WESTINGHOUSE ELECTRIC COMPANY
Western Zirconium Plant

Evaporation Pond Area
Ongoing Monitoring Plan

Prepared by

Project 24585369

February 2013

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amsl	above mean sea level
AOC	Area of Concern
bgs	below ground surface
cm/sec	centimeter per second
CMS	Corrective Measures Study
COC	chain-of-custody
DSHW	Utah Division of Solid and Hazardous Waste
DWQ	Utah Division of Water Quality
EDD	electronic data deliverable
ft	Feet
GPS	global positioning system
LCS	laboratory control samples
mg/L	milligrams per liter
mL	milliliter
MDL	method detection limit
NAD 27	North American Datum of 1927
NOV	Notice of Violation
NTU	Nephelometric Turbidity Units
OMP	Ongoing Monitoring Plan
PARCC	precision, accuracy, representativeness, comparability and completeness
PID	photoionization detector
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SWB	Surface Water Body
SWMU	Solid Waste Management Unit
TDS	total dissolved solids
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality (references to UDEQ include the Utah Divisions of Radiation Control, Solid and Hazardous Waste, and Water Quality)
UDWQ	Utah Department of Environmental Quality, Division of Water Quality
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
WZ	Western Zirconium
ºC	degrees Centigrade

1.0 INTRODUCTION

The methods and procedures detailed within this *Evaporation Pond Area Ongoing Monitoring Plan* (OMP) describe the fieldwork which will be conducted to monitor the performance of the barrier wall to be constructed around the evaporation ponds at the Western Zirconium (WZ) Plant in Ogden, Utah (Figure 1). This document provides the requirements for performing and documenting the OMP-related activities.

1.1 OBJECTIVE AND SCOPE

The objective of the ongoing monitoring program is to monitor the effectiveness of the pond barrier wall in preventing leakage from the evaporation ponds entering the environment. The program will also monitor chemical changes in site ground and surface water that were previously contaminated by leakage from the evaporation ponds. The ongoing monitoring program sampling plan is summarized in Table 1 of this OMP. Sentry well data will be used to determine if the facility is in compliance with the Groundwater Discharge Permit-specific groundwater protection levels. The locations of the monitoring points are illustrated in Figure 2.

Ongoing monitoring in the pond area includes a combination of groundwater elevation measurements and chemical analysis of selected monitoring wells, piezometers, and surface water bodies as follows:

- Groundwater elevations will be measured quarterly at approximately 24 new paired piezometers (12 locations with a piezometer installed on both the inboard and outboard side of the barrier wall). These will be designated as PP1A&B through PP12A&B.

- Groundwater elevation and gradient will continue to be monitored on a quarterly basis at existing piezometers (NP1R, NP2R, NP3, NP4, NP5, P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P14, P15, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, and TP34).

- Chemical constituents groundwater elevations will be monitored annually in eight new plume wells installed around the outside perimeter of the barrier wall (PW1, PW2, PW3, PW4, PW5, PW6, PW7, and PW8), and in six existing plume wells (N1, N2, R1, S2, S3, and S8). Sampling at these points will be for information only, and not for permit compliance.

- Chemical constituents will be monitored semi-annually at six surface water bodies (SWB-3, SWB-7, SWB-8, SWB-9, SWB-10, and SWB-11). Sampling at these points will be for information only, and not for permit compliance.

- Chemical constituents will be monitored quarterly in eight sentry wells that show no or minimal impact from pond leakage (S4, S5, S6, S7, S9, S10, S11, and S12). This monitoring will be used to show that pond contamination is not spreading beyond these wells by demonstrating compliance with Groundwater Permit Protection Levels.

Many historic monitoring wells and piezometers previously located around the evaporation ponds were within the path of construction for the barrier wall, or were located inside the barrier wall project footprint and have been abandoned. Other monitoring wells and piezometers were located within the excavation area at Area of Concern (AOC) 13 and have been abandoned. The former locations of abandoned monitoring wells and piezometers are depicted in Figure 3.

All other Western Zirconium activities are beyond the scope of this document. The objectives and scope of other environmental activities at Western Zirconium will be detailed in other project-specific work plans, including the monitoring of plant area groundwater. All Western Zirconium investigation and monitoring activities will be performed in accordance with the Utah Division of Solid and Hazardous Waste (DSHW) Stipulation and Consent Agreement, and the Utah Division of Water Quality (DWQ) Settlement Agreement.

This OMP will be used in conjunction with the Western Zirconium Quality Assurance Project Plan (QAPP, Westinghouse, 2002). The QAPP details procedures that will ensure the quality and integrity of the samples, accuracy and precision of the analyses, representativeness of the results, and completeness of the information obtained.

1.2 PROJECT BACKGROUND

The barrier wall was planned as part of a Resource Conservation and Recovery Act (RCRA) Corrective Action to address apparent pond leakage and surface migration of pond water contamination at the plant site. The Corrective Action is in response to a Notice of Violation (NOV) issued by the Utah DWQ. The nature and extent of contamination attributable to the pond system was studied as part of the Corrective Action Process and reported in the Phase I and Phase II RCRA Facility Investigations (RFI's) prepared by URS (URS, 2003a, URS, 2003b, URS, 2004a and URS, 2004b). These documents contain details of the contamination assessment which verifies the need to control leakage from the evaporation ponds.

The barrier wall is intended to reduce seepage from the unlined evaporation ponds and to the extent possible, reduce contamination from migrating off the site. The barrier wall will be constructed around the perimeter of the evaporation ponds, and will be keyed into a thick, low-permeability clay layer identified by numerous drilling investigations. The clay layer is located approximately 25 to 40 feet (ft) below the dike top surface. The barrier wall will be constructed as an approximately 3-foot thick soil-sepiolite barrier wall combined with a high-density polyethylene (HDPE) barrier. The barrier wall materials have been selected based on criteria requiring low permeability, durability, and chemical compatibility with the waters in the evaporation ponds. The barrier wall will be constructed so that the soil-sepiolite barrier wall and HDPE sheet piles extend above the ground surface to an elevation of at least 4,220 ft above mean sea level (amsl). Above the original ground surface, the sheet pile will be protected by constructing an armored berm around it consisting of compacted fine-grained native materials and protective rock layers. This berm and barrier system is intended to provide secondary containment for leakage from the ponds.

1.2.1 Site Description

Western Zirconium is an operating unit of the Nuclear Fuels Business Unit of Westinghouse Electric Company, LLC. The facility is located at the eastern base of Little Mountain approximately 12 miles west of Ogden, Utah. The site address is 10,000 West 900 South, Ogden, Utah 84404-9799 (Figure 1). Western Zirconium encompasses 1,100 acres of land and has about 50 buildings. Evaporation ponds cover approximately 110 acres of the site (Figure 2). Western Zirconium extracts zirconium and hafnium metals from raw materials, and then fabricates these metals into products used primarily by the nuclear fuels industry.

1.2.2 Waste Water Pond Descriptions

The existing evaporation ponds were constructed between 1978 and 1985 and cover about 130 acres of the approximately 1,100-acre plant site. The ponds were constructed by building 12 foot high dikes upon the existing ground surface forming the ponds. The original pond drawings and specifications called for one to two feet of compacted impervious silt to line the bottom of the ponds and to extend to form the body of the dikes. A three foot wide cutoff trench constructed of the same material was to extend from the bottom of the dike into the existing fines underlying the dike. There are no independent verifications that the liners were actually constructed as designed.

All industrial waste water at the plant is presently neutralized and transferred to one of the six operational ponds in the pond system. The operational pond system (see Figure 2) consists of two Ammonium Chloride Ponds (A1 and A2), two Calcium Chloride Ponds (C1 and C2), one sodium Chloride Pond (S1), and an emergency or upset pond (U1). Ponds C1 and C2 receive waste waters from the Chlorination, Reduction, and Fabrication processes. Ponds A1 and A2 receive waste water from the Separation Department. Pond S1 receives waste water from the Chlorination process caustic scrubber and blow down from the plant cooling towers. Pond U1 receives waste water from the Separation Process air pollution control pad. The seven active waste water ponds have a surface area of 95.1 acres at their maximum operating level. Maximum operating volume of the ponds is 571.1 acre feet. The ponds are surrounded by a dike system that is mostly composed of silty sands and gravels with a gravel-surfaced road with little if any surface vegetation. The dike crest ranges from a minimum width of about 12 ft to a maximum width of about 16 ft. Soft ground surrounds the perimeter of the dike system. Monitoring wells have been installed around the perimeters of the ponds to monitor groundwater quality. Approximately 200,000 gallons of waste water per day is currently sent to the pond complex, although this flow is planned to be adjusted in the future.

The Reclaimed Pond area (Figure 2) was originally two ammonium chloride ponds that are no longer actively receiving plant waste waters and has since been capped. The Zirconium Raffinate Pond (Z1) is adjacent to the Reclaimed Pond area and also does not currently receive plant waste water.

1.2.3 Previous Site Investigations

Groundwater monitoring has been conducted around the evaporation ponds since 1979. In addition, recent studies to assess contamination in the evaporation pond area have been completed and are summarized below.

- During October and November 2002, a Phase I RFI (URS, 2003a) of the evaporation pond area assessed potential contamination at ten solid waste management units (SWMUs) and one AOC.
- From December 2003 through June 2004, a Phase II RFI (URS, 2004b) of the evaporation pond area completed the characterization of the evaporation pond area.
- From 2002 through 2005, human health risk-based criteria for the Western Zirconium evaporation pond area were developed (URS, 2004c). Based on the results of the RFI, the Human Health Risk Assessment, Western Zirconium, Evaporation Ponds Area (HHRA) (URS, 2007) evaluated the potential for non-cancer and cancer risks to humans potentially exposed to pond area SWMUs and the Lowlands AOC.
- In 2004, ecological risk-based criteria for Western Zirconium were developed (URS, 2004a). The potential for risk to ecological receptors exposed to contaminants from non-plant areas SWMUs and AOCs was evaluated and resulting chemicals of potential ecological concern were determined in the Ecological Risk Assessment (URS, 2008).
- The *Wetland Delineation Report for Westinghouse Electric Company LLC, Western Zirconium Weber County, Utah* (URS, 2009a) described wetlands and other water features at Western Zirconium.
- A Corrective Measures Study (URS, 2010) for both the pond area and the plant area was issued in April 2010 for review by the Utah Department of Environmental Quality, Solid and Hazardous Waste Division.

1.3 SITE PHYSICAL CHARACTERISTICS

1.3.1 Geology

The physical setting of the monitoring area consists of an alkali flat situated along the eastern flank of Little Mountain. The Western Zirconium property slopes from a high elevation of 4,664 ft amsl just below the peak of Little Mountain on the west side, to a low elevation of approximately 4,208 ft amsl near the eastern portion of the property.

The eastern side of the property is located within the historic shoreline zone of the Great Salt Lake. Partial erosion of the historic shoreline zone east of Little Mountain has produced knob-and-swale topography (Currey, 1980). Knob-and-swale topography generally is characterized by low mounds or rounded hills separated by lowland shallow depressions, which generates undulating topography. The soils forming in the bottom of the swales are highly saline and highly alkaline (United States Department of Agriculture, [USDA], 1968). Alkali soils form on relatively flat terrain and consist of soils that are encrusted with alkali salts that have become concentrated over time by evaporation and poor drainage. Alkali soils are typically poorly drained, and form in arid and semi-arid regions. The resulting surface water quality is typically highly saline and highly alkaline. The northern boundary area and the eastern portions of Western Zirconium's property are comprised entirely of knob-and-swale topography.

Little Mountain is located within the Basin and Range physiographic province, which is characterized by north-trending mountain ranges separated by linear valleys. The bedrock of Little Mountain represents an eroded remnant of Cretaceous thrusting, uplifted by Basin and

Range faulting. An eastward-dipping normal fault trends roughly north and south at the eastern flank of Little Mountain and projects beneath Western Zirconium's property at a location and depth that are not known with certainty (Feth et al., 1966). Thermal water is discharged along this fault at Hooper Hot Springs, located approximately 10 miles south of Western Zirconium. There are many seeps that produce sodium chloride-rich water, which are located on a northwest-trending line between Hooper Hot Springs and Little Mountain. These seeps may be influenced by groundwater migrating up this fault zone (Feth et al., 1966).

1.3.2 Groundwater

Western Zirconium is located within the Little Mountain sub district of the Weber Delta hydro geologic district as described by Feth et al. (1966). Groundwater in this sub district is saline due to dominant chemical constituents consisting of sodium and chloride, and is generally highly mineralized with high levels of total dissolved solids (TDS). Feth et al. (1966) suggest that the majority of TDS is picked up by groundwater as it slowly seeps upward through the confining silts and clays between shallower and deeper aquifers. Groundwater and spring discharges along a nearby major fault zone may contain TDS greater than 10,000 milligrams per liter (mg/L).

Throughout the Salt Lake Valley, groundwater occurs in shallow unconfined aquifers and in deeper confined aquifers. On a regional basis, the deep aquifer is beneficial as a drinking water source, although less so near the Great Salt Lake. The shallow aquifer throughout the East Shore area is not suitable for potable use. Water quality is related to the overall regional flow patterns. The principal recharge areas for deeper confined aquifers are the high-level bench gravels along the front of the Wasatch Mountains, which occur from approximately 4,800 to 5,200 ft amsl. From this recharge area, flow in the deeper aquifers is toward the west and produces a vertical gradient from deeper to shallower aquifers. Information available from the State of Utah Department of Natural Resources water rights database indicate that wells used for irrigation and stock watering in the vicinity of the Western Zirconium site penetrate the deep aquifer at depths greater than 100 ft below ground surface (bgs).

Shallow unconfined groundwater near Western Zirconium is part of the overall groundwater system, but it is not used due to its high TDS concentration, generally poor water quality, and low yield. The shallow water is derived from recharge and groundwater flow from the Wasatch Mountains, local infiltration, upward flow of groundwater due to artesian pressure, and possible recharge from Little Mountain. Shallow groundwater varies in depth across the site from near ground surface to as deep as 20 ft bgs in the plant area. Groundwater within the plant area generally moves towards the east (MWH, 2006) while groundwater flow in the area of the evaporation ponds is generally radial from the center of the pond area or to the east in areas farther from the evaporation ponds (URS, 2011), which may be related to the infiltration of water from the evaporation ponds. Groundwater elevations and flow direction may be altered by the installation of the barrier wall (see Section 1.3.5).

1.3.3 Surface Water

Western Zirconium is located just north of the Weber River Delta in an undeveloped area on the plains just east of the Great Salt Lake, which is known as the East Shore Area. Little Mountain forms a natural barrier between the Western Zirconium site and the Great Salt Lake, forcing surface water in the area to flow either northward or southward around Little Mountain.

The Weber River drainage is the nearest fluvial system to the Western Zirconium site, located to the east and south of the property. The Weber River originates in the Western Uinta Mountains at 11,200 ft amsl and enters the Wasatch Front through Weber Canyon. The total watershed drainage area consists of about 2,345 square miles in Weber, Davis, Morgan, and Summit Counties. The North Fork of the Weber River is located approximately 1.5 miles to the south of Western Zirconium. The Weber River flows into Ogden Bay, where it has formed a delta, known as the Weber River Delta. The delta is the site of the Ogden Bay State Waterfowl Management Area, the closest protected wildlife habitat area to the Western Zirconium site.

Due to the topography of Little Mountain, which has its highest elevations and widest extent near the southern part of the Western Zirconium site, surface water drains northward via storm water ditch that drains to the storm water holding area surface water body (SWB) 3. SWB-3 has formed behind the fill material associated with the construction of the railroad just north of the property boundary. Its extent and volume vary seasonally. In the past, when the water level in SWB-3 reached a high enough elevation it could flow through culverts northward beneath the railroad to the alkali flat north of the railroad. However, in the summer of 2002, Western Zirconium bermed the areas near the culverts to prevent storm water runoff from leaving the property.

Currently most surface water in this part of the site accumulates in several lowland locations, particularly during the winter and spring seasons. The sources of this water include storm water and snow melt, which accumulates and persists at the surface due to the poorly drained nature of native soils, high water table, and flat topography, and groundwater in areas where the potentiometric surface exceeds the ground surface elevation (URS, 2010). Surface water is frequently not present during drier, warmer periods.

1.3.4 Aqueous Matrix Interaction

Seepage from the evaporation ponds is a substantial source of groundwater contamination in the immediate vicinity of the evaporation ponds. Evaporation pond water enters the aquifer via leakage through the evaporation pond bottoms and surrounding dikes, which are a blend of native silt, clay, and sand from the site. Flow and transport are mainly horizontal, away from the elevated head in the evaporation ponds. Vertical flow and contaminant transport are impeded by the confining clay beneath the evaporation ponds, the surficial aquifer, and the slight upward vertical gradient beneath the site.

Over time, a broad groundwater mound has formed beneath the collective evaporation pond area. The groundwater flow direction, and thus the contaminant transport direction, is radially away in all directions from the mound. These flow directions gradually bend to coincide with the vicinity groundwater gradient at some distance from the evaporation ponds. The leakage into groundwater, and movement of contaminated groundwater, may be occurring at a slow rate. This is qualitatively evidenced by the fact that the evaporation ponds have been in operation since 1978, and in approximately 26 years the plume has not yet reached some sentry well locations, which are located from 700 to 1,500 ft outside of the evaporation pond dikes at various locations (see Figure 2). The attenuation of contaminants over time is also preventing them from reaching sentry locations.

The groundwater contaminants are believed to have contributed to the concentrations of contaminants in surface water. In some areas in the vicinity of the evaporation ponds, the potentiometric surface exceeds the ground surface elevations during some seasons of the year. Therefore, the contaminated groundwater is believed to mix with surface water in those locations (URS, 2010).

Localized areas of groundwater contamination north of the property, which have been difficult to correlate with the evaporation pond groundwater plume, are believed to be attributable to overland flow and infiltration of contaminated surface water. In the summer of 2002, Western Zirconium constructed berms at all culverts along the northern property boundary to prevent surface water from leaving the site. Also, a berm was constructed across a swale area north of the evaporation ponds to stop overland surface water flow before it can get to the eastern-most of the culverts. There are no known culverts along the southern or eastern property boundary that would allow surface water to flow off of the property and cause similar problems.

1.3.5 Subsurface Barrier Wall System Concept

The barrier wall system design concept will use a composite soil-sepiolite slurry/HDPE barrier wall within a new small containment dike and stabilized foundation/work pad, outside the existing ponds, to contain existing and future groundwater and surface water contamination. The low permeability of the barrier wall will prevent lateral migration of groundwater leakage from the ponds. By constructing the wall to an adequate depth within the underlying fine material that constitutes a confining layer, vertical migration of groundwater will also be controlled. By including a small dike, surface seepage is controlled. By including a stabilized foundation/work pad, construction access is provided and long term seismic stability is obtained. The wall alignment was selected to contain seepage areas immediately outside the existing ponds where the highest concentrations of contaminants exist. This area reflects a substantial portion of seepage given relatively slow outward migration in low permeability natural clayey soils. The system offers the following features:

- The barrier wall depth takes advantage of the underlying native clays to prevent vertical seepage under the wall;
- The alignment setback from the existing pond dikes allows barrier wall and dike construction without affecting existing dike stability;
- The alignment setback exposes the wall to lower seepage concentrations and gradients while containing the areas with the highest concentrations of prior seepage contamination adjacent to the existing ponds;
- The new perimeter dike creates additional secondary spill containment for the total pond system; and
- The work pad in combination with a small dike provides construction access in the wet soft marshy site and cost effective long-term static and seismic foundation stability.

The constructed subsurface barrier wall is to meet the following minimum requirements:

- The wall is to have a permeability of $1x10^{-7}$ centimeters per second (cm/sec) or less.

- The wall depth must penetrate low permeable soils which will perform as a vertical barrier, preventing groundwater from passing underneath the wall.
- The wall must be constructible with the various site constraints.
- The wall materials must be compatible with the existing pond waters.

Additional details regarding the design criteria for the barrier wall were provided in the *Design Basis for Selection and Construction of a Subsurface Barrier Wall Around the Evaporative Pond System* (URS, 2009b). The installation of the barrier wall is expected to result in a decrease in contaminant concentrations in groundwater and surface water outside of the wall over time. The design of the barrier wall was reviewed by the Utah Department of Environmental Quality (UDEQ), and the construction was permitted by UDEQ.

Western Zirconium anticipates that the Reclaimed Pond (see Figure 2) will be used to contain waters that will collect in the interstitial space between the outer dikes of the evaporation pond complex and the containment wall. These waters will come both from precipitation and waste water that currently leaks out of the toes of the existing evaporation ponds. Water will be periodically pumped from this interstitial space back to the reclaimed pond to minimize the level of water in this space. This is so the interstitial area can act as secondary containment for the evaporation pond waste waters in case of a breach of one of the pond outer dikes.

2.0 SAMPLING PROGRAM

Many years of quarterly groundwater monitoring have been performed at Western Zirconium, and a large volume of historic data exists for many locations at the site. The pond area monitoring plan has evolved over time to meet the needs of Western Zirconium and UDEQ as more data have been collected. This OMP was developed using the historic data, but the focus of the plan has changed with the installation of the barrier wall. The plan now assesses the effectiveness of the wall in containing the groundwater contaminants within the pond area and the natural attenuation of contaminants in groundwater and surface water outside of the barrier wall.

2.1 GROUNDWATER MONITORING

The sampling schedule and monitoring parameters for the ongoing monitoring program are summarized in Table 1. A summary of the required analytical methods is provided in Table 2. The rationale for the selection of the monitoring locations is presented below. Sampling methods are presented in Section 3.

2.1.1 Groundwater Monitoring Locations

Barrier wall performance will be monitored by collecting quarterly groundwater data from the locations shown in Figure 2. Because the evaporation ponds create a groundwater mound, the proposed barrier wall can be determined to provide containment if the piezometric surface becomes higher inside the wall than immediately outside the wall. In order to provide sufficient data, it is proposed that 24 new paired piezometers be constructed adjacent to the proposed wall, with one piezometer on both its inboard and outboard sides. New piezometers will be completed to the depth of the proposed barrier wall. They will be screened from five ft bgs to total depth. The proposed locations of these piezometers are shown on Figure 2. In addition, the existing five nested piezometers will continue to be measured to confirm that an upward groundwater gradient exists underneath the ponds. This gradient (or at least the lack of a significant downgradient gradient) is necessary to prevent the migration of pond contaminants to the lower aquifer, or migrating under the wall and eventually daylighting to surface water outside the wall.

No groundwater analytical samples are proposed to be collected from the pairs of piezometers located adjacent to the wall. Due to slow-moving groundwater and the persistence of groundwater contaminants at the site, it is believed that the performance of the wall may more effectively be evaluated by observing changes in the potentiometric surface across its alignment rather than through comparing analytical results. It is possible that a successfully functioning barrier wall could create conditions that would temporarily increase contaminant concentrations along the outer boundary of the wall due to localized impacts on hydraulic gradients and natural attenuation. For example, an effective barrier wall could lower the potentiometric surface immediately outside the wall, which would reverse the direction of the flow of groundwater from the ponds. Contaminants would then be redirected towards the outer boundary of the wall, potentially resulting in increased concentrations of groundwater contaminants in monitoring wells. In this scenario, analytical results from wells located immediately outside the wall would be similar for both a successfully performing and leaky barrier wall. However, the piezometers (both within and outside the barrier wall) will be constructed such that they could be used for groundwater sampling in the future if necessary.

Many monitoring wells and piezometers previously located around the evaporation ponds were within the path of construction for the barrier wall, or were located inside the barrier wall and would no longer be accessible due to an expected rise in shallow groundwater elevations within the wall. Other monitoring wells and piezometers were located within areas of excavation at AOC 13. All of these wells and piezometers were abandoned prior to construction activities. The locations of monitoring wells and piezometers abandoned during the barrier wall construction and other excavation activities are displayed in Figure 3 and are listed in Table 3. Figure 3 and Table 3 also list two piezometers (P13 and TP1) that were abandoned prior to the beginning of the construction of the barrier wall.

2.1.2 Groundwater Elevation Measurements

Static groundwater elevations will be recorded at all piezometers and wells quarterly. The data will be used to estimate barrier effectiveness, support site characterization, corrective action, and/or site maintenance as appropriate. Groundwater elevations will be measured with an electronic water level indicator. The water level in all wells must be measured before any wells are purged. This is typically accomplished by measuring the water levels in all the wells one day and beginning the purging and sampling of the wells the following day. The water level indicator will be lowered into the well until a change in conductivity indicates that groundwater has been encountered. The depth to water will be measured from the reference point at the top of the well casing. If the reference point cannot be located, the depth will be measured from the top north side of the casing. All measurements will be made to +0.01 foot. Field measurements will be used in conjunction with the surveyed elevations of the top of each well or piezometer casing to determine the groundwater surface elevation above mean sea level. Piezometers located within the inboard side of the dike system have been installed within the dike so that the piezometers are still accessible even if the area between the wall and the ponds becomes inundated with water.

All water level measurements will be identified by the monitoring well or piezometer designation and recorded on the appropriate Groundwater Sampling Log form, and/or a Static Water Level Log form. Examples of Groundwater Sampling Log forms and Static Water Level Log forms are provided in Appendix A. Documentation procedures are described in detail in Section 10.

2.2 GROUNDWATER PERMIT PROTECTION LEVELS

In response to a comment by the Utah Department of Environmental Quality, Division of Water Quality (UDWQ) in March 2012 (UDWQ, 2012), Western Zirconium has analyzed the TDS concentrations in samples collected from the sentry wells. The results of this analysis are presented in Table 4. The mean and 95% upper confidence level (UCL) for the TDS data for the pond area are both greater than 10,000 mg/L. According to Utah Administrative Code (UAC) R317-6-3, groundwater containing more than 10,000 mg/L is categorized as Class IV groundwater. Therefore, protection levels for the pond area groundwater will be established to protect human health and the environment, as specified by UAC R317-6-4.7.

Background levels for each parameter considered in the groundwater compliance monitoring are presented for each well in Table 5. The background level is represented as the mean of historical data for each analyte in each sentry well (UDWQ, 2012). The "background level" in this case is actually a baseline level for each well. The details regarding the methods for calculating background levels are provided in Appendix B of this plan.

2.2.1 Sentry Wells

Per agreement with the UDWQ (UDWQ, 2012), permit protection levels have been determined for contaminants of ecological concern (COECs) in surface water that may be detected in the sentry well groundwater samples; this is due to the inferred linkage between the contaminants in shallow groundwater and surface water (URS, 2010). These protection levels are identified in the Western Zirconium Groundwater Discharge Permit to be issued by the State of Utah DWQ and are listed in Table 6. Some of the other groundwater contaminants that were previously monitored in groundwater and surface water at Western Zirconium, but were not identified as COECs in surface water, are also included in Table 6. (For an explanation of why some contaminants were previously monitored at Western Zirconium but are no longer monitored, refer to Section 2.4.) All monitoring results from sentry well groundwater samples shall be compared to these permit limits.

The values in Table 6 utilize the lowest of three risk-based values: (1) the site-specific screening level for COECs in surface water provided in the approved Ecological Risk Assessment (ERA) (URS, 2008), (2) the concentration listed in R317-6-002, or (3) a site-specific risk-based screening level for human receptors. However, if the background level (see Table 5) exceeded the lesser of the risk-based values, then the background value was used as the protection level in Table 6. The values in Table 6 are preliminary, because eight sampling events for some analytes were not available, and no values are currently available for proposed sentry well S12. An exceedance of a groundwater protection level at a sentry well will require Western Zirconium to install a replacement sentry well outside of the plume near that location, while continuing to monitor the old sentry well as a plume well.

2.2.2 Existing Plume Wells

After the barrier wall is installed, analytical results from existing plume well groundwater samples will be compared to the results from the 3rd Quarter 2012 sampling event. The evaluation of trends in these wells will consider the variability observed during past sampling events for each respective well. It is predicted that chemical concentrations in existing plume wells will decrease and naturally attenuate after the barrier wall is installed.

2.2.3 New Plume Wells

At the completion of barrier wall construction, new plume wells will be installed along the outside perimeter of the new dike to replace the historic wells that were abandoned during wall construction. These wells will be installed in areas affected by the existing groundwater plume and it is fully expected that there will be contaminants detected in groundwater samples from these wells. Because these wells are new, no baseline chemical data will exist when sampling begins. These wells will be sampled for eight quarters to establish a baseline for the wells. It is predicted that concentrations of contaminants at these new plume wells will decrease and naturally attenuate over time due to the presence of the barrier wall.

2.3 SURFACE WATER MONITORING

Surface water bodies SWB-3, SWB-7, SWB-8, SWB-9, SWB-10, and SWB-11 will be sampled semi-annually for ammonia, cyanide (total), barium (total), cadmium (dissolved), selenium (dissolved), uranium (dissolved), zirconium (total), nitrate+nitrite, radium 226+228, TDS, and pH. A summary of the sampling program is provided in Table 1. A summary of analytical methods is provided in Table 2. Surface water sample results will continue to be compared to the site-specific risk-based levels defined in Western Zirconium's site-specific ecological risk assessment (URS, 2008).

2.4 CHANGES FROM THE PREVIOUS OMP

- Wells S2 and S8 have shown contamination and will no longer be sampled as sentry wells. Wells S2 and S8 will be sampled as plume wells.
- The sentry wells S4, S5, S6, S7, S9, S10, S11 and S12(new) will be sampled quarterly for ammonia, cyanide (total), barium (total), cadmium (dissolved), selenium (dissolved), uranium (dissolved), zirconium (total), nitrate+nitrite, radium 226+228, TDS, and pH. The radiologicals gross alpha, gross beta, thorium 230, and thorium 232 that were historically sampled will no longer be sampled. The approved ERA did not identify them as COECs in surface water. Total metals, except for barium and zirconium, will also no longer be sampled as they were not identified as COECs in surface water in the ERA. Chloroform will no longer be sampled for because it was not identified as a COEC in surface water. Only those analytes identified in the Groundwater Discharge Permit (summarized in Table 6) will be analyzed going forward. Preliminary groundwater protection levels have been established for each of the above analytes as shown in Table 6 and as described above. All analytical values will be compared to these limits.
- Well S2 is being removed as a sentry well due to increasing concentrations of nitrate+nitrite. Well S2 will continue to be sampled as a plume well. A sentry well replacement for S2 will not be established as both sentry wells S10 and S11 are directly down gradient of well S2, and S10 is only approximately 600 feet away. S2 is located in a north-south drainage, but S10 is also located in this drainage further down gradient.
- Well S8 is also being removed as a sentry well due to the increasing concentration of nitrate+nitrite. Well S8 will also continue to be sampled as a plume well. A new sentry well (S12) will be located downgradient of Well S8 and north of the property line. A potential location is shown on Figure 2. The exact location will be established with approval of the state once the barrier wall has been completed and the potentiometric surface following the wall installation has been analyzed.
- Surface water body SWB-6 will no longer be sampled. This surface water body will now be isolated inside the new barrier wall.
- Surface water bodies will be sampled semi-annually instead of quarterly. Historically even though surface water bodies are scheduled to be sampled quarterly, they cannot be

sampled in the 1st quarter as they are frozen, and are usually dry in the third quarter. Surface water bodies will be scheduled to be sampled during the second and fourth quarters.

- Surface water bodies SWB-3, SWB-7, SWB-8, SWB-9, SWB-10, and SWB-11 will be sampled semi-annually for ammonia, cyanide (total), barium (total), cadmium (dissolved), selenium (dissolved), uranium (dissolved), zirconium (total), nitrate+nitrite, radium 226+228, TDS, and pH. The previous "Full Suite" list of analytes (general chemistry parameters, radiological parameters, metals, volatile organic compounds, and semi-volatile organic compounds) sampled for historically will no longer be analyzed. Surface water bodies will only be sampled for the analytes listed in Table 6. Surface water analytical results will be compared to the site-specific values developed in the ERA.

- Plume wells 4A, 5B, 5C, 5D, 6A, 6B, 7A, 7C, 8A, 8B, R2, R3, R4, and S1 have been abandoned and removed. The majority of these wells were located within in the footprint of the barrier wall. At the completion of barrier wall construction, new plume wells will be installed outside of the new dike. These wells will be completed at depths similar to the previously abandoned plume wells. Plume wells (PW) PW1, PW2, PW3, PW4, PW5, PW6, PW7, PW8, S2 and S8 will be sampled annually for ammonia, cyanide (total), barium (total), cadmium (dissolved), selenium (dissolved), uranium (dissolved), zirconium (total), nitrate+nitrite, radium 226+228, TDS, and pH. All analytical values will be compared to the Preliminary Groundwater Protection Limits in Table 6.

  The new plume wells will be installed as close as practically possible to the outboard side of the new barrier wall. The exact location of the wells will be determined after completion of the wall. The wells will be installed to a depth of approximately 20 ft, with the last ten feet of the well casing screened. Specific details for new well installation are contained in Appendix B, Attachment A.

- Twelve pairs of piezometers will be installed at approximately equal distances around the barrier wall. One of the pair will be installed inside the wall and the other of the pair will be installed directly across the wall on the outside. The groundwater level in the piezometers will be measured quarterly. It is expected that mounding of the groundwater will occur inside the barrier wall, and that a difference in water level should become established between the paired piezometers. Data from the piezometers will be used for comparison purposes only and as an indication of the walls effectiveness. The piezometers will not be utilized as a point of compliance. The twelve pairs of piezometers will act as measurement points to assess the difference in groundwater elevations inside and outside of the barrier wall.

- Nested piezometers NP1R, NP2R, NP3, NP4, and NP5 will continue to be monitored quarterly for groundwater elevations. The groundwater elevations in these piezometers have historically been measured quarterly and elevations analyzed to determine the vertical groundwater gradient under the ponds. Historically, a slight upward gradient has existed. This groundwater gradient monitoring will continue. In addition, other existing piezometers outside of the barrier wall will be monitored quarterly for groundwater elevations.

3.0 WATER SAMPLING

Groundwater and surface water monitoring at Western Zirconium will be performed according to the methods and procedures described in this section. All monitoring activities will be completed in accordance with an approved health and safety plan.

3.1 GROUNDWATER SAMPLING

3.1.1 Purpose of Groundwater Sampling

Data obtained from the sampling of monitoring wells will be used to evaluate groundwater quality beneath the site and compliance with water quality protection standards. The types of data to be obtained from groundwater monitoring include laboratory analytical results and water quality parameters. Wells that are part of a groundwater compliance-monitoring network will be monitoring wells constructed in accordance with R317-6-6.3.1.6.

3.1.2 Monitoring Well Locations

Figure 2 shows the locations of monitoring wells and other sampling locations at the Western Zirconium facility. Table 7 contains a summary of well construction information for all wells. Table 8 contains a summary of nested piezometer construction information. Table 1 is a summary of the ongoing monitoring schedule.

3.1.3 Groundwater Sample Designation

Groundwater samples will be identified by their media type, location identification (ID), and date of sample collection in the format of media-location ID-date. For groundwater, the media will be identified by GW. The location ID is the alphanumeric well identification, and the date is a two-digit month followed by a two-digit day followed by a two-digit year.

Example: A groundwater sample collected from well S2 on June 1, 2013 would be designated as GW-S2-060113.

3.1.4 Groundwater Sampling Equipment

Monitoring wells will continue to be purged and sampled with dedicated bladder pumps. If dedicated pumps are not functioning properly they will be repaired prior to sampling, or a portable bladder pump will be used to collect the sample. Groundwater samples will be collected in sample containers as specified in Table 2.

Groundwater quality parameters will be measured in the field (e.g., pH, conductivity, temperature, Eh, and turbidity) with portable instruments, such as a Horiba U-22. Static water level will be measured with an electronic water-level meter. All field instruments will be calibrated according to the manufacturer's recommendations prior to use and documented on the Equipment Calibration Form (see Appendix A).

If at any time a well that is currently part of the monitoring program is found to be unusable, it will be evaluated to see if it can be returned to usefulness by the next sampling event. If it is determined that the well cannot be restored to usefulness, a substitute well will be selected and the UDEQ will be contacted for approval.

3.1.5 Monitoring Well Sampling Methods and Procedures

Wherever possible, monitoring wells will be purged and sampled using "low-stress" techniques (United States Environmental Protection Agency, [EPA], 1993). Each monitoring well will be purged and sampled at a rate of ≤ 0.3 liters per minute until field-measured parameters stabilize to ensure groundwater is representative of the aquifer before samples are collected. At a minimum, the parameters of turbidity, pH, conductivity, and temperature will be monitored during purging using portable meters. Parameters will be measured every three minutes during purging.

At least two consecutive field measurements made three minutes apart shall fall within the ranges stated below before well purging will be considered complete:

- turbidity = ±10 percent or <5 nephelometric turbidity units (NTUs),
- pH = ±0.2 units,
- temperature = ±1 degrees Centigrade (ºC),
- conductivity = ±10 percent, and
- Eh = ±10 percent.

Because a long history of groundwater analyses at Western Zirconium indicates only low concentrations of chemicals outside of the location of the barrier wall, and because low-stress purging generates minimal volumes of water, purge water will be discharged to the ground surface. Purge water will be discharged at least ten feet away from the wellhead. Groundwater samples will be collected immediately after field-measured parameters have stabilized. Groundwater samples will be collected in appropriate sample containers supplied by the analytical laboratory. Pumped samples that require field filtration will be filtered by attaching an in-line filter directly to the discharge line. A new filter and new or dedicated pump tubing will be used at each monitoring well. Groundwater samples will be placed in the appropriate sample containers. Sample container and filtration requirements are indicated in Table 2. Samples requiring cooling will be stored in an ice-chilled cooler.

If at any time a monitoring well will not sustain an adequate purge rate to allow the low stress sampling technique to be performed, the well will not be sampled. Western Zirconium will notify UDEQ of the problem with the well and will propose an appropriate solution.

3.1.6 Decontamination Procedures

All non-dedicated or non-disposable sampling equipment that directly contacts groundwater will be decontaminated prior to each use. Decontamination procedures are described in detail in Section 9.0.

3.1.7 Documentation Procedures

A Groundwater Sampling Form will be completed at each groundwater sampling location at the time of sampling. An example Groundwater Sampling Log form is included in Appendix A. Full chain-of-custody (COC) protocol will be employed from sample collection through analysis and data reporting (see Section 6.0). The documentation procedures described in Section 10.0 will be followed.

3.2 SURFACE WATER BODY SAMPLING

3.2.1 Purpose of Surface Water Sampling

Data obtained from the sampling of surface water bodies will be used to evaluate surface water quality at the site. Only laboratory analytical results are obtained from surface water sampling. The data will be used to evaluate the attenuation of COECs in the surface water.

3.2.2 Surface Water Sampling Locations

Figure 2 shows the locations of surface water bodies and sampling locations at the Western Zirconium facility. Table 1 is a summary of the proposed ongoing monitoring schedule.

3.2.3 Surface Water Sample Designation

Surface water samples will be identified by their media type, location ID, and date of sample collection in the format of media-location ID-date. For surface water, the media will be identified by SW. The location ID is the surface water body identification number, and the date is a two-digit month followed by a two-digit day followed by a two-digit year.

Example: A surface water sample collected from SWB-3 on March 5, 2013 would be designated as SWB-3-030513.

3.2.4 Surface Water Sampling Equipment

Surface water bodies will be sampled with a portable peristaltic pump. The peristaltic pump will be used to draw the surface water through a 0.45-micron filter to collect sample aliquots that require field filtration. Surface water samples will be collected in sample containers as specified in Table 2.

3.2.5 Surface Water Sampling Methods and Procedures

Sample aliquots will be collected with a portable peristaltic pump and filled from dedicated Teflon lined tubing. For sample aliquots that require field filtration, a portable peristaltic pump will be used to draw surface water from the dipper through a 0.45-micron filter and into the sample containers. If at any time a surface water body is dry during a sampling event, it will be by-passed and sampled during the next scheduled event.

3.2.6 Decontamination Procedures

All non-dedicated or non-disposable sampling equipment that directly contacts surface water will be decontaminated prior to each use. Decontamination procedures are described in detail in Section 9.0.

3.2.7 Documentation Procedures

A Surface Water Sampling Log form will be completed for each surface water sampling point (some of the requested information on this form will not apply to surface water samples). An example of the Surface Water Sampling Log form is included in Appendix A. Full COC protocol will be employed from sample collection through analysis and data reporting (see Section 6.0). The documentation procedures described in Section 10.0 will be followed.

4.0 QA/QC SAMPLING

To ensure overall data quality, the following quality assurance/quality control (QA/QC) samples will be collected during this sampling program, or as required by specific analytical test methods:

QA/QC Samples	Requirement
Temperature Blank	One in each sample cooler where the preservation criterion of ≤6°C is required
Blind Duplicate	Ten percent of the total number of environmental samples for each matrix and analysis
Matrix Spike	Five percent of the total number of samples for each matrix and analysis.
Matrix Spike Duplicate and/or Method Duplicate	Five percent of the total number of samples for each matrix and analysis.

4.1 PURPOSE OF QA/QC SAMPLING

The accuracy of laboratory performance with respect to the analytical system will be monitored with laboratory control samples (LCSs). Matrix spike (MS) samples will be used to assess the accuracy of the analytical methods with respect to the site-specific sample matrix. Matrix spike duplicate (MSD) and/or method duplicate (MD) samples (radiochemistry parameters) will be used to assess the precision with respect to the analytical methods. Blind duplicate samples will be collected to measure the precision of sampling and analysis. Representativeness of groundwater samples will be ensured by sampling after field-measured parameters have stabilized during purging and by decontaminating all non-dedicated equipment between samples. Completeness will be assured by analyzing for all pertinent analytes. The use of standard approved sampling and analytical methods and analysis of QA/QC samples will ensure the comparability of the data. The QA/QC procedures will aid in determining sample validity.

4.2 QA/QC SAMPLE DESIGNATION

QA/QC samples will be designated based on their type. A "TB" will designate temperature blanks along with the date it was submitted for analysis (e.g., TB-060113 for a temperature blank sent on June 1, 2013). For multiple samples on the same day, a lower case letter will be used after the date to differentiate the samples (e.g., TB-060113a and TB-060113b).

Blind duplicates will be designated using a fictitious ID number and sample collection time on the COC record and on the sample label. The actual well designation for the blind duplicate will be noted on the appropriate sampling log form.

Example: A field duplicate for samples collected from well S2 collected on June 1, 2013 could be designated as GW-S92-060113.

Samples collected for MS and MSD and/or MD analyses will have the same designation as the associated environmental sample and will be identified as a MS/MSD sample in the MS/MSD column on the COC.

4.3 QA/QC SAMPLING EQUIPMENT

QA/QC samples for water samples will be collected with the same equipment as that described for the collection of environmental samples for each respective program.

4.4 QA/QC SAMPLING METHODS AND PROCEDURES

QA/QC samples will be collected during this OMP to enable data quality evaluation and validation. In general, QA/QC samples are collected using the same procedures as those for the collection of environmental samples, with notable exceptions as described in the following subsections.

4.4.1 Temperature Blanks

Temperature blanks consist of a 40 milliliter (mL) glass vial filled with reagent-grade water. The temperature of this sample is measured at the time the samples are received by the laboratory. Temperature blanks will be used to assess whether the preservation criterion of ≤6°C has been met.

4.4.2 Blind Duplicates

A blind duplicate sample is a second sample collected at the same location and time as the original sample. Blind duplicate samples are collected simultaneously or in immediate succession using identical techniques. Blind duplicates will be collected at selected locations to provide estimates of the total sampling and analytical precision. At least one duplicate sample will be analyzed from each group of ten environmental samples of the same matrix. Blind duplicate samples will be analyzed for all analyses required for the original sample. The blind duplicates will be handled and analyzed in the same manner as all environmental samples; however, the COC forms will not indicate which samples are duplicates. A record of the duplication will be made on the appropriate sampling log form.

4.4.3 Matrix Spike, Matrix Spike Duplicates, and Method Duplicates

Samples submitted for matrix spiking will be collected from locations that are known or assumed to be relatively free of contamination and can produce a sufficient amount of sample to easily fill all sample containers. At least one matrix spike and matrix spike duplicate sample or method duplicate sample will be analyzed from each group of 20 environmental samples of the same matrix. The MS, MSD, and MD samples will be spiked in the laboratory. The concentrations and compounds that are used for spike testing will be appropriate for the Western Zirconium site and are discussed in the QAPP. A record of the MS/MSD collection will be made on the appropriate sampling log form.

4.5 DECONTAMINATION PROCEDURES

Decontamination procedures for QA/QC sampling equipment are the same as those described for the associated environmental sample. Decontamination procedures are described in detail in Section 9.0.

4.6 DOCUMENTATION PROCEDURES

The identification of all QA/QC samples will be documented on the associated sampling log form. Full COC procedures will be employed from sample collection through analysis and data reporting (see Section 6.0). Documentation procedures are described in detail in Section 10.0.

5.0 SAMPLE HANDLING, LABELING, AND SHIPPING

All samples collected as part of this OMP will be handled according to the procedures described in this section. All sampling activities will be completed in accordance with the Western Zirconium Health and Safety Plan.

5.1 SAMPLE LABELING

All sample containers will be labeled at the time of sample collection. Labels will be completed legibly with permanent ink. The following information will be recorded on the sample label:

- Sample designation,
- Date and time of collection,
- Place of collection,
- Name of collector, and
- Analysis requested and preservative.

5.2 SAMPLE SHIPPING

Samples will be packaged and delivered or shipped by the sampler within 24 hours of sample collection. Groundwater and surface water samples requiring temperature control will be placed on ice in an insulated cooler for shipment and cooled to the required temperature of ≤6°C as quickly as possible.

Sampling personnel will deliver samples to local laboratories, or will deliver samples to a shipping carrier for overnight delivery to non-local laboratories. Authorized laboratory personnel will acknowledge receipt of shipment by signing and dating the COC form and returning a copy to the Project Manager or designate. If the samples are shipped via an overnight carrier, the following procedure will be used for packaging:

- Inert cushioning material will be placed in the bottom of the cooler,
- The cooler will be lined with a large plastic bag,
- Each sample container will be sealed in a resealable plastic bag and placed upright in the cooler,
- Wet ice and additional packaging materials will be placed around the containers,
- Wet ice will be double bagged,
- A temperature blank will be included in each cooler,
- Pertinent paperwork such as the COC form will be placed in a resealable plastic bag and taped to the inside lid of the cooler,
- Signed custody seal will be attached to the cooler in two places and covered with clear tape in such a way that the custody seal must be broken to open the cooler,

- The cooler will be sealed with packaging tape, and
- A shipping label will be affixed to the outside of the cooler.

5.3 CUSTODY SEALS

Custody seals will be attached to all shipping containers before the samples leave the custody of sampling personnel. Custody seals will bear the signature of the collector and the date signed. Signed and dated seals will be attached so that they must be broken in order to open shipping containers.

6.0 CHAIN-OF-CUSTODY PROCEDURES

The possession and handling of all environmental samples will be traceable from the time of collection, through analysis, until final disposition. Documentation of the sample history is referred to as the COC. Required components of the COC program include:

- Sample designation,
- Date and time of collection,
- Matrix type,
- Number of containers,
- Analyses requested,
- Remarks section to relay potential hazards or other information to the laboratory,
- Name and signature of collector,
- Signature of persons involved in the chain of possession,
- Date and time of each change of custody,
- Internal temperature of container when opened at the laboratory, and
- Condition of samples when received by laboratory.

A COC record will be completed and will accompany every sample shipment. In addition, a sample or shipping container is considered to be in a person's custody if it is:

- In a person's physical possession,
- In view of the person after he or she has taken possession,
- Secured by the person so that no one can tamper with it, or
- In a secured area.

7.0 ANALYTICAL METHODS

The analytical methods to be used for the analysis of the samples are provided in Table 2. The contracted laboratory will have current certification for all analytical and preparation methods used which are covered under the Utah Environmental Laboratory Certification Program. Furthermore, all laboratory analyses must have method detection limits below the applicable groundwater or surface water quality standard for each parameter. When analytical methods are updated by the subcontracted laboratory, the most current equivalent method will be used. All changes by the subcontracted laboratory to the analytical method used, or the use of an updated method, and the reason for the change will be documented in writing and provided to Western Zirconium and the UDEQ prior to implementation.

8.0 STATIC WATER LEVEL MEASUREMENTS

Groundwater elevations in monitoring wells will be measured quarterly for use in the development of potentiometric surface contour maps. All monitoring activities will be completed in accordance with an approved health and safety plan.

8.1 PURPOSE OF GROUNDWATER ELEVATION MEASUREMENT

Groundwater elevation measurements will be used to determine groundwater flow direction and gradients, and to aid in predicting chemical migration directions and rates. The data will be used to support site characterization and corrective action, as appropriate. Table 8 contains a summary of nested piezometer construction information for all nested piezometers.

8.2 STATIC WATER LEVEL MEASUREMENT EQUIPMENT

Groundwater levels will be measured quarterly in all piezometers and monitoring wells with an electronic water level indicator. The Static Water Level Log form is included in Appendix A.

8.3 STATIC WATER LEVEL MEASUREMENT PROCEDURE

The water level in all wells must be measured before any wells are purged. This is typically accomplished by measuring the water levels in all the wells one day and beginning the purging and sampling of the wells the following day. The water level indicator will be lowered into the well until a change in conductivity indicates that groundwater has been encountered. The depth to water will be measured from the reference point at the top of the well casing. If the reference point cannot be located, the depth will be measured from the top north side of the casing. All measurements will be made to ±0.01 foot. Field measurements will be used in conjunction with the surveyed elevations of the top of each well or piezometer casing to determine the groundwater surface elevation above mean sea level.

8.4 DECONTAMINATION PROCEDURES

All down-hole measuring equipment will be decontaminated before each use by washing it with non-phosphate detergent and triple rinsing with deionized or distilled water. Decontamination procedures are described in detail in Section 9.0.

8.5 DOCUMENTATION PROCEDURES

All water level measurements will be identified by the monitoring well or piezometer designation and recorded on the appropriate Groundwater Sampling Log form, and/or a Static Water Level Log form. Examples of Groundwater Sampling Log forms and Static Water Level Log forms are shown in Appendix A. Documentation procedures are described in detail in Section 10.0.

9.0 DECONTAMINATION PROCEDURES

All dedicated, non-dedicated, and/or non-disposable sampling equipment will be thoroughly decontaminated before each use, between each location, and at the completion of the sampling program. All sampling activities will be completed in accordance with the Western Zirconium Health and Safety Plan (URS, 2003b). The following procedures will be used:

- Clean equipment thoroughly in non-phosphate detergent solution using brushes as necessary,
- Rinse thoroughly with tap water,
- Rinse thoroughly with deionized or distilled water, and
- Allow equipment to air dry.

Between use, equipment will be stored in plastic bags or dedicated cases to prevent contamination from dust or soil.

All downhole measuring equipment will be decontaminated before each use by washing with a non-phosphate detergent solution and triple rinsing with deionized or distilled water. If a non-dedicated pump is necessary to evacuate a well, it will be flushed thoroughly with potable water and decontaminated according to the above procedure between each well. New or dedicated tubing will be used at each sample location.

10.0 DOCUMENTATION PROCEDURES

Entries will be recorded on sampling log sheets each time activities are conducted in the field. All data generated during monitoring and any comments or other notes will be entered directly into the appropriate sampling log forms using permanent, indelible ink. All corrections will follow the error correction protocol of one line through the error and initial and date of correction.

Sampling situations vary widely. No general rules can specify the extent of information that must be recorded on the field log forms. However, records will contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory. Photographs also may be taken to document field activities. All sampling log sheets and field logs will be kept under strict control and stored in a location so as to make it accessible to the Project Manager. Typical field log form entries may include the following:

- Location, description, and photographs, if applicable of the sampling point,
- Details of the sampling site (e.g., the elevation of the casing, casing diameter and depth, integrity of the casing),
- Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., filters and absorbing reagents),
- Documentation of calibration procedures for field instruments,
- Identification of sampling crew members,
- Type of sample (e.g., groundwater, or soil),
- Number and volume of sample taken,
- Sampling methodology,
- Sample preservation,
- Date and time of collection,
- Collector's sample identification number(s),
- Sample distribution and transportation method,
- References such as maps of the sampling site,
- Field observations,
- Any field measurements made (e.g., pH, temperature, conductivity, and water depth),
- Decontamination procedures, and
- Signature and date by the personnel responsible for observations.

Activity-specific field forms must be completed during field sampling activities. Examples of these types of forms are presented in Appendix A:

- Static Water Level Log,
- Surface Water Sampling Log,
- Groundwater Sampling Log,
- Equipment Calibration Log, and
- COC Record.

11.0 DATA MANAGEMENT

The data management procedures that will be followed are outlined in Section 15.0 of the QAPP (Westinghouse, 2002). The following subsections discuss the data validation, database management, and quarterly report submittal requirements specific to this OMP.

11.1 DATA VALIDATION

The laboratory scope-of-work has been developed by the project chemist and includes QA/QC sample requirements and performance criteria, the process for method non-compliance, data package and electronic deliverable requirements, and penalties for late or rejected data. These requirements and procedures to fulfill the requirements are described in the QAPP (Westinghouse, 2002).

All analytical data will be validated and all decisions and recommendations will be based upon validated data. Data validation procedures are described in the QAPP (Westinghouse, 2002) and will be performed by the project chemist. The process through which data will be accepted or rejected will be based upon specific data validation criteria. The data will be validated in accordance with the criteria contained in EPA's Functional Guidelines (EPA, 2008 and EPA, 2010), as pertinent to the SW-846 analytical methods and QA acceptance criteria contained in the QAPP. Data assessment procedures in accordance with precision, accuracy, representativeness, comparability and completeness (PARCC) parameters are described in detail in Section 13.0 of the QAPP (Westinghouse, 2002).

A data validation report will be completed for each quarterly analytical data set. The validation report will discuss the validation methodology and findings. Data qualifiers will be imported into the project database and checked to ensure data completeness.

11.2 DATABASE MANAGEMENT

Analytical data will be received from the laboratory in both electronic and hardcopy formats. The electronic data deliverable (EDD) will be delivered to URS in a format specified by the project Database Manager. All analytical data will be electronically uploaded into the project database. The data received will be checked against the COCs to ensure accuracy of laboratory sample log in, and to ensure that the data received is complete. The analytical data in the database will be further cross-checked with the hardcopy data reports to ensure accuracy. Any discrepancies will be resolved prior to document or database submittals.

11.3 REPORT SUBMITTALS

The quarterly monitoring report for each quarterly event will be prepared and submitted to UDEQ 30 days prior to the start of the next quarterly sampling event, as detailed in Table 1. However, if submittal of the summary report is delayed due to circumstances beyond Western Zirconium's control, (e.g., laboratory missed required delivery date) the start date for the next quarter of sampling shall not be delayed. A quarterly monitoring report will be prepared to present the analytical results following each quarter.

The quarterly monitoring report will include a statistical analysis of the quarterly analytical results. The statistical analysis will be performed to evaluate whether a confirmed detection has occurred at a sentry well location. Criteria for the statistical analysis are provided in Appendix B.

12.0 REFERENCES

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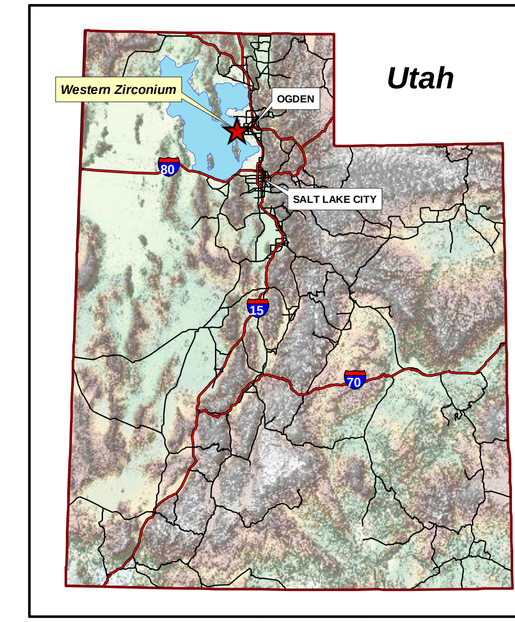
FIGURES

STATE INDEX



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Regional Overview Map

Evaporation Pond Area
Ongoing Monitoring Plan
Western Zirconium

Westinghouse URS

Figure 1

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Path: X:\Projects\WesternZirconium\Slurry Wall\2012\Fig2_MonitoringLocations.mxd

- Sentry Well (Existing)
- Sentry Well (Proposed; location approximate)
- Plume Well (Existing)
- Plume Well (Proposed; location approximate)
- Surface Water Sampling Location
- Piezometer (Existing)
- Piezometer (Proposed; location approximate)
- Nested Piezometer (Existing)
- Barrier Wall
- Western Zirconium Property Boundary

N
W E
S

300 0 300 600
Feet

Monitoring Locations

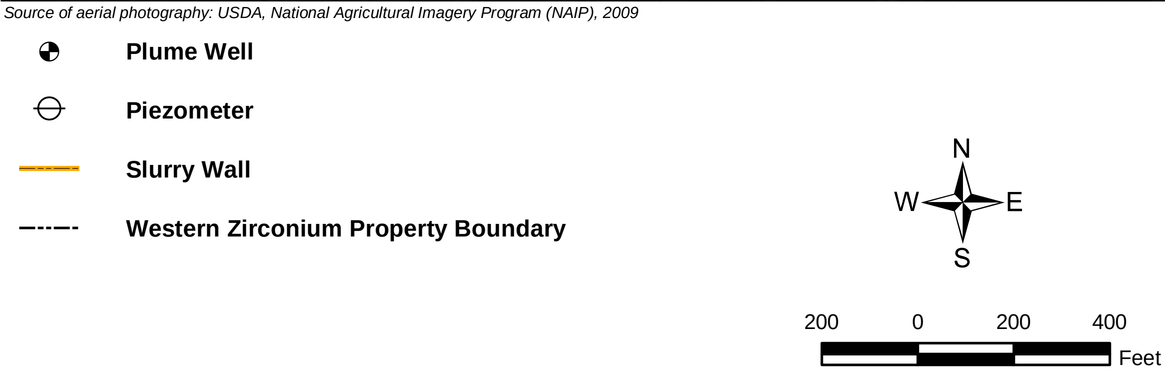
Evaporation Pond Area
Ongoing Monitoring Plan

Western Zirconium

Westinghouse URS

FIGURE 2

Source of aerial photography: USDA, National Agricultural Imagery Program (NAIP), 2009



Wells and Piezometers Previously Abandoned

Evaporation Pond Area
Ongoing Monitoring Plan

Western Zirconium

Westinghouse

URS

FIGURE 3

TABLES

Table 1: Western Zirconium Evaporation Pond Area Ongoing Monitoring Program Summary

Ongoing Monitoring Plan Schedule

Event	*First Quarter*	*Second Quarter*	*Third Quarter*	*Fourth Quarter*	*Comments*
Sampling	March	June	September	December	Sampling will begin the week that includes the first day of the sampling month.
Submit Report to UDEQ	May	August	November	February	The report will be submitted 30 days prior to the start of the next quarter of sampling.

Ongoing Monitoring Program Sampling Requirements

Sampling Locations	*First Quarter Analytical Samples*	*Second Quarter Analytical Samples*	*Third Quarter Analytical Samples*	*Fourth Quarter Analytical Samples*	*Comments*
Sentry Wells[1]	Groundwater Discharge Permit Parameters[5]; Groundwater Elevation	Groundwater Discharge Permit Parameters[5]; Groundwater Elevation	Ground water Discharge Permit Parameters[5]; Groundwater Elevation	Groundwater Discharge Permit Parameters[5]; Groundwater Elevation	Sentry wells will be sampled quarterly for at least 8 consecutive samplings after installation of the barrier wall to establish a base line. Sampling frequency will be re-evaluated after that period.
Plume Wells[2]	Groundwater Elevation; No Sampling	Groundwater Elevation; No Sampling	Groundwater Discharge Permit Parameters[5]; Groundwater Elevation	Groundwater Elevation; No Sampling	Plume wells will be sampled once per year during the third quarter sampling event. New plume wells will be sampled for 8 consecutive quarters; and thereafter will be annual.
Surface Water Bodies[3]	No Sampling	Groundwater Discharge Permit Parameters[5]	No Sampling	Groundwater Discharge Permit Parameters[5]	Surface water bodies will be sampled semi-annually when surface water is present.
Piezometers[4]	Groundwater Elevation	Groundwater Elevation	Groundwater Elevation	Groundwater Elevation	Groundwater elevations in the paired and nested piezometers will be used to confirm correct function of the wall.

[1] Sentry Wells are monitoring wells S4, S5, S6, S7, S9, S10, S11, and S12.
[2] Plume Wells are monitoring wells PW1, PW2, PW3, PW4, PW5, PW6, PW7, PW8, N1, N2, R1, S2, S3, and S8.
[3]Surface Water Bodies: SWB-3, SWB-7, SWB-8, SWB-9, SWB-10, and SWB-11.
[4]Piezometers: PP1A&B, PP2A&B, PP3A&B, PP4A&B, PP5A&B, PP6A&B, PP7A&B, PP8A&B, PP9A&B, PP10A&B, PP11A&B, PP12A&,B NP1R, NP2R, NP3, NP4, NP5, P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P14, P15, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, and TP34.
[5]Groundwater Discharge Parameters: ammonia, cyanide (total), barium (total), cadmium (dissolved), selenium (dissolved), uranium (dissolved), zirconium (total), nitrate+nitrite, radium 226+228, TDS, and pH.

Table 2: Western Zirconium Evaporation Pond Area Ongoing Monitoring Program Summary Analyses and Sampling Requirements

Analytes	***Analytical Method***	***Sampling Container[1]***	***Preservative***	***Filter***
Physical Characteristics				
pH	SW-846 9040	Polyethylene, 1 x 125 mL	None, refrigerate at ≤6°C	None
Total Dissolved Solids	A2540	Polyethylene, 1 x 125 mL	None, refrigerate at ≤6°C	0.45 micron filter
Inorganic Chemicals				
Ammonia	EPA 350.1	Amber glass, 1 x 500 mL	pH<2 sulfuric acid, refrigerate at ≤6°C	None
Nitrate+Nitrite	EPA 353.2	Polyethylene, 1 x 500 mL	None, refrigerate at ≤6°C	None
Cyanide, Total	SW-846 9012	Polyethylene, 1 x 250 mL	pH>11 sodium hydroxide	None
Metals				
Barium Total	SW846 6010	Polyethylene, 1 x 500 mL	pH<2 nitric acid, refrigerate at ≤6°C	None
Cadmium Dissolved	SW846 6020	Polyethylene, 1 x 500 mL	pH<2 nitric acid, refrigerate at ≤6°C	0.45 micron filter
Selenium Dissolved	SW846 6020	Polyethylene, 1 x 500 mL	pH<2 nitric acid, refrigerate at ≤6°C	0.45 micron filter
Zirconium Total	SW846 6010	Polyethylene, 1 x 500 mL	pH<2 nitric acid, refrigerate at ≤6°C	None
Radiological				
Uranium*	SW-846 6020	Polyethylene, 1 x 500 mL	pH<2 nitric acid, refrigerate at ≤6°C	0.45 micron filter
Radium 226	EPA903.0-M	Polyethylene, 2 x 1 gallon cubitainer	pH<2 nitric acid	0.45 micron filter
Radium 228	EPA904.0-M	Polyethylene, 2 x 1 gallon cubitainer	pH<2 nitric acid	0.45 micron filter

mL – milliliter
°C – degrees Centigrade
All containers require Teflon-lined caps to minimize container cross-contamination and loss of analyte. Containers are typically provided by the laboratory and may differ from the type and size indicated.
* Uranium is analyzed using Method 6020 but is regulated as a radionuclide. Therefore, samples collected for uranium analysis are filtered in the field in order to comply with sampling procedures for radionuclides.

Table 3: List of Historic Wells and Piezometers Abandoned in Pond Area Prior to or During Barrier Wall Construction

Piezometer ID	***Well ID***
P13*	S1
P16	R2
TP1*	R3
TP13	R4
TP14	4A
TP15	5B
TP16	5C
TP17	5D
TP18	6A
TP19	6B
TP20	7A
TP21	7C
TP22	8A
TP23	8B
TP24	A14
TP25	A15
TP26	
TP27	
TP28	
TP29	
TP30	
TP31	
TP32	
TP33	

*Piezometers P13 and TP1 were abandoned before the construction of the barrier wall. All other locations shown in this table were abandoned as part of the barrier wall construction.

Table 4: Classification of Pond Area Groundwater

Total Dissolved Solids[1]	*mg/L*
Pond Area Mean	12,315
Pond Area Standard Deviation	13,211
Pond Area 95% Upper Confidence Limit using gamma distribution	18,423
Pond Area Groundwater Classification[2]	Class IV

[1] Statistics were calculated using the combined total dissolved solids data from sentry wells S4, S5, S6, S7, S9, S10 and S11.
[2] Per Utah Administration Code Rule R317-6-3, groundwater containing greater than 10,000 mg/L total dissolved solids is considered Class IV groundwater; and as such is subject only to protection levels established to protect human health and the environment under R317-6-4.

Table 5: Background Levels in Sentry Wells

Parameters	Sentry Well Mean of Historical Data [1]							
	S4	**S5**	**S6**	**S7**	**S9**	**S10**	**S11**	**Units**
Ammonia	7.3	5.3	5.9	3.2	3.3	4.9	9.6	mg/L
Cyanide - Total	0.0031	0.0029	0.0033	0.0043	0.0039	0.0028	0.0024	mg/L
Barium - Total	0.15	0.19	0.10	0.24	0.19	0.49	0.16	mg/L
Cadmium - Dissolved[2]	0.00006	0.00008	0.00006	0.00006	0.00009	0.00004	0.00023	mg/L
Selenium - Dissolved[2]	0.015	0.010	0.019	0.003	0.002	0.001	0.004	mg/L
Uranium - Dissolved	0.00048	0.00026	0.00960	0.00387	0.00008	0.00063	0.00062	mg/L
Zirconium - Total	0.0048	0.0029	0.0075	0.0035	0.0030	0.0034	0.0153	mg/L
Nitrate+Nitrite	0.07	0.08	0.08	0.04	0.08	0.12	0.06	mg/L
Radium 226+228	2.0	2.3	2.8	0.9	0.9	2.6	3.6	pCi/L

[1] The calculation of mean excluded statistical outliers. Data include 1st quarter 2002 through 3rd quarter 2012. Non-detects were set to a value of one-half the method detection limit or, for radiological parameters, one-half the minimum detectable activity. Values were considered outliers if they are greater than the 3rd quartile, plus 3 interquartile ranges.

[2] Data for dissolved cadmium and selenium were available for the majority of the sentry wells during only two sampling events from 3rd quarter 2002 to 4th quarter 2002. Therefore, total cadmium and total selenium were used as proxy data until eight sampling events for dissolved cadmium and dissolved selenium are available.

Table 6: Preliminary Protection Levels for Sentry Wells

Parameters	Units	Protection Levels Specified by UAC R317-6-2	Site-Specific Risk-Based Protection Level	Source of Site-Specific Risk-Based Protection Level	Preliminary Protection Levels for Sentry Wells[1]							
					S4	S5	S6	S7	S9	S10	S11	S12
Ammonia	mg/L	N/A	0.34	ERA	9.5	6.9	8.0	4.5	4.2	7.0	11.7	TBD
Cyanide- Total[2]	mg/L	0.2	0.0052	ERA	0.0087	0.0082	0.0079	0.0078	0.0103	0.0094	0.0052	TBD
Barium- Total	mg/L	2	0.004	ERA	0.290	0.291	0.128	0.349	0.204	0.840	0.255	TBD
Cadmium- Dissolved[3]	mg/L	0.005	0.00064	ERA	0.00064	0.00064	0.00067	0.00064	0.00064	0.00064	0.00064	TBD
Selenium- Dissolved[3]	mg/L	0.05	0.0046	ERA	0.015	0.013	0.022	0.0049	0.0046	0.010	0.051	TBD
Uranium- Dissolved[4]	mg/L	0.03	0.0026	ERA	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	TBD
Zirconium- Total	mg/L	N/A	0.017	ERA	0.017	0.017	0.021	0.017	0.017	0.017	0.030	TBD
Nitrate+Nitrite	mg/L	10	N/A	N/A	10	10	10	10	10	10	10	TBD
Radium 226+228	pCi/L	5	N/A	N/A	5.0	5.0	5.0	5.0	5.0	5.6	6.6	TBD
TDS	mg/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	TBD
pH	pH units	6.5 - 8.5	N/A	N/A	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	TBD

CMS = Corrective Measures Study, revised April 2010 (URS, 2010).
ERA = Final Ecological Risk Assessment, January 2008 (URS, 2008).
N/A = Not applicable
TBD = To be determined
TDS = total dissolved solids
UAC = Utah Administrative Code

[1] Groundwater in the pond area is classified as Class IV (see Table 4). For wells in Class IV groundwater areas, protection levels for groundwater are established only as necessary to protect human health and the environment . The preliminary protection level was determined as the lesser of the protection level specified by UAC R317-6-2 and the site-specific risk-based protection level, or the background level (see Table 5), if the background level was greater. The protection levels are preliminary because additional background data need to be collected for certain wells or analytes. No protection level for TDS is specified. See UAC R317-6-4.7.

[2] The ERA estimated a cleanup goal for free cyanide rather than total cyanide. Free cyanide is a subset of total cyanide. Western Zirconium, however, has traditionally monitored total cyanide, and the Utah Department of Water Quality has requested in a letter dated March 22, 2012 that the analyses and protection levels be established for total cyanide to be consistent with historical data. The analytical results for total cyanide will be greater than the actual concentrations of free cyanide.

[3] Data for dissolved cadmium and selenium were available for the majority of the sentry wells during only two sampling events from 3rd quarter 2002 to 4th quarter 2002. Therefore, total cadmium and total selenium were used as proxy data until eight sampling events for dissolved cadmium and dissolved selenium are available.

[4] The ERA estimated a cleanup goal for total uranium rather than dissolved uranium. Uranium is regulated as a radionuclide, and samples collected for uranium analysis are filtered in the field in order to comply with sampling procedures

Table 7: Well Construction Details and Selected Data

Location ID	*Location Easting*	*Location Northing*	*Top of Casing Elevation (ft amsl)*	*Ground Surface Elevation (ft amsl)*	*Well Stickup (ft)*	*Reported Well Depth (ft bgs)*
S2	397403.92	4568849.81	4219.70	4217.20	2.50	20
S4	398178.39	4568769.81	4218.43	4216.00	2.43	20
S5	398250.29	4568325.23	4217.93	4215.40	2.53	20
S6	398324.11	4567893.76	4216.60	4214.60	2.00	17.3
S7	398312.66	4567417.02	4217.05	4214.50	2.55	20
S8	398015.36	4567297.12	4220.80	4218.10	2.70	20
S9	397581.84	4567358.31	4218.94	4216.60	2.34	20
S10	397241.82	4568952.83	4216.34	4213.70	2.60	20
S11	397807.59	4569238.86	4214.65	4213.77	1.0	20
PW1	**Well construction details will be provided after wells are installed following the construction of the barrier wall.**					
PW2						
PW3						
PW4						
PW5						
PW6						
PW7						
PW8						

amsl – above mean sea level
bgs – below ground surface
ft – feet

Table 8: Nested Piezometer Details and Selected Data

Location ID	*Location Easting*	*Location Northing*	*Ground Surface (ft amsl)*	*Top of Screen (ft bgs)*	*Screen Length (ft)*	*Mid Screen Elevation (ft amsl)[a]*	*Top of Casing Elevation (ft amsl)*
NP1R-S	397263.72	4568550.77	4220.63	22	10	4193.63	4223.08
NP1R-M			4220.64	42	10	4173.64	4223.28
NP1R-D			4220.37	55	10	4160.37	4223.13
NP2R-S	398023.60	4568351.18	4217.59	19	10	4193.59	4220.42
NP2R-M			4217.46	32	10	4180.46	4220.00
NP2R-D			4217.23	50	10	4162.23	4219.85
NP3-S	398030.54	4567641.34	4223.97	26	6	4194.97	4226.55
NP3-M			4223.97	47	8	4172.97	4226.44
NP3-D			4223.97	62	8	4157.97	4226.45
NP4-S	397232.18	4567939.85	4224.94	27	8	4193.94	4227.38
NP4-M			4224.94	50	7	4171.44	4227.44
NP4-D			4224.94	62	8	4158.94	4227.44
NP5-S	397570.62	4568538.62	4219.73	20	10	4194.73	4222.34
NP5-M			4219.30	40	10	4174.30	4222.03
NP5-D			4219.44	55	10	4159.44	4222.00

amsl – above mean sea level
bgs – below ground surface
ft – feet

APPENDIX A

EXAMPLES OF FIELD LOGS

Western Zirconium
Static Water Level Log

Location ID	Date	Time	Depth to Water (ft)	Location ID	Date	Time	Depth to Water (ft)
Monitoring Wells				**Piezometers**			
N1				**P1**			
N2				**P2**			
R1				**P3**			
S2				**P4**			
S3				**P5**			
S4				**P6**			
S5				**P7**			
S6				**P8**			
S7				**P9**			
S8				**P10**			
S9				**P11**			
S10				**P12**			
S11				**P13**			
PW1				**P14**			
PW2				**P15**			
PW3				**TP1**			
PW4				**TP5**			
PW5				**TP6**			
PW6				**TP7**			
PW7				**TP10**			
PW8				**TP11**			
				TP12			
				TP34			

Western Zirconium
Static Water Level Log

Location ID	Date	Time	Depth to Water (ft)	Location ID	Date	Time	Depth to Water (ft)
Nested Piezometers							
NP1R-S							
NP1R-M							
NP1R-D							
NP2R-S							
NP2R-M							
NP2R-D							
NP3-S							
NP3-M							
NP3-D							
NP4-S							
NP4-M							
NP4-D							
NP5-S							
NP5-M							
NP5-D							
PM-1							
SWB-3							
SWB-6							
SWB-7							
SWB-8							
SWB-9							
SWB-10							
SWB-11							

Comments:

Western Zirconium
Surface Water Sampling Log

General Information

Sample Identification: ______________________

Date Sampled: ______________________

Sampler: ______________________

Climate: ______________________

Ambient Temperature: ______________________

Sampling Information

Area Sampled: ______________________

Sample Location: ______________________

Sampling Equipment: ______________________

Filtered Aliquots: ______________________

Sampling Method: ______________________

Sampling Start Time: ______________________

Sampling End Time: ______________________

QA/QC Sampling: ______________________

Observations / Remarks:

Western Zirconium
Ground Water Sampling Log

General Information

Well Identification: ____________________
Sampler: ____________________
Date Sampled: ____________________
Climate: ____________________
Ambient Temperature: ____________________
____

Well Evacuation

Purge Method: ____________________
Purge Rate: * ____________________
Time Start Purge: ____________________
Time End Purge: ____________________
Total Volume Purged: ____________________
Static Water Level: ____________________

Sampling Information

Sampling Rate: * ____________________
Time Start Sampling: ____________________
Time End Sampling: ____________________
QA/QC Sampling: ____________________
Filtered Aliquots: ____________________

Well Condition / Remarks:

____
____
____

Purge Measurements

Parameter	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Reading 6
Time						
Water Level (ft btoc)						
pH						
Conductivity (mS/cm)						
Turbidity (NTU)						
Temperature (^oC)						
Eh/Redox (mV)						

Parameter	Reading 7	Reading 8	Reading 9	Reading 10	Reading 11	Reading 12
Time						
Water Level (ft btoc)						
pH						
Conductivity (mS/cm)						
Turbidity (NTU)						
Temperature (^oC)						
Eh/Redox (mV)						

Stabilization

pH: +/- 0.2
Temperature: +/- 1 ^oC
Conductivity: +/- 10 %
Eh/Redox: +/- 10 %

*Standard maximum purge and sampling rate = 0.3 liters per minute
btoc – below top of casing

Western Zirconium
Equipment Calibration Log

Project: ____________________

Date: ____________________

Personnel: ____________________

Weather: ____________________

Temperature: ____________________

Humidity: ____________________

Instrument (√):

pH Meter ____________

Conductivity ____________

Turbidity ____________

Eh meter ____________

Other ____________

CALIBRATION AND CONTINUING CALIBRATION LOG

Time	Calibration Standard	Calibration Standard Expiration Date	Meter Reading	Observations/Comments

URS

CHAIN OF CUSTODY/LABORATORY ANALYSIS REQUEST FORM

URS Corporation ● 756 East Winchester Street, Suite 400, Salt Lake City, UT 84107 ● 801-904-4000 ● Fax 801-904-4100

Project Name:	Project Number:
Project Manager: Report CC:	
Project Location:	
Phone #	FAX #
Sampler's Signature	Sampler's Printed Name

ANALYSIS REQUESTED

FIELD SAMPLE ID	SAMPLE DATE	SAMPLE TIME	MATRIX	MS/MSD	Total Number of Containers																	REMARKS

INVOICE INFORMATION	Matrix Key:	SPECIAL INSTRUCTIONS/COMMENTS
BILL TO: URS CORPORATION	GW = Ground Water SW = Surface Water O = Other ____________	

SAMPLE RECEIPT: CONDITION/COOLER TEMP:________________ CUSTODY SEALS: Y N

RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
Signature	Signature	Signature	Signature
Printed Name	Printed Name	Printed Name	Printed Name
Date/Time	Date/Time	Date/Time	Date/Time

 White and Yellow to lab **Pink – sample management** **Cooler _____ of _____**

APPENDIX B

SENTRY WELL MONITORING, DATA EVALUATION, AND REPLACEMENT PROCEDURES

APPENDIX B

B1.0 SENTRY WELL MONITORING, DATA EVALUATION, AND REPLACEMENT PROCEDURES

Criteria for evaluating sentry well data to determine whether the groundwater contamination plume has reached a particular well location is provided in this appendix.

B1.1 MONITORING

The function of sentry wells is to detect the migration of an identified contamination plume to an area that was previously uncontaminated. To detect this migration, sentry wells are located in an uncontaminated downgradient area, but as close to the leading edge of the contamination plume as possible. Sentry wells are sampled in accordance with the requirements and schedule specified in this *Ongoing Monitoring Plan* (OMP). New sentry wells are sampled quarterly for four consecutive quarters for the full suite of analyses to establish a chemical baseline, and to evaluate whether the plume has reached the sentry location. After four quarters, the sampling of new wells will be re-evaluated.

B1.2 DATA EVALUATION

The purpose of sentry well data evaluation is to determine if contaminant plume migration has reached the sentry well location. The contaminant plume will be considered to have reached a sentry well if there is a confirmed detection of a constituent in groundwater that is a statistically significant increase over the background sample mean concentration, and is above the site-specific groundwater protection level listed in this OMP for at least two quarters during any four consecutive quarters. Confirmed detection will also require that the concentration of the contaminant be an unqualified concentration report from the laboratory. This means that the reported concentration must be equal to or greater than the method detection limit (MDL) for non-radiological parameters or the minimum detectable activity (MDA) for radiological parameters, and that sufficient quality control objectives were met such that the concentration was not qualified as an "estimated concentration".

For cases where the analytical result is reported as being less than the MDL (or MDA for radiological parameters), or when the result is qualified with "U" or "UJ", one half of the reported MDL (or MDA for radiological parameters) will be used in the calculation of the background mean sample concentration.

A statistically significant increase would occur if the calculated concentration exceeds the background sample mean concentration plus twice the standard deviation. However, in cases where all of the results have been calculated using one half of the MDL or "U" or "UJ" qualified result, and the analyte has never been detected by the laboratory; the calculated result will not be considered a confirmed detection, and no action will be required even if the statistical calculation results exceeds the background sample mean concentration plus twice the background sample standard deviation.

Results that indicate the contaminant plume has reached a sentry well will trigger a discussion between Utah Department of Environmental Quality (UDEQ) and Western Zirconium regarding the circumstances of the statistical increase and changes in groundwater quality at the site.

B1.3 REPLACEMENT OF SENTRY WELLS

A sentry well could be deemed a pond well after discussion and agreement between UDEQ and Western Zirconium, if these conditions have occurred:

- the contaminant is determined to be statistically increasing in the sentry well; and
- the contaminant is detected above the site- site-specific groundwater protection level; and
- the statistical increase is not a preliminary statistical increase; and
- the concentration of the contaminant is an unqualified concentration.

If after discussion between UDEQ and Western Zirconium, a sentry well is deemed to be a pond well, Western Zirconium will submit to the state a proposal to install a new sentry well, if it is decided that installation of a new sentry well is necessary. New sentry wells will be located outside of the contamination plume, but as close as practical to the existing sentry well network to allow for the monitoring of plume migration in that area. Western Zirconium will install new sentry wells after it has received agreement from the state as to the location of the new well and the constituents to be sampled. Methods for installing new sentry wells are provided in Attachment A, and the new sentry wells will be surveyed in accordance with the methods provided in Attachment B.

B2.0 DETERMINATION OF SENTRY WELL VALIDITY

Sentry well analytical results will be statistically evaluated to determine if contaminant plume constituents have reached these locations. The designated sentry wells are wells S4, S5, S6, S7, S9, S10, S11, and S12.

All inorganic analytes in each designated sentry well will be statistically evaluated to determine if the concentrations detected during the quarter of sampling exceeded the background sample mean plus background sample two sample standard deviations above background for each well.

B2.1 STATISTICAL EVALUATION OF CHEMICAL COMPOUNDS DETECTED IN SENTRY WELLS

To determine if detected analytes are present at statistically significant concentrations, the background sample mean plus two background sample standard deviations will be calculated for inorganic analytes detected at each designated sentry well using the following equation:

$$BMSD = \bar{x} + 2\,s$$

where: $BMSD$ = background mean + 2 background standard deviations
$\bar{x}$ = background sample mean
s = background sample standard deviation

The background sample mean was calculated from previous quarterly data using the following equation:

$$\bar{x} = \frac{R_{Q-1} + R_{Q-2} + \ldots . R_{Q-N}}{N}$$

where: R = analytical result for designated quarter
Q = current quarter
N = number of previous quarters

The background sample standard deviation was calculated using the following equation:

$$s = \sqrt{\frac{\sum\left(R_x - \bar{x}\right)^2}{N-1}}$$

Where: R_x = each result in the data set

The data set for background sample mean and the background sample standard deviation will exclude statistical outliers that do not represent groundwater quality in the area.

A statistically significant increase exists if the current result exceeds the background sample mean plus twice the background sample standard deviation. For the background statistical calculations, the following conventions have been established:

- An assumed chemical concentration equal to one half of the MDL was used in statistical calculations for the evaluation of non-detect results.
- An assumed chemical concentration equal to one half of the MDL (or one half of the maximum detectable activity for radiologicals) was used in statistical calculations for the evaluation of results qualified with “U” or “UJ” validation flags.
- Reported concentrations qualified with an “R” validation flag will be excluded from the statistical analysis data set.
- Reported concentrations qualified with flags other than “U”, “UJ”, or “R” will be used in statistical calculations at the laboratory-reported value without modification.
- Radiological statistical calculations used the result plus the variance as the concentration used in the mean and standard deviation calculations.
- If field duplicate sample data are available in addition to the normal sample data, only the normal sample will be used in the calculation; field duplicates are collected only for the purpose of quality assurance.
- Statistical outliers will be excluded from the dataset. Statistical outliers will be identified as values that exceed the 3rd quartile plus 3 interquartile ranges (NCSS Users Guide I, Number Cruncher Statistical Systems, Dr. Jerry L. Hintze, August 2001) for the analytical data for that sampling location.

ATTACHMENTS

Attachment A	Monitoring Well Drilling and Installation Procedures
Attachment B	Site Survey Procedures

ATTACHMENT A

MONITORING WELL DRILLING AND INSTALLATION PROCEDURES

ATTACHMENT A

I MONITORING WELL DRILLING AND INSTALLATION PROCEDURES

Methods and procedures to be followed for installing new monitoring wells at Western Zirconium are described in this Attachment, along with the required drilling equipment, well design and development, and decontamination procedures. Procedures for the abandonment of monitoring wells that are no longer useful for water quality monitoring or water level observation are also included.

II PURPOSE OF MONITORING WELLS

Stratigraphic data obtained during drilling of new monitoring wells will be used to evaluate the hydrogeology of the area. Information obtained from subsurface soil sampling activities includes a soil description using the Unified Soil Classification System at each sampling point. Groundwater sampling of additional monitoring wells will be used to determine the movement of existing ground water plumes.

III PROPOSED LOCATIONS

New monitoring wells may be used to characterize the upgradient "background" quality of groundwater moving onto the site, identify the nature of groundwater in areas of specific concern, and to monitor potential off-site migration of contamination. New monitoring well locations and depths will be based on data obtained in the field, and on agreements with oversight agencies. After drilling and well construction activities are completed, all new wells will be surveyed for location and elevation (see Attachment B of this Appendix).

IV MONITORING WELL DESIGN AND DESIGNATION

Existing wells at Western Zirconium have a numeral and letter designation (e.g., R1, 4A, S1). Future monitoring wells will be designated in a similar manner.

V DRILLING AND WELL INSTALLATION EQUIPMENT AND PROCEDURES

The monitoring wells will be drilled from the ground surface to total depth using hollow-stem augers or other techniques, as specified in the project-specific work plan. Monitoring well borings in soil will be continuously sampled with a split spoon to ensure detection of water-bearing units. A sample catcher may be placed at the end of the sampler so that unconsolidated soils are not lost as the sampler is retrieved from the borehole. The sampler will be driven with a standard 140-pound hammer falling 30 inches. No circulating fluid, drilling mud, or other additives will be used during hollow-stem auger drilling without pre-approval of the Western Zirconium Project Manager. During drilling activities, soil samples for chemical and/or geotechnical analysis may be collected from the borehole prior to well installation. All cuttings will be properly disposed of, in accordance with the project-specific work plan.

To prevent collapse of the borehole wall, the monitoring wells will be installed through the inside of the hollow-stem augers as they are retracted from the boring. Monitoring wells will typically be constructed of Schedule 40 polyvinyl chloride (PVC) screen and blank casing. Well screens typically will have 0.01-inch slots and will be ten feet long. However, the actual casing type, diameter, depth, slot size, and screened interval will be determined in the field and will be based on site-specific observations made during installation of the borehole. Monitoring well construction details will be specified in project-specific work plans. The PVC blank casing will extend from the top of the screen to approximately two feet above the ground surface. The annular space between the PVC and the borehole will be filled with silica sand from the bottom of the borehole to two feet above the top of the screen. A 1-foot layer of granular bentonite will be placed above the sand pack and the remainder of the annulus will be filled with neat cement. No accelerators, such as calcium chloride, will be added to the cement. A locking protective steel casing will be placed over the PVC well casing and will be set in a concrete pad.

VI MONITORING WELL DEVELOPMENT EQUIPMENT AND PROCEDURES

The monitoring wells will be developed in an effort to return the nearby formation to natural conditions and ensure that the well will produce samples representative of the aquifer. The monitoring wells will be developed using a surge block, pump, bailer, or a combination of these tools. Development will consist of surging to loosen sediments that may have been smeared along the borehole wall while drilling, and to settle the sand pack (which increases the filtering abilities of the sand by decreasing its porosity). A pump or bailer will then be used to purge the well of sediments dislodged while surging. The monitoring wells will be developed no sooner than 24 hours after grouting and well construction is completed. Development will continue until the turbidity of the purge water is <5 Nephelometric Turbidity Units (NTUs), or until turbidity measurements have stabilized. Turbidity will be considered to be stable if five borehole volumes have been removed and three consecutive turbidity measurements are within ±10 percent of each other. Because a long history of groundwater analyses indicate only low concentrations of chemicals exist even in close proximity to the evaporation ponds, development water will be discharged to the ground surface at least ten feet away from the well. Development water from wells installed at locations that are not on Western Zirconium's property will be disposed at the plant Jacuzzi. An example Well Development Log form is included in this Attachment.

VII MONITORING WELL ABANDONMENT PROCEDURES

If any of the monitoring points being utilized under this program are deemed to require permanent abandonment for any reason, Western Zirconium will notify Utah Department of Environmental Quality (UDEQ), and the abandonment will be performed according to the procedures described in this section. The determination to permanently abandon a monitoring well will be documented in project-specific work plans, or during the annual reassessment of the monitoring program. To properly abandon wells or piezometers that are no longer useful for ground water monitoring or water level observation, the following procedures typically will be followed:

- Remove concrete plugs, if present,

- Remove the concrete apron and protective casing, if present,
- Pull casing from ground, if possible,
- If the entire casing can be removed from the ground, fill the exposed borehole up to the ground surface with neat cement grout or granular bentonite,
- If the casing cannot be removed from the ground, fill the casing to the surface with neat cement grout or granular bentonite, and
- All abandonment activities will be performed by a Utah licensed well driller in accordance with UAC R655-4-11.4.

VIII DECONTAMINATION PROCEDURES

All downhole equipment will be thoroughly steam cleaned to remove any visible soil, sediment, or residue prior to use at each location. Downhole equipment includes the drill rig, all drill pipe, pumps, and any tools. Equipment, tools, and supplies will be placed on racks, sawhorses, or plastic sheeting while they are being steam-cleaned. Items will be steam-cleaned until they are free of visible debris, and wash water dripping from items appears to be clear. Steam-cleaned items will remain off the ground until they are used. URS's on-site representative will supervise and approve decontamination activities.

After a monitoring well is completed, the drill rig will be moved a distance of 50 to 100 feet from the borehole. At this location, any mud or grease that has accumulated during drilling will be removed by steam cleaning. If muddy conditions exist, the tires of the drill rig and any other equipment will be cleaned before the equipment is moved to the next location. This procedure will minimize the potential for cross-contamination from one site to another.

IX DOCUMENTATION PROCEDURES

Boring Log forms will be used to record descriptions of the subsurface stratigraphy encountered during drilling, the depth and type of samples collected, and the water level. In addition, photoionization detector (PID) readings will be recorded. The field geologist will prepare boring logs during drilling operations. Well construction details will be recorded in the associated boring log. An example Boring Log form is included in this Attachment. Documentation procedures are described in detail in this OMP.

Western Zirconium
Well Development Log

Site:___________________________ Date:______________

Personnel:____

Well/Piezometer ID:________

Casing Diameter:___________

Depth to Water:____________ Total Depth_________ Reference Point:___________

Calculated Casing Volume:________

Well Evacuation Method:________________ Surge Method:__________________

Time	Volume Evacuated	pH	Temp.	Conductivity	Turbidity	Observations/Notes

Project: **Project Location:** **Project Number:**	**Log of:** _________	
	North:	East:
	Surf Elev:	Casing Elevation:

Date(s) Drilled	Logged By	Approved By
Drilling Method	Diameter of Borehole	Approximate Ground Water Elevation
Drill Rig Type	Drilling Company	Total Depth
Driller's Name	Sampler Type	
Comments		

Depth, Feet	PID	Blow Count	Percent Recovery	USCS Class	**LITHOLOGIC DESCRIPTION** (USCS NAME; COLOR; SIZE AND ANGULARITY OF EACH COMPONENT OR PLASTICITY; DENSITY; MOISTURE CONTENT; ADDITIONAL FACTS)	**REMARKS/ OTHER TESTS**	**WELL** Well Material		Pack Material	Depth, Feet
0										0
5										5
10										10
15										15

URS

Sheet _____ of _____

Project:
Project Location:
Project Number:

Log of: ________

North:	East:
Surf Elev:	Casing Elevation:

Depth, Feet	PID	Blow Count	Percent Recovery	USCS Classification	LITHOLOGIC DESCRIPTION (USCS NAME; COLOR; SIZE AND ANGULARITY OF EACH COMPONENT OR PLASTICITY; DENSITY; MOISTURE CONTENT; ADDITIONAL FACTS)	REMARKS/ OTHER TESTS	WELL: Well Material	WELL	WELL: Pack Material	Depth, feet
15										15
20										20
25										25
30										30

Sheet ____ of _____

URS

Project: **Project Location:** **Project Number:**	**Log of:** ________
North:	East:
Surf Elev:	Casing Elevation:

Depth, Feet	PID	Blow Count	Percent Recovery	USCS Classification	**LITHOLOGIC DESCRIPTION** (USCS NAME; COLOR; SIZE AND ANGULARITY OF EACH COMPONENT OR PLASTICITY; DENSITY; MOISTURE CONTENT; ADDITIONAL FACTS)	**REMARKS/ OTHER TESTS**	**WELL** Well Material		Pack Material	Depth, feet
35										35
40										40
45										45
50										50

Sheet ____ of _____

URS

Project:
Project Location:
Project Number:

Log of: ________

North:	East:
Surf Elev:	Casing Elevation:

Depth, Feet	PID	Blow Count	Percent Recovery	USCS Classification	LITHOLOGIC DESCRIPTION (USCS NAME; COLOR; SIZE AND ANGULARITY OF EACH COMPONENT OR PLASTICITY; DENSITY; MOISTURE CONTENT; ADDITIONAL FACTS)	REMARKS/ OTHER TESTS	WELL: Well Material	WELL	WELL: Pack Material	Depth, feet
55										55
60										60
65										65

Sheet ____ of _____

URS

Project:	Log of: ________	
Project Location:	North:	East:
Project Number:	Surf Elev:	Casing Elevation:

Depth, Feet	PID	Blow Count	Percent Recovery	USCS Classification	LITHOLOGIC DESCRIPTION (USCS NAME; COLOR; SIZE AND ANGULARITY OF EACH COMPONENT OR PLASTICITY; DENSITY; MOISTURE CONTENT; ADDITIONAL FACTS)	REMARKS/ OTHER TESTS	WELL: Well Material	WELL	WELL: Pack Material	Depth, feet
70										70
75										75
80										80
85										85

Sheet ____ of _____

URS

Project: **Project Location:** **Project Number:**	**Log of:** ________ North: East: Surf Elev: Casing Elevation:

Depth, Feet	PID	Blow Count	Percent Recovery	USCS Classification	**LITHOLOGIC DESCRIPTION** (USCS NAME; COLOR; SIZE AND ANGULARITY OF EACH COMPONENT OR PLASTICITY; DENSITY; MOISTURE CONTENT; ADDITIONAL FACTS)	**REMARKS/ OTHER TESTS**	**WELL** Well Material		Pack Material	Depth, feet
90										90
95										95
100										100

Sheet ____ of _____

URS

ATTACHMENT B

SITE SURVEY PROCEDURES

ATTACHMENT B

I SITE SURVEY PROCEDURES

Survey data will be used to accurately locate sampling locations. Elevation data will be used to determine ground water flow direction and gradient. These data will be used in production of site maps and for site characterization. Project-specific work plans will specify whether land survey or global positioning system (GPS) survey is required.

II SURVEY PROCEDURES

New wells, or other new sample locations, will be surveyed by a land surveyor licensed in the state of Utah. The survey will include horizontal coordinates, ground surface elevation, and top-of-casing elevation. Elevation measurements will be made to within 0.1 foot for horizontal control, and to within 0.01 foot for vertical control. To enable correlation between past, present, and future surveys, survey data will be reported in the Universal Transverse Mercator (UTM) Zone 12 North American Datum of 1927 (NAD 27) Coordinate System.