/m^3 (as Ba) See: IDLH INDEX	**Conversion**

Physical Description
White, odorless solid.

MW: 261.4	BP: Decomposes	MLT: 1094°F	Sol: 9%
VP: Low	IP: ?		Sp.Gr: 3.24
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid, but will accelerate the burning of combustible materials.

Incompatibilities & Reactivities
Acids, oxidizers, aluminum-magnesium alloys, (barium dioxide + zinc) [Note: Contact with combustible material may cause fire.]

Measurement Methods
NIOSH 7056; OSHA ID121
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Water flush immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 5 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator

Up to 12.5 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.

Up to 25 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 50 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin, upper respiratory system; skin burns; gastroenteritis; muscle spasm; slow pulse, extrasystoles; hypokalemia

Target Organs Eyes, skin, respiratory system, heart, central nervous system

See also: INTRODUCTION See ICSC CARD: 1480 See MEDICAL TESTS: 0021

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Beryllium & beryllium compounds (as Be)

CAS 7440-41-7 (metal)

Be (metal)

RTECS DS1750000 (metal)

Synonyms & Trade Names
Beryllium metal: Beryllium
Other synonyms vary depending upon the specific beryllium compound.

DOT ID & Guide
1566 154 (compounds)
1567 134 (powder)

Exposure Limits

NIOSH REL: Ca C 0.0005 mg/m^3 See Appendix A

OSHA PEL: TWA 0.002 mg/m^3
C 0.005 mg/m^3 (30 minutes) with a maximum peak of 0.025 mg/m^3

IDLH Ca [4 mg/m^3 (as Be)] See: IDLH INDEX

Conversion

Physical Description
Metal: A hard, brittle, gray-white solid.

MW: 9.0	BP: 4532°F	MLT: 2349°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 1.85 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of a powder or dust.

Incompatibilities & Reactivities
Acids, caustics, chlorinated hydrocarbons, oxidizers, molten lithium

Measurement Methods
NIOSH 7102, 7300, 7301, 7303, 9102; OSHA ID125G, ID206
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: Daily
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash

First Aid (See procedures)
Eye: Irrigate immediately

Breathing: Fresh air

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin and/or eye contact

Symptoms Berylliosis (chronic exposure): anorexia, weight loss, lassitude (weakness, exhaustion), chest pain, cough, clubbing of fingers, cyanosis, pulmonary insufficiency; irritation eyes; dermatitis; [potential occupational carcinogen]

Target Organs Eyes, skin, respiratory system

Cancer Site [lung cancer]

See also: INTRODUCTION See ICSC CARD: 0226 See MEDICAL TESTS: 0025

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Boron oxide	**CAS** 1303-86-2
B_2O_3	**RTECS** ED7900000
Synonyms & Trade Names Boric anhydride, Boric oxide, Boron trioxide	**DOT ID & Guide**

Exposure Limits	**NIOSH REL**: TWA 10 mg/m^3
	OSHA PEL†: TWA 15 mg/m^3

IDLH 2000 mg/m^3 See: 1303862	**Conversion**

Physical Description
Colorless, semitransparent lumps or hard, white, odorless crystals.

MW: 69.6	BP: 3380°F	MLT: 842°F	Sol: 3%
VP: 0 mmHg (approx)	IP: 13.50 eV		Sp.Gr: 2.46
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid

Incompatibilities & Reactivities
Water [Note: Reacts slowly with water to form boric acid.]

Measurement Methods
NIOSH 0500
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Water flush promptly
Breathing: Fresh air
Swallow: Medical attention immediately

Respirator Recommendations NIOSH

Up to 50 mg/m^3:
(APF = 5) Any quarter-mask respirator. Click here for information on selection of N, R, or P filters.*

Up to 100 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.*
(APF = 10) Any supplied-air respirator*

Up to 250 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.*

Up to 500 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 2000 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure

mode in combination with an auxiliary self-contained positive-pressure breathing apparatus **Escape:** (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms Irritation eyes, skin, respiratory system; cough; conjunctivitis; skin erythema (skin redness)
Target Organs Eyes, skin, respiratory system
See also: INTRODUCTION See ICSC CARD: 0836

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Cadmium dust (as Cd)

CAS 7440-43-9 (metal)

Cd (metal)

RTECS EU9800000 (metal)

Synonyms & Trade Names
Cadmium metal: Cadmium
Other synonyms vary depending upon the specific cadmium compound.

DOT ID & Guide
2570 154 (cadmium compound)

Exposure Limits

NIOSH REL*: Ca See Appendix A [*Note: The REL applies to all Cadmium compounds (as Cd).]

OSHA PEL*: [1910.1027] TWA 0.005 mg/m^3 [*Note: The PEL applies to all Cadmium compounds (as Cd).]

IDLH Ca [9 mg/m^3 (as Cd)] See: IDLH INDEX

Conversion

Physical Description
Metal: Silver-white, blue-tinged lustrous, odorless solid.

MW: 112.4	BP: 1409°F	MLT: 610°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 8.65 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid in bulk form, but will burn in powder form.

Incompatibilities & Reactivities
Strong oxidizers; elemental sulfur, selenium & tellurium

Measurement Methods
NIOSH 7048, 7300, 7301, 7303, 9102; OSHA ID121, ID125G, ID189, ID206
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: No recommendation
Eyes: No recommendation
Wash skin: Daily
Remove: No recommendation
Change: Daily

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations (See Appendix E) NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion

Symptoms Pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [potential occupational carcinogen]

Target Organs respiratory system, kidneys, prostate, blood

Cancer Site [prostatic & lung cancer]

See also: INTRODUCTION See ICSC CARD: 0020 See MEDICAL TESTS: 0035

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Calcium hydroxide	**CAS** 1305-62-0
$Ca(OH)_2$	**RTECS** EW2800000
Synonyms & Trade Names Calcium hydrate, Caustic lime, Hydrated lime, Slaked lime	**DOT ID & Guide**

Exposure Limits	**NIOSH REL**: TWA 5 mg/m^3
	OSHA PEL: TWA 15 mg/m^3 (total) 5 mg/m^3 (resp)

IDLH N.D. See: IDLH INDEX	**Conversion**

Physical Description
White, odorless powder. [Note: Readily absorbs CO_2 from the air to form calcium carbonate.]

MW: 74.1	BP: Decomposes	MLT: 1076°F (Decomposes) (Loses H_2O)	Sol(32°F): 0.2%
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 2.24
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid

Incompatibilities & Reactivities
Maleic anhydride, phosphorus, nitroethane, nitromethane, nitroparaffins, nitropropane [Note: Attacks some metals.]

Measurement Methods
NIOSH 7020; OSHA ID121
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes) Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations Not available.
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin, upper respiratory system; eye, skin burns; skin vesiculation; cough, bronchitis, pneumonitis

Target Organs Eyes, skin, respiratory system

See also: INTRODUCTION See ICSC CARD: 0408

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Chromium metal	**CAS** 7440-47-3
Cr	**RTECS** GB4200000
Synonyms & Trade Names Chrome, Chromium	**DOT ID & Guide**

Exposure Limits	**NIOSH REL**: TWA 0.5 mg/m^3 See Appendix C
	OSHA PEL*: TWA 1 mg/m^3 See Appendix C [*Note: The PEL also applies to insoluble chromium salts.]
IDLH 250 mg/m^3 (as Cr) See: 7440473	**Conversion**

Physical Description
Blue-white to steel-gray, lustrous, brittle, hard, odorless solid.

MW: 52.0	BP: 4788°F	MLT: 3452°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 7.14
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but finely divided dust burns rapidly if heated in a flame.

Incompatibilities & Reactivities
Strong oxidizers (such as hydrogen peroxide), alkalis

Measurement Methods
NIOSH 7024, 7300, 7301, 7303, 9102; OSHA ID121, ID125G
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: No recommendation
Eyes: No recommendation
Wash skin: No recommendation
Remove: No recommendation
Change: No recommendation

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH

Up to 2.5 mg/m^3:
(APF = 5) Any quarter-mask respirator. Click here for information on selection of N, R, or P filters.*

Up to 5 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.*
(APF = 10) Any supplied-air respirator*

Up to 12.5 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.*

Up to 25 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 250 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure

mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin; lung fibrosis (histologic)

Target Organs Eyes, skin, respiratory system

See also: INTRODUCTION See ICSC CARD: 0029 See MEDICAL TESTS: 0052

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Cobalt metal dust and fume (as Co)

CAS 7440-48-4

Co

RTECS GF8750000

Synonyms & Trade Names
Cobalt metal dust, Cobalt metal fume

DOT ID & Guide

Exposure Limits	
	NIOSH REL: TWA 0.05 mg/m^3
	OSHA PEL†: TWA 0.1 mg/m^3

IDLH 20 mg/m^3 (as Co) See: 7440484

Conversion

Physical Description
Odorless, silver-gray to black solid.

MW: 58.9	BP: 5612°F	MLT: 2719°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 8.92
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but finely divided dust will burn at high temperatures.

Incompatibilities & Reactivities
Strong oxidizers, ammonium nitrate

Measurement Methods
NIOSH 7027, 7300, 7301, 7303, 9102; OSHA ID121, ID125G, ID213
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: No recommendation
Wash skin: When contaminated
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH

Up to 0.25 mg/m^3:
(APF = 5) Any quarter-mask respirator. Click here for information on selection of N, R, or P filters.

Up to 0.5 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.*
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.*
(APF = 10) Any supplied-air respirator*

Up to 1.25 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.*
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.*

Up to 2.5 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 20 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-

pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus **Escape:** (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms Cough, dyspnea (breathing difficulty), wheezing, decreased pulmonary function; weight loss; dermatitis; diffuse nodular fibrosis; respiratory hypersensitivity, asthma
Target Organs Skin, respiratory system
See also: INTRODUCTION See ICSC CARD: 0782 See MEDICAL TESTS: 0055

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Copper (dusts and mists, as Cu)

CAS 7440-50-8

Cu

RTECS GL5325000

Synonyms & Trade Names
Copper metal dusts, Copper metal fumes

DOT ID & Guide

Exposure Limits

NIOSH REL*: TWA 1 mg/m^3 [*Note: The REL also applies to other copper compounds (as Cu) except Copper fume.]

OSHA PEL*: TWA 1 mg/m^3 [*Note: The PEL also applies to other copper compounds (as Cu) except copper fume.]

IDLH 100 mg/m^3 (as Cu) See: 7440508

Conversion

Physical Description
Reddish, lustrous, malleable, odorless solid.

MW: 63.5	BP: 4703°F	MLT: 1981°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 8.94
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but powdered form may ignite.

Incompatibilities & Reactivities
Oxidizers, alkalis, sodium azide, acetylene

Measurement Methods
NIOSH 7029, 7300, 7301, 7303, 9102; OSHA ID121, ID125G
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 5 mg/m^3:
(APF = 5) Any quarter-mask respirator. Click here for information on selection of N, R, or P filters.*

Up to 10 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.*
(APF = 10) Any supplied-air respirator*

Up to 25 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.*

Up to 50 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 100 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Irritation eyes, respiratory system; cough, dyspnea (breathing difficulty), wheezing

Target Organs Eyes, skin, respiratory system, liver, kidneys (increase(d) risk with Wilson's disease)

See also: INTRODUCTION See ICSC CARD: 0240 See MEDICAL TESTS: 0057

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Iron oxide dust and fume (as Fe)

CAS 1309-37-1

Fe_2O_3

RTECS NO7400000
NO7525000 (fume)

Synonyms & Trade Names
Ferric oxide, Iron(III) oxide

DOT ID & Guide
1376 135 (spent)

Exposure Limits
NIOSH REL: TWA 5 mg/m^3
OSHA PEL: TWA 10 mg/m^3

IDLH 2500 mg/m^3 (as Fe) See: 1309371

Conversion

Physical Description
Reddish-brown solid. [Note: Exposure to fume may occur during the arc-welding of iron.]

MW: 159.7	BP: ?	MLT: 2664°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 5.24
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid

Incompatibilities & Reactivities
Calcium hypochlorite

Measurement Methods
NIOSH 7300, 7301, 7303, 9102; OSHA ID121, ID125G
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: No recommendation
Eyes: No recommendation
Wash skin: No recommendation
Remove: No recommendation
Change: No recommendation

First Aid (See procedures)
Breathing: Respiratory support

Respirator Recommendations NIOSH

Up to 50 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator

Up to 125 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.

Up to 250 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 2500 mg/m^3:
(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape: (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection
Exposure Routes inhalation
Symptoms Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis)
Target Organs respiratory system
See also: INTRODUCTION See ICSC CARD: 1577 MEDICAL TESTS: 0122

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Lead	**CAS** 7439-92-1
Pb	**RTECS** OF7525000
Synonyms & Trade Names Lead metal, Plumbum	**DOT ID & Guide**

Exposure Limits	NIOSH REL*: TWA (8-hour) 0.050 mg/m^3 See Appendix C [*Note: The REL also applies to other lead compounds (as Pb) -- see Appendix C.]
	OSHA PEL*: [1910.1025] TWA 0.050 mg/m^3 See Appendix C [*Note: The PEL also applies to other lead compounds (as Pb) -- see Appendix C.]

IDLH 100 mg/m^3 (as Pb) See: 7439921	**Conversion**

Physical Description
A heavy, ductile, soft, gray solid.

MW: 207.2	BP: 3164°F	MLT: 621°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 11.34
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form.

Incompatibilities & Reactivities
Strong oxidizers, hydrogen peroxide, acids

Measurement Methods
NIOSH 7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA ID121, ID125G, ID206
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: Daily
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap flush promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations (See Appendix E) NIOSH/OSHA

Up to 0.5 mg/m^3:
(APF = 10) Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator

Up to 1.25 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter

Up to 2.5 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 50 mg/m^3:
(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Up to 100 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension

Target Organs Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue

See also: INTRODUCTION See ICSC CARD: 0052 See MEDICAL TESTS: 0127

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Lithium hydride

CAS 7580-67-8

LiH

RTECS OJ6300000

Synonyms & Trade Names
Lithium monohydride

DOT ID & Guide
1414 138
2805 138 (fused, solid)

Exposure Limits
NIOSH REL: TWA 0.025 mg/m^3
OSHA PEL: TWA 0.025 mg/m^3

IDLH 0.5 mg/m^3 See: 7580678

Conversion

Physical Description
Odorless, off-white to gray, translucent, crystalline mass or white powder.

MW: 7.95	BP: Decomposes	MLT: 1256°F	Sol: Reacts
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 0.78
Fl.P: NA	UEL: NA	LEL: NA	

Combustible Solid that can form airborne dust clouds which may explode on contact with flame, heat, or oxidizers.

Incompatibilities & Reactivities
Strong oxidizers, halogenated hydrocarbons, acids, water [Note: May ignite SPONTANEOUSLY in air and may reignite after fire is extinguished. Reacts with water to form hydrogen & lithium hydroxide.]

Measurement Methods
OSHA ID121
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: Brush (DO NOT WASH)
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash, Quick drench (>0.5 mg/m^3)

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Brush (DO NOT WASH)
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA
Up to 0.25 mg/m^3:
(APF = 10) Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator
Up to 0.5 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes	inhalation, ingestion, skin and/or eye contact
Symptoms	Irritation eyes, skin; eye, skin burns; mouth, esophagus burns (if ingested); nausea; muscle twitches; mental confusion; blurred vision
Target Organs	Eyes, skin, respiratory system, central nervous system
See also: INTRODUCTION See ICSC CARD: 0813 See MEDICAL TESTS: 0129	

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Magnesium oxide fume	**CAS** 1309-48-4
MgO	**RTECS** OM3850000
Synonyms & Trade Names Magnesia fume	**DOT ID & Guide**

Exposure Limits	**NIOSH REL**: See Appendix D
	OSHA PEL†: TWA 15 mg/m^3

IDLH 750 mg/m^3 See: 1309484	**Conversion**

Physical Description
Finely divided white particulate dispersed in air. [Note: Exposure may occur when magnesium is burned, thermally cut, or welded upon.]

MW: 40.3	BP: 6512°F	MLT: 5072°F	Sol(86°F): 0.009%
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 3.58
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid

Incompatibilities & Reactivities
Chlorine trifluoride, phosphorus pentachloride

Measurement Methods
NIOSH 7300, 7301, 7303; OSHA ID121
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: No recommendation
Eyes: No recommendation
Wash skin: No recommendation
Remove: No recommendation
Change: No recommendation

First Aid (See procedures)
Breathing: Respiratory support

Respirator Recommendations OSHA

Up to 150 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator

Up to 375 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.

Up to 750 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin and/or eye contact	
Symptoms Irritation eyes, nose; metal fume fever: cough, chest pain, flu-like fever	
Target Organs Eyes, respiratory system	
See also: INTRODUCTION See ICSC CARD: 0504 See MEDICAL TESTS: 0251	

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Manganese compounds and fume (as Mn)

CAS 7439-96-5 (metal)

Mn (metal)

RTECS OO9275000 (metal)

Synonyms & Trade Names
Manganese metal: Colloidal manganese, Manganese-55
Synonyms of other compounds vary depending upon the specific manganese compound.

DOT ID & Guide

Exposure Limits

NIOSH REL*: TWA 1 mg/m^3 ST 3 mg/m^3 [*Note: Also see specific listings for Manganese cyclopentadienyl tricarbonyl, Methyl cyclopentadienyl manganese tricarbonyl, and Manganese tetroxide.]

OSHA PEL*: C 5 mg/m^3 [*Note: Also see specific listings for Manganese cyclopentadienyl tricarbonyl and Methyl cyclopentadienyl manganese tricarbonyl.]

IDLH 500 mg/m^3 (as Mn) See: 7439965

Conversion

Physical Description
A lustrous, brittle, silvery solid.

MW: 54.9	BP: 3564°F	MLT: 2271°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 7.20 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Combustible Solid

Incompatibilities & Reactivities
Oxidizers [Note: Will react with water or steam to produce hydrogen.]

Measurement Methods
NIOSH 7300, 7301, 7303, 9102; OSHA ID121, ID125G
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: No recommendation
Eyes: No recommendation
Wash skin: No recommendation
Remove: No recommendation
Change: No recommendation

First Aid (See procedures)
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH

Up to 10 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator

Up to 25 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.

Up to 50 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 500 mg/m^3:
(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-

pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion

Symptoms Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage

Target Organs respiratory system, central nervous system, blood, kidneys

See also: INTRODUCTION See ICSC CARD: 0174 See MEDICAL TESTS: 0131

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Mercury compounds [except (organo) alkyls] (as Hg)

CAS 7439-97-6 (metal)

Hg (metal)

RTECS OV4550000 (metal)

Synonyms & Trade Names
Mercury metal: Colloidal mercury, Metallic mercury, Quicksilver
Synonyms of "other" Hg compounds vary depending upon the specific compound.

DOT ID & Guide
2809 172 (metal)

Exposure Limits

NIOSH REL:
Hg Vapor: TWA 0.05 mg/m^3 [skin]
Other: C 0.1 mg/m^3 [skin]

OSHA PEL†:
TWA 0.1 mg/m^3

IDLH 10 mg/m^3 (as Hg) See: 7439976

Conversion

Physical Description
Metal: Silver-white, heavy, odorless liquid. [Note: "Other" Hg compounds include all inorganic & aryl Hg compounds except (organo) alkyls.]

MW: 200.6	BP: 674°F	FRZ: -38°F	Sol: Insoluble
VP: 0.0012 mmHg	IP: ?		Sp.Gr: 13.6 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Liquid

Incompatibilities & Reactivities
Acetylene, ammonia, chlorine dioxide, azides, calcium (amalgam formation), sodium carbide, lithium, rubidium, copper

Measurement Methods
NIOSH 6009; OSHA ID140
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: No recommendation
Wash skin: When contaminated
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations
Mercury vapor: NIOSH
Up to 0.5 mg/m^3:
(APF = 10) Any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern†
(APF = 10) Any supplied-air respirator
Up to 1.25 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern†(canister)
Up to 2.5 mg/m^3:
(APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern†
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern†
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/PAPRTS(canister)
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Up to 10 mg/m^3:
(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode
Emergency or planned entry into unknown concentrations or IDLH conditions:

(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure- demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus

Other mercury compounds: NIOSH/OSHA
Up to 1 mg/m^3:
(APF = 10) Any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern†
(APF = 10) Any supplied-air respirator
Up to 2.5 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern†(canister)
Up to 5 mg/m^3:
(APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern†
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern†
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/PAPRTS(canister)
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Up to 10 mg/m^3:
(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis, pneumonitis; tremor, insomnia, irritability, indecision, headache, lassitude (weakness, exhaustion); stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria

Target Organs Eyes, skin, respiratory system, central nervous system, kidneys

See also: INTRODUCTION See ICSC CARD: 0056 See MEDICAL TESTS: 0136

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Nickel metal and other compounds (as Ni)

CAS 7440-02-0 (Metal)

Ni (Metal)

RTECS QR5950000 (Metal)

Synonyms & Trade Names
Nickel metal: Elemental nickel, Nickel catalyst
Synonyms of other nickel compounds vary depending upon the specific compound.

DOT ID & Guide

Exposure Limits

NIOSH REL*: Ca TWA 0.015 mg/m^3 See Appendix A [*Note: The REL does not apply to Nickel carbonyl.]

OSHA PEL*†: TWA 1 mg/m^3 [*Note: The PEL does not apply to Nickel carbonyl.]

IDLH Ca [10 mg/m^3 (as Ni)] See: 7440020

Conversion

Physical Description
Metal: Lustrous, silvery, odorless solid.

MW: 58.7	BP: 5139°F	MLT: 2831°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 8.90 (Metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Combustible Solid; nickel sponge catalyst may ignite SPONTANEOUSLY in air.

Incompatibilities & Reactivities
Strong acids, sulfur, selenium, wood & other combustibles, nickel nitrate

Measurement Methods
NIOSH 7300, 7301, 7303, 9102; OSHA ID121, ID125G
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: No recommendation
Wash skin: When contaminated/Daily
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Skin: Water flush immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Sensitization dermatitis, allergic asthma, pneumonitis; [potential occupational carcinogen]

Target Organs Nasal cavities, lungs, skin

Cancer Site [lung and nasal cancer]

See also: INTRODUCTION See ICSC CARD: 0062 See MEDICAL TESTS: 0156

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Potassium cyanide (as CN)	**CAS** 151-50-8
KCN	**RTECS** TS8750000
Synonyms & Trade Names Potassium salt of hydrocyanic acid	**DOT ID & Guide** 1680 157 (solid) 3413 157 (solution)

Exposure Limits	NIOSH REL*: C 5 mg/m^3 (4.7 ppm) [10-minute] [*Note: The REL also applies to other cyanides (as CN) except Hydrogen cyanide.]
	OSHA PEL*: TWA 5 mg/m^3 [*Note: The PEL also applies to other cyanides (as CN) except Hydrogen cyanide.]
IDLH 25 mg/m^3 (as CN) See: cyanides	**Conversion**

Physical Description
White, granular or crystalline solid with a faint, almond-like odor.

MW: 65.1	BP: 2957°F	MLT: 1173°F	Sol(77°F): 72%
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 1.55
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid, but contact with acids releases highly flammable hydrogen cyanide.

Incompatibilities & Reactivities
Strong oxidizers (such as acids, acid salts, chlorates & nitrates) [Note: Absorbs moisture from the air forming a syrup.]

Measurement Methods
NIOSH 6010, 7904
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA
Up to 25 mg/m^3:
(APF = 10) Any supplied-air respirator
(APF = 50) Any self-contained breathing apparatus with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin, upper respiratory system; asphyxia; lassitude (weakness, exhaustion), headache, confusion; nausea, vomiting; increased respiratory rate, slow gasping respiration; thyroid, blood changes

Target Organs Eyes, skin, respiratory system, cardiovascular system, central nervous system, thyroid, blood

See also: INTRODUCTION See ICSC CARD: 0671

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Selenium	**CAS** 7782-49-2
Se	**RTECS** VS7700000
Synonyms & Trade Names Elemental selenium, Selenium alloy	**DOT ID & Guide** 2658 152 (powder)

Exposure Limits	NIOSH REL*: TWA 0.2 mg/m^3 [*Note: The REL also applies to other selenium compounds (as Se) except Selenium hexafluoride.]
	OSHA PEL*: TWA 0.2 mg/m^3 [*Note: The PEL also applies to other selenium compounds (as Se) except Selenium hexafluoride.]

IDLH 1 mg/m^3 (as Se) See: 7782492 **Conversion**

Physical Description
Amorphous or crystalline, red to gray solid. [Note: Occurs as an impurity in most sulfide ores.]

MW: 79.0	BP: 1265°F	MLT: 392°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 4.28
Fl.P: NA	UEL: NA	LEL: NA	

Combustible Solid

Incompatibilities & Reactivities
Acids, strong oxidizers, chromium trioxide, potassium bromate, cadmium

Measurement Methods
NIOSH 7300, 7301, 7303, 9102, S190 (II-7); OSHA ID121
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: No recommendation
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation
Provide: Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA
Up to 1 mg/m^3:
(APF = 5) Any quarter-mask respirator. Click here for information on selection of N, R, or P filters.*
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.*
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin, nose, throat; visual disturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breath, gastrointestinal disturbance; dermatitis; eye, skin burns; in animals: anemia; liver necrosis, cirrhosis; kidney, spleen damage
Target Organs Eyes, skin, respiratory system, liver, kidneys, blood, spleen
See also: INTRODUCTION See ICSC CARD: 0072 See MEDICAL TESTS: 0202

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Silver (metal dust and soluble compounds, as Ag)

CAS 7440-22-4 (metal)

Ag (metal)

RTECS VW3500000 (metal)

Synonyms & Trade Names
Silver metal: Argentum
Synonyms of soluble silver compounds such as Silver nitrate ($AgNO_3$) vary depending upon the specific compound.

DOT ID & Guide

Exposure Limits
NIOSH REL: TWA 0.01 mg/m^3
OSHA PEL: TWA 0.01 mg/m^3

IDLH 10 mg/m^3 (as Ag) See: IDLH INDEX

Conversion

Physical Description
Metal: White, lustrous solid.

MW: 107.9	BP: 3632°F	MLT: 1761°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 10.49 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid, but flammable in form of dust or powder.

Incompatibilities & Reactivities
Acetylene, ammonia, hydrogen peroxide, bromoazide, chlorine trifluoride, ethyleneimine, oxalic acid, tartaric acid

Measurement Methods
NIOSH 7300, 7301, 9102; OSHA ID121
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated ($AgNO_3$)
Change: Daily
Provide: Eyewash

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Water flush
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA
Up to 0.25 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode£
(APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter£
Up to 0.5 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Up to 10 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes	inhalation, ingestion, skin and/or eye contact
Symptoms	Blue-gray eyes, nasal septum, throat, skin; irritation, ulceration skin; gastrointestinal disturbance
Target Organs	Nasal septum, skin, eyes
See also: INTRODUCTION See ICSC CARD: 0810 See MEDICAL TESTS: 0208	

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Thallium (soluble compounds, as Tl)

CAS

RTECS

Synonyms & Trade Names
Synonyms vary depending upon the specific soluble thallium compound.

DOT ID & Guide
1707 151 (compounds, n.o.s.)

Exposure Limits

NIOSH REL: TWA 0.1 mg/m^3 [skin]

OSHA PEL: TWA 0.1 mg/m^3 [skin]

IDLH 15 mg/m^3 (as Tl) See: thallium

Conversion

Physical Description
Appearance and odor vary depending upon the specific soluble thallium compound.

Properties vary depending upon the specific soluble thallium compound.			

Incompatibilities & Reactivities
Varies

Measurement Methods
NIOSH 7300, 7301, 7303, 9102; OSHA ID121
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Water flush promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 0.5 mg/m^3:
(APF = 5) Any quarter-mask respirator. Click here for information on selection of N, R, or P filters.

Up to 1 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator

Up to 2.5 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.

Up to 5 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 15 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Nausea, diarrhea, abdominal pain, vomiting; ptosis, strabismus; peri neuritis, tremor; retrosternal (occurring behind the sternum) tightness, chest pain, pulmonary edema; convulsions, chorea, psychosis; liver, kidney damage; alopecia; paresthesia legs

Target Organs Eyes, respiratory system, central nervous system, liver, kidneys, gastrointestinal tract, body hair

See also: INTRODUCTION See MEDICAL TESTS: 0228

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Vanadium dust

CAS 1314-62-1

V_2O_5

RTECS YW2450000

Synonyms & Trade Names
Divanadium pentoxide dust, Vanadic anhydride dust, Vanadium oxide dust, Vanadium pentaoxide dust
Other synonyms vary depending upon the specific vanadium compound.

DOT ID & Guide
2862 151

Exposure Limits

NIOSH REL*: C 0.05 mg V/m^3 [15-minute] [*Note: The REL applies to all vanadium compounds except Vanadium metal and Vanadium carbide (see Ferrovanadium dust).]

OSHA PEL†: C 0.5 mg V_2O_5/m^3 (resp)

IDLH 35 mg/m^3 (as V) See: vandust

Conversion

Physical Description
Yellow-orange powder or dark-gray, odorless flakes dispersed in air.

MW: 181.9	BP: 3182°F (Decomposes)	MLT: 1274°F	Sol: 0.8%
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 3.36
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid, but may increase intensity of fire when in contact with combustible materials.

Incompatibilities & Reactivities
Lithium, chlorine trifluoride

Measurement Methods
NIOSH 7300, 7301, 7303, 7504, 9102; OSHA ID185
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH (as V)

Up to 0.5 mg/m^3:
(APF = 10) Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators. Click here for information on selection of N, R, or P filters.*
(APF = 10) Any supplied-air respirator*

Up to 1.25 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter*

Up to 2.5 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 35 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure

mode in combination with an auxiliary self-contained positive-pressure breathing apparatus **Escape:** (APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms Irritation eyes, skin, throat; green tongue, metallic taste, eczema; cough; fine rales, wheezing, bronchitis, dyspnea (breathing difficulty)
Target Organs Eyes, skin, respiratory system
See also: INTRODUCTION See ICSC CARD: 0596

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Zinc oxide

CAS 1314-13-2

ZnO

RTECS ZH4810000

Synonyms & Trade Names
Zinc peroxide

DOT ID & Guide
1516 143

Exposure Limits

NIOSH REL: Dust: TWA 5 mg/m^3 C 15 mg/m^3
Fume: TWA 5 mg/m^3 ST 10 mg/m^3

OSHA PEL†: TWA 5 mg/m^3 (fume) TWA 15 mg/m^3 (total dust) TWA 5 mg/m^3 (resp dust)

IDLH 500 mg/m^3 See: 1314132

Conversion

Physical Description
White, odorless solid.

MW: 81.4	BP: ?	MLT: 3587°F	Sol(64°F): 0.0004%
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 5.61
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid

Incompatibilities & Reactivities
Chlorinated rubber (at 419°F), water [Note: Slowly decomposed by water.]

Measurement Methods
NIOSH 7303, 7502; OSHA ID121, ID143
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)
Skin: No recommendation
Eyes: No recommendation
Wash skin: No recommendation
Remove: No recommendation
Change: No recommendation

First Aid (See procedures)

Breathing: Respiratory support

Respirator Recommendations NIOSH/OSHA

Up to 50 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.
(APF = 10) Any supplied-air respirator

Up to 125 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.

Up to 250 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 500 mg/m^3:
(APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation

Symptoms Metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough; lassitude (weakness, exhaustion); metallic taste; headache; blurred vision; low back pain; vomiting; malaise (vague feeling of discomfort); chest tightness; dyspnea (breathing difficulty), rales, decreased pulmonary function

Target Organs respiratory system

See also: INTRODUCTION See ICSC CARD: 0208 See MEDICAL TESTS: 0246

Appendix G – Route to Hospital

MAPQUEST

What's your 2008 Credit Score?
Excellent 750 - 840
Good 660 - 749
Fair 620 - 659
Poor 340 - 619
I Don't Know ???
Find out INSTANTLY!

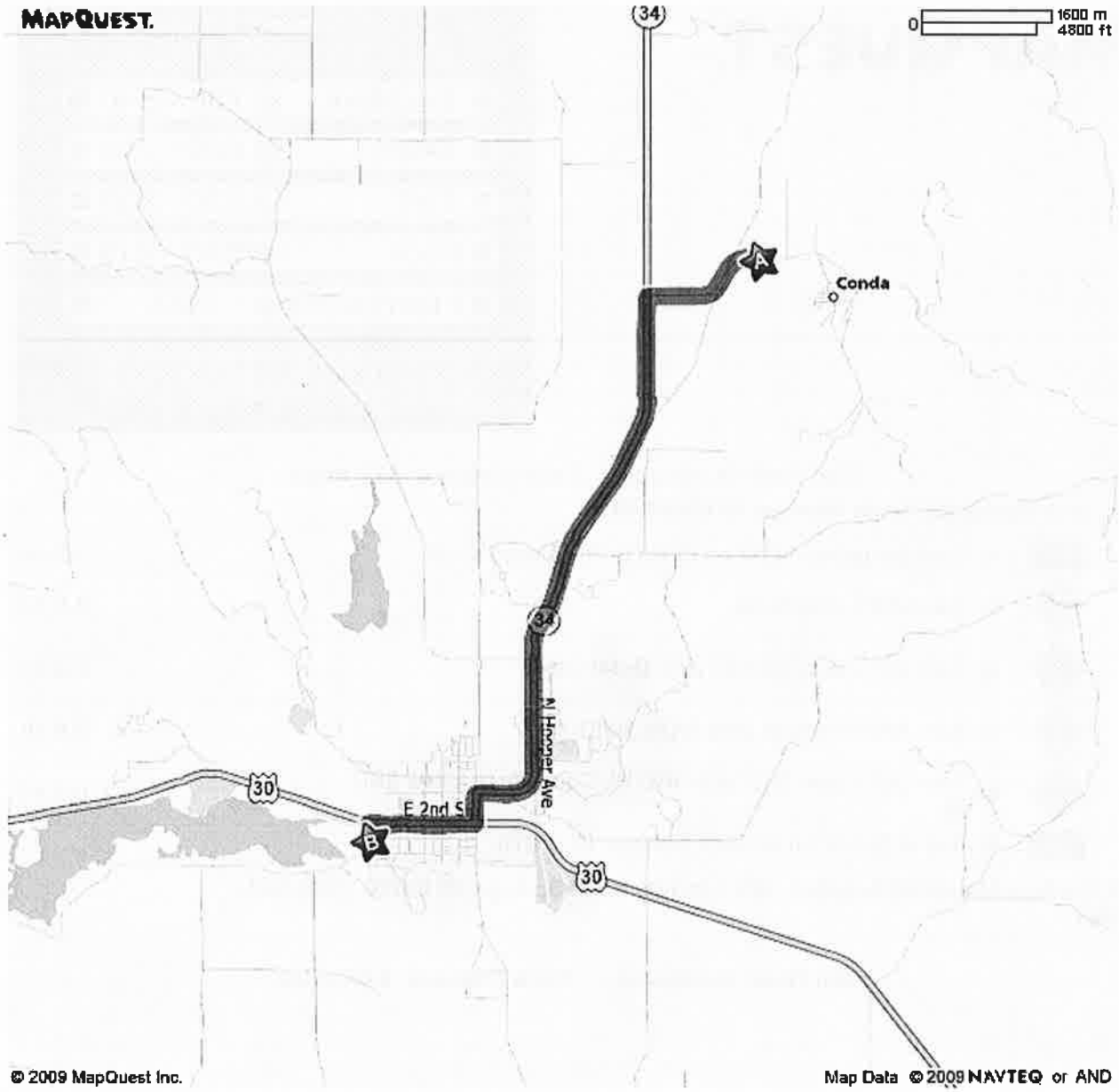
Total Time: 14 minutes **Total Distance: 8.07 miles**

A: 3010 Conda Rd, Soda Springs, ID 83276-5301

START	**1:** Start out going WEST on CONDA RD toward ID-34.	1.2 mi
	2: Turn LEFT onto ID-34.	5.5 mi
	3: Turn LEFT onto 3RD ST E/S ID-34/ID-34.	0.3 mi
	4: Turn RIGHT onto E 2ND S/US-30/ID-34.	0.9 mi
	5: Turn LEFT onto 3RD W/S 3RD W. Continue to follow 3RD W.	0.2 mi
END	**6:** End at 300 S 3rd W Soda Springs, ID 83276	

B: Caribou Memorial Hospital: 300 S 3rd W, Soda Springs, ID 83276, (208) 547-3341

Total Time: 14 minutes **Total Distance: 8.07 miles**



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