Evaluation of Hydrogeologic Zone Connectivity Through Tritium and Stable Isotope Sampling and Analysis

BMI Common Areas (Eastside)

Clark County, Nevada

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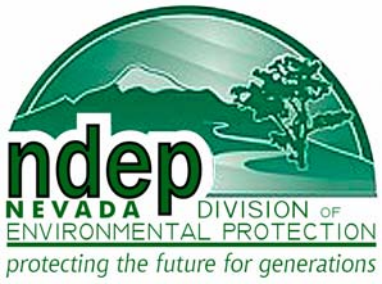

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Prepared for:

Daniel B. Stephens & Associates, Inc.
6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

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1. Introduction

During the planning of aquifer testing activities by Daniel B. Stephens & Associates, Inc. (DBS&A), the need to evaluate the connectivity between the BMI Common Areas, Eastside (the Site) water-bearing zones became apparent. Accordingly, pursuant to the aquifer testing work plan (DBS&A, 2007), DBS&A and Basic Remediation Company (BRC) conducted sampling and analysis of tritium and stable isotopes to address the connectivity between the three designated water-bearing zones at the Site: the Shallow Zone, the Middle Zone, and the Deep Zone (NDEP, 2009). This report presents the sampling data and interpretations regarding zone connectivity and addresses comments from the Nevada Division of Environmental Protection (NDEP) (Appendix A), dated April 24, 2009, regarding BRC's technical memorandum dated March 26, 2009, entitled *Tritium and Stable Isotope Sampling & Analysis, and Evaluation of Hydrogeologic Zone Connectivity, BMI Common Areas (Eastside), Clark County, Nevada.*

2. Background

The study area is located near the BMI Industrial Complex in Clark County, Nevada, approximately 13 miles southeast of Las Vegas and 2 miles northeast of the City of Henderson's downtown (Figure 1). Physiographically, the Site is situated approximately 2 miles west of the River Mountains and 1 mile north of the McCullough Range. As shown in Figure 1, the surface topography in the vicinity of the Site slopes in a westerly to northwesterly direction from the River Mountains and in a northerly to northeasterly direction from the McCullough Range. At the Site, the surface topography slopes in a northerly direction toward Las Vegas Wash.

Over the past 65 years, numerous private and public entities have owned, leased, or operated facilities on the original 5,000 acres and have engaged in a wide range of commercial and other activities, including the manufacturing of chemicals and metals. Historically, a network of ditches, canals, flumes, and unlined ponds was used for the disposal of aqueous waste from the original magnesium plant and, later, other industrial plants and the municipality adjacent to it. The Site as described herein encompasses approximately 2,287 acres of the original 5,000-acre deed referred to as the Eastside Area (Figure 2).

2.1 Geology

The depositional environment of the various strata encountered beneath the Site has been characterized through drilling and sampling of numerous borings installed during previous investigations. The Site is located on alluvial fan sediments, with a surface that slopes to the north-northeast, toward Las Vegas Wash, at a gradient of approximately 0.02. The uppermost two geologic formations encountered at the Site are the focus of this report:

- The uppermost unit is composed of relatively coarse-grained Quaternary alluvial sediments.

- These alluvial sediments are underlain by lacustrine sediments known as the Muddy Creek Formation (TMCf). For the most part, the lacustrine TMCf is comprised of silts

and clays, although a coarser facies was noted in the southwest portion of the site (Section 2.2.2).

These geologic units are described in Sections 2.1.1 and 2.2.2.

2.1.1 Quaternary Alluvium

The uppermost strata beneath the Site consist primarily of alluvial sands and gravels of Quaternary age (Carlsen et al., 1991) and are mapped and referred to as Quaternary alluvium (Qal). The alluvial fan deposits are composed of volcanic materials that were shed from various nearby mountains and then coalesced in the Las Vegas Valley. The Qal is typically on the order of 50 feet thick at the Site, with a maximum thickness of 65 feet noted to the southwest of the Southern rapid infiltration basins (RIBs). The variations of the thickness of the Qal are, in part, a result of the non-uniform contact between the Qal and the underlying TMCf. The Qal is not present in localized areas of the northernmost portion of the Site, where it was removed as a result of previous gravel mining. Such areas where excavation has occurred previously (such as Tuscany Village or the Weston Hills development) have since been backfilled to allow for residential development.

Whereas the original surface of the Qal prior to development was a nominally planar surface that, as a whole, dipped gently to the north, the contact between the Qal and the underlying TMCf is not a planar surface. The unconformity between these two geologic units is a result of erosion of the TMCf prior to the deposition of the alluvial sediments that comprise the Qal. As the TMCf was eroded, broad channels were incised into its surface and were subsequently filled with the alluvium, resulting in the development of several paleochannels of varying depths and width. BRC et al. (2006) have interpreted that two paleochannels originating to the east and west of the Southern RIBs join at the southern end of the former location of the historical spray wheel to form one paleochannel that runs north beneath the Northern RIBs and then northeasterly to the Las Vegas Wash.

As indicated by the borelog data, the structural surface of the TMCf also exhibits a topographic gradient to the north-northeast. However, the TMCf topography does not appear to be so deeply incised that the current flow of groundwater is controlled by paleochannel features. The

degree to which these paleochannels act as preferential pathway(s) for groundwater flow and contaminant migration is presently uncertain and is most likely a function of the amount and location of groundwater present.

Plate 1 is a structure contour of the top of the TMCf (base of the Qal) based on the evaluation of geophysical surveys and logs as later refined by the interpretation of more than 500 boring logs. The plate details the irregular nature of the topographic surface of the TMCf, as well as the presence of the three dominant paleochannels that trend north-northeast toward the Las Vegas Wash. As depicted in Plate 1, the data demonstrate that two of the three paleochannels originate from off-site in the southern portion of the study area and then extend generally northward to the Site's Western Hook and No-Build sub-areas. BRC understands that work is ongoing by TIMET regarding the occurrence of any paleochannels in the southwest portion of the Site. As this information becomes available, the conceptual site model will be revised as necessary.

2.1.2 Tertiary Muddy Creek Formation

The TMCf underlies much of the Las Vegas Valley and is more than 2,000 feet thick in places. At the Site, this unit is encountered beneath the Qal, where an unconformity separates the two geologic units. The depth to the top of the TMCf ranges from approximately 27 feet below ground surface (ft bgs) at well MCF-11 to approximately 65 ft bgs southwest of the Southern RIBs. At the Site, the TMCf was encountered to the maximum explored depth of 430 ft bgs. The TMCf is typically fine-grained (sandy silt and clayey silt), although thin layers (interbeds or "stringers") with increased sand content are encountered sporadically.

A coarser-grained facies of the TMCf occurs off-site and in the southwest portion of the study area (at well MCF-27, for example). The proportion of coarser-grained sediments in the upper portion of the TMCf decreases to the north beneath the Site. This more permeable TMCf facies is interpreted as being caused by an influx of slightly coarser alluvial deposits into the older lacustrine depositional environment. One possible ramification of the presence of these coarser TMCf sediments near the southwestern border of the Site is that they may serve as a potential pathway for chemicals to migrate into the TMCf.

2.2 Hydrogeology

The uppermost water-bearing zone is unconfined and present primarily in the Qal (referred to as the Shallow Zone), although at some locations on the Site, Shallow Zone groundwater is first encountered in the uppermost portion of the TMCf (referred to as the Upper Muddy Creek Formation [UMCf]). This unconfined Shallow Zone groundwater generally flows in a northerly direction toward Las Vegas Wash. The Shallow Zone groundwater is generally continuous across the Site, but there are areas where Shallow Zone wells are dry.

Below the Shallow Zone, deeper groundwater occurs in sporadically encountered lenses in the Middle Zone, designated between approximately 90 and 270 ft bgs.

Deep Zone groundwater is generally continuous across the Site and is characterized with wells screened below 270 ft bgs to a maximum nominal depth of 400 feet bgs. Groundwater elevation data from the last several rounds of groundwater monitoring (2006, 2007, 2008, 2009) show that Deep Zone groundwater is confined, and the potentiometric surface of Deep Zone groundwater is oriented generally north toward Las Vegas Wash (MWH, 2008). A January 2009 NDEP-produced document entitled *Hydrogeologic and Lithologic Nomenclature Unification* (NDEP, 2009) defines the rationale behind the definitions of the Shallow, Middle, and Deep Zones at the Site and at adjacent properties.

3. Historical Groundwater Characterization Activities

As previously reported to NDEP, BRC has conducted many investigation activities to collect data upon which to base an evaluation of the connectivity between the Site water-bearing zones. During investigations conducted in 2004, BRC and its consultants:

- Advanced 13 exploratory borings to a depth of approximately 400 ft bgs.
- Conducted geophysical logging of the 13 borings to a depth of approximately 400 ft bgs.
- Drilled 50 additional boreholes at 27 locations throughout the Site using mud rotary , hollow-stem auger, and rotary sonic drilling methods.
- Collected continuous core soil samples from 3 of the 400-foot mud-rotary borings (locations 1, 4, and 6) and from all of the boreholes drilled with the rotary sonic drilling method (18 locations).
- Collected 94 saturated soil samples and 12 in-situ groundwater samples from the various water-bearing zones at the Site for fast turnaround analysis of perchlorate using U.S. Environmental Protection Agency (EPA) method 314.0.
- Installed 44 groundwater monitor wells, including 8 wells in the Qal and 27 wells in the UMCf.

Since 2004, BRC has conducted the following activities:

- Reported on five groundwater monitoring events conducted between April to June 2006 and April to July 2008. The first monitoring event included collection and reporting of water elevations for 104 wells and water sample chemical analytic results for 53 wells. The monitoring scope has increased over the course of the five monitoring events. The fifth monitoring event included collection and reporting of water elevations for 155 wells and water sample chemical analytic results for 106 wells. A sixth round of sampling was completed in August and September of 2009.

- Conducted and reported on an aquifer testing program conducted at the Site.

- Installed numerous monitoring wells at upgradient and downgradient property boundary locations at the Site.

- Conducted analytic and numerical groundwater modeling.

4. Technical Approach

BRC and DBS&A have evaluated methods to assess the hydraulic connectivity of the Site water-bearing zones. This section discusses the rationale that provides the basis for using tritium and stable isotopes to evaluate Site water-bearing zone connectivity.

4.1 Injected Tracers

BRC and DBS&A do not believe that the use of injected tracer testing to directly assess the connectivity of the three water-bearing zones (or even the connectivity of the UMCf with groundwater in the Qal) is practical for two main reasons:

- The travel time for a conservative tracer introduced in the upper portion of the UMCf to migrate upward into the Qal where it could potentially be observed in a monitor well is at least on the order of several years and quite possibly much longer.

- Due to what are expected to be heterogeneous and unidentified specific flow paths for tracer migration, appropriate target sampling location(s) are, as a practical matter, unknowable.

The following calculation illustrates what BRC believes is the main problem with using tracer injection to evaluate saturated zone connectivity at the Site.

The 2004 groundwater well measurement data indicated that vertical hydraulic gradients were upward at most locations but downward in some, and ranged in magnitude from approximately 0.018 to 0.180. Assuming that the increased sand content of the Middle Zone lenses has an overall hydraulic conductivity of 1×10^{-4} centimeters per second (cm/s) and an effective porosity of 30 percent, the average groundwater velocity can be estimated using Darcy's Law:

$$v = \frac{Ki}{n_e}$$

where v = average groundwater pore velocity (cm/s)
K = saturated hydraulic conductivity (cm/s)
i = gradient (unitless, L/L)
n_e = effective porosity (unitless, L^3/L^3)
L = travel distance

Using a gradient of 0.018 (MWH, 2008), the calculated average pore velocity would be:

$$v = 6 \times 10^{-6} \text{ cm/s} = 0.017 \text{ ft/d}$$

Assuming this average pore velocity, it would take a tracer about 5 years to travel 30 feet in the vertical direction, assuming that no other retardation factors apply. Although other assumed values could be applied in the travel time calculation, BRC believes that the main constraint will be the average hydraulic conductivity of the intervening materials between the tracer release point and the target reception point. The 1×10^{-4}-cm/s value was selected to be on the expected high end of possibilities; the actual hydraulic conductivity may be lower, perhaps by 10 to 100 times.

Furthermore, the sporadic nature of the UMCf sand lenses indicates that a straight-line path is not realistic and that the path is instead tortuous and longer, possibly much longer, than accounted for in the above analysis (i.e., the actual flow path is not likely to be only 30 feet). This greater length would increase the tracer travel time even more. Although it is theoretically possible to reduce expected tracer travel times by inducing a higher hydraulic gradient by pumping or injection, BRC does not believe that this approach is appropriate because there is a significant likelihood that flow pathways would be opened where none existed prior to creation of the induced gradient, and the results of such a study would therefore not be representative of the flow regime observed at the Site.

In addition to the travel time problem, insufficient data are currently available (and are not likely to be reasonably attainable) to characterize the location of the point of intersection of the Middle Zone sand lenses with either the overlying Shallow Zone or the underlying Deep Zone. Therefore, it is not possible to confidently identify the proper location for a monitor well to

capture the tracer as it discharges from the Middle Zone into either the Shallow Zone or the Deep Zone.

4.2 Historical Tracers

Use of historical tracers is a promising approach for application at the Site. Historical tracers result from human activities or events in the past, such as contaminant spills or atmospheric nuclear testing (^{3}H and ^{36}Cl). Known industrial chemical contaminants at the Site from previous operational activities, such as perchlorate and tetrachloroethylene (PCE), are evaluated in this report, together with groundwater elevation data, to provide qualitative evidence of connectivity, or lack thereof, between the three Site water-bearing zones. Total dissolved solids (TDS) distribution is also evaluated. However, uncertainties with respect to source location, concentration, timing of chemical release, and the non-conservative behavior of some chemicals makes it difficult to use this information to quantify the connectivity in terms of the flux of groundwater between water-bearing zones.

The presence of an event marker, such as bomb tritium, in groundwater can provide evidence that a component of that water recharged during a particular time period. Because of tritium's short half-life (12.32 years), the use of bomb tritium as a hydrologic tracer is relatively temporary. Before significant amounts of tritium were injected into the atmosphere through nuclear activities in the 1950s and 1960s, precipitation had an estimated natural background of approximately 5 to 10 tritium units (TU) (Illinois Environmental Protection Agency, 1997). Radioactive decay of the tritium in any water recharged before the 1950s would therefore leave no detectable tritium today. Tritium content in precipitation in North America since the advent of atmospheric nuclear bomb testing in 1952 reached an atmospheric high in approximately 1963, and has diminished significantly since that time to the present atmospheric levels. In the southern hemisphere, the bomb pulse has already decayed to within 15 TU of natural background. Over 20 years ago, Bentley et al. (1986) reported that bomb tritium will be difficult to detect in 10 to 20 years.

The actual tritium content varies widely with location (Illinois Environmental Protection Agency, 1997). The Santa Maria, California and the Albuquerque, New Mexico stations have tritium monitoring stations with some of the longest monitoring records in the U.S. (Figures 3 and 4,

respectively). Santa Maria is located approximately 400 miles west-southwest of the Site; Albuquerque is located approximately 490 miles east-southeast of the Site. At Santa Maria, peak atmospheric tritium concentrations of about 1,300 TU were recorded from 1962 through early 1964, but by late 1964, tritium concentrations had diminished to less than 400 TU. Today, atmospheric background levels in the northern hemisphere are between about 5 and 30 TU (IAEA/WMO, 2006).

For 1976, the last year of record at Santa Maria, the average tritium atmospheric content from nine Santa Maria reporting stations was 15.33 TU (IAEA, 2009). Albuquerque, New Mexico reported a mean atmospheric tritium content of 7.3 TU from 12 reporting stations in 2001. These data are in agreement with the statement by the IAEA (2009) that, "Atmospheric tritium concentrations have been decreasing over the last 30 years and are currently almost at their low, natural levels, making tritium less useful as a hydrological tracer."

While tritium was chemically analyzed and evaluated for the Site monitoring wells sampled, the evaluation is qualitative and based on the absence or presence of tritium. Nonetheless, it provides an additional useful line of evidence in the interpretation of the source and fate and transport of chemicals at the Site.

4.3 Stable Isotopes

Stable isotopes were sampled as an alternative means of evaluating the connectivity between the three water-bearing zones and to potentially gain insight as to the origin of the water in the individual zones.

In an atom of any element, the atomic number is used to represent the number of protons in a nucleus. Because the chemical properties of an element are primarily determined by the number of protons in the atom, the atomic number characterizes the element. In the uncharged state, the number of positively charged protons is equal to the number of negatively charged electrons. More subtle differences in physical behavior result from differing numbers of uncharged neutrons that may exist in the nuclei of atoms of a given element.

The sum of the number of protons and neutrons in an atomic nucleus is the nuclear mass number. The atomic mass number is an approximation of the atomic mass.

An isotope is a variation of an element produced by differences in the number of neutrons in the nucleus of the element; hence, isotopes of an element have different masses. In the most stable and abundant nuclides of the light elements (i.e., elements with relatively low atomic masses), the numbers of protons and neutrons are equal (Mook, 2006). In the case of hydrogen, one single proton ($^{1}_{}H$) is also stable. Unstable atoms can be caused by an excess of protons or neutrons. Examples include tritium ($^{3}_{1}H$) and carbon-14 ($^{14}_{6}C$). On the other hand, for light elements a slight excess of neutrons does not necessarily result in instability. For example, there are two stable isotopes of hydrogen, $^{1}_{}H$ and $^{2}_{1}H$, and three stable isotopes of oxygen, $^{16}_{8}O$, $^{17}_{8}O$, and $^{18}_{8}O$. The probability of forming nuclei with unequal numbers of protons and neutrons is smaller, and the natural concentrations of those isotopes are thus smaller as well (Mook, 2006). Therefore, the majority of water molecules (H_2O) contain only atoms of ^{1}H and ^{16}O; only a fraction contain other isotopes.

The chemical and some physical properties of the isotopes of one element are not exactly equal, resulting in slightly different chemical and physical properties brought about by mass differences of the atomic nuclei (Mook, 2006). In general, heavier isotopic molecules have lower mobility caused by lower diffusion velocity and lower frequency of collision with other molecules (Mook, 2006). The heavier isotopic molecules can also have higher binding energy which, for example, can result in a lower vapor pressure and thus a lower tendency to evaporate from the liquid phase and a higher tendency to condense from the vapor phase (Mook, 2006).

Considering this isotopic mass difference at the molecular level, the two stable, or non-radioactive, isotopes of hydrogen—^{1}H (protium [H]) and ^{2}H (deuterium [D])—and the three stable isotopes of oxygen—^{16}O, ^{17}O, and ^{18}O—form part of the water molecule. Forces that drive the hydrologic cycle will tend to impart measureable differences in the abundance of stable isotopes in water at different locations and different times. Thus, analyses of their concentrations in groundwater can be used to trace movement of water in the subsurface.

Laboratory analyses can determine the ratio of isotopes in a water sample. For the Site sample analyses, the isotopic ratios of $^{18}O/^{16}O$ and $^{2}H/^{1}H$ (D/H) were interpreted. The isotope ratio from a Site sample was compared to the isotopic ratio of a reference material called Vienna Standard Mean Ocean Water (VSMOW). The comparison is made by means of the parameter δ, defined by Fetter (1988) for isotope ratios of oxygen and hydrogen (expressed in parts per thousand [‰]) as:

$$\delta^{18}O\ (‰) = \left[\frac{\left(^{18}O/^{16}O\right)_{sample}}{\left(^{18}O/^{16}O\right)_{VSMOW}} - 1\right]10^{3}$$

$$\delta^{2}H\ (‰) = \left[\frac{\left(^{2}H/^{2}H\right)_{sample}}{\left(^{2}H/^{2}H\right)_{VSMOW}} - 1\right]10^{3}$$

It is well established that the isotopic composition of precipitation at a particular location will vary seasonally and with individual storms (Mook, 2006). The isotopic composition of precipitation will also vary among locations depending upon climate and elevation. Nevertheless, the composition of all precipitation generally falls on a straight line plot of $\delta^{2}H$ versus $\delta^{18}O$. This line is called the Global Meteoric Water Line (GMWL).

After liquid water is formed from vapor (as in precipitation), the isotopic ratios of ^{18}O and ^{2}H do not change and are locked into the water molecule except when a body of water is exposed to either (1) geothermal heating or (2) evaporation, such as from ponds or lakes in dry climates. The stable isotope concentration of the precipitation can be modified subsequent to precipitation; this modified signature of the soil water can be used to reveal the origin of the water.

Evaporation of soil water or evaporation from a free water surface leads to an increase in the concentration of the stable isotopes ^{2}H and ^{18}O in the residual water, since the lighter isotopes ^{1}H and ^{16}O are preferentially lost during evaporation as vapor. This physical process is known as fractionation. When water evaporates, the heavier atoms or molecules tend to remain behind in the liquid phase, thus leading to enrichment in the concentration (fractionation) of the

heavier isotopes in the residual liquid, as the lighter isotopes preferentially fractionate into the vapor phase.

Another process that can change the stable isotope signature of a parcel of water is a rock-water interaction such as exchange with water in hydrated minerals. For example, evaporites such as gypsum ($CaSO_4 \bullet 2H_20$) are hydrated by the highly fractionated water from which they precipitated, and dissolution of the mineral or exchange of water with the mineral will release this fractionated water into more recently recharged water and shift its isotopic signature in proportion to the mixing.

In geothermal systems, significant isotope exchange of hydrogen and oxygen occurs between rock and water, due to membrane filtration through layers of semipermeable clays as well as hydration or dehydration of secondary minerals. Water that is heated geothermally becomes relatively enriched in ^{18}O due to the water coming into equilibrium with elevated concentrations of that isotope in minerals. Hydrogen is not similarly affected (Mook, 2006).

5. Site Investigation

During the fifth quarterly groundwater monitoring and sampling performed during April through July 2008, groundwater samples were collected from the three water-bearing zones at the Site and analyzed for tritium and stable isotopes. During the groundwater monitoring and sampling performed in August and September 2009 at the Site, additional samples were collected from the Deep Zone. No additional samples were collected for tritium analysis during this event. The results of the laboratory analyses were used to determine if the isotopic character of the water in the three water-bearing zones could be differentiated on the basis of their isotopic signature and to assess the connectivity between the three site water-bearing zones.

The laboratory analyses for stable isotopes of hydrogen and oxygen were conducted by Isotech Laboratories, Inc., in Champaign, Illinois; a copy of their report is provided in Appendix B.

5.1 Tritium and Isotope Sample Collection

Between April 22 and July 18, 2008 groundwater samples were collected and analyzed as part of a groundwater monitoring event conducted by MWH Americas, Inc (MWH). MWH reported those data in a report entitled, *Fifth Round Groundwater Monitoring Report (April - July 2008), BMI Common Areas (Eastside), Clark County, Nevada.* Samples were collected and analyzed for the following constituents:

- $\delta^{18}O$ (Ratio of stable isotopes of oxygen [^{18}O to ^{16}O] relative to the VSMOW)
- $\delta^{2}H$ (Ratio of stable isotopes of hydrogen (^{2}H [deuterium] to ^{1}H [protium]) relative to the VSMOW)
- Tritium (^{3}H) (radioactive isotope of hydrogen)

The samples were collected from the following monitoring wells (Figure 5):

- *Northern Site Area (near Las Vegas Wash):* Wells AA-08 (Shallow Zone), MCF-08B-R (Middle Zone), and MCF-17A (Deep Zone)

- *Northern Site Area (upgradient of northern RIBs):* Wells MCF-05 (Middle Zone) and MCF-20A (Deep Zone) (Shallow Zone Well DM-5 was proposed but not sampled due to lack of water.)

- *Middle Site Area (near high perchlorate and TDS detections):* Wells MCF-16C (Shallow Zone), MCF-16B (Middle Zone), and MCF-16A (Deep Zone)

- *Southern Site Area (near plants sites):* Wells AA-01 (Shallow Zone), MCF-02B (Middle Zone), and MCF-01A (Deep Zone)

Between August 21 and September 29, 2009, additional groundwater samples were collected by Converse Consultants, Inc. (Converse) and analyzed for stable isotopes. This sampling event focused on deep wells and those data are reported here for the first time. The samples from the 2009 monitoring event were collected from the following monitoring wells:

- *MCF-02A:* Located at the southern end of the Site, approximately 1,830 feet north-northwest of the intersection of Boulder Highway and Lake Mead Drive

- *MCF-06A-R:* Located at the north-central edge of the Site, on the boundary with the Weston Hill property

- *MCF-18A:* Located approximately 390 feet west-northwest of the northwest corner of the City of Henderson Northern RIBs

- *MCF-18A (FD):* Field duplicate collected from monitoring well MCF-18A

- *MCF-29A:* Located at the northwestern corner of the Weston Hills property, immediately south of Las Vegas Wash

- *MCF-31A:* Located adjacent to the north-central boundary of the Tuscany Village property

- *MCF-30A:* Located approximately 460 feet east of the northwest corner of the Tuscany Village property, south of the C channel

5.2 Isotope Results

The results of the stable isotope and tritium laboratory analyses are summarized in Table 1. The analytical results of stable isotope sampling (δ^2H versus $\delta^{18}O$) are also plotted in Figure 6, along with results of the tritium (^3H) sample analyses. The isotopic values from these samples are co-plotted with the Global Meteoric Water Line (GMWL), which as discussed in Section 4.3, is defined by the annual average stable isotope composition of precipitation at locations around the globe.

The range of δ^2H values measured in the Site samples generally fell within the range of expected δ^2H VSMOW values for temperate zone precipitation: –60 to –95 ‰ (Mook, 2006). Likewise, the range of $\delta^{18}O$ values measured in the Site samples generally fell within the range of expected $\delta^{18}O$ VSMOW values for temperate zone precipitation: –2 to –15 ‰ (Mook, 2006). The stable isotope concentrations in most of the Deep Zone wells are relatively high and indicate a source of water that has been strongly fractionated, based on values plotting to the right of the GMWL by shifts in $\delta^{18}O$ of approximately 6 to 11‰ and the clustering of the values along a line with a slope of approximately 3.3 (Figure 6). This behavior is discussed in more detail in Section 5.3.2.

5.3 Data Interpretation

5.3.1 Tritium

Three Shallow Zone monitoring well samples were tested for tritium during the April through July 2008 sampling event. Two of the samples (AA-08 and AA-01) were collected from wells screened in the Qal and contained tritium above the detection limit (1 TU) with activities of 5.18 and 9.88 TU, respectively. These sample results represent water that has recharged relatively recently. Theoretically, this water could have recharged any time since the 1950s or 1960s when atmospheric levels of tritium were much higher, and the tritium concentrations in the

subsurface were then subsequently reduced to present levels by radioactive decay and possibly mixing with older groundwater.

However, Site data from aquifer testing indicates that water travel velocities within the Qal are relatively fast. For example, pumping tests conducted at well AA-08 yielded an average horizontal hydraulic conductivity (Kh) value of 510 feet per day (ft/d) at this location (Kleinfelder, 2007). This Kh value is the highest measured at the Eastside Area. Using a groundwater gradient (i) estimated from the April through July 2008 sampling event (MWH, 2008) (0.022 foot per foot near well AA-08) and an estimate for soil porosity (n) of 0.25, average groundwater velocity (v) in the vicinity of well AA-08 can be estimated:

$$v = (Kh * i) / n = (510 \text{ ft/d}) (0.022) / (0.25) = 45 \text{ ft/d}$$

Based on this computed velocity and a travel distance of approximately 8,000 feet between the Southern RIBs and the Northern RIBs, groundwater traverses the distance in an average travel time of 178 days, or 0.49 year. This short average travel time, when compared to a tritium half life of 12.42 years, leads to a conclusion that water containing bomb tritium would have flushed from the system faster than it could have decayed to the currently observed levels. Therefore, the most likely explanation is that the tritium concentrations in the samples collected from the Qal represent water with a component that has recharged relatively recently, within approximately the last decade.

All other samples were screened in the UMCf and contained no tritium above a detection limit of 1 TU. As indicated in Section 4.2, the pre-bomb atmospheric tritium level was on the order of 5 to 10 TU. While recognizing that the amount of data is limited, the tritium data are consistent with previous Site soil physical hydraulic data, post-purging well recovery data, and aquifer test data, all of which demonstrate that there is a significant permeability contrast between the Qal and UMCf, that is, the permeability of the UMCf is significantly lower (orders of magnitude lower) than the overlying Qal. Both of the samples collected from the Shallow Zone wells completed in the Qal contain tritium at levels that are within the range of current background.

The rest of the samples were below the tritium detection limit and were collected from wells having various screened interval depths within the UMCf. These data suggest one of two scenarios:

- Groundwater is on the order of at least 37 years old (assuming that three tritium decay half-lives are required to reduce atmospheric [assumed for this calculation to average 7.5 TU] background concentrations of tritium to below the detection limit of 1 TU).

- Vertical gradients (discussed below), have caused younger groundwater to mix with older groundwater, resulting in diluted concentrations below the detection limit. For example, monitoring well MCF-16C is screened at the relatively shallow depth interval of 53 to 73 ft bgs. One of the strongest upward gradients at the Site has been measured between the Middle Zone and the Shallow Zone at Location 16. Shallow Zone water impacted by tritium at atmospheric concentrations that was mixed with enough water from a deeper zone in which tritium is below the detection limit could conceivably yield a sample result of nondetect for tritium. Appendix C presents the compiled historical groundwater elevation data for monitoring wells representative of the three defined water-bearing zones at the Site, along with the historical record of the direction and magnitude of the vertical gradient between the three defined water-bearing zones. Figure C-1 shows the paired monitoring well locations for which data are presented.

This latter scenario is unlikely, however, because the relatively low UMCf permeability would tend to limit the flux of water that would contribute to mixing between waters in the Qal and those from the UMCf. An estimate of flux from the UMCf was completed with the numerical flow model recently completed for the Eastside Area (for the current period [2007] simulation) (DBS&A, 2009). Simulated flow from the UMCf (shallow, model layer 2) to the Qal is 21,558 cubic feet per day (ft^3/d). The total Qal lateral outflow to Las Vegas Wash gravels is 293,589 ft^3/d (this does not include outflow at pumping wells). The fraction of Qal flow to the wash gravels that is attributable to the UMCf flux is therefore 21,558 / 293,589 or 7 percent (assuming complete mixing).

Using the value of 7 percent and assuming complete mixing, the resulting ratio of Qal water to UMCf water would be 13.3 to 1. Using the highest detected concentration of tritium in the Qal

water (9.88 TU) at the mixing ratio of 13.3 to 1 would result in a diluted tritium concentration of 9.83 TU, only slightly different from the originally considered concentration. Thus, mixing of younger Qal water with older UMCf water (of lower tritium content) is expected to have very little effect on the tritium concentration of sampled Qal waters.

5.3.2 Stable Isotopes

5.3.2.1 2008 Sampling

With the exception of the samples collected from monitoring wells MCF-05 and MCF-20A, the plot of δ^2H as a function of $\delta^{18}O$ forms a generally straight line subparallel to the GMWL.

The April 22 and July 18, 2008 samples collected from monitoring wells MCF-05 and MCF-20A are isotopically heavier than, and distinct from, the other samples collected in 2008. Well MCF-20A is a Deep Zone well that has a screened interval from 360 to 380 ft bgs. Well MCF-05 is screened at a relatively deep depth interval within the Middle Zone at 221 to 231 ft bgs. These two wells are located in the vicinity of the focus of high TDS concentrations that were reported for samples from the Deep Zone and the Middle Zone by MWH (2008).

The data represent one line of evidence that the elevated TDS in this area of the Deep and Middle Zones is the result of groundwater that is in contact with a paleo-evaporitic deposit.

5.3.2.2 2009 Sampling

In order to further evaluate groundwater quality, to determine whether other wells with the conceptualized influence of the paleo-evaporitic deposit exhibit isotopic fractionation, and to estimate the extent of influence of the paleo-evaporitic deposit, six additional Deep Zone wells were sampled between August 25 and September 29, 2009. In the stable isotope plot of δ^2H as a function of $\delta^{18}O$ illustrated in Figure 6, all of these samples except for MCF-02A plotted below the GMWL and to the right of the $\delta^{18}O$ analytic values for MCF-05 and MCF-20-A. This indicates that these well samples, anticipated to be affected by the postulated paleo-evaporitic deposit, have undergone isotopic fractionation and are enriched in the heavier isotopes, ^{18}O and ^2H. These data lend further support to the interpretation that the elevated TDS in this area of the Deep and Middle Zones is the result of groundwater that is in contact with a paleo-evaporitic deposit.

5.3.2.3 Spatial Analysis

Spatial analysis was also performed to determine if the area of the Deep Zone that is influenced by dissolution of salts from the paleo-evaporitic deposit could be estimated. Figure 7 presents posted results of the $\delta^{18}O$ laboratory analyses for each well sampled, including combined data from both the 2008 and 2009 sampling events, along with isoconcentration contours of the $\delta^{18}O$ data. The contoured interpretation indicates that the area of greatest fractionation, and therefore enrichment of the Deep Zone groundwater by ^{18}O, is focused at and north of the northern BRC boundary, with the main portion of the influenced area beneath the Weston Hills and Tuscany Village developments.

Similarly, Figure 8 presents posted results of the $\delta^{2}H$ laboratory analyses for each well sampled during the 2008 and 2009 sampling events, as well as isoconcentration contours of the $\delta^{2}H$ data. Again, the contoured interpretation indicates that the area of greatest fractionation, and therefore enrichment of the Deep Zone groundwater by ^{18}O, is focused at and north of the northern BRC boundary, with the main portion of the influenced area beneath the Weston Hills and Tuscany Village developments, as well as the City of Henderson Northern RIBs.

Both isoconcentration plots of the spatial distribution of $\delta^{18}O$ and $\delta^{2}H$ laboratory analytic results are consistent with the interpretation that water in this area has been isotopically fractionated and that there is a concentrated Deep Zone area of ^{18}O- and ^{2}H-enriched groundwater (Figures 7 and 8).

5.3.2.4 Global Meteoric Water Line

A generally valid relationship between $\delta^{2}H$ and $\delta^{18}O$ values of precipitation from various parts of the world is represented by the equation:

$$\delta^{2}H = (8)\ (\delta^{18}O) + 10‰ \text{ SMOW} \qquad \text{(Mook, 2006)}$$

A refinement of the equation following the introduction of the VSMOW standard and the collection of additional samples was stated by Rozanski et al. (1993) as follows:

$$\delta^{2}H = (8.13)\ (\delta^{18}O) + 10.8‰ \text{ VSMOW}$$

This relationship, referred to as the Global Meteoric Water Line (GMWL) (Section 4.3), is plotted on Figure 9. As indicated by the above linear equations, the GMWL has a slope of approximately 8 (Figure 9). The changes to δ^2H and $\delta^{18}O$ in a water body that occur during the process of evaporation have been calculated and presented in scientific literature. As evaporation proceeds, the residual water departs from the GMWL along a line with a slope typically between 3 and 5, with lower slopes corresponding to lower relative humidities (Clark and Fritz, 1999). Though the evaporative process varies by climatic condition, under tropical conditions (and with no mixing of the water or perturbations other than evaporation), the resulting ratio has been calculated as:

$$\frac{\Delta^2\delta}{\Delta^{18}\delta} = 4.5 \pm 0.5 \qquad \text{(Mook, 2006)}$$

Plots of evaporative lines with slopes of 4 and 5 are presented in Figure 9 for comparative purposes.

For the Site isotopic data collected, a trend of the Deep Zone sample data indicated a clear departure from the GMWL, consistent with a trend that is caused by evaporation. Linear regression was conducted on the δ^2H and $\delta^{18}O$ values obtained from all the Deep Zone wells sampled in both 2008 and 2009. The resulting best-fit linear equation ($\delta^2H = 3.3(\delta^{18}O) - 54$; $R^2 = 0.97$) confirmed the recognition of that trend. The plot of the regressed line, which has a slope of approximately 3.3, is shown in Figure 6. This slope departure from the GMWL is consistent with the fractionation of the sampled water by evaporation during a previous paleoclimatic time period, presumably of Tertiary age (the same age as the TMCf, ended approximately 2.6 million years before present).

5.3.2.5 Isoconcentration Plots

Appendix D provides isoconcentration plots (Figures D-1 through D-18) created with 2009 data for selected parameters evaluated in past monitoring reports (arsenic, hexavalent chromium, perchlorate, radium 226+228, PCE, and TDS). As depicted in the TDS figures (D-16 through D-18), the area of elevated TDS is focused in an area at and north of the northern boundary of the Site. This area of TDS impacts is coincident with the area of enriched ^2H and ^{18}O. The isoconcentration plots of the distribution of groundwater with enriched ^{18}O and ^2H (Figures 7

and 8) show a focused region of heavy isotope enrichment in the same area that is characterized by elevated TDS. This coincident occurrence is consistent with and indicative of an area that is the focus of evaporite deposits.

5.3.2.6 Gypsum Deposits

Significant presence of salts has also been observed at the depth of interest in the geologic column and in the area influenced by elevated groundwater TDS and enriched ^{2}H and ^{18}O. For example, boring logs MCF-06A-R, MCF-20A, MCF-28A (weak reaction to HCl), MCF-29A (strong reaction to HCl), MCF-30A (strong reaction to HCl), and MCF-31A (strong reaction to HCl) are all located within the area of influence of $\delta^{2}H$ and $\delta^{18}O$ enrichment (GES, 2008, 2009). All of these boring had an abundant presence of gypsum crystals ($CaSO_4 \bullet 2H_20$), as noted in the boring logs. Figure 10 presents a photograph of sample gypsum crystals collected from Deep Zone boring Location 16. Nearer to the center of the ^{2}H and ^{18}O enrichment area and the elevated TDS area, reaction to HCl (as noted in the borelogs based upon on-site field screening tests) in layers within the screened intervals was generally greater. At more distal areas of influence by isotope fractionation and elevated groundwater TDS, reaction to HCl in layers within the screened interval was generally weaker. Reaction to HCl is a commonly used field screening tool to test for the presence of calcium carbonate ($CaCO_3$), also sometimes referred to as calcite, lime, or caliche, depending on its genesis and morphology. The concurrent presence of $CaCO_3$ with $CaSO_4 \bullet 2H_20$ would be expected in an evaporitic deposit.

Based on the observance of gypsum crystals and the positive screening tests for $CaCO_3$ during borehole drilling and sampling, it is likely that the high TDS in the Deep Zone groundwater is caused by the mineral weathering and dissolution of salts, including $CaSO_4 \bullet 2H_20$ and $CaCO_3$. An example of weathering would be the formation of gypsum by the addition of water (H_2O) to anhydrite ($CaSO_4$):

$$CaSO_4 \bullet 2H_2O \leftrightarrow CaSO_4 + 2H_2O$$

gypsum anhydrite

A marked increase in volume accompanies the reaction of anhydrite to gypsum. If this takes place within a rock, physical disintegration can occur (Birkeland, 1976).

An example of dissolution of an evaporite mineral deposit is the dissolution of calcium carbonate:

$$CaCO_3 + CO_2 + H_2O \leftrightarrow Ca^{2+} + 2HCO^{3-} \qquad \text{(Birkeland, 1976)}$$

The rate of dissolution of salts is dependent upon pH, temperature, and in the case of $CaCO_3$, the partial pressure of CO_2. The pH of the wells in the Deep Zone of the area of high TDS concentrations, as measured during the April through July 2008 monitoring event is generally slightly acid (e.g., 6.7 to 6.8 in monitoring wells MCF-6A-R, MCF-18A, and MCF-20A) to slightly alkaline (e.g., 7.3 to 7.5 in monitoring wells MCF-8A and MCF-17A).

Solubilities are typically compared using solubility product constants. The solubility product constant for $CaCO_3$ at room temperature is 8.7×10^{-9}, whereas the solubility product constant for $CaSO_4$ at room temperature is 6.1×10^{-5} (Anderson, 1968). From this it can be seen that the solubility product of $CaSO_4$ is about 7,000 times greater than that of $CaCO_3$. For comparative purposes and to assess the potential salt load in water that might be expected, the actual solubility of various salts under ideal conditions can be given. The solubility of $CaCO_3$ at 25°C is about 15 milligrams per liter (mg/L), whereas the solubility of $CaSO_4$ at 20°C is about 240,000 mg/L. Under saturated solution conditions, the combination of these salts alone, and primarily the geologically plentiful gypsum, can account for the TDS concentrations that have been observed at and north of the northern Site boundary. In addition, some boring logs note gypsum "ghosts," where euhedral crystals have dissolved in-situ, leaving a mold of the original crystal form behind in the UMCf clay matrix.

The phenomenon of water salinization by encounter with evaporite deposits has been observed before in southern Nevada. For example Lake Mead, where it is impounded behind Hoover Dam, overlies deposits of gypsiferous sediments (evaporite deposits), and dissolution of this gypsum substantially increases the salinity of the Colorado River (Bohn et al., 1979).

5.3.2.7 Piper and Stiff Diagrams

Piper and Stiff diagrams illustrating the general water chemistry of groundwater samples collected from the Shallow, Middle, and Deep water-bearing zones are presented in

Appendix E. A comparison of Piper and Stiff diagrams between water-bearing zones indicates that groundwater in all three zones is generally enriched in chloride and sulfate anions.

Shallow Zone groundwater samples generally exhibit no dominant cation. Several exceptions, wells AA-UW-4, AA-UW-3, COH-2A, and WMW5.58SS, are slightly enriched with sodium cation. In the Middle Zone, wells COH-1, MCF-02B, MCF-05, MCF-08B, MCF-24B, MCF-28B, MCF-29B, and MCF-31B are relatively depleted of calcium and relatively enriched with magnesium and sodium. In the Deep Zone, wells MCF-3A, MCF-12A, MCF-18A, MCF-20A, and NCF-25A are dominated by sodium cations, while wells MCF-06A, MCF-07A, MCF-21A, and MCF-24A are dominated by magnesium and sodium cations.

The data plotted in the Piper and Stiff diagrams (Appendix E) are consistent with groundwater that contains dissolved salts dominated by the cations calcium, magnesium, and sodium and the anions sulfate and chloride. Differences between dominant cations in the Shallow versus the Middle and Deep water-bearing zones are likely due to differences in the geologic source material through which groundwater is flowing. The Piper and Stiff diagram data and plots, when examined alone, reveal no information regarding whether the dissolved salts are sourced from an evaporite deposit or from an anthropogenic source.

5.3.2.8 Modern Day Analogues

Present-day examples exist of lakes in closed basins where the buildup of TDS is equivalent to that observed in this area of the Deep Zone. Primarily, these example lakes exist in closed topographic basins with no discharges by surface streams or seepage and with a groundwater gradient toward a lake or playa. These are the settings in which evaporite deposits readily form. For example, the Great Salt Lake in Utah had measured salinity of 276,000 parts per million (ppm) in 1932, Owens Lake in California had measured salinity of 213,700 ppm in 1905, and the Dead Sea in Palestine has a salinity level of 220,000 ppm (van der Leeden et al., 1990).

5.3.2.9 Plants Area Impacts vs. Natural Evaporite Deposits

The above interpretation (Section 5.3.2.6) is contrasted with an alternative hypothesis that postulates that high TDS process waters from historical Plants Area operations was disposed in the BMI Evaporation Ponds and subsequently infiltrated and percolated into the Deep Zone where it is now detected. Several observations that are inconsistent with this hypothesis are

consistent with the interpretation that considers evaporitic deposits as the source of high TDS in the Deep Zone. These are:

- Shallow Zone TDS and perchlorate concentrations indicate the presence of these compounds in the vicinity of monitoring well MCF-16C. Darcy's Law was used to make a simple calculation of the average travel time from Location 16 to Location 20 within the Deep Zone. The calculation is simplified and does not account for dispersion or potential preferred pathways. It assumes a gradient of 0.037 ft/ft, a Deep Zone hydraulic conductivity of 1 x 10^{-4} cm/s, a porosity of 0.30, and a travel distance (L) of 3,980 feet (the distance between Locations 16 and 20). Based on this calculation, the average travel time from Location 16 to Location 20 would be approximately 312 years, with a velocity (v) of 12.8 feet per year. Even given this long travel time, this calculation is highly conservative in that it does not account for the vertical travel time from the evaporation pond bottoms to the Deep Zone, a nominal distance of 350 feet through the low-permeability sediments of the UMCf.

  A more complete calculation, incorporating dispersion, was also conducted. An analytic solution of the advection dispersion was used (Fetter, 1999):

$$C = \frac{C_o}{2}\left[erfc\left(\frac{L - vt}{2\sqrt{Dt}}\right)\right] \qquad \text{Eq. 1}$$

  where C_o = the input concentration
  erfc = complementary error function
  D = dispersion coefficient.

  The dispersion coefficient was calculated as a function of the travel distance and velocity, as given by Fetter (2001):

$$D = 0.83 \cdot (\log L)^{2.414} \cdot v \qquad \text{Eq. 2}$$

The resulting breakthrough curve, showing normalized concentration (C/C_o) versus time, is provided in Figure 11. The first arrival is greater than 200 years, and the mean arrival time is 312 years.

- Based on review of the 2009 sampling data (report in preparation), other chemicals coincident with the high-TDS area in the Shallow Zone (e.g., hexavalent chromium and perchlorate) do not have a similar distribution in the Deep Zone, suggesting that the Deep Zone high TDS concentrations are not related to the Shallow Zone high TDS concentrations at Locations 6 and 16. PCE was also detected in Shallow Zone wells in the southwestern portion of the Site and not in any Deep Zone wells, again suggesting the lack of downward flow and transport from the Shallow Zone to the Deep Zone. Comparison of water quality between the Shallow and Deep Zones Stiff diagrams (Appendix E) suggests that the Shallow Zone has water quality that contrasts with the Middle and Deep Zones, as described in Section 5.3.2.7.

- Vertical gradient evaluations (Appendix C) suggest that there is a general upward gradient, with groundwater movement from the Deep Zone to the Middle and Shallow Zones. The movement of a TDS plume from the Evaporation Pond bottoms to the Deep Zone at any historical time would have likely had to overcome the upward vertical gradient. It is recognized, however, that the gradient is downward at Locations 6 and 3. The gradient is variable between the Shallow Zone and the Middle Zone, but also generally upward. Significantly, however, the gradient is downward in selected locations on the northern portion of the Site (excluding the western portion of the Western Hook).

- Migration in the Deep Zone from upgradient off-site source(s) is indicated for hexavalent chromium (Cr(VI)). This is consistent with the hypothesis that the BMI Plants Area impacts are loading the coarse-grained facies of the UMCf (UMCf–cg) where this unit is present to the south of the Eastside Area.

  For example, a simplified calculation of average travel time (t) in the UMCf-cg (not accounting for longitudinal dispersion, which would reduce the value of t) can be completed with the following estimates:

- Kh of the UMCf-cg assumed to be within the range of modeled values for the Qal (100 ft/d) (DBS&A, 2009)
- Gradient (i) assumed to be on the order of 0.02 ft/ft
- Porosity of 0.30
- Travel distance (L) of approximately 5,000 feet (approximate distance between the Plants area and well AA-27 where Cr(VI) has been detected [MWH, 2008]).

Based on this calculation, the travel time from the plants area to AA-27 would be approximately:

- $t = L / v$
- $v = (Kh * i) / n$ = (100 ft/d x 0.02) / 0.3 = approximately 7 ft/d
- t = (5,000 feet) / (7 ft/d) = 714 days = approximately 2 years

The more complex calculation incorporating dispersion that was used for Deep Zone travel time from Location 16 to Location 20 (Equations 1 and 2) was also conducted. The resulting breakthrough curve, showing normalized concentration (C / C_o) versus time, is given in Figure 12. The first arrival time is greater than 1 year, and the mean arrival time is approximately 2 years, consistent with the Darcy's law calculation given above.

5.3.3 Vertical Gradients

Vertical gradients, as measured in the five recent Eastside monitoring events, have been generally upward. A summary table of vertical gradient data, including adjustments made for difference in groundwater density between water bearing zones and adjustments made to account for variable position on the potentiometric surface, is presented in Appendix C.

This generally upward gradient condition is consistent with the position of the Site at the relatively distal end of two coalescing alluvial deposits from the River Mountains and McCullough Range. In general, high-energy alluvial sediments are deposited near their source,

resulting in a geologic profile dominated by coarser-textured soils that are conducive to downward recharge of precipitation and mountain runoff. At more distal locations, it is common to encounter lower-energy alluvial sediments that result in a geologic profile dominated by finer-textured soils. The distal portions of alluvial deposits often comprise pressure zones where confining or semiconfining zones exist. Water in these zones is often laterally recharged at depth, resulting in pressure buildup that is sustained by the head of water created in the upslope vertical recharge zones.

At the Site, there are isolated locations where downward gradients exist. For example, the 2009 monitoring event elevation data (MWH, 2008) indicate a small downward gradient between the Shallow Zone and the Middle Zone at Location 12 (0.011); the gradient between the Shallow Zone and Deep Zone at Location 12 is upward (0.060). A downward gradient was also calculated between the Middle Zone and the Deep Zone at Location 28 (0.217); well elevation data for the Shallow Zone at this location were not available to make a comparison. A slight downward gradient was also calculated between the Shallow Zone and the Deep Zone at Location 7 (0.007); the direction of gradient has alternated between up and down at this location in previous monitoring events. Historically, downward vertical gradients have been measured at Location 6 (groundwater elevation was not measured in 2009; previous 2007 vertical gradient was 0.043), which is immediately adjacent to the site of a former gravel mining enterprise where most of the Qal had been removed at one time, exposing the UMCf at that location.

5.3.4 Anthropogenic Chemical Impacts

The distributions in groundwater of chemicals produced by, or as byproducts of, mine processing, manufacturing, and waste disposal activities provide an indication of the connectivity of water-bearing zones. Chemicals that have been evaluated based on concentrations detected in the 2009 monitoring event (MWH, 2008) include those also discussed in prior groundwater monitoring reports: arsenic (As), hexavalent chromium (Cr(VI)), perchlorate, TDS, PCE, and radium 226+228 (Ra226+228).

Cr(VI) was detected at elevated concentrations in Shallow Zone groundwater. The data indicate that the Shallow Zone Cr(VI) appears to be derived, at least in part, from an off-site source(s) where concentrations are as high as 1,400 micrograms per liter (μg/L) (monitoring well PC-28)

to the west and 28 μg/L (monitoring well POU3) to the south. Cr(VI) concentrations in the Middle Zone (typically less than 10 μg/L) are generally significantly less than those in the Shallow Zone. Cr(VI) concentrations in the Deep Zone (typically less than 20 μg/L) are also significantly less than those in the Shallow Zone. Exceptions are MCF-27 (34 μg/L), where an off-site source to the south appears to be indicated, and upgradient well MCF-3A (38 μg/L). For comparison, Cr(VI) was detected in Eastside soil samples at relatively low concentrations and only at the upgradient well locations AA-UW-1 (0.25 mg/kg at 60 feet), AA-UW-3 (0.4 mg/kg at 30 feet), and AA-UW-4 (0.22 mg/kg at 10 feet) (ERM, 2009).

Perchlorate was detected at elevated concentrations in the Shallow Zone. The data indicate that the Shallow Zone perchlorate appears to be derived from an off-site source(s) to the west (concentrations as high as 500,000 μg/L in monitoring well PC-28). On-site concentrations are as high as 15,000 μg/L (monitoring well BEC-6).

Perchlorate concentrations in the Middle Zone are generally significantly less that those in the Shallow Zone. Notable detections in the Middle Zone include monitoring wells MCF-06B (5,580 μg/L), MCF-12C (430 μg/L), and MCF-03B (93.3 μg/L) (all detected during the April through July 2008 monitoring event). Perchlorate was also detected in well MCF-01B (672 μg/L) during the same round of monitoring, but this appears to be attributable to an off-site source to the southwest.

Though perchlorate was not analyzed for samples from several locations, the data that were produced indicate that there were few and low detections of perchlorate in the Deep Zone. During the 2009 monitoring event perchlorate was detected in Deep Zone wells MCF-01A (0.17 μg/L), MCF-27 (0.79 μg/L), MCF-12A (0.049 μg/L), MCF-31A (5.7 μg/L), MCF-18A (6.1 μg/L); MCF-28A (17 μg/L), and MCF-18A (6.1 μg/L) (except for MCF-28A, all of these detections had J qualifiers, indicating that the reported values are estimated). In the 2009 event, lower laboratory detection levels were reported than ever before, with some detections reported in parts per trillion range. These detections have focused concern on field sampling protocols and, based on historical concentration trends, the potential that these low detected concentrations could be potential field sampling aberrations. BRC will perform a complete review of the sampling logs and, as a result, may present a revised analysis of these data.

TDS in the Shallow Zone generally mimicked the distribution of perchlorate in the Shallow Zone. The data indicate that the Shallow Zone elevated TDS appears to be sourced, at least in part, from an off-site source(s) to the west, where concentrations as high as 11,000 mg/L (monitoring well PC-67) were detected, and potentially from the eastern portion of the Upper Ponds area on the Site where monitoring well MCF-16C had a locally elevated concentration of 11,500 mg/L.

TDS at depth, however, shows a different distribution than perchlorate. TDS concentrations in the northern area of the Middle Zone were as high as 180,000 mg/L at monitoring well MCF-05. In the Deep Zone TDS concentrations are also locally high in the northern area of the Deep Zone. The highest concentrations were noted in wells MCF-31A (185,000 mg/L) and MCF-06A (178,000 mg/L).

These elevated concentrations prompted further investigation using stable isotope techniques. This area of high TDS concentrations is interpreted as being caused by a separate source of salts where groundwater has encountered paleo-evaporite deposits in the Deep Zone. This is consistent with the interpretation that the Site is located in the distal portion of the regional alluvial system. As detailed in Section 5.3.2.6, boring logs also showed the presence of paleo-evaporite deposits in the Deep Zone in this area.

PCE is generally at low to nondetectable concentrations in the Shallow Zone. Well AA-20 has a low concentration (5.1 μg/L), only slightly above the maximum contaminant level (MCL) for PCE. One exception, well AA-01 (54 μg/L) appears to indicate an off-site source to the south-southwest. Both the Middle Zone and Deep Zone well samples were below the detection limit (< 1 μg/L) for PCE.

A localized area of elevated Ra 226+228 activity in the Shallow Zone was observed in the vicinity of wells MCF-06B (16.1 picocuries per liter [pCi/L]) and DBMW-12 (12.7 pCi/L). Middle Zone wells were generally below the MCL of 5 pCi/L with the exception of MCF-16B (9.35 pCi/L). Deep Zone wells showed localized impacts above the MCL. Notable Ra 226+228 detections in the Deep Zone included MCF-28A (40.4 pCi/L), MCF-08A (9.92 pCi/L), MCF-24A (8.1 pCi/L), MCF-21A (28.4 pCi/L), and MCF-16A (16.1 pCi/L).

6. Summary

Evaluation of the data indicates that only limited or incidental connectivity exits between the three water-bearing zones at the Site.

Analysis of tritium samples indicates that the water in the Shallow Zone (Qal) is younger than water in the Middle or Deep Zones. Stable isotope analyses indicate that the elevated TDS in the Deep Zone is not sourced at the surface, but rather is present because of deep, isolated groundwater encountering and dissolving natural paleo-evaporite deposits. The Piper and Stiff diagram evaluations are consistent with this and indicate that the general chemistry of water in the Shallow Zone is contrasted from that in the Middle and Deep Zones.

Vertical gradients between the Shallow and Deep Zones at the Site are generally upward, with a localized area of downward gradient at Location 6. (Location 6 is immediately adjacent to the site of a former gravel mining enterprise where most of the Qal had been removed at one time, exposing the UMCf at that location). Though no data are available to assess historical vertical gradients, it is expected that similar gradient conditions would have existed in the past, based on the Site location as a pressure zone in a mixed alluvial fan and lacustrine depositional environment.

Chemical impacts to the Shallow Zone appear to be independent of those in the Deep Zone and vice versa. The Middle Zone wells appear to variously have impacts influenced by those in both the Shallow and Deep Zones. Though Shallow Zone TDS and perchlorate chemical distribution signatures were very similar, the respective impacts were much different in the Deep Zone. This indicates an origin for the Deep Zone TDS other than migration from the Shallow Zone.

It is interpreted that the Shallow Zone and the Deep Zone are largely isolated from one another at the Site. However, there could be limited and incidental connection between the Shallow Zone and the Deep Zone via the Middle Zone. The large depth interval and generally low permeability of the Middle Zone together serve to greatly modulate and buffer hydraulic variation and chemical transport between the Shallow and the Deep Zones.

References

Anderson, H.V. 1968. *Chemical calculations.* McGraw-Hill Book Company, 305p.

Basic Remediation Company (BRC), Environmental Resources Management, Montgomery Watson Harza, and Daniel B. Stephens & Associates, Inc.. 2006. *BRC closure plan, BMI Common Areas, Clark County, Nevada*. August 2006.

Bentley, H.W., F.M. Phillips, and S.N. Davis. 1986. ^{36}Cl in the terrestrial environment. pp. 422-475 *in* Fritz, P. and J.C. Fones (eds.), *Handbook of environmental isotope geochemistry.* Elsevier Science, New York.

Birkeland, P.W. 1976. *Pedology, weathering and geomorphological research.* Oxford University Press, New York, New York, 285p.

Bohn, H.L., B.L. McNeal, and G.A. O'Connor. 1979. *Soil chemistry.* Wiley-Interscience, John Wiley & Sons, New York, New York, 329p.

Carlsen, C.L., R.C. Lunnis, and D.E. Prudie. 1991. *Changes in water levels and water quality in shallow groundwater, Pittman-Henderson Area, Clark County, Nevada, resulting from diversion of industrial cooling water from ditch to pipeline in 1985*. Water-Resources Investigation Report 89-4093, U.S. Geological Survey, Carson City, Nevada.

Clark, I.D., and P. Fritz. 1999. *Environmental Isotopes in Hydrogeology*, 2nd printing. Lewis Publishers, Boca Raton, Florida.

Daniel B. Stephens & Associates, Inc. (DBS&A). 2007. *Revised aquifer testing work plan, BMI Common Area Eastside, Henderson, Nevada.* Prepared for Basic Remediation Company; Submitted to Nevada Division of Environmental Protection. January 9, 2007.

DBS&A. 2009. *Updated groundwater flow model calibration, BMI Upper and Lower Ponds area.* Prepared for Basic Remediation Company; Submitted to Nevada Division of Environmental Protection. May 14, 2009.

Environmental Resources Management (ERM). 2009. Soil sampling analytical database, BMI Common Areas, Eastside (unpublished).

Fetter, C.W. 1988. *Applied hydrogeology.* Prentice Hall, Upper Saddle River, New Jersey.

Fetter, C.W. 2001. *Applied hydrogeology,* Fourth Edition. Prentice Hall, Upper Saddle River, New Jersey.

Fetter, 1999. *Contaminant Hydrogeology, Second Edition*. Prentice Hall, Upper Saddle River, New Jersey.

Geotechnical & Environmental Services, Inc. (GES). 2008. Letter from Richard A. Cook and Kyle S. Hansen to Ranajit Sahu, Basic Remediation Company, regarding BRC Eastside deep monitor wells field activity report, Henderson, Nevada. June 16, 2008.

GES. 2009. Letter from Richard A. Cook and Kyle S. Hansen to Ranajit Sahu, Basic Remediation Company, regarding Eastside monitor wells field activity report, Henderson, Nevada. August 10, 2009.

Illinois Environmental Protection Agency. 1997. Use of tritium in assessing aquifer vulnerability. Available at <http://www.epa.state.il.us/water/tritium.html>. October 1997.

International Atomic Energy Agency (IAEA)/World Meteorological Organization (WMO). 2006. Global network of isotopes in precipitation. The GNIP Database. Accessible at <http://isohis.iaea.org>.

International Atomic Energy Agency (IAEA). 2009. Water isotope system for data analysis, visualization and electronic retrieval (WISER). <http://nds121.iaea.org/wiser/>.

Kleinfelder. 2007. *Implementation of the revised aquifer testing work plan, BMI Common Area Eastside, Henderson, Nevada.* Project No.83173.10. November 16, 2007.

Montgomery Watson Harza (MWH). 2008. *Fifth round groundwater monitoring report, April - July 2008, BMI Common Areas (Eastside), Clark County, Nevada.* Prepared for Basic Remediation Company (BRC), Henderson, Nevada. December 2008.

Mook, W.G. 2006. *Introduction to isotope hydrology: Stable and radioactive isotopes of hydrogen, oxygen and carbon.* Taylor & Francis, London, 226p.

Nevada Division of Environmental Protection (NDEP). 2009. *Hydrogeologic and Lithologic Nomenclature Unification.* [Guidance letter to various parties associated with the BMI Plant Sites and Common Areas.] January 6, 2009.

Rozanski, K., L. Araguás-Araguás, and R. Gonfiantini 1993. Isotopic patterns in modern global precipitation. pp.1-36, in Swart, P.K.. K.C. Lohmann, J. McKenzie, and S. Savin (eds.) *Climate change in continental isotopic records*. Geophysical Monograph No. 78, , AGU, Washington, D.C.

van der Leeden, F., F.L. Troise, and D.K. Todd. 1990. *The water encyclopedia.* Lewis Publishers, Chelsea, Michigan, 808p.

Figures

S:\Projects\BRC\ES06.0067.00_Deep_Soil_Background_Investigation\Sept06_Draft\Figures\Fig_1_Site_Loc_Topo_Map.pdf

BMI COMMON AREAS

BMI INDUSTRIAL AREA

2,000 1,000 0 2,000 Feet

Nevada-Clark Co. 7.5 Minute Series (Topographic)
Henderson, Nevada SE, Boulder City NW, and Sloan NE Quadrangles

BMI Site
Henderson, Nevada

N

FIGURE 1

SITE LOCATION AND TOPOGRAPHIC MAP

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 1881262
MKJ MWH	09/28/06	FILE: GIS/BRC/BKGD_FIGURE1.MXD

M:/PROJECTS/ES04.0212_BRC_COMMONS_AREA/GIS/MXDS/AERIAL_PHOTO_BASE_2004.MXD 602//9

N

0 2,000 Feet

Explanation

Site boundary

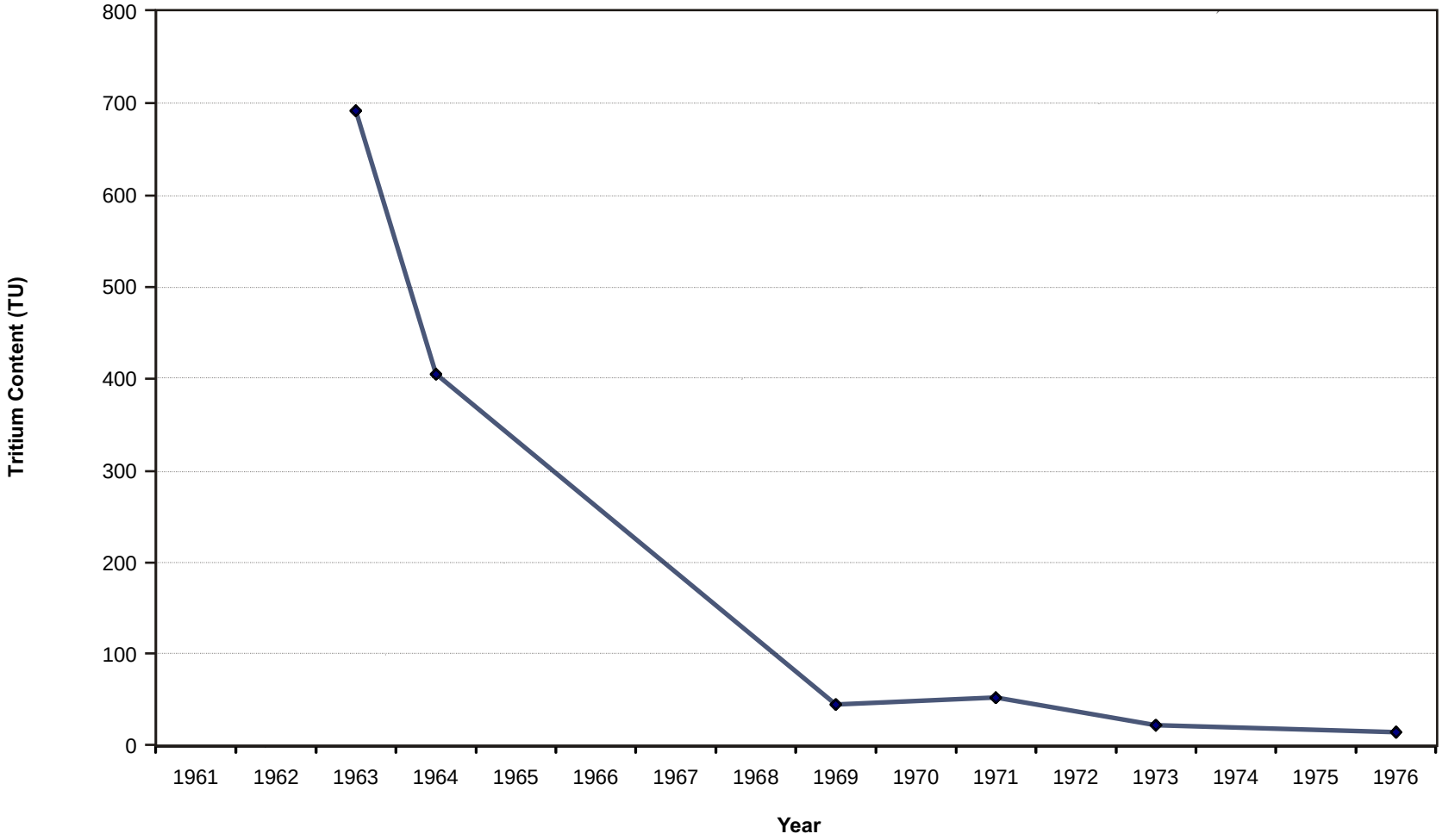
BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 2
AERIAL PHOTOGRAPH SEPTEMBER 2003

Basic Remediation COMPANY

Prepared by: DWR (DBS&A) Date: 09-08-06

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/FLUID_LEVELS/GROUNDWATER_DEEP_ZONE.MXD 907111



BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 3
Atmospheric Tritium Content
Santa Maria, California
1961-1976

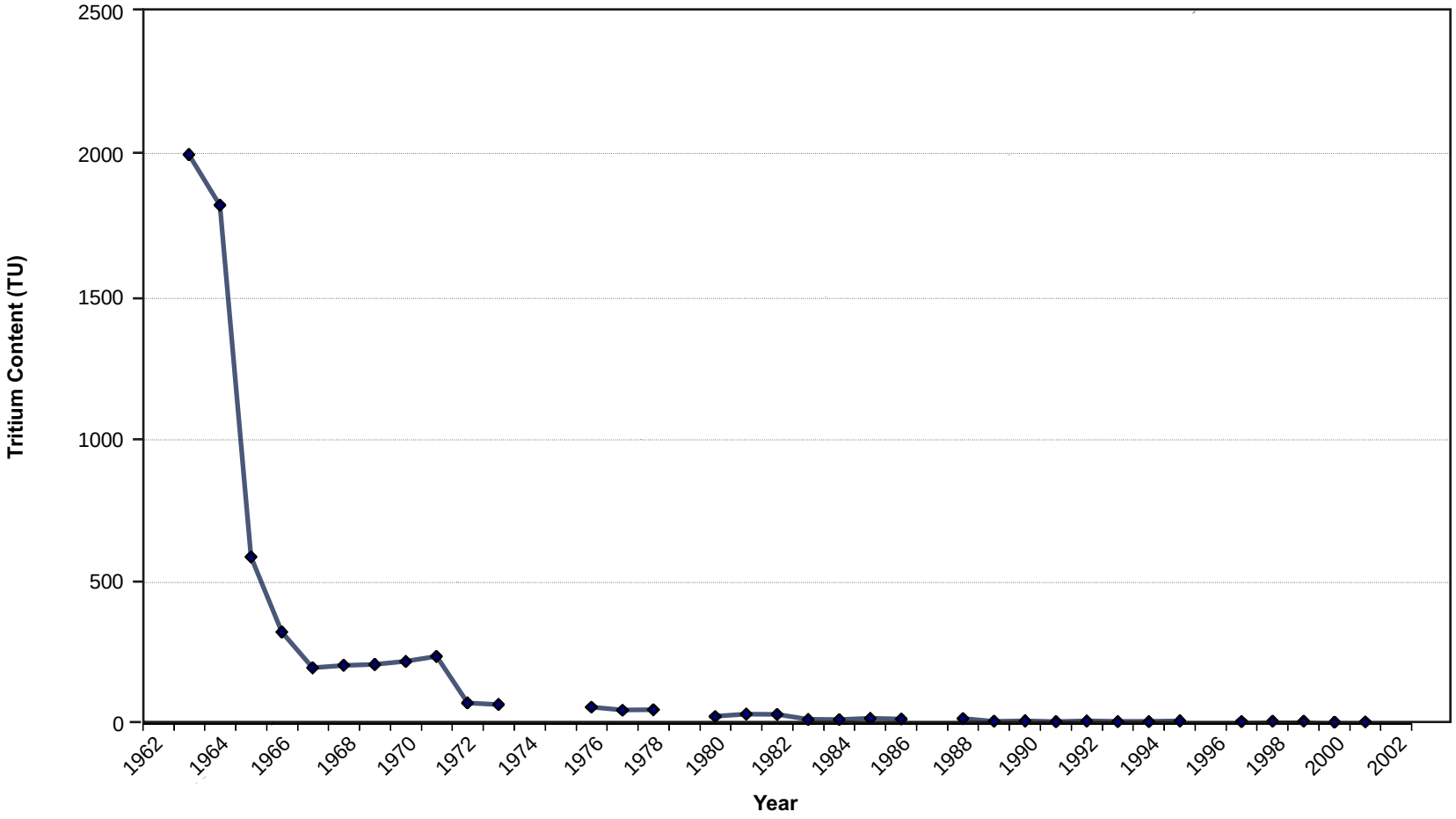
Basic Remediation COMPANY

Prepared by: DBS&A MNW

Date 12-15-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/VDR_DRAWINGS\FIG4_ATMOSPHERIC_TRITIUM_CONTENT_1961-1976.CDR

Daniel B. Stephens & Associates, Inc.



BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 4
Atmospheric Tritium Content
Albuquerque, New Mexico
1963-2001

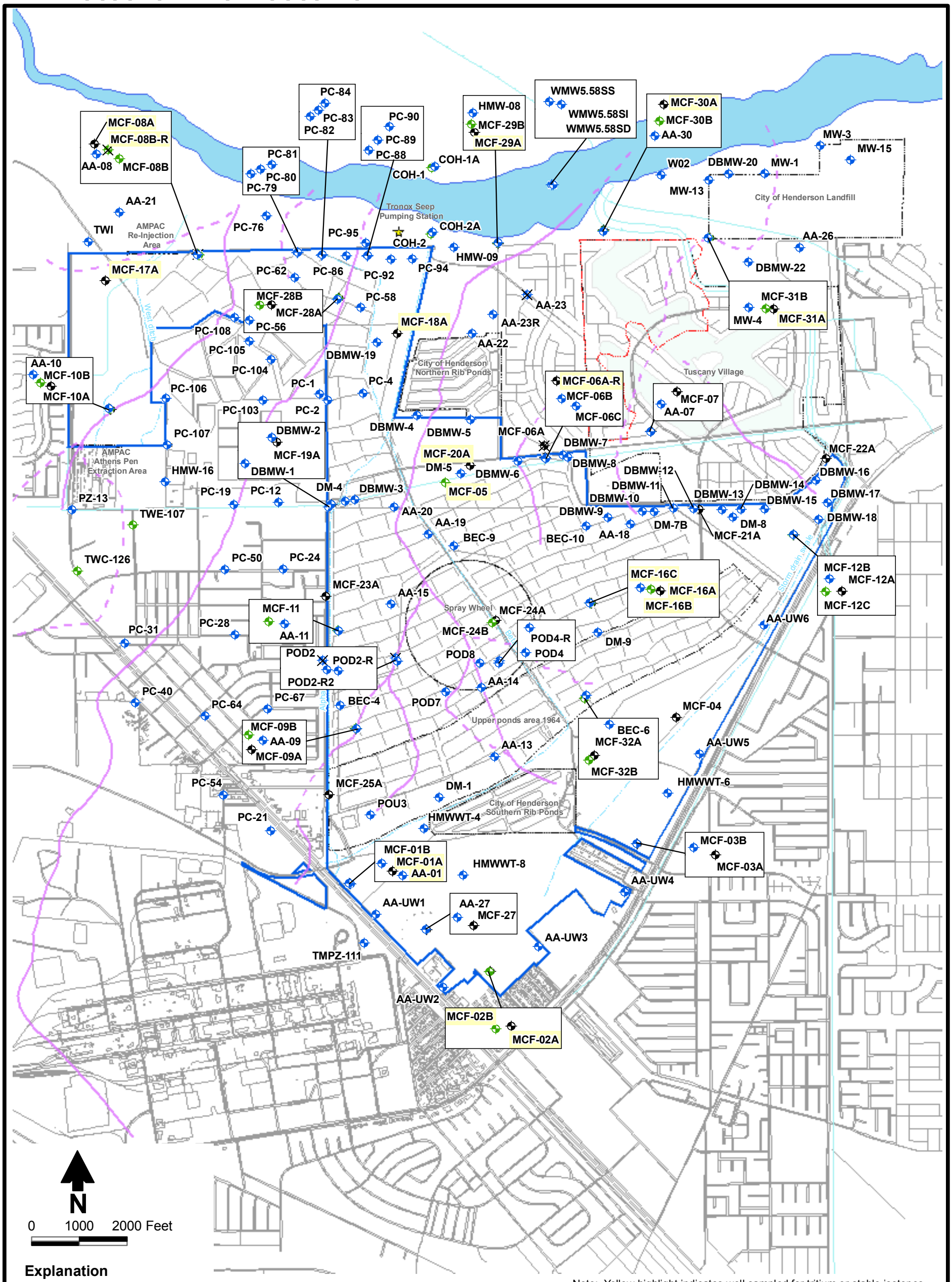
Basic Remediation COMPANY

Prepared by: DBS&A MNW Date 12-15-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/VDR_DRAWINGS\FIG4_ATMOSPHERIC_TRITIUM_CONTENT_ALBUQUERQUE_1963-2001.CDR

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/BASE_MAPS/MASTER_SITE_MAP_ALL_MONITORING_WELLS.MXD 901221



Explanation

- Shallow Zone Monitoring well
- Middle Zone Monitoring well
- Deep Zone Monitoring well
- Abandoned Shallow Zone Monitoring well
- Abandoned Middle Zone Monitoring well
- Abandoned Deep Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets

Note: Yellow highlight indicates well sampled for tritium or stable isotopes.

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 5

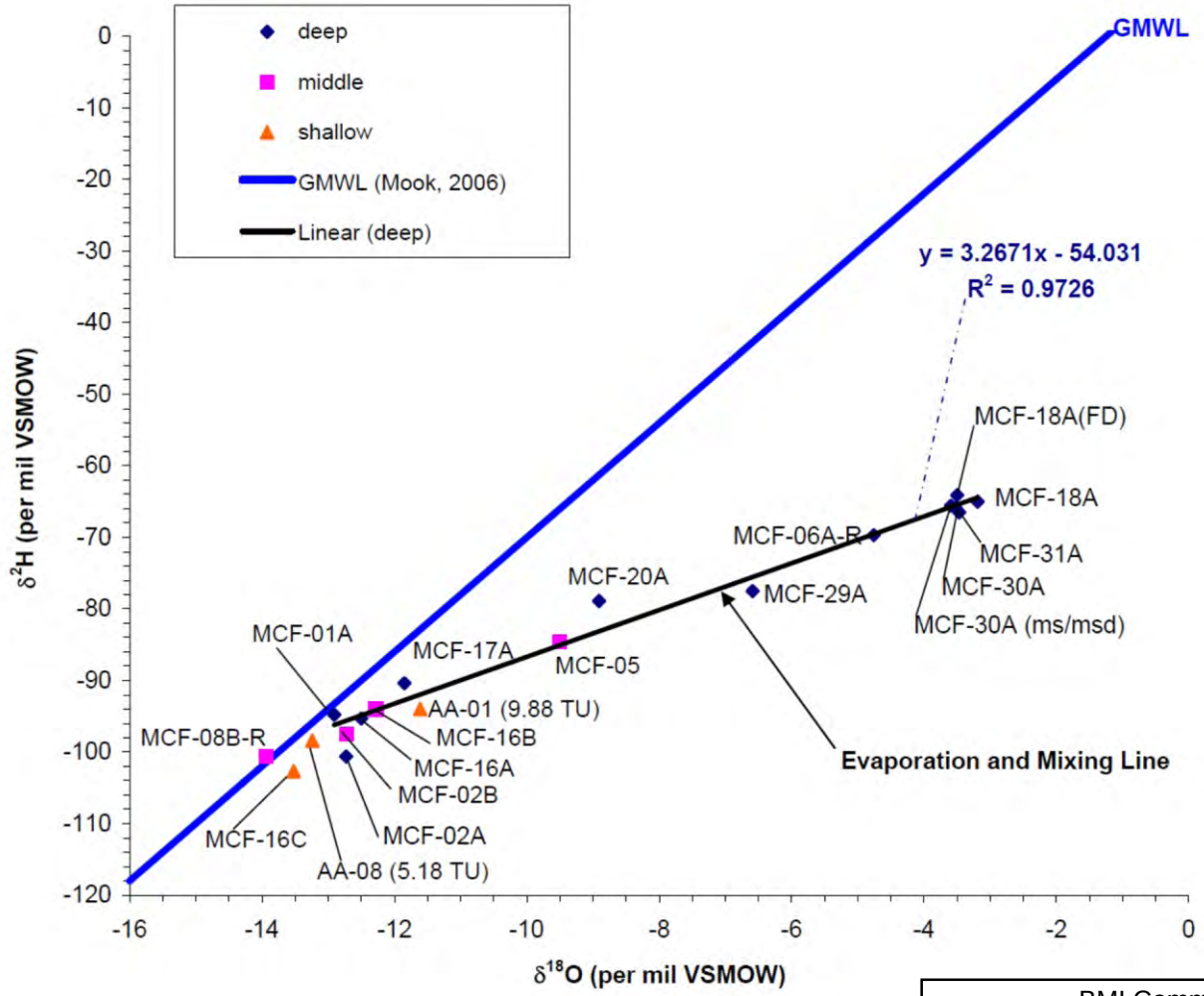
Monitoring Well Locations

Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-21-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/BASE_MAPS/MASTER_SITE_MAP_ALL_MONITORING_WELLS.MXD 909011

Daniel B. Stephens & Associates, Inc.



BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 6
Groundwater Samples
Stable Isotope Analytic
Results and GMWL

Basic Remediation COMPANY

Prepared by: DBS&A MNW

Date 12-15-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/VDR_DRAWINGS\FIG7_GW_ISOTOPE_ANALYTIC_RESULTS.CDR

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/FIG09_DEL18O_DEEP.MXD 901221

MCF-29A
-6.5
MCF-30A
-3.50
MCF-31A
-3.17
MCF-08A
MCF-17A
-11.85
MCF-28A
MCF-18A
-3.19
MCF-10A
MCF-07
MCF-06A
MCF-06A-R
MCF-22A
MCF-20A
-8.91
MCF-06C
-4.76
MCF-19A
MCF-21A
MCF-12A
MCF-23A
MCF-24A
MCF-16A
-12.5
MCF-32A
MCF-04
MCF-09A
MCF-25A
MCF-03A
MCF-01A
-12.91
MCF-27
MCF-02A
-12.73

Tronox Seep Pumping Station
AMPAC Re-Injection Area
City of Henderson Landfill
City of Henderson Northern Rib Ponds
Tuscany Village
AMPAC Athens Pen Extraction Area
Spray Wheel
Upper ponds area 1964
City of Henderson Southern Rib Ponds
West ditch
Alpha ditch
Bravo ditch
Storm drain swale

-3.5
-4.5
-5.5
-6.5
-7.5
-8.5
-9.5
-10.5
-11.5
-12.5

N
0 1000 2000 Feet

Explanation

- Deep Zone Monitoring well
- Abandoned Deep Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- $Del^{18}O$ concentration contours (dashed where inferred)

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 7
Deep Zone
$Del^{18}O$ Concentrations
in Groundwater

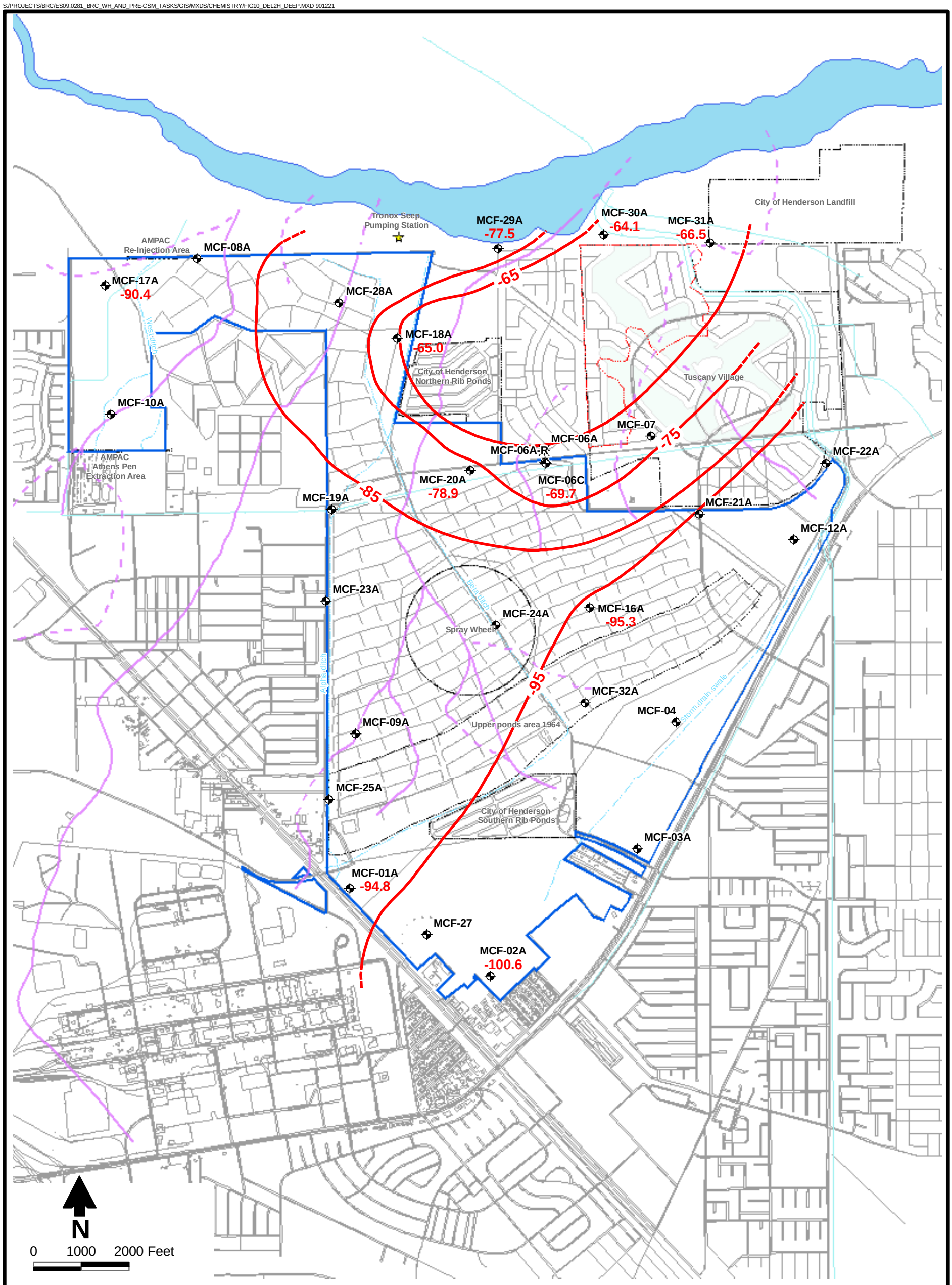
Basic Remediation COMPANY

Prepared by: DBS&A MNW Date 12-17-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/DEL2_H_DEEP.MXD 907121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/FIG10_DEL2H_DEEP.MXD 901221



Explanation

- Deep Zone Monitoring well
- Abandoned Deep Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Del^2H concentration contours (dashed where inferred)

BMI Common Areas (Eastside)
Henderson, Nevada

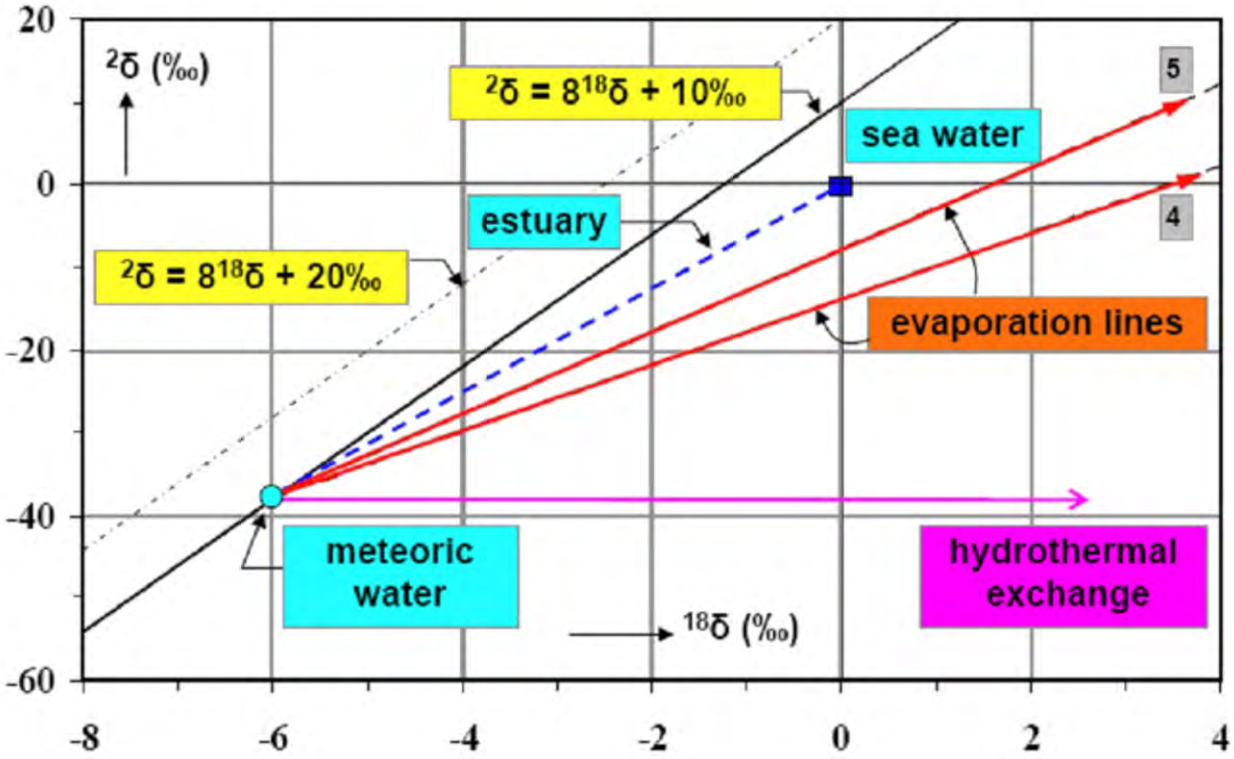
FIGURE 8
Deep Zone
Del^2H Concentrations
in Groundwater

Basic Remediation COMPANY

Prepared by: DBS&A MNW Date 12-17-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/DEL2H_DEEP.MXD 908121

Daniel B. Stephens & Associates, Inc.



Source: Mook, 2006

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 9
Relationship of ^{18}O and ^{2}H Variations in Natural Waters

Basic Remediation COMPANY

Prepared by: DBS&A MNW Date 12-16-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/VDR_DRAWINGS\FIG07_RELATIONSHIP_OF_O&H_MOOK.CDR

Daniel B. Stephens & Associates, Inc.

Note: Example of gypsum crystals commonly encountered in the northern portion of the Site. These nominally 3 to 4 inch crystals were collected from location 16 at 225 ft bgs.

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 10
Example of Gypsum Crystals

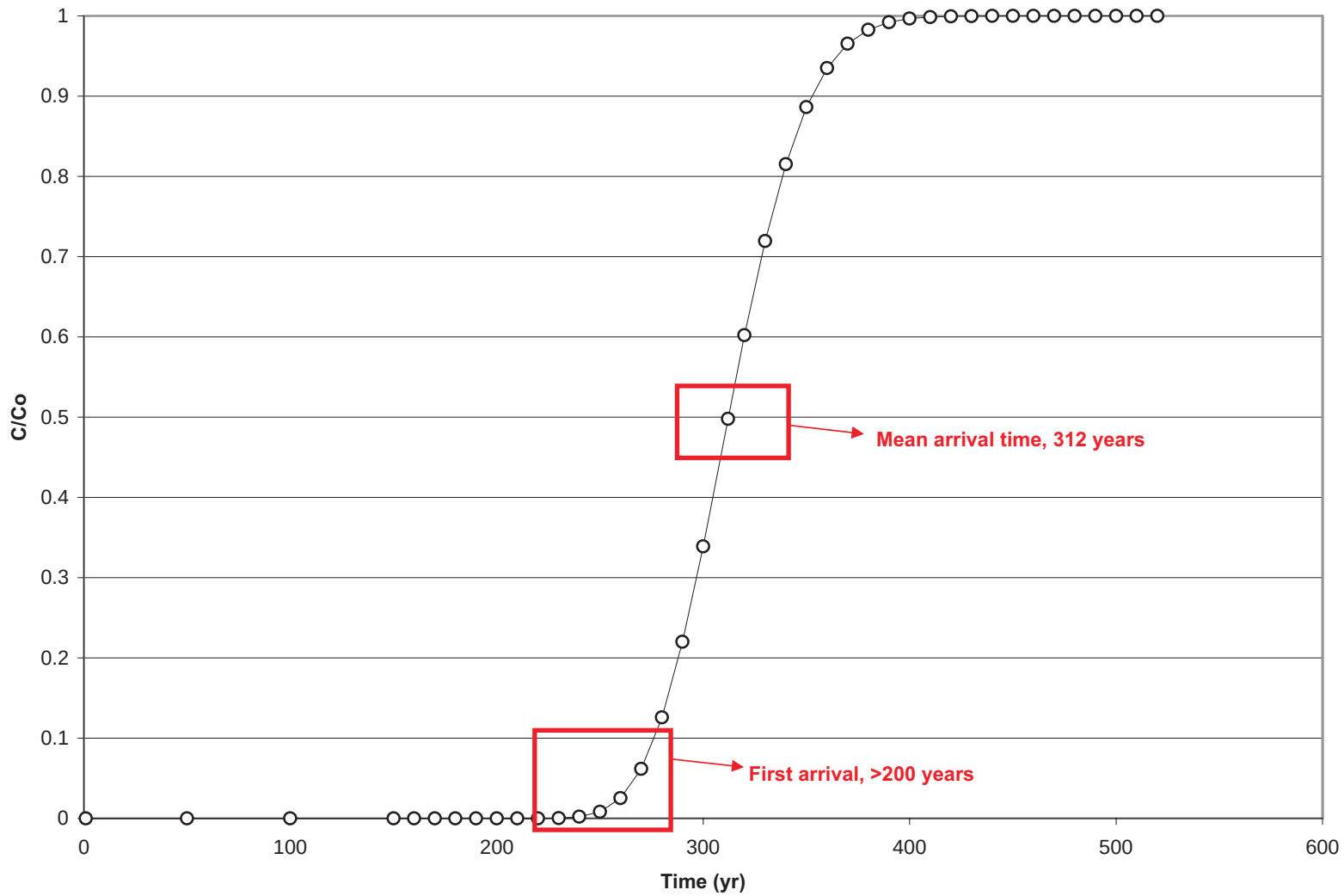
Basic Remediation COMPANY

Prepared by: DBS&A MNW Date 12-16-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/VDR_DRAWINGS\FIG12_GYPSUM_CRYSTALS.CDR

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/Fig13_First_arrival_and_mean_travel_time_deep_zone.cdr



BMI Common Areas (Eastside)
Henderson, Nevada

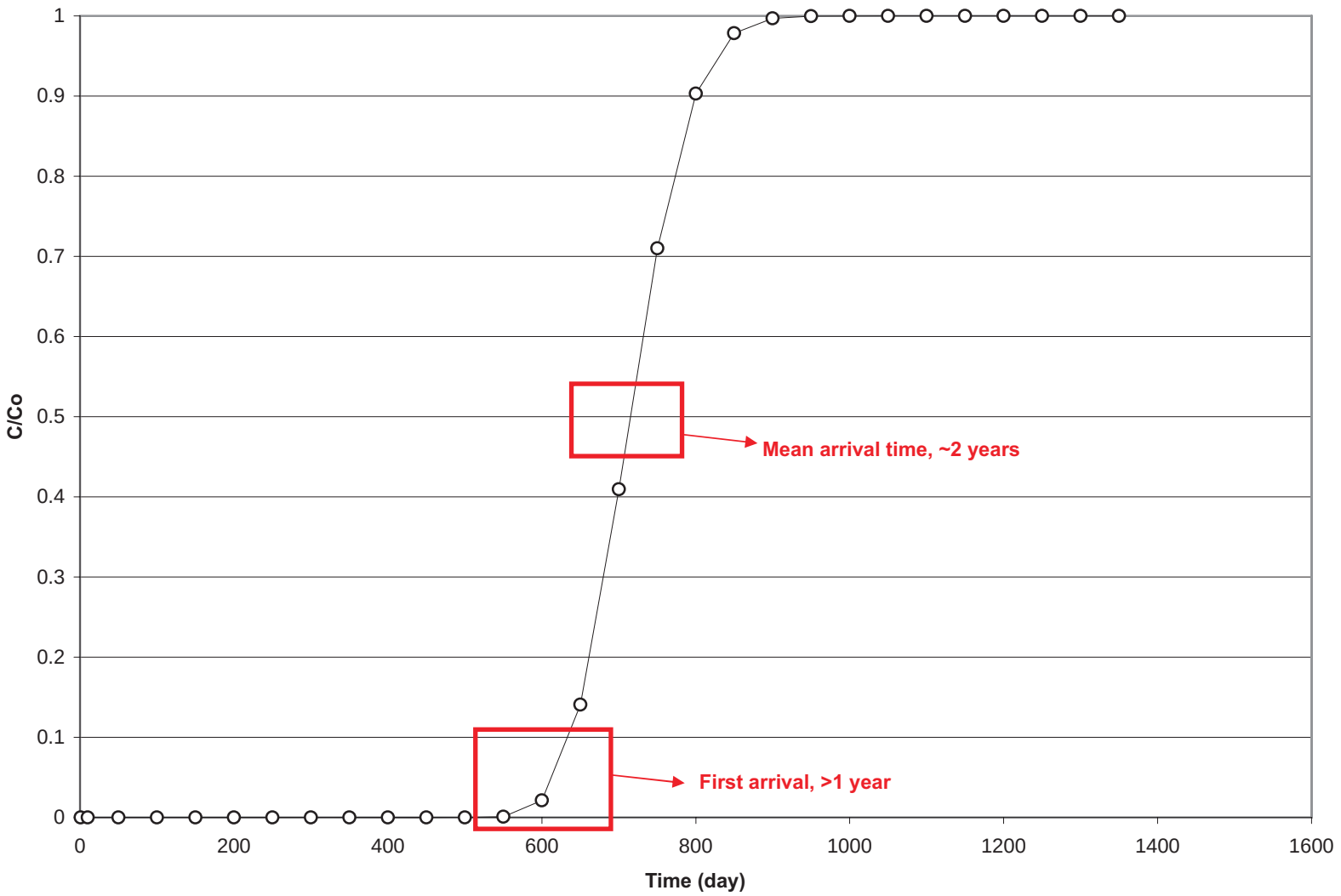
FIGURE 11
Atmospheric Tritium Content
First Arrival and Mean Travel Time
Location 16 to Location 20 (Deep Zone)

Basic Remediation COMPANY

Prepared by:	Date	
DBS&A CRS	12-21-09	S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/VDR_DRAWINGS\Fig13_First_arrival_and_mean_travel_time_deep_zone.cdr

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/Fig14_First_arrival_and_mean_travel_time_shallow_zone.cdr



BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE 12
Atmospheric Tritium Content
First Arrival and Mean Travel Time
Plants Area to AA-27 (Shallow Zone)

Basic Remediation COMPANY

Prepared by: DBS&A CRS

Date 12-21-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/VDR_DRAWINGS\Fig14_First_arrival_and_mean_travel_time_shallow_zone.cdr

Daniel B. Stephens & Associates, Inc.

Plate

N

0 1,500 3,000 Feet

Updated 12-17-09

Explanation

- New data point used in contouring (2008/2009)
- Data point used in contouring (2006)
- Site boundary
- Top of Muddy Creek Formation contour (ft msl)
- Paleochannels (dashed where inferred)
- Las Vegas wash

Daniel B. Stephens & Associates, Inc.

BMI Common Areas (Eastside)
Henderson, Nevada

PLATE 1
TOPOGRAPHIC SURFACE OF THE MUDDY CREEK FORMATION

Basic Remediation Company

Prepared by: CRF (DBS&A) Date: 12-28-09

S:\PROJECTS\BRC\ES09.0281 BRC_WH AND PRE-CSM TASKS\GIS\MXDS\REPORTS\FIG03_TOP_MUDDY_CREEK_12-17-09_D-SIZE.MXD 901221

Table

Table 1. Isotopic Data Results Summary
BMI Common Areas (Eastside) Groundwater Sampling
April–July 2008 and August–September 2009

Location	Well	Water Bearing Zone	Screen Interval (ft bgs)		Date	Delta-D [a] (‰)	Delta-O [b] (‰)	Tritium (TU)
			Top	Bottom				
Western Hook	AA-08	Shallow	5	35	5/16/2008	–98.4	–13.24	5.18
	MCF-08B-R	Middle	116.5	136.5	7/23/2008	–100.6	–13.94	< 1
	MCF-17A	Deep	367	387	7/21/2008	–90.4	–11.85	< 1
East of Spray Wheel	MCF-16C	Shallow	53	73	5/19/2008	–102.7	–13.52	< 1
	MCF-16B	Middle	283.7	313.7	5/19/2008	–94	–12.28	< 1
	MCF-16A	Deep	364.5	384.5	5/19/2008	–95.3	–12.5	< 1
Near Pittman lateral	MCF-05	Middle	221	231	4/30/2008	–84.6	–9.5	< 1
	MCF-20A	Deep	360	380	7/18/2008	–78.9	–8.91	< 1
Southwestern Site boundary	AA-01	Shallow	29	49	4/22/2008	–94	–11.61	9.88
Southern Site boundary	MCF-02B	Middle	215	235	4/24/2008	–97.5	–12.72	< 1
Southwestern Site boundary	MCF-01A	Deep	335	355	4/28/2008	–94.8	–12.91	< 1
Southern Site boundary	MCF-02A	Deep	360	380	8/25/2009	–100.6	–12.73	NA
North Central Site boundary	MCF-06A-R	Deep	353	373	9/25/2009	–69.7	–4.76	NA
390 ft W-NW of COH RIBs	MCF-18A	Deep	380	400	9/25/2009	–65.0	–3.19	NA
390 ft W-NW of COH RIBs	MCF-18A (FD)	Deep	380	400	9/25/2009	–65.9	–3.52	NA
NW corner, Weston Hills property	MCF-29A	Deep	259.5	379.5	10/1/2009	–77.5	–6.59	NA
North central boundary of Tuscany	MCF-31A	Deep	361	381	10/1/2009	–66.5	–3.47	NA
NW corner of the Tuscany Village	MCF-30A	Deep	350	370	10/8/2009	–64.1	–3.50	NA
NW corner of the Tuscany Village	MCF-30A (ms/msd)	Deep	350	370	10/8/2009	–65.6	–3.59	NA

[a] Delta^{2}H – Stable Isotopes of Hydrogen (Deuterium [^{2}H] to Protium [^{1}H])
[b] Delta^{18}O – Stable Isotopes of oxygen (^{18}O/^{16}O)

ft bgs = Feet below ground surface
‰ = Per mil relative to VSMOW
TU = Tritium unit (1 TU is equivalent to approximately 3.19 picoCuries per liter)
< = Analyte detected below reporting limit shown
NA = Not analyzed

Appendix A

Response to Comments

Responses to Nevada Division of Environmental Protection (NDEP) Comments, dated April 24, 2009, to Tritium and Stable Isotope Sampling and Analysis, and Evaluation of Hydrogeologic Zone Connectivity, BMI Common Areas (Eastside), Clark County, Nevada, dated March 26, 2009
NDEP Facility ID# H-000688

1. General, where previous data, figures and tables are referenced, please reproduce and include as appendix materials (as feasible). Additionally, this document (once finalized and approved) should be incorporated in the conceptual site model (CSM) update expected in the summer of 2009.

   Response: In the revised document, applicable reference materials will be included in an appendix. Also, this document will be incorporated into the CSM as noted.

2. Page 11, first paragraph, please include referenced Quaternary alluvium (Qal) water travel velocity and residence time calculations.

   Response: These calculations will be included in the revised document.

3. Page 11, second paragraph, NDEP concurs that the amount of data presented for tritium analysis is limited, however, NDEP is unsure that additional data will provide commensurate value.

   Response: Comment noted.

4. Page 11, number 2, BRC should also consider discussing (and presenting) information relating to vertical gradients at the Site.

   Response: Vertical gradient information will be included in the revised document and the CSM.

5. Page 12, first paragraph, please provide mass flux/mixing calculations to support assertion of limited flux and mixing of Qal and Upper Muddy Creek formation (UMCf) waters.

   Response: These calculations will be included in the revised document.

6. Page 12, third paragraph, NDEP concurs that the isotopically heavier signature of MCF-05 and MCF-20A may support the concept that the source of high total dissolved solids (TDS) in these locations is evaporitic deposits, however, the logical process appears to be incomplete, please expand. For example, has the evaporitic deposit been characterized in terms of nature and extent? Have the mineral(s) of the deposit been identified? What are the basic geochemical reactions and kinetics, related to observed water chemistry? Do other wells screened within the conceptualized deposit exhibit isotope fractionation? Conversely, are the wells which plot on the "Local Meteoric Water Line" located within the same conceptual deposit? Can this theory be supported using Piper and Stiff diagrams?

Response: The CSM will include hydrogeologic cross-sections that illustrate the lateral and vertical extent of the evaporite deposits, to the extent known. The deposits have been characterized in boring logs as gypsum-bearing sediments. The observed water chemistry, as it relates to the evaporite deposits rich in gypsum ($CaSO_4$), will be evaluated in the CSM. A discussion of evaporite dissolution will be included. The CSM will evaluate the spatial distribution of the conceptualized evaporite deposit relative to wells that plot on the Local Meteoric Water Line.

The April 28, 2009 Eastside groundwater sampling plan includes supplemental isotope sampling to further evaluate groundwater quality. Piper and Stiff diagrams will be used to evaluate if groundwater sampled from wells installed within the interpreted evaporite deposit have a unique geochemical signature. This evaluation will be presented in the CSM.

7. Page 12, number 1, the advective travel time calculation is presented as being conservative; NDEP has several exceptions with this statement as follows:

   a. The logical starting point for such transport calculation should be the former TIMET Spray Wheel or TIMET ponds rather than location 16 as these appear to be the primary potential Site source for water and TDS.

Response: A revised transport calculation, with the former TIMET Spray Wheel of the TIMET ponds as the starting point, will be evaluated and presented if appropriate . in the CSM. In any case, this issue will be discussed.

   b. The calculation does not account for dispersion, and only provides an average seepage velocity rather than a more conservative "toe" travel time for solutes.

Response: Dispersion will be input into the revised calculation.

   c. The calculation does not account for preferential pathways; NDEP has observed boring cores from various locations at the Site, and has observed a natural cleavage plane especially in the presence of "evaporite" crystals within boring cores. Preferential pathways may also be present due to heterogeneity. Also, vertical preferential pathways, such as soil macro-structures, may dominate flow and transport, especially through media which has resided below paleosurfaces.

Response: As part of the calculation to be presented in the CSM, BRC will evaluate the evidence and potential for preferential flow pathways in both horizontal and vertical directions.

8. Page 13, number 2, as noted above, please include the referenced chemical maps as appendix material.

Response: As discussed in the response to Comment No.1 above, in the revised document, applicable reference materials will be included in an appendix.

9. Page 13, number 3, please discuss if the previous water quality data been quality control checked using standard operating procedures (SOPs) (e.g.: cation anion balance checks) and flagged accordingly. BRC should also discuss if the data is usable. Please include the most pertinent Piper and Stiff diagrams as appendix material.

Response: Cation anion balance checks have been completed for the data from each BRC groundwater monitoring event. The results of the CAB checks are currently in review with the laboratory to determine why some analyses do not meet the 5% balance criteria. The results of the CAB analysis, and revised Piper and Stiff diagrams, if needed, will be included in the revised document.

10. Page 13, number 4, BRC assumes that the present-time observed general upward gradient was also the historical case. Please consider the degree of hydraulic gradient reversal which would be induced via TIMET Spray Wheel, evaporation pond, and rapid infiltration basin infiltration and mounding. Please account for density-driven flow in your consideration.

Response: This task is underway in preparation for inclusion in the CSM.

11. Page 13, number 5, the assertion of hexavalent chromium migration within the Deep Zone appears to be inconsistent with travel time calculations presented in page 12, number 1. Please support this assertion with similar calculations.

Response: The coarse-grained facies of the TMC (TMCcg) is interpreted to be present to the south of the Eastside site, that is, sand lenses within the TMCcg are anticipated to be facilitating contaminant transport in this area. The CSM will discuss this concept in detail. As applicable, the revised isotope tech memo will include a revised calculation to demonstrate the anticipated travel time in the TMCcg.

12. Page 14, Anthropogenic Chemical Impacts, the NDEP has the following comments:

    a. Iso-concentration maps need to be included with this discussion.

Response: Iso-concentration maps from the 5th round monitoring event will be included as an appendix to the revised document.

    b. BRC refers to the elevated arsenic detection limits as a limiting factor. It appears that this document will need to be revisited after the next round of sampling when usable data is gathered.

Response: Additional arsenic sampling has been proposed in the Eastside groundwater sampling plan, dated April 28, 2009. The new data will be incorporated into the interpretation of the isotopic data for the Eastside area as well as the overall Eastside CSM.

13. Page 15, first paragraph, hexavalent chromium concentrations are noted to have been present in the Middle and Deep Zones. What is the current conceptual model for these occurrences? Are soil analytical data available that can support or refute hexavalent chromium as an anthropogenic tracer?

Response: The current hypothesis for the CrVI conceptual model is that sand lenses in the TMCcg are facilitating transport from the offsite area. This concept will be described in detail in the CSM along with supporting data. Soil data for CrVI will be reviewed for the revised isotope tech memo to evaluate if anthropogenic sources are present in the Eastside area.

14. Page 15, second paragraph, perchlorate concentrations are stated to have been "essentially" not detected in the Deep Zone. Does this mean that detections were made? If so, what is the current conceptual model for these occurrences? BRC also states that perchlorate was not analyzed for several locations; since perchlorate is among the most relevant anthropogenic tracers for the Site, please sample for perchlorate at all Middle and Deep Zone locations, including those of the most recent round of well installations. Also, please insure the use of the lowest possible laboratory detection limit. As discussed with BRC previously, it may be necessary to utilize a different analytical method to gather meaningful data.

Response: In the 5th round groundwater sampling event, perchlorate was detected in Western Hook area deep well MCF-10A at 2.38 J. Additional perchlorate sampling and analysis with a different laboratory method has been proposed in the April 28, 2009 Eastside groundwater sampling plan. The new data will be incorporated into the interpretation of the isotopic data for the Eastside area as well as the overall Eastside CSM.

15. Page 16, Summary, second paragraph, as noted previously by NDEP, it appears that most of the data used to generate the referenced Piper and Stiff diagrams is unusable. This issue will need to be revisited once usable data is collected.

Response: Please see the response to Comment No.9 above.

16. Page 16, fifth paragraph, the relationship between the former gravel mining operation, and the localized area of downward gradient at Location 6, is unclear. Please explain.

Response: Currently there is no clear relationship that is evident between the former mine and the gradient at Location 6. This information is included in the document as a matter of completeness. If a relationship is determined to be present it will be detailed in the revised document and in the CSM.

Appendix B

Laboratory Reports

ISOTECH
ISOTECH LABORATORIES INC

ANALYSIS REPORT

Water Analysis

Lab Number: 172091 Job Number: 12040

Submitter Sample Name: MCF-29A

Submitter Sample ID:

Submitter Job #: 06-43226-07

Company: GEL Laboratories, LLC

Field or Site: BMI Commons Area (Eastside)

Location:

Depth/Formation:

Container Type: 1 Liter Plastic Bottle

Sample Collected: 9/29/2009 Results Reported: 10/15/2009

Delta D of water	-77.5 per mil relative to VSMOW
Delta O-18 of water	-6.59 per mil relative to VSMOW
Tritium content of water	na
Delta C-13 of DIC	na
Carbon-14 content of DIC	na
Delta N-15 of nitrate	na
Delta O-18 of nitrate	na
Delta S-34 of sulfate	na
Delta O-18 of sulfate	na

Remarks:

ISOTECH
ISOTECH LABORATORIES INC

ANALYSIS REPORT

Water Analysis

Lab Number: 172092 Job Number: 12040

Submitter Sample Name: MCF-31A

Submitter Sample ID:

Submitter Job #: 06-43226-07

Company: GEL Laboratories, LLC

Field or Site: BMI Commons Area (Eastside)

Location:

Depth/Formation:

Container Type: 1 Liter Plastic Bottle

Sample Collected: 9/29/2009 Results Reported: 10/15/2009

Delta D of water	-66.5 per mil relative to VSMOW
Delta O-18 of water	-3.47 per mil relative to VSMOW
Tritium content of water	na
Delta C-13 of DIC	na
Carbon-14 content of DIC	na
Delta N-15 of nitrate	na
Delta O-18 of nitrate	na
Delta S-34 of sulfate	na
Delta O-18 of sulfate	na

Remarks:

ISOTECH
ISOTECH LABORATORIES INC

ANALYSIS REPORT

Water Analysis

Lab Number:	172516	Job Number:	12066
Submitter Sample Name:	MCF-30A		
Submitter Sample ID:			
Submitter Job #:	06-43226-07		
Company:	GEL Laboratories, LLC		
Field or Site:	BMI Commons Area (Eastside)		
Location:			
Depth/Formation:			
Container Type:	1 Liter Plastic Bottle		
Sample Collected:	10/05/2009	Results Reported:	10/15/2009

Delta D of water	-64.1 per mil relative to VSMOW
Delta O-18 of water	-3.51 per mil relative to VSMOW
Tritium content of water	na
Delta C-13 of DIC	na
Carbon-14 content of DIC	na
Delta N-15 of nitrate	na
Delta O-18 of nitrate	na
Delta S-34 of sulfate	na
Delta O-18 of sulfate	na

Remarks:

ISOTECH
ISOTECH LABORATORIES INC

ANALYSIS REPORT

Water Analysis

Lab Number:	172517	Job Number:	12066
Submitter Sample Name:	MCF-30A (ms/msd)		
Submitter Sample ID:			
Submitter Job #:	06-43226-07		
Company:	GEL Laboratories, LLC		
Field or Site:	BMI Commons Area (Eastside)		
Location:			
Depth/Formation:			
Container Type:	1 Liter Plastic Bottle		
Sample Collected:	10/05/2009	Results Reported:	10/15/2009

Delta D of water	-65.6 per mil relative to VSMOW
Delta O-18 of water	-3.59 per mil relative to VSMOW
Tritium content of water	na
Delta C-13 of DIC	na
Carbon-14 content of DIC	na
Delta N-15 of nitrate	na
Delta O-18 of nitrate	na
Delta S-34 of sulfate	na
Delta O-18 of sulfate	na

Remarks:

ISOTECH
ISOTECH LABORATORIES INC

ANALYSIS REPORT

Water Analysis

Lab Number: 169383 Job Number: 11869

Submitter Sample Name: MCF-02A

Submitter Sample ID:

Submitter Job #: 06-43226-07

Company: GEL Laboratories, LLC

Field or Site: BMI Commons Area (Eastside)

Location:

Depth/Formation:

Container Type: Plastic Bottle

Sample Collected: 8/21/2009 Results Reported: 9/01/2009

Delta D of water	-100.6 per mil relative to VSMOW
Delta O-18 of water	-12.73 per mil relative to VSMOW
Tritium content of water	na
Delta C-13 of DIC	na
Carbon-14 content of DIC	na
Delta N-15 of nitrate	na
Delta O-18 of nitrate	na
Delta S-34 of sulfate	na
Delta O-18 of sulfate	na

Remarks:

ISOTECH
ISOTECH LABORATORIES INC

ANALYSIS REPORT

Water Analysis

Lab Number: 171282 Job Number: 11991

Submitter Sample Name: MCF-06A-R

Submitter Sample ID:

Submitter Job #:

Company: GEL Laboratories, LLC

Field or Site: BMI Commons Area (Eastside)

Location:

Depth/Formation:

Container Type: Plastic Bottle

Sample Collected: 9/21/2009 Results Reported: 10/01/2009

Delta D of water	-69.7 per mil relative to VSMOW
Delta O-18 of water	-4.76 per mil relative to VSMOW
Tritium content of water	na
Delta C-13 of DIC	na
Carbon-14 content of DIC	na
Delta N-15 of nitrate	na
Delta O-18 of nitrate	na
Delta S-34 of sulfate	na
Delta O-18 of sulfate	na

Remarks:

ISOTECH
ISOTECH LABORATORIES INC

ANALYSIS REPORT

Water Analysis

Lab Number: 171283 Job Number: 11991

Submitter Sample Name: MCF-18A

Submitter Sample ID:

Submitter Job #:

Company: GEL Laboratories, LLC

Field or Site: BMI Commons Area (Eastside)

Location:

Depth/Formation:

Container Type: Plastic Bottle

Sample Collected: 9/21/2009 Results Reported: 10/01/2009

Delta D of water	-65.0 per mil relative to VSMOW
Delta O-18 of water	-3.19 per mil relative to VSMOW
Tritium content of water	na
Delta C-13 of DIC	na
Carbon-14 content of DIC	na
Delta N-15 of nitrate	na
Delta O-18 of nitrate	na
Delta S-34 of sulfate	na
Delta O-18 of sulfate	na

Remarks:

ISOTECH
ISOTECH LABORATORIES INC

ANALYSIS REPORT

Water Analysis

Lab Number: 171284 Job Number: 11991

Submitter Sample Name: MCF-18A (FD)

Submitter Sample ID:

Submitter Job #:

Company: GEL Laboratories, LLC

Field or Site: BMI Commons Area (Eastside)

Location:

Depth/Formation:

Container Type: Plastic Bottle

Sample Collected: 9/21/2009 Results Reported: 10/01/2009

Delta D of water	-65.9 per mil relative to VSMOW
Delta O-18 of water	-3.52 per mil relative to VSMOW
Tritium content of water	na
Delta C-13 of DIC	na
Carbon-14 content of DIC	na
Delta N-15 of nitrate	na
Delta O-18 of nitrate	na
Delta S-34 of sulfate	na
Delta O-18 of sulfate	na

Remarks:

Isotech Water Data

Job 12066

BMI Commons Area (Eastside)

Isotech Lab No.	Sample Name	Analysis Date	δD H_2O ‰	$\delta^{18}O$ H_2O ‰
172516	MCF-30A	10/8/2009	-64.1	-3.50
172517	MCF-30A (ms/msd)	10/8/2009	-65.6	-3.59

Isotech Water Data

Job 11991

BMI Commons Area (Eastside)

Isotech Lab No.	Sample Name	Analysis Date	δD H_2O ‰	$\delta^{18}O$ H_2O ‰
171282	MCF-06A-R	9/25/2009	-69.7	-4.76
171283	MCF-18A	9/25/2009	-65.0	-3.19
171284	MCF-18A (FD)	9/25/2009	-65.9	-3.52

Isotech Water Data

Job 11869

BMI Commons Area (Eastside)

Isotech Lab No.	Sample Name	Analysis Date	δD H_2O ‰	$\delta^{18}O$ H_2O ‰
169383	MCF-02A	8/25/2009	-100.6	-12.73

Isotech Water Data

Job 12040

BMI Commons Area (Eastside)

Isotech Lab No.	Sample Name	Analysis Date	$\delta D\ H_2O$ ‰	$\delta^{18}O\ H_2O$ ‰
172091	MCF-29A	10/1/2009	-77.5	-6.59
172092	MCF-31A	10/1/2009	-66.5	-3.47

Appendix C

Vertical Gradient Data

Appendix C. Summary of Vertical Gradient Data
BRC Common Areas - Eastside (updated for 2009 Data)

Deep/Shallow Well Pairs

Deep Well	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)	Ground Surface elevation (ft AMSL)	Screen Midpoint (ft AMSL) (zi)	Groundwater Elevation (ft AMSL) (hi)	GW Elevation Date Measured	Groundwater TDS (mg/L)	TDS Date Measured	Groundwater Temperature (C)	GW Density (g/cm^3) (pi)	Fresh Water Head, (ft AMSL (h(f)	**Shallow Well**	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)	Ground Surface elevation (ft AMSL)	Screen Midpoint (ft AMSL) (zi)	Groundwater Elevation (ft AMSL) (hi)	GW Elevation Date Measured	Groundwater TDS (mg/L)	TDS Date Measured	Groundwater Temperature (C)	GW Density (g/cm^3) (pi)	Fresh Water Head (ft AMSL) (hf)
MCF-01A	335	355	1754.44	1409.44	1720.21	7/25/04	--	--	--	--	--	AA-01	29	49	1754.93	1715.93	1712.03	4/8/04	--	--	--	--	--
MCF-01A	335	355	1754.44	1409.44	1723.51	4/18/06	3570	05/30/06	27.72	0.999	1723.20	AA-01	29	49	1754.93	1715.93	1712.35	4/18/06	3430	04/26/06	25.01	1.000	1712.35
MCF-01A	335	355	1754.44	1409.44	1726.61	7/27/06	4020	08/07/06	26.39	0.997	1725.66	AA-01	29	49	1754.93	1715.93	1711.69	7/27/06	3930	08/01/06	24.84	1.000	1711.69
MCF-01A	335	355	1754.44	1409.44	1727.87	10/16/06	4060	10/24/06	26.01	1.000	1727.87	AA-01	29	49	1754.93	1715.93	1711.50	10/16/06	3310	10/18/06	23.88	1.000	1711.50
MCF-01A	335	355	1754.44	1409.44	1726.47	1/22/07	3930	02/02/07	23.4	1.000	1726.47	AA-01	29	49	1754.93	1715.93	1711.45	1/22/07	3730	01/25/07	24	1.000	1711.45
MCF-01A	335	355	1754.44	1409.44	1716.51	8/6/09	3900	08/14/09	26.8	1.000	1716.51	AA-01	29	49	1754.93	1715.93	1707.20	8/6/09	3800	08/14/09	24.9	1.000	1707.20
MCF-08A	350	370	1579.02	1219.02	**ARTESIAN**	4/7/04	--	--	--	--	--	AA-08	5	35	1578.46	1558.46	1566.82	6/7/04	--	--	--	--	--
MCF-08A	350	370	1579.02	1219.02	**ARTESIAN**	4/21/06	110000	06/07/06	24.59	1.082	(a)	AA-08	5	35	1578.46	1558.46	1567.69	4/21/06	5070	05/25/06	23.48	1.001	1567.70
MCF-08A	350	370	1579.02	1219.02	**ARTESIAN**	7/26/06	113000	08/23/06	23.8	1.084	(a)	AA-08	5	35	1578.46	1558.46	1565.47	7/26/06	4390	08/14/06	23.3	1.001	1565.48
MCF-08A	350	370	1579.02	1219.02	**ARTESIAN**	10/17/06	113000	11/10/06	25.73	1.084	(a)	AA-08	5	35	1578.46	1558.46	1568.82	10/17/06	4640	11/01/06	23.65	1.001	1568.83
MCF-08A	350	370	1579.02	1219.02	**ARTESIAN**	1/23/07	116000	02/08/07	22.5	1.087	(a)	AA-08	5	35	1578.46	1558.46	1568.72	1/23/07	4700	02/08/07	23.4	1.001	1568.73
MCF-08A	350	370	1579.02	1219.02	**ARTESIAN**	8/4/09	99800	09/06/09	26.49	1.073		AA-08	5	35	1578.46	1558.46	1565.58	8/4/09	3500	08/20/09	26.25	0.999	1565.57
MCF-10A	365	385	1613.32	1238.32	1613.06	4/14/04	--	--	--	--	--	AA-10	10	40	1612.54	1587.54	1595.91	7/9/04	--	--	--	--	--
MCF-10A	365	385	1613.32	1238.32	**ARTESIAN**	4/21/06	8080	05/31/06	24.96	1.003	(a)	AA-10	10	40	1612.54	1587.54	1596.04	4/21/06	4880	05/12/06	23.36	1.001	1596.05
MCF-10A	365	385	1613.32	1238.32	1601.56	7/27/06	6800	08/21/06	24.3	1.002	1602.29	AA-10	10	40	1612.54	1587.54	1596.97	7/27/06	4720	08/11/06	23.2	1.001	1596.98
MCF-10A	365	385	1613.32	1238.32	1607.46	10/17/06	7700	11/14/06	25.01	1.003	1608.57	AA-10	10	40	1612.54	1587.54	1596.75	10/17/06	4770	10/27/06	22.63	1.001	1596.76
MCF-10A	365	385	1613.32	1238.32	1612.18	1/23/07	7270	02/16/08	22.51	1.003	1613.30	AA-10	10	40	1612.54	1587.54	1596.89	1/23/07	4560	02/05/07	22.9	1.001	1596.90
MCF-10A	365	385	1613.32	1238.32	**ARTESIAN**	8/3/09	4200	09/06/09	25.3	1.000	(a)	AA-10	10	40	1612.54	1587.54	1595.05	8/3/09	4110	08/19/09	23.6	1.001	1595.06
MCF-12A	349.5	369.5	1713.68	1354.18	1658.06	7/22/04	--	--	--	--	--	MCF-12B	64	84	1712.74	1638.74	1648.18	6/5/04	--	--	--	--	--
MCF-12A	349.5	369.5	1713.68	1354.18	1661.03	4/27/06	5950	05/18/06	28.13	1.003	1661.95	MCF-12B	64	84	1712.74	1638.74	1649.08	4/27/06	2630	05/23/06	25.14	0.999	1649.07
MCF-12A	349.5	369.5	1713.68	1354.18	1661.21	7/27/06	5900	08/10/06	25.6	1.001	1661.52	MCF-12B	64	84	1712.74	1638.74	1648.33	7/27/06	2520	08/09/06	26.7	0.999	1648.32
MCF-12A	349.5	369.5	1713.68	1354.18	1661.36	10/16/06	7580	01/25/00	24.64	1.003	1662.28	MCF-12B	64	84	1712.74	1638.74	1648.20	10/16/06	2620	11/08/06	24.54	0.999	1648.19
MCF-12A	349.5	369.5	1713.68	1354.18	1661.54	1/24/07	6320	01/24/00	24.8	1.002	1662.15	MCF-12B	64	84	1712.74	1638.74	1647.75	1/24/07	2760	02/15/07	21.19	1.000	1647.75
MCF-12A	349.5	369.5	1713.68	1354.18	1663.63	8/6/09	7300	09/06/09	28.73	1.002	1664.25	MCF-12B	64	84	1712.74	1638.74	1646.79	8/6/09	2900	08/25/09	30.04	0.998	1646.77
MCF-16A	364.5	384.5	1689.67	1315.17	1661.98	4/6/04	--	--	--	--	--	MCF-16C	53	73	1689.88	1626.88	1629.98	6/11/04	--	--	--	--	--
MCF-16A	364.5	384.5	1689.67	1315.17	1643.84	4/20/06	81800	05/18/06	25.74	1.059	1663.23	MCF-16C	53	73	1689.88	1626.88	1626.23	4/20/06	8150	05/22/06	23.3	1.004	1626.23
MCF-16A	364.5	384.5	1689.67	1315.17	1643.62	7/26/06	83800	08/21/06	24.0	1.061	1663.66	MCF-16C	53	73	1689.88	1626.88	1625.88	7/26/06	8190	08/16/06	25.8	1.003	1625.88
MCF-16A	364.5	384.5	1689.67	1315.17	1643.84	10/17/06	86400	11/06/06	24.14	1.063	1664.55	MCF-16C	53	73	1689.88	1626.88	1625.66	10/17/06	7010	11/06/06	23.53	1.003	1625.66
MCF-16A	364.5	384.5	1689.67	1315.17	1644.13	1/22/07	88300	02/16/07	23.2	1.065	1665.51	MCF-16C	53	73	1689.88	1626.88	1625.51	1/22/07	6480	02/20/07	22.3	1.003	1625.51
MCF-16A	364.5	384.5	1689.67	1315.17	1644.98	8/5/09	78800	2009	26.50	1.056	1663.45	MCF-16C	53	73	1689.88	1626.88	1625.04	8/5/09	11500	--	25.1	1.005	1625.03
MCF-27	361.5	381.5	1787.03	1415.53	1763.48	7/14/04	--	--	--	--	--	AA-27	61.5	81.5	1786.85	1715.35	1729.98	7/13/04	--	--	--	--	--
MCF-27	361.5	381.5	1787.03	1415.53	1773.50	4/20/06	1460	05/19/06	26.42	0.998	1772.78	AA-27	61.5	81.5	1786.85	1715.35	1723.58	4/19/06	4080	04/27/06	24.97	1.000	1723.58
MCF-27	361.5	381.5	1787.03	1415.53	1774.28	7/26/06	1260	08/02/06	25.58	0.998	1773.56	AA-27	61.5	81.5	1786.85	1715.35	1722.66	7/26/06	4240	08/02/06	24.65	1.000	1722.66
MCF-27	361.5	381.5	1787.03	1415.53	1774.88	10/16/06	1170	10/20/06	25.41	0.998	1774.16	AA-27	61.5	81.5	1786.85	1715.35	1722.61	10/16/06	4220	10/19/06	24.67	1.000	1722.61
MCF-27	361.5	381.5	1787.03	1415.53	1775.27	1/22/07	968	02/20/07	24.3	0.998	1774.55	AA-27	61.5	81.5	1786.85	1715.35	1722.46	1/22/07	4340	02/02/07	24.9	1.000	1722.46
MCF-27	361.5	381.5	1787.03	1415.53	1779.58	8/6/09	600	09/25/09	26.7	0.997	1778.49	AA-27	61.5	81.5	1786.85	1715.35	1721.27	8/6/09	3300	09/03/09	40.7	0.994	1721.23
MCF-06A	373.5	393.5	1588.80	1205.3	1563.27	4/16/04	--	--	--	--	--	MCF-06C	44	59	1630.42	1578.92	1584.17	7/15/04	--	--	--	--	--
MCF-06A	373.5	393.5	1588.80	1205.3	1519.38	4/20/06	186000	05/30/06	26.27	1.144	1564.61	MCF-06C	44	59	1630.42	1578.92	1580.63	4/20/06	47600	05/22/06	24.09	1.033	1580.69
MCF-06A	373.5	393.5	1588.80	1205.3	1509.54	7/27/06	185000	08/21/06	25.1	1.143	1553.05	MCF-06C	44	59	1630.42	1578.92	1579.38	7/26/06	6280	08/08/06	23.97	1.002	1579.38
MCF-06A	373.5	393.5	1588.80	1205.3	1512.00	10/16/06	205000	11/13/06	23.44	1.162	1561.68	MCF-06C	44	59	1630.42	1578.92	1578.93	10/17/06	6720	10/30/06	23.57	1.002	1578.93
MCF-06A	373.5	393.5	1588.80	1205.3	1515.31	1/23/07	191000	02/23/07	20.4	1.151	1562.12	MCF-06C	44	59	1630.42	1578.92	1578.09	1/23/07	6980	02/01/07	22.3	1.003	1578.09
MCF-06A	373.5	393.5	1588.80	1205.3	(c)	8/6/09	--	--	--	--	--	MCF-06C	44	59	1630.42	1578.92	1575.81	8/3/09	6200	09/17/09	25.2	1.002	1575.80
MCF-07	350	370	1610.07	1250.07	1524.30	7/24/04	--	--	--	--	--	AA-07	30	50	1610.12	1570.12	1570.81	7/23/04	--	--	--	--	--
MCF-07	350	370	1610.07	1250.07	(b)	5/24/06	--	--	--	--	--	AA-07	30	50	1610.12	1570.12	1572.10	5/24/06	2030	06/06/06	23.99	0.999	1572.10
MCF-07	350	370	1610.07	1250.07	1523.04	8/30/06	174000	08/30/06	25.0	1.134	1559.62	AA-07	30	50	1610.12	1570.12	1572.05	7/27/06	1990	08/16/06	23.58	0.999	1572.05
MCF-07	350	370	1610.07	1250.07	1532.33	10/16/06	182000	11/10/06	24.29	1.141	1572.13	AA-07	30	50	1610.12	1570.12	1571.99	10/16/06	2120	11/03/06	23.63	0.999	1571.99
MCF-07	350	370	1610.07	1250.07	1530.38	1/23/07	193000	02/23/07	23.8	1.151	1572.71	AA-07	30	50	1610.12	1570.12	1572.01	1/23/07	2170	02/26/07	23.3	0.999	1572.01
MCF-07	350	370	1610.07	1250.07	1533.56	8/6/09	166000	09/17/09	25.4	1.127	1569.56	AA-07	30	50	1610.12	1570.12	1571.84	8/6/09	2500	08/14/09	24.4	0.999	1571.84
MCF-09A	270	290	1694.26	1414.26	1667.29	4/18/04	--	--	--	--	--	AA-09	30	65	1694.11	1646.61	1663.46	7/7/04	--	--	--	--	--
MCF-09A	270	290	1694.26	1414.26	1657.36	4/20/06	--	--	--	--	--	AA-09	30	65	1694.11	1646.61	1659.16	4/20/06	5670	05/01/06	25.3	1.001	1659.17
MCF-09A	270	290	1694.26	1414.26	1657.20	7/26/06	24800	08/21/06	25.93	1.015	1660.84	AA-09	30	65	1694.11	1646.61	1658.64	7/26/06	5740	08/11/06	24.38	1.002	1658.66
MCF-09A	270	290	1694.26	1414.26	1657.30	10/17/06	26800	11/14/06	25.05	1.017	1661.43	AA-09	30	65	1694.11	1646.61	1658.35	10/17/06	5890	10/23/06	24.52	1.002	1658.37
MCF-09A	270	290	1694.26	1414.26	1657.18	1/22/07	30700	02/16/07	25.53	1.020	1662.04	AA-09	30	65	1694.11	1646.61	1658.48	1/22/07	6150	01/26/07	24.4	1.002	1658.50
MCF-09A	270	290	1694.26	1414.26	1656.38	8/3/09	22100	08/20/09	28.17	1.013	1659.53	AA-09	30	65	1694.11	1646.61	1657.91	8/3/09	6600	08/19/09	28.19	1.002	1657.93
MCF-19A	340	360	--	--	(c)	(c)	(c)	(c)	--	(c)	(c)	DBMW-2	20	40	--	--	(c)	(c)	(c)	(c)	--	(c)	(c)
MCF-19A	340	360	--	--	(c)	(c)	115000	9/13/09	27.09	1.09		DBMW-2	20	40	--	--	1592.29	8/3/09	6400	9/13/09	28.98	1.001	(c)
MCF-28A	365.57	385.57	1564.73	1189.16	1526.75	8/3/09	18800	10/5/09	26.81	1.011	1530.46	PC-56	48	54.8	--	--	--	--	--	--	--	--	--
MCF-29A	355.8	375.8	1543.48	1177.68	1541.03	8/3/09	161000	10/5/09	26.45	1.123	1585.72	HMW-08	360	380	--	--	1521.86	8/3/09	5900	10/05/09	--	--	--
MCF-30A	346.74	366.74	1527.60	1170.86	1522.96	8/3/09	175000	10/14/09	26.35	1.134	1570.14	AA-30	8.20	28.20	1529.84	1511.64	1513.04	8/3/09	5000.00	9/17/09	23.5	1.001	1513.04
MCF-31A	356.78	376.78	1528.04	1161.26	1524.19	8/3/09	185000	10/5/09	27.83	1.142	1575.73	MW-4	20	30	1520.05	1495.05	1498.59	8/6/09	14400	09/25/09	26.49	1.007	1498.61
MCF-32A	346.61	366.61	1727.88	1371.27	1696.64	8/3/09	--	--	--	--	--	BEC-6	65	80	--	--	1657.88	8/3/09	7300	10/05/09	--	--	--

Appendix C. Summary of Vertical Gradient Data
BRC Common Areas - Eastside (updated for 2009 Data)

		Uncorrected for Groundwater Density			Corrected for Groundwater Density			Corrected for Equipotential Surface (lateral distance between wells)						
Deep Well	**Shallow Well**	Point Water Head Delta (ft)	Point Water Head Deep/Shallow Vertical Gradient (ft/ft)	Point Water Head Vertical Flow Direction	Fresh Water Head Delta (ft AMSL)	Fresh Water Head Deep/Shallow Vertical Gradient (ft/ft)	Vertical Flow Direction	Horizontal Gradient	Distance Between Wells Along Gradient	Well Name	Revised GW Elevation/Head	Fresh Water Head Delta (ft AMSL)	Fresh Water Head Deep/Shallow Vertical Gradient (ft/ft)	Fresh Head Vertical Flow Direction
MCF-01A	AA-01	-8.18	0.03	UP	--	--	--	--	--	--	--	--	--	--
MCF-01A	AA-01	-11.16	0.04	UP	-10.85	0.04	UP	0.0165	8	AA-01	1712.22	-10.98	0.04	UP
MCF-01A	AA-01	-14.92	0.05	UP	-13.97	0.05	UP	0.0137	5	AA-01	1711.62	-14.04	0.05	UP
MCF-01A	AA-01	-16.37	0.05	UP	-16.37	0.05	UP	0.0086	8	AA-01	1711.43	-16.44	0.05	UP
MCF-01A	AA-01	-15.02	0.05	UP	-15.02	0.05	UP	0.0093	10	AA-01	1711.36	-15.11	0.05	UP
MCF-01A	AA-01	-9.31	0.03	UP	-9.31	0.03	UP	0.0208	4	AA-01	1707.12	-9.39	0.03	UP
MCF-08A	AA-08	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-08A	AA-08	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-08A	AA-08	(a)	(a)	UP	(a)	(a)	UP	--	--	--	-	(a)	(a)	UP
MCF-08A	AA-08	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-08A	AA-08	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-08A	AA-08	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-10A	AA-10	-17.15	0.05	UP	--	--	--	--	--	--	--	--	--	--
MCF-10A	AA-10	(a)	(a)	UP	(a)	(a)	UP	0.0070	-12	AA-10	1596.13	(a)	(a)	UP
MCF-10A	AA-10	-4.59	0.01	UP	-5.31	0.02	UP	0.0138	-28	AA-10	1597.37	-4.92	0.01	UP
MCF-10A	AA-10	-10.71	0.03	UP	-11.81	0.03	UP	0.0105	0	AA-10	1596.76	-11.81	0.03	UP
MCF-10A	AA-10	-15.29	0.04	UP	-16.40	0.05	UP	0.0133	0	AA-10	1596.90	-16.40	0.05	UP
MCF-10A	AA-10	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-12A	MCF-12B	-9.88	0.03	UP	--	--	--	--	--	--	--	--	--	--
MCF-12A	MCF-12B	-11.95	0.04	UP	-12.88	0.05	UP	0.0168	-17	MCF-12B	1649.36	-12.60	0.04	UP
MCF-12A	MCF-12B	-12.88	0.05	UP	-13.20	0.05	UP	0.0821	-17	MCF-12B	1649.72	-11.80	0.04	UP
MCF-12A	MCF-12B	-13.16	0.05	UP	-14.09	0.05	UP	0.0118	-16.5	MCF-12B	1648.38	-13.90	0.05	UP
MCF-12A	MCF-12B	-13.79	0.05	UP	-14.40	0.05	UP	0.0254	-17	MCF-12B	1648.18	-13.97	0.05	UP
MCF-12A	MCF-12B	-16.84	0.06	UP	-17.47	0.06	UP	0.0227	-17	MCF-12B	1647.17	-17.08	0.06	UP
MCF-16A	MCF-16C	-32.00	0.10	UP	--	--	--	--	--	--	--	--	--	--
MCF-16A	MCF-16C	-17.61	0.06	UP	-37.00	0.12	UP	0.0181	28	MCF-16C	1625.72	-37.51	0.12	UP
MCF-16A	MCF-16C	-17.74	0.06	UP	-37.78	0.12	UP	0.0261	13	MCF-16C	1625.54	-38.12	0.12	UP
MCF-16A	MCF-16C	-18.18	0.06	UP	-38.89	0.12	UP	0.0134	21	MCF-16C	1625.37	-39.17	0.13	UP
MCF-16A	MCF-16C	-18.62	0.06	UP	-40.01	0.13	UP	0.0157	22	MCF-16C	1625.16	-40.35	0.13	UP
MCF-16A	MCF-16C	-19.94	0.06	UP	-38.42	0.12	UP	0.02	-27.87	MCF-16C	1625.64	-37.81	0.12	UP
MCF-27	AA-27	-33.50	0.11	UP	--	--	--	--	--	--	--	--	--	--
MCF-27	AA-27	-49.92	0.17	UP	-49.20	0.16	UP	0.0112	-14	AA-27	1723.74	-49.05	0.16	UP
MCF-27	AA-27	-51.62	0.17	UP	-50.90	0.17	UP	0.0142	-9	AA-27	1722.79	-50.77	0.17	UP
MCF-27	AA-27	-52.27	0.17	UP	-51.55	0.17	UP	0.0093	-14.5	AA-27	1722.74	-51.42	0.17	UP
MCF-27	AA-27	-52.81	0.18	UP	-52.09	0.17	UP	0.0107	-14.5	AA-27	1722.61	-51.94	0.17	UP
MCF-27	AA-27	-58.31	0.19	UP	-57.25	0.19	UP	0.0313	-9.3	AA-27	1721.53	-56.96	0.19	UP
MCF-06A	MCF-06C	20.90	-0.06	DOWN	--	--	--	--	--	--	--	--	--	--
MCF-06A	MCF-06C	61.25	-0.16	DOWN	16.08	-0.04	DOWN	0.0214		MCF-06C	1580.69	16.08	-0.04	DOWN
MCF-06A	MCF-06C	69.84	-0.19	DOWN	26.33	-0.07	DOWN	0.0074		MCF-06C	1579.38	26.33	-0.07	DOWN
MCF-06A	MCF-06C	66.93	-0.18	DOWN	17.25	-0.05	DOWN	0.0078		MCF-06C	1578.93	17.25	-0.05	DOWN
MCF-06A	MCF-06C	62.78	-0.17	DOWN	15.97	-0.04	DOWN	0.0086		MCF-06C	1578.09	15.97	-0.04	DOWN
MCF-06A	MCF-06C	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	
MCF-07	AA-07	46.51	-0.15	DOWN	--	--	--	--	--	--	--	--	--	--
MCF-07	AA-07	(b)	(b)	(b)	(b)	(b)	(b)	--	--	--	--	(b)	(b)	(b)
MCF-07	AA-07	49.01	-0.15	DOWN	12.43	-0.04	DOWN	0.0102	15	AA-07	1571.89	12.28	-0.04	DOWN
MCF-07	AA-07	39.66	-0.12	DOWN	-0.14	0.0004	UP	0.0134	4.5	AA-07	1571.93	-0.20	0.00	UP
MCF-07	AA-07	41.63	-0.13	DOWN	-0.70	0.0022	UP	0.0188	7.5	AA-07	1571.87	-0.84	0.00	UP
MCF-07	AA-07	38.28	-0.12	DOWN	2.28	-0.0071	DOWN	0.0167	10.7	AA-07	1571.66	2.10	-0.01	DOWN
MCF-09A	AA-09	-3.83	0.02	UP	--	--	--	--	--	--	--	--	--	--
MCF-09A	AA-09	1.80	-0.01	DOWN	--	--	--	0.0157	-14	AA-09	1659.38	-0.22	0.00	UP
MCF-09A	AA-09	1.44	-0.01	DOWN	-2.18	0.01	UP	0.0196	-19	AA-09	1659.04	-1.81	0.01	UP
MCF-09A	AA-09	1.05	-0.005	DOWN	-3.06	0.01	UP	0.0118	-18	AA-09	1658.59	-2.85	0.01	UP
MCF-09A	AA-09	1.30	-0.01	DOWN	-3.20	0.01	UP	0.0222	-15	AA-09	1658.84	-3.20	0.01	UP
MCF-09A	AA-09	1.53	-0.01	DOWN				0.0227	-17.89	AA-09	1658.34	-1.19	0.01	UP
MCF-19A	DBMW-2	(c)	(c)	(c)	(c)	(c)	(c)	--	--	--	--	(c)	(c)	(c)
MCF-19A	DBMW-2	(c)	(c)	(c)	(c)	(c)	(c)							
MCF-28A	PC-56	--	--	--	--	--	--	0.0046	22	PC-56	--	--	--	--
MCF-29A	HMW-08	-19.17	--	UP	--	--	--	0.0227	-15	HMW-08	--	--	--	--
MCF-30A	AA-30	-9.92	0.029	UP	-57.10	(c)	(c)	0.0625	13	AA-30	1512.24	-57.90	0.17	UP
MCF-31A	MW-4	-25.60	(c)	UP	-77.11	(c)	(c)	0.0132	3	MW-4	1498.58	-77.14	0.23	UP
MCF-32A	BEC-6	-38.76	--	UP	--	--	--	0.0192	-17	BEC-6	--	--	--	--

Appendix C. Summary of Vertical Gradient Data
BRC Common Areas - Eastside (updated for 2009 Data)

Middle/Shallow Well Pairs

Middle Well	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)	Ground Surface elevation (ft AMSL)	Screen Midpoint (ft AMSL) (zi)	Groundwater Elevation (ft AMSL) (hi)	Date Measured	Groundwater TDS (mg/L)	TDS Date Measured	Groundwater Temperature (C)	GW Density (g/cm^3) (pi)	Fresh Water Head, Hf (ft AMSL) (h(f)	Shallow Well	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)	Ground Surface elevation (ft AMSL)	Screen Midpoint (ft AMSL) (zi)	Groundwater Elevation (ft AMSL) (hi)	Date Measured	Groundwater TDS (mg/L)	TDS Date Measured	Groundwater Temperature (C)	GW Density (g/cm^3) (pi)	Fresh Water Head, Hf (ft AMSL)
BEC-9	44	59	--	--	1570.98	7/27/06	6020	08/02/06	22.8	1.002	--	AA-19	22	42.0	1639.88	1607.88	1,601.02	7/26/06	--	--	--	--	--
BEC-9	44	59	--	--	1570.20	10/16/06	5120	10/19/06	23.51	1.001	--	AA-19	22	42.0	1639.88	1607.88	1,599.85	10/17/06	--	--	--	--	--
BEC-9	44	59	--	--	1569.15	1/22/07	5900	01/29/07	22.6	1.002	--	AA-19	22	42.0	1639.88	1607.88	1,598.54	1/22/07	--	--	--	--	--
BEC-9	44	59	--	--	1564.88	8/4/09	5300	08/25/09	27.26	1.000		AA-19	22	42.0	1639.88	1607.88	Dry	8/3/09	--	--	--	--	--
MCF-10B	84	104	1612.38	1518.38	1597.87	7/9/04	--	--	--	--	--	AA-10	10	40	1612.38	1587.38	1595.91	7/9/04	--	--	--	--	--
MCF-10B	84	104	1612.38	1518.38	1597.92	4/21/06	2050	05/18/06	24.35	0.999	1597.84	AA-10	10	40	1612.38	1587.38	1596.04	4/21/06	4880	05/01/06	23.36	1.001	1596.05
MCF-10B	84	104	1612.38	1518.38	1598.08	7/27/06	2030	08/15/06	23.75	0.999	1598.00	AA-10	10	40	1612.38	1587.38	1596.97	7/27/06	4610	08/11/06	23.2	1.001	1596.98
MCF-10B	84	104	1612.38	1518.38	1598.81	10/17/06	2050	11/10/06	23.67	0.999	1598.73	AA-10	10	40	1612.38	1587.38	1596.75	10/17/06	4770	10/23/06	22.63	1.001	1596.76
MCF-10B	84	104	1612.38	1518.38	1598.85	1/23/07	2150	02/27/07	23.0	0.999	1598.77	AA-10	10	40	1612.38	1587.38	1596.89	1/23/07	4560	01/26/07	22.9	1.001	1596.90
MCF-10B	84	104	1612.38	1518.38	1597.75	8/3/09	2200	08/25/09	23.9	0.999	1597.67	AA-10	10	40	1612.38	1587.38	1595.05	8/3/09	4110	08/19/09	23.6	1.001	1595.06
MCF-11	93.5	103.5	1657.75	1559.25	1632.13	7/13/04	--	--	--	--	--	AA-11	9	29	1658.00	1639	1632.84	4/15/04	--	--	--	--	--
MCF-11	93.5	103.5	1657.75	1559.25	1630.82	4/20/06	3470	05/16/08	25.11	1.000	1630.82	AA-11	9	29	1658.00	1639	1630.62	4/20/06	--	--	--	--	--
MCF-11	93.5	103.5	1657.75	1559.25	1630.12	7/26/06	3250	08/16/08	24.4	1.000	1630.12	AA-11	9	29	1658.00	1639	1629.96	7/26/06	--	--	--	--	--
MCF-11	93.5	103.5	1657.75	1559.25	1629.89	10/17/06	3350	10/27/08	24.01	0.999	1629.82	AA-11	9	29	1658.00	1639	1629.74	10/17/06	--	--	--	--	--
MCF-11	93.5	103.5	1657.75	1559.25	1630.11	1/23/07	3520	02/23/07	23.7	1.000	1630.11	AA-11	9	29	1658.00	1639	1629.87	1/23/07	--	--	--	--	--
MCF-11	93.5	103.5	1657.75	1559.25	1629.47	8/3/09	2700	08/20/09	25.0	0.999	1629.40	AA-11	9	29	1658.00	1639	1629.32	8/3/09	--	--	--	--	--
MCF-12C	155	175	1713.03	1548.03	1647.56	7/21/04	--	--	--	--	--	MCF-12B	64	84	1712.74	1638.74	1648.18	6/5/04	--	--	--	--	--
MCF-12C	155	175	1713.03	1548.03	1648.68	4/27/06	1690	05/22/06	24.97	0.998	1648.48	MCF-12B	64	84	1712.74	1638.74	1649.08	4/27/06	2630	05/23/06	25.14	0.999	1649.07
MCF-12C	155	175	1713.03	1548.03	1647.97	7/27/06	1820	08/10/06	25.3	0.998	1647.77	MCF-12B	64	84	1712.74	1638.74	1648.33	7/27/06	2520	08/09/06	26.7	0.999	1648.32
MCF-12C	155	175	1713.03	1548.03	1647.76	10/16/06	2010	11/03/06	24.35	0.999	1647.66	MCF-12B	64	84	1712.74	1638.74	1648.20	10/16/06	2620	11/08/06	24.54	0.999	1648.19
MCF-12C	155	175	1713.03	1548.03	1647.28	1/24/07	2100	02/22/07	21.7	0.999	1647.18	MCF-12B	64	84	1712.74	1638.74	1647.75	1/24/07	2760	02/15/07	21.19	1.000	1647.75
MCF-12C	155	175	1713.03	1548.03	1646.25	8/6/09	1000	08/25/09	29.14	0.997	1645.96	MCF-12B	64	84	1712.74	1638.74	1646.79	8/6/09	2900	08/25/09	30.04	0.998	1646.77
MCF-16B	283.7	313.7	1689.67	1390.97	1628.46	7/23/04	--	--	--	--	--	MCF-16C	53	73	1689.88	1626.88	1629.98	6/11/04	--	--	--	--	--
MCF-16B	283.7	313.7	1689.67	1390.97	1626.55	4/20/06	64800	05/01/06	25.83	1.046	1637.39	MCF-16C	53	73	1689.88	1626.88	1626.23	4/20/06	8150	05/22/06	23.3	1.004	1626.23
MCF-16B	283.7	313.7	1689.67	1390.97	1627.11	7/26/06	70000	08/23/06	24.31	1.050	1638.92	MCF-16C	53	73	1689.88	1626.88	1625.88	7/26/06	8190	08/16/06	25.8	1.003	1625.88
MCF-16B	283.7	313.7	1689.67	1390.97	1626.95	10/17/06	72200	11/06/06	23.34	1.052	1639.22	MCF-16C	53	73	1689.88	1626.88	1625.66	10/17/06	7010	11/06/06	23.53	1.003	1625.66
MCF-16B	283.7	313.7	1689.67	1390.97	1626.83	1/22/07	74400	02/20/07	19.50	1.055	1639.80	MCF-16C	53	73	1689.88	1626.88	1625.51	1/22/07	6480	02/20/07	22.3	1.003	1625.51
MCF-16B	283.7	313.7	1689.67	1390.97	1628.37	8/5/09	64300	--	24.4	1.045	1639.05	MCF-16C	53	73	1689.88	1626.88	1625.04	8/5/09	11500	--	25.10	1.005	1625.03
MCF-1B	55	85	1753.95	1683.95	1713.88	6/7/04	--	--	--	--	--	AA-01	29	49	1754.96	1715.96	1712.03	4/8/04	--	--	--	--	--
MCF-1B	55	85	1753.95	1683.95	1712.16	4/18/06	2000	05/11/06	24.89	0.999	1712.13	AA-01	29	49	1754.96	1715.96	1712.35	4/18/06	3430	04/26/06	25.01	1.000	1712.35
MCF-1B	55	85	1753.95	1683.95	1711.50	7/27/06	2070	07/31/06	25.89	0.998	1711.44	AA-01	29	49	1754.96	1715.96	1711.69	7/27/06	3930	08/01/06	24.84	1.000	1711.69
MCF-1B	55	85	1753.95	1683.95	1711.34	10/16/06	1980	11/06/06	23.67	0.999	1711.31	AA-01	29	49	1754.96	1715.96	1711.50	10/16/06	3310	10/18/06	23.88	1.000	1711.50
MCF-1B	55	85	1753.95	1683.95	1711.28	1/22/07	1830	02/14/06	23.93	0.999	1711.25	AA-01	29	49	1754.96	1715.96	1711.45	1/22/07	3730	01/25/07	24	1.000	1711.45
MCF-1B	55	85	1753.95	1683.95	1709.23	8/6/09	1990	08/12/09	25.7	0.998	1709.18	AA-01	29	49	1754.96	1715.96	1707.20	8/6/09	3800	08/14/09	24.9	1.000	1707.20
MCF-6B	67	82	1630.40	1555.9	1590.58	7/16/04	--	--	--	--	--	MCF-06C	44	59	1630.42	1578.92	1584.17	7/15/04	--	--	--	--	--
MCF-6B	67	82	1630.40	1555.9	1581.18	4/20/06	31400	05/18/06	24.38	1.021	1581.71	MCF-06C	44	59	1630.42	1578.92	1580.63	4/20/06	47600	05/22/06	24.09	1.033	1580.69
MCF-6B	67	82	1630.40	1555.9	1580.25	7/26/06	39700	08/09/06	24.02	1.027	1580.91	MCF-06C	44	59	1630.42	1578.92	1579.38	7/26/06	6280	08/08/06	23.97	1.002	1579.38
MCF-6B	67	82	1630.40	1555.9	1579.92	10/17/06	38200	10/31/06	25.63	1.026	1580.54	MCF-06C	44	59	1630.42	1578.92	1578.93	10/17/06	6720	10/30/06	23.57	1.002	1578.93
MCF-6B	67	82	1630.40	1555.9	1578.79	1/23/07	39700	02/01/06	19.3	1.029	1579.45	MCF-06C	44	59	1630.42	1578.92	1578.09	1/23/07	6980	02/01/07	22.3	1.003	1578.09
MCF-6B	67	82	1630.40	1555.9	1576.97	8/3/09	11500	09/06/09	26.6	1.001	1576.99	MCF-06C	44	59	1630.42	1578.92	1575.81	8/3/09	6200	09/17/09	25.2	1.002	1575.80
MCF-8B	107.5	137.5	1578.43	1455.93	1570.59	6/9/04	--	--	--	--	--	AA-08	5	35	1578.46	1558.46	1566.82	6/7/04	--	--	--	--	--
MCF-8B	107.5	137.5	1578.43	1455.93	1578.43	4/21/06	27100	05/23/06	23.45	1.018	1580.63	AA-08	5	35	1578.46	1558.46	1567.69	4/21/06	5070	05/25/06	23.48	1.001	1567.70
MCF-8B	107.5	137.5	1578.43	1455.93	1576.89	7/26/06	26200	08/23/06	23.87	1.017	1578.95	AA-08	5	35	1578.46	1558.46	1565.47	7/26/06	4390	08/14/06	23.3	1.001	1565.48
MCF-8B	107.5	137.5	1578.43	1455.93	1577.54	10/17/06	26800	11/10/06	23.80	1.018	1579.73	AA-08	5	35	1578.46	1558.46	1568.82	10/17/06	4640	11/01/06	23.65	1.001	1568.83
MCF-8B	107.5	137.5	1578.43	1455.93	1578.59	1/23/07	28300	02/08/07	22.6	1.019	1580.92	AA-08	5	35	1578.46	1558.46	1568.72	1/23/07	4700	02/08/07	23.4	1.001	1568.73
MCF-8B	107.5	137.5	1578.43	1455.93	(c)	8/4/09	--	--	--	--	--	AA-08	5	35	1578.46	1558.46	1565.58	8/4/09	3500	08/20/09	26.25	0.999	1565.57
MCF-9B	105	125	1693.00	1578	1663.43	7/7/04	--	--	--	--	--	AA-09	30	65	1694.11	1646.61	1663.46	7/7/04	--	--	--	--	--
MCF-9B	105	125	1693.00	1578	1660.14	4/20/06	3390	05/03/06	25.30	1.000	1660.14	AA-09	30	65	1694.11	1646.61	1659.16	4/20/06	5670	05/01/06	25.3	1.001	1659.17
MCF-9B	105	125	1693.00	1578	1659.39	7/26/06	3510	08/04/06	25.99	0.999	1659.31	AA-09	30	65	1694.11	1646.61	1658.64	7/26/06	5740	08/11/06	24.38	1.002	1658.66
MCF-9B	105	125	1693.00	1578	1659.21	10/17/06	3420	10/25/06	23.32	1.000	1659.21	AA-09	30	65	1694.11	1646.61	1658.35	10/17/06	5890	10/23/06	24.52	1.002	1658.37
MCF-9B	105	125	1693.00	1578	1659.09	1/22/07	3620	02/12/06	20.74	1.001	1659.21	AA-09	30	65	1694.11	1646.61	1658.48	1/22/07	6150	01/26/07	24.4	1.002	1658.50
MCF-9B	105	125	1693.00	1578	1657.58	8/3/09	3000	08/20/09	29.58	0.998	1659.17	AA-09	30	65	1694.11	1646.61	1657.91	8/3/09	6600	08/19/09	28.19	1.002	1657.93
MCF-28B	168	188	1565.24	1387.24	1567.76	8/3/09	45300	10/8/09	24.8	1.031	1573.36	PC-56	48	54.8	--	--	--	--	--	--	--	--	--
MCF-29B	155	175	1543.52	1378.52	1529.69	8/3/09	--	--	--	--	--	HMW-08	360	380	--		1521.86	8/3/09	5900	10/05/09	--	--	--
MCF-30B	140.52	160.52	1528.84	1378.32	1513.06	8/3/09	168000	10/14/09	27.1	1.128	1530.31	AA-30	8.20	28.20	1529.84	1511.64	1513.04	8/3/09	5000.00	9/17/09	23.5	1.001	1513.04
MCF-31B	205.74	225.74	1523.95	1308.21	1456.21	8/3/09	89700	--	--	--	--	MW-4	20	30	1520.05	1495.05	1498.59	8/6/09	14400	09/25/09	26.49	1.007	1498.61
MCF-32B	140	160	1728.31	1578.31	1663.40	8/3/09	2900	10/8/09	24.3	0.999	1663.31	BEC-6	65	80	--	--	1657.88	8/3/09	7300	10/05/09	--	--	--

Appendix C. Summary of Vertical Gradient Data
BRC Common Areas - Eastside (updated for 2009 Data)

		Uncorrected for Groundwater Density			Corrected for Groundwater Density			Corrected for Equipotential Surface						
Middle Well	**Shallow Well**	Point Water Head Delta (ft AMSL)	Point Water Head Intermediate/Shallow Vertical Gradient (ft/ft)	Point Water Head Vertical Flow Direction	Fresh Water Head Delta (ft AMSL)	Fresh Water Head Intermediate/Shallow Vertical Gradient (ft/ft)	Fresh Head Vertical Flow Direction	Horizontal Gradient	Distance Between Wells Along Gradient	Well Name	Revised GW Elevation/Head	Fresh Water Head Delta (ft AMSL)	Fresh Water Head Intermediate/Shallow Vertical Gradient (ft/ft)	Fresh Head Vertical Flow Direction
BEC-9	AA-19	30.04	--	DOWN	--	--	--	--	--	--	--	--	--	--
BEC-9	AA-19	29.65	--	DOWN	--	--	--	--	--	--	--	--	--	--
BEC-9	AA-19	29.39	--	DOWN	--	--	--	--	--	--	--	--	--	--
BEC-9	AA-19	--	--	--	--	--	--							
MCF-10B	AA-10	-1.96	0.03	UP	--	--	--	--	--	--	--	--	--	--
MCF-10B	AA-10	-1.88	0.03	UP	-1.79	0.03	UP	0.0070	-12	AA-10	1596.13	-1.71	0.02	UP
MCF-10B	AA-10	-1.11	0.02	UP	-1.02	0.01	UP	0.0138	-19	AA-10	1597.24	-0.76	0.01	UP
MCF-10B	AA-10	-2.06	0.03	UP	-1.97	0.03	UP	0.0105	-4	AA-10	1596.80	-1.93	0.03	UP
MCF-10B	AA-10	-1.96	0.03	UP	-1.87	0.03	UP	0.0133	-8	AA-10	1597.01	-1.76	0.03	UP
MCF-10B	AA-10	-2.70	0.04	UP				0.0096	-16.8	AA-10	1595.22	-2.45	0.04	UP
MCF-11	AA-11	0.71	-0.01	DOWN	--	--	--	--	--	--	--	--	--	--
MCF-11	AA-11	-0.20	0.00	UP	--	--	--	0.0118	-6	AA-11	1630.69	-0.07	0.001	UP
MCF-11	AA-11	-0.16	0.00	UP	--	--	--	0.0168	-6	AA-11	1630.06	-0.10	0.001	UP
MCF-11	AA-11	-0.15	0.00	UP	--	--	--	0.0235	-6	AA-11	1629.88	-0.14	0.002	UP
MCF-11	AA-11	-0.24	0.00	UP	--	--	--	0.0157	-4	AA-11	1629.93	-0.06	0.001	UP
MCF-11	AA-11	-0.15	0.00	UP	--	--	--	0.0125	-3.69	AA-11	1629.37	-0.05	0.001	UP
MCF-12C	MCF-12B	0.62	-0.01	DOWN	--	--	--	--	--	--	--	--	--	--
MCF-12C	MCF-12B	0.40	0.00	DOWN	0.59	-0.01	DOWN	0.0168	-10	MCF-12B	1649.24	0.76	-0.01	DOWN
MCF-12C	MCF-12B	0.36	0.00	DOWN	0.55	-0.01	DOWN	0.0821	-8	MCF-12B	1648.98	1.21	-0.01	DOWN
MCF-12C	MCF-12B	0.44	0.00	DOWN	0.53	-0.01	DOWN	0.0118	-9	MCF-12B	1648.30	0.64	-0.01	DOWN
MCF-12C	MCF-12B	0.47	-0.01	DOWN	0.57	-0.01	DOWN	0.0254	-10	MCF-12B	1648.00	0.82	-0.01	DOWN
MCF-12C	MCF-12B	0.54	-0.01	DOWN	0.82	-0.01	DOWN	0.0227	-8.6	MCF-12B	1646.97	1.01	-0.01	DOWN
MCF-16B	MCF-16C	1.52	-0.01	DOWN	--	--	--	--	--	--	--	--	--	--
MCF-16B	MCF-16C	-0.32	0.00	UP	-11.16	0.05	UP	0.0181	13	MCF-16C	1625.99	-11.39	0.05	UP
MCF-16B	MCF-16C	-1.23	0.01	UP	-13.04	0.06	UP	0.0261	6	MCF-16C	1625.72	-13.20	0.06	UP
MCF-16B	MCF-16C	-1.29	0.01	UP	-13.56	0.06	UP	0.0134	12	MCF-16C	1625.49	-13.73	0.06	UP
MCF-16B	MCF-16C	-1.32	0.01	UP	-14.30	0.06	UP	0.0157	11	MCF-16C	1625.33	-14.47	0.06	UP
MCF-16B	MCF-16C	-3.33	0.01	UP	-14.02	0.06	UP	0.0217	-13.93	MCF-16C	1625.33	-13.72	0.06	UP
MCF-1B	AA-01	-1.85	0.06	UP	--	--	--	--	--	--	--	--	--	--
MCF-1B	AA-01	0.19	-0.01	DOWN	0.22	-0.01	DOWN	0.0165	24.8	AA-01	1711.94	-0.19	0.01	UP
MCF-1B	AA-01	0.19	-0.01	DOWN	0.25	-0.01	DOWN	0.0137	14	AA-01	1711.50	0.05	0.00	DOWN
MCF-1B	AA-01	0.16	0.00	DOWN	0.19	-0.01	DOWN	0.0086	21	AA-01	1711.32	0.01	0.00	DOWN
MCF-1B	AA-01	0.17	-0.01	DOWN	0.20	-0.01	DOWN	0.0093	24.9	AA-01	1711.22	-0.03	0.00	UP
MCF-1B	AA-01	-2.03	0.06	UP	-1.98	0.06	UP	0.0208	24.9	AA-01	1706.68	-2.50	0.08	UP
MCF-6B	MCF-06C	-6.41	0.28	UP	--	--	--	--	--	--	--	--	--	--
MCF-6B	MCF-06C	-0.55	0.02	UP	-1.02	0.04	UP	0.0214	4	MCF-06C	1580.60	-1.11	0.05	UP
MCF-6B	MCF-06C	-0.87	0.04	UP	-1.53	0.07	UP	0.0074	0	MCF-06C	1579.38	-1.53	0.07	UP
MCF-6B	MCF-06C	-0.99	0.04	UP	-1.61	0.07	UP	0.0078	3	MCF-06C	1578.91	-1.64	0.07	UP
MCF-6B	MCF-06C	-0.70	0.03	UP	-1.37	0.06	UP	0.0086	6	MCF-06C	1578.04	-1.42	0.06	UP
MCF-6B	MCF-06C	-1.16	0.05	UP	-1.19	0.05	UP	0.0068	0	MCF-06C	1575.80	-1.19	0.05	UP
MCF-8B	AA-08	-3.77	0.04	UP	--	--	--	--	--	--	--	--	--	--
MCF-8B	AA-08	-10.74	0.10	UP	-12.94	0.13	UP	0.0124	9	AA-08	1567.59	-13.05	0.13	UP
MCF-8B	AA-08	-11.42	0.11	UP	-13.47	0.13	UP	0.0138	6	AA-08	1565.39	-13.55	0.13	UP
MCF-8B	AA-08	-8.72	0.09	UP	-10.90	0.11	UP	0.0105	10	AA-08	1568.73	-11.00	0.11	UP
MCF-8B	AA-08	-9.87	0.10	UP	-12.19	0.12	UP	0.0105	8	AA-08	1568.65	-12.27	0.12	UP
MCF-8B	AA-08	(c)	(c)	(c)	--	--	--	--	--	--	--	--	--	--
MCF-9B	AA-09	0.03	0.00	DOWN	--	--	--	--	--	--	--	--	--	--
MCF-9B	AA-09	-0.98	0.01	UP	-0.97	0.01	UP	0.0157	7	AA-09	1659.06	-1.08	0.02	UP
MCF-9B	AA-09	-0.75	0.01	UP	-0.64	0.01	UP	0.0196	2	AA-09	1658.62	-0.68	0.01	UP
MCF-9B	AA-09	-0.86	0.01	UP	-0.84	0.01	UP	0.0118	5	AA-09	1658.31	-0.90	0.01	UP
MCF-9B	AA-09	-0.61	0.01	UP	-0.71	0.01	UP	0.0235	8	AA-09	1658.32	-0.89	0.01	UP
MCF-9B	AA-09	0.33	0.00	DOWN	-1.24	0.02	UP	0.0227	2.56	AA-09	1657.87	-1.30	0.02	UP
MCF-28B	PC-56	--	--	--	--	--	--	0.0046	31	PC-56	--	--	--	--
MCF-29B	HMW-08	-7.83	-0.01	UP	--	--	--	0.0227	-26	HMW-08	--	--	--	--
MCF-30B	AA-30	-0.02	0.00	UP	-17.26	0.13	UP	0.0625	26	AA-30	1511.44	-18.86	0.14	UP
MCF-31B	MW-4	42.38	-0.23	DOWN	--	--	--	0.0132	4	MW-4	1498.56	--	--	--
MCF-32B	BEC-6	-5.52	#VALUE!	UP	--	--	--	0.0192	-14	BEC-6	--	--	--	--

Appendix C. Summary of Vertical Gradient Data
BRC Common Areas - Eastside (updated for 2009 Data)

Deep/Middle Well Pairs

Deep Well	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)	Ground Surface elevation (ft AMSL)	Screen Midpoint (ft AMSL) (zi)	Groundwater Elevation (ft AMSL) (hi)	GW Elevation Date Measured	Groundwater TDS (mg/L)	TDS Date Measured	Groundwater Temperature (C)	GW Density (g/cm^3) (pi)	Fresh Water Head, Hf (ft AMSL) (h(f)	Middle Well	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)	Ground Surface elevation (ft AMSL)	Screen Midpoint (ft AMSL) (zi)	Groundwater Elevation (ft AMSL) (hi)	GW Elevation Date Measured	Groundwater TDS (mg/L)	TDS Date Measured	Groundwater Temperature (C)	GW Density (g/cm^3) (pi)	Fresh Water Head, Hf (ft AMSL)
MCF-10A	365	385	1613.32	1238.32	1613.06	4/14/04	--	--	--	--		MCF-10B	84	104	1612.38	1518.38	1597.87	7/9/04	--	--	--	--	--
MCF-10A	365	385	1613.32	1238.32	**ARTESIAN**	4/21/06	8080	05/31/06	24.96	1.003	--	MCF-10B	84	104	1612.38	1518.38	1597.92	4/21/06	2050	05/18/06	24.35	0.999	1597.84
MCF-10A	365	385	1613.32	1238.32	1601.56	7/27/06	6800	08/15/06	24.3	1.002	1602.29	MCF-10B	84	104	1612.38	1518.38	1598.08	7/27/06	2030	08/15/06	23.75	0.999	1598.00
MCF-10A	365	385	1613.32	1238.32	1607.46	10/17/06	7700	11/10/06	25.01	1.003	1608.57	MCF-10B	84	104	1612.38	1518.38	1598.81	10/17/06	2050	11/10/06	23.67	0.999	1598.73
MCF-10A	365	385	1613.32	1238.32	1612.18	1/23/07	7270	02/27/06	22.51	1.003	1613.30	MCF-10B	84	104	1612.38	1518.38	1598.85	1/23/07	2150	02/27/07	23.0	0.999	1598.77
MCF-10A	365	385	1613.32	1238.32	**ARTESIAN**	8/3/09	4200	09/06/09	25.3	1.000	--	MCF-10B	84	104	1612.38	1518.38	1597.75	8/3/09	2200	08/25/09	23.9	0.999	1597.67
MCF-12A	349.5	369.5	1713.68	1354.18	1658.06	7/22/04	--	--	--	--		MCF-12C	155	175	1713.03	1548.03	1647.56	7/21/04	--	--	--	--	--
MCF-12A	349.5	369.5	1713.68	1354.18	1661.03	4/27/06	5950	05/18/06	28.13	1.003	1661.95	MCF-12C	155	175	1713.03	1548.03	1648.68	4/27/06	1690	05/22/06	24.97	0.998	1648.48
MCF-12A	349.5	369.5	1713.68	1354.18	1661.21	7/27/06	5900	08/10/06	25.6	1.001	1661.52	MCF-12C	155	175	1713.03	1548.03	1647.97	7/27/06	1820	08/10/06	25.3	0.998	1647.77
MCF-12A	349.5	369.5	1713.68	1354.18	1661.36	10/16/06	7580	11/10/06	24.64	1.003	1662.28	MCF-12C	155	175	1713.03	1548.03	1647.76	10/16/06	2010	11/03/06	24.35	0.999	1647.66
MCF-12A	349.5	369.5	1713.68	1354.18	1661.54	1/24/07	6320	02/23/07	24.8	1.002	1662.15	MCF-12C	155	175	1713.03	1548.03	1647.28	1/24/07	2100	02/22/07	21.7	0.999	1647.18
MCF-12A	349.5	369.5	1713.68	1354.18	1663.63	8/6/09	7300	09/06/09	28.73	1.002	1664.25	MCF-12C	155	175	1713.03	1548.03	1646.25	8/6/09	1000	08/25/09	29.14	0.997	1645.96
MCF-16A	364.5	384.5	1689.67	1315.17	1661.98	4/6/04	--	--	--	--		MCF-16B	283.7	313.7	1689.75	1391.05	1628.46	7/23/04	--	--	--	--	--
MCF-16A	364.5	384.5	1689.67	1315.17	1643.84	4/20/06	81800	05/18/06	25.74	1.059	1663.23	MCF-16B	283.7	313.7	1689.75	1391.05	1626.55	4/20/06	64800	05/01/06	25.83	1.046	1637.38
MCF-16A	364.5	384.5	1689.67	1315.17	1643.62	7/26/06	83800	08/21/06	24.0	1.061	1663.66	MCF-16B	283.7	313.7	1689.75	1391.05	1627.11	7/26/06	70000	08/23/06	24.31	1.050	1638.91
MCF-16A	364.5	384.5	1689.67	1315.17	1643.84	10/17/06	86400	11/06/06	24.14	1.063	1664.55	MCF-16B	283.7	313.7	1689.75	1391.05	1626.95	10/17/06	72200	11/06/06	23.34	1.052	1639.22
MCF-16A	364.5	384.5	1689.67	1315.17	1644.13	1/22/07	88300	02/16/07	23.2	1.065	1665.51	MCF-16B	283.7	313.7	1689.75	1391.05	1626.83	1/22/07	74400	02/20/07	19.50	1.055	1639.80
MCF-16A	364.5	384.5	1689.67	1315.17	1644.98	8/5/09	78800	--	28.50	1.055	1663.12	MCF-16B	283.7	313.7	1689.75	1391.05	1628.37	8/5/09	64300	--	24.4	1.045	1639.05
MCF-1A	335	355	1754.44	1409.44	1720.21	7/25/04	--	--	--	--		MCF-1B	55	85	1753.95	1683.95	1713.88	6/7/04	--	--	--	--	--
MCF-1A	335	355	1754.44	1409.44	1723.51	4/18/06	3570	05/30/06	27.72	0.999	1723.20	MCF-1B	55	85	1753.95	1683.95	1712.16	4/18/06	2000	05/11/06	24.89	0.999	1712.13
MCF-1A	335	355	1754.44	1409.44	1726.61	7/27/06	4020	08/07/06	26.39	0.997	1725.66	MCF-1B	55	85	1753.95	1683.95	1711.50	7/27/06	2070	07/31/06	25.89	0.998	1711.44
MCF-1A	335	355	1754.44	1409.44	1727.87	10/16/06	4060	10/24/06	26.01	1.000	1727.87	MCF-1B	55	85	1753.95	1683.95	1711.34	10/16/06	1980	11/06/06	23.67	0.999	1711.31
MCF-1A	335	355	1754.44	1409.44	1726.47	1/22/07	3930	02/02/07	23.4	1.000	1726.47	MCF-1B	55	85	1753.95	1683.95	1711.28	1/22/07	1830	02/14/06	23.93	0.999	1711.25
MCF-1A	335	355	1754.44	1409.44	1716.51	8/6/09	3900	08/14/09	26.8	1.000	1716.51	MCF-1B	55	85	1753.95	1683.95	1709.23	8/6/09	1990	08/12/09	25.7	0.998	1709.18
MCF-2A	360	380	1816.44	1446.44	1770.22	3/24/04	--	--	--	--		MCF-2B	215	235	1816.36	1591.36	1751.83	7/8/04	--	--	--	--	--
MCF-2A	360	380	1816.44	1446.44	1775.11	4/18/06	494	05/10/06	26.55	0.997	1774.12	MCF-2B	215	235	1816.36	1591.36	1757.25	4/20/06	622	05/05/06	26.92	0.997	1756.75
MCF-2A	360	380	1816.44	1446.44	1775.80	7/27/06	560	08/04/06	26.66	0.997	1774.81	MCF-2B	215	235	1816.36	1591.36	1757.40	7/27/06	620	08/21/06	26.2	0.997	1756.90
MCF-2A	360	380	1816.44	1446.44	1776.48	10/16/06	492	11/07/06	25.68	0.997	1775.49	MCF-2B	215	235	1816.36	1591.36	1757.62	10/16/06	650	11/03/06	26.76	0.997	1757.12
MCF-2A	360	380	1816.44	1446.44	1776.98	1/22/07	623	02/15/07	25.54	0.997	1775.99	MCF-2B	215	235	1816.36	1591.36	1757.59	1/22/07	638	02/20/07	25.3	0.997	1757.09
MCF-2A	360	380	1816.44	1446.44	1781.50	8/6/09	1100	08/25/09	26.2	0.998	1780.83	MCF-2B	215	235	1816.36	1591.36	1758.12	8/6/09	2200	08/25/09	26.6	0.998	1757.79
MCF-3A	364	384	1783.23	1409.23	1732.71	2/25/04	--	--	--	--		MCF-3B	57	77	1783.46	1716.46	1741.72	7/9/04	--	--	--	--	--
MCF-3A	364	384	1783.23	1409.23	1736.73	4/20/06	694	06/07/06	26.0	0.997	1735.75	MCF-3B	57	77	1783.46	1716.46	1742.02	4/20/06	2590	05/12/06	24.75	0.999	1741.99
MCF-3A	364	384	1783.23	1409.23	1737.12	7/27/06	631	08/14/06	25.09	0.998	1736.46	MCF-3B	57	77	1783.46	1716.46	1741.80	7/27/06	2450	08/16/06	24.68	0.999	1741.77
MCF-3A	364	384	1783.23	1409.23	1737.57	10/16/06	627	11/02/06	24.21	0.998	1736.91	MCF-3B	57	77	1783.46	1716.46	1741.56	10/16/06	2490	11/03/06	24.86	0.999	1741.53
MCF-3A	364	384	1783.23	1409.23	1737.81	1/22/07	640	02/27/07	21.8	0.998	1737.15	MCF-3B	57	77	1783.46	1716.46	1741.61	1/22/07	2610	02/20/07	24.2	0.999	1741.58
MCF-3A	364	384	1783.23	1409.23	1742.00	8/6/09	700	08/19/09	25.6	0.997	1741.00	MCF-3B	57	77	1783.46	1716.46	1740.67	8/6/09	1900	08/20/09	26.4	0.998	1740.62
MCF-6A	373.5	393.5	1588.80	1205.3	1563.27	4/16/04	--	--	--	--		MCF-6B	67	82	1630.40	1555.9	1590.58	7/16/04	--	--	--	--	--
MCF-6A	373.5	393.5	1588.80	1205.3	1519.38	4/20/06	186000	05/30/06	26.27	1.144	1564.61	MCF-6B	67	82	1630.40	1555.9	1581.18	4/20/06	31400	05/18/06	24.38	1.021	1581.71
MCF-6A	373.5	393.5	1588.80	1205.3	1509.54	7/27/06	185000	08/21/06	25.1	1.143	1553.05	MCF-6B	67	82	1630.40	1555.9	1580.25	7/26/06	39700	08/09/06	24.02	1.027	1580.91
MCF-6A	373.5	393.5	1588.80	1205.3	1512.00	10/16/06	205000	11/13/06	23.44	1.162	1561.68	MCF-6B	67	82	1630.40	1555.9	1579.92	10/17/06	38200	10/31/06	25.63	1.026	1580.54
MCF-6A	373.5	393.5	1588.80	1205.3	1515.31	1/23/07	191000	02/23/07	20.4	1.151	1562.12	MCF-6B	67	82	1630.40	1555.9	1578.79	1/23/07	39700	02/01/06	19.3	1.029	1579.45
MCF-6A	373.5	393.5	1588.80	1205.3	(c)	8/6/09	--	--	--	--	--	MCF-6B	67	82	1630.40	1555.9	1576.97	8/3/09	11500	09/06/09	26.6	1.001	1576.99
MCF-8A	350	370	1579.02	1219.02	**ARTESIAN**	4/7/04	--	--	--	--	--	MCF-8B	107.5	137.5	1578.43	1455.93	1570.59	6/9/04	--	--	--	--	--
MCF-8A	350	370	1579.02	1219.02	**ARTESIAN**	4/21/06	110000	06/07/06	24.59	1.082	**--**	MCF-8B	107.5	137.5	1578.43	1455.93	1578.43	4/21/06	27100	05/23/06	23.45	1.018	1580.64
MCF-8A	350	370	1579.02	1219.02	**ARTESIAN**	7/26/06	113000	08/23/06	23.8	1.084	**--**	MCF-8B	107.5	137.5	1578.43	1455.93	1576.89	7/26/06	26200	08/23/06	23.87	1.017	1578.95
MCF-8A	350	370	1579.02	1219.02	**ARTESIAN**	10/17/06	113000	11/10/06	25.73	1.084	**--**	MCF-8B	107.5	137.5	1578.43	1455.93	1577.54	10/17/06	26800	11/10/06	23.80	1.018	1579.73
MCF-8A	350	370	1579.02	1219.02	**ARTESIAN**	1/23/07	116000	02/08/07	22.5	1.087	**--**	MCF-8B	107.5	137.5	1578.43	1455.93	1578.59	1/23/07	28300	02/08/07	22.6	1.019	1580.92
MCF-8A	350	370	1579.02	1219.02	**ARTESIAN**	8/4/09	99800	09/06/09	26.49	1.073	**--**	MCF-8B	107.5	137.5	1578.43	1455.93	(c)	8/4/09	--	--	--	--	--
MCF-8A	350	370	1579.02	1219.02	(c)	(c)	(c)	(c)	(c)	(c)	(c)	MCF-8B-R	116.5	136.5	1578.43	1451.93	(c)	(c)	(c)	(c)	(c)	(c)	(c)
MCF-8A	350	370	1579.02	1219.02	(c)	(c)	99800	09/06/09	26.49	1.073		MCF-8B-R	116.5	136.5	1578.43	1451.93	(c)	(c)	24800	8/25/09	26.05	1.015	(c)
MCF-9A	270	290	1694.26	1414.26	1667.29	4/18/04	--	--	--	--	--	MCF-9B	105	125	1693.00	1578	1663.43	7/7/04	--	--	--	--	--
MCF-9A	270	290	1694.26	1414.26	1657.36	4/20/06	--	--	--	--	--	MCF-9B	105	125	1693.00	1578	1660.14	4/20/06	3390	05/03/06	25.30	1.000	1660.14
MCF-9A	270	290	1694.26	1414.26	1657.20	7/26/06	24800	08/21/06	25.93	1.015	1660.84	MCF-9B	105	125	1693.00	1578	1659.39	7/26/06	3510	08/04/06	25.99	0.999	1659.31
MCF-9A	270	290	1694.26	1414.26	1657.30	10/17/06	26800	11/14/06	25.05	1.017	1661.43	MCF-9B	105	125	1693.00	1578	1659.21	10/17/06	3420	10/25/06	23.32	1.000	1659.21
MCF-9A	270	290	1694.26	1414.26	1657.18	1/22/07	30700	02/16/07	25.53	1.020	1662.04	MCF-9B	105	125	1693.00	1578	1659.09	1/22/07	3620	02/12/06	20.74	1.001	1659.17
MCF-9A	270	290	1694.26	1414.26	1656.38	8/3/09	22100	08/20/09	28.17	1.013	1659.53	MCF-9B	105	125	1693.00	1578	1657.58	8/3/09	3000	08/20/09	29.58	0.998	1657.42
MCF-24A	(c)	(c)	(c)	(c)	--	--	5300	9/6/09	27.51	1.000	--	MCF-24B	343.4	363.4	1680.00	1326.6	1617.98	8/4/09	27500	10/14/09	23.4	1.018	1623.22
MCF-28A	365.57	385.57	1564.73	1189.16	1526.75	8/3/09	188000	10/5/09	26.81	1.011	1530.46	MCF-28B	168	188	1565.24	1387.24	1567.76	8/3/09	45300	10/8/09	24.8	1.031	1573.36
MCF-29A	355.8	375.8	1543.48	1177.68	1541.03	8/3/09	161000	10/5/09	26.45	1.123	1585.72	MCF-29B	155	175	1543.52	1378.52	1529.69	8/3/09	--	--	--	--	--
MCF-30A	346.74	366.74	1527.60	1170.86	1522.96	8/3/09	175000	10/14/09	26.35	1.134	1570.14	MCF-30B	140.52	160.52	1528.84	1378.32	1513.06	8/3/09	168000	10/14/09	27.1	1.128	1530.31
MCF-31A	356.78	376.78	1528.04	1161.26	1524.19	8/3/09	185000	10/5/09	27.83	1.142	1575.73	MCF-31B	205.74	225.74	1523.95	1308.21	1456.21	8/3/09	--	--	--	--	--
MCF-32A	346.61	366.61	1728.31	1371.7	1696.64	8/3/09	--	--	--	--	--	MCF-32B	140	160	1728.31	1578.31	1663.40	8/3/09	2900	10/8/09	24.3	0.999	1663.31

Appendix C. Summary of Vertical Gradient Data
BRC Common Areas - Eastside (updated for 2009 Data)

		Uncorrected for Groundwater Density			Corrected for Groundwater Density			Corrected for Equipotential Surface						
Deep Well	**Middle Well**	Point Water Head Delta (ft AMSL)	Point Water Head Deep/Intermediate Vertical Gradient (ft/ft)	Point Water Head Vertical Flow Direction	Fresh Water Head Delta (ft AMSL)	Fresh Water Head Deep/Intermediate Vertical Gradient (ft/ft)	Fresh Head Vertical Flow Direction	Horizontal Gradient	Distance Between Wells Along Gradient	Well Name	Revised GW Elevation/Head	Fresh Water Head Delta (ft AMSL)	Fresh Water Head Deep/Intermediate Vertical Gradient (ft/ft)	Fresh Head Vertical Flow Direction
MCF-10A	MCF-10B	-15.19	0.05	UP	--	--	--	--	--	--	--			
MCF-10A	MCF-10B	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-10A	MCF-10B	-3.48	0.01	UP	-4.29	0.02	UP	0.0118	-10	MCF-10A	1602.40	-4.40	0.02	UP
MCF-10A	MCF-10B	-8.65	0.03	UP	-9.84	0.04	UP	0.0047	-7	MCF-10A	1608.60	-9.87	0.04	UP
MCF-10A	MCF-10B	-13.33	0.05	UP	-14.53	0.05	UP	0.0118	-6	MCF-10A	1613.37	-14.60	0.05	UP
MCF-10A	MCF-10B	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-12A	MCF-12C	-10.50	0.05	UP	--	--	--	--	--	--	--	--	--	--
MCF-12A	MCF-12C	-12.35	0.06	UP	-13.47	0.07	UP	0.0181	7.5	MCF-12A	1661.81	-13.34	0.07	UP
MCF-12A	MCF-12C	-13.24	0.07	UP	-13.75	0.07	UP	0.0261	7	MCF-12A	1661.33	-13.56	0.07	UP
MCF-12A	MCF-12C	-13.60	0.07	UP	-14.62	0.08	UP	0.0118	6	MCF-12A	1662.21	-14.55	0.08	UP
MCF-12A	MCF-12C	-14.26	0.07	UP	-14.97	0.08	UP	0.0376	7	MCF-12A	1661.89	-14.71	0.08	UP
MCF-12A	MCF-12C	-17.38	0.09	UP	-18.29	0.09	UP	0.0500	1	MCF-12A	1664.22	-18.26	0.09	UP
MCF-16A	MCF-16B	-33.52	0.44	UP	--	--	--	--	--	--	--	--	--	--
MCF-16A	MCF-16B	-17.29	0.23	UP	-25.15	0.33	UP	0.0357	19.6	MCF-16A	1662.53	-25.15	0.33	UP
MCF-16A	MCF-16B	-16.51	0.22	UP	-24.74	0.33	UP	0.0186	9	MCF-16A	1663.49	-24.58	0.32	UP
MCF-16A	MCF-16B	-16.89	0.22	UP	-25.33	0.33	UP	0.0235	10	MCF-16A	1664.31	-25.09	0.33	UP
MCF-16A	MCF-16B	-17.30	0.23	UP	-25.32	0.33	UP	0.0308	12.8	MCF-16A	1665.12	-25.32	0.33	UP
MCF-16A	MCF-16B	-16.61	0.22	UP	-23.66	0.31	UP	0.0357	11.40	MCF-16A	1662.71	-23.66	0.31	UP
MCF-1A	MCF-1B	-6.33	0.02	UP	--	--	--	--	--	--	--	--	--	--
MCF-1A	MCF-1B	-11.35	0.04	UP	-11.06	0.04	UP	0.0157	20	MCF-1A	1722.88	-10.75	0.04	UP
MCF-1A	MCF-1B	-15.11	0.06	UP	-14.21	0.05	UP	0.0261	18	MCF-1A	1725.19	-13.74	0.05	UP
MCF-1A	MCF-1B	-16.53	0.06	UP	-16.56	0.06	UP	0.0188	19	MCF-1A	1727.51	-16.20	0.06	UP
MCF-1A	MCF-1B	-15.19	0.06	UP	-15.22	0.06	UP	0.0314	15	MCF-1A	1726.00	-14.75	0.05	UP
MCF-1A	MCF-1B	-7.28	0.03	UP	-7.33	0.03	UP	0.0128	11.77	MCF-1A	1716.36	-7.18	0.03	UP
MCF-2A	MCF-2B	-18.39	0.13	UP	--	--	--	--	--	--	--	--	--	--
MCF-2A	MCF-2B	-17.86	0.12	UP	-17.37	0.12	UP	0.0196	-4.5	MCF-2A	1774.21	-17.46	0.12	UP
MCF-2A	MCF-2B	-18.40	0.13	UP	-17.91	0.12	UP	0.0038	-9	MCF-2A	1774.85	-17.94	0.12	UP
MCF-2A	MCF-2B	-18.86	0.13	UP	-18.37	0.13	UP	0.0152	-12	MCF-2A	1775.67	-18.55	0.13	UP
MCF-2A	MCF-2B	-19.39	0.13	UP	-18.90	0.13	UP	0.0103	-12	MCF-2A	1776.11	-19.02	0.13	UP
MCF-2A	MCF-2B	-23.38	0.16	UP	-23.04	0.16	UP	0.0250	-12.16	MCF-2A	1781.13	-23.35	0.16	UP
MCF-3A	MCF-3B	9.01	-0.03	DOWN	--	--	--	--	--	--	--	--	--	--
MCF-3A	MCF-3B	5.29	-0.02	DOWN	6.35	-0.02	DOWN	0.0108	9.7	MCF-3A	1735.64	6.35	-0.02	DOWN
MCF-3A	MCF-3B	4.68	-0.02	DOWN	5.31	-0.02	DOWN	0.0102	4	MCF-3A	1736.42	5.35	-0.02	DOWN
MCF-3A	MCF-3B	3.99	-0.01	DOWN	4.62	-0.02	DOWN	0.0078	8	MCF-3A	1736.85	4.68	-0.02	DOWN
MCF-3A	MCF-3B	3.80	-0.01	DOWN	4.55	-0.01	DOWN	0.0091	13.2	MCF-3A	1737.03	4.55	-0.01	DOWN
MCF-3A	MCF-3B	-1.33	0.00	UP	-0.23	0.00	UP	0.0132	11.5	MCF-3A	1740.85	-0.23	0.001	UP
MCF-6A	MCF-6B	27.31	-0.08	DOWN	--	--	--	--	--	--	--	--	--	--
MCF-6A	MCF-6B	61.80	-0.18	DOWN	17.10	-0.05	DOWN	--	--	--	--	--	--	--
MCF-6A	MCF-6B	70.71	-0.20	DOWN	27.86	-0.08	DOWN	--	--	--	--	--	--	--
MCF-6A	MCF-6B	67.92	-0.19	DOWN	18.86	-0.05	DOWN	--	--	--	--	--	--	--
MCF-6A	MCF-6B	63.48	-0.18	DOWN	17.33	-0.05	DOWN	--	--	--	--	--	--	--
MCF-6A	MCF-6B	(c)	(c)	(c)										
MCF-8A	MCF-8B	(a)	(a)	UP	--	--	--	--	--	--	--	--	--	--
MCF-8A	MCF-8B	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-8A	MCF-8B	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-8A	MCF-8B	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-8A	MCF-8B	(a)	(a)	UP	(a)	(a)	UP	--	--	--	--	(a)	(a)	UP
MCF-8A	MCF-8B	(a)	(a)	UP										
MCF-8A	MCF-8B-R	(c)	(c)	(c)	(c)	(c)	(c)	--	--	--	--	(c)	(c)	(c)
MCF-8A	MCF-8B-R	(c)	(c)	(c)										
MCF-9A	MCF-9B	-3.86	0.02	UP	--	--	--	--	--	--	--	--	--	--
MCF-9A	MCF-9B	2.78	-0.02	DOWN	--	--	--	0.0235	23	MCF-9A	1656.82	3.32	-0.02	DOWN
MCF-9A	MCF-9B	2.19	-0.01	DOWN	-1.54	0.01	UP	0.0147	23	MCF-9A	1660.51	-1.20	0.01	UP
MCF-9A	MCF-9B	1.91	-0.01	DOWN	-2.22	0.01	UP	0.0235	22	MCF-9A	1660.91	-1.70	0.01	UP
MCF-9A	MCF-9B	1.91	-0.01	DOWN	-2.87	0.02	UP	0.0078	23	MCF-9A	1661.86	-2.69	0.02	UP
MCF-9A	MCF-9B	1.20	-0.01	DOWN	-2.11	0.01	UP	0.0263	21.72	MCF-9A	1658.96	-1.54	0.01	UP
MCF-24A	MCF-24B	(c)	(c)	(c)	(c)	(c)	(c)	0.04	-3	MCF-24A	--	(c)	(c)	(c)
MCF-28A	MCF-28B	41.01	-0.21	DOWN	42.89	-0.22	DOWN	0.02	0	MCF-28A	1530.46	42.89	-0.22	DOWN
MCF-29A	MCF-29B	-11.34	0.06	UP	(c)	(c)	(c)	0.00	-6	MCF-29A	1585.73	-56.04	0.28	UP
MCF-30A	MCF-30B	-9.90	0.05	UP	-39.83	0.19	UP	0.01	-8	MCF-30A	1570.19	-39.88	0.19	UP
MCF-31A	MCF-31B	-67.98	0.46	UP	(c)	(c)	(c)	0.02	14	MCF-31A	1575.49	-119.28	0.81	UP
MCF-32A	MCF-32B	-33.24	0.16	UP	(c)	(c)	(c)	0.03	-1	MCF-32A	1696.68	-33.37	0.16	UP

-- - Well not sampled or parameter data not available/not applicable.
(a) - Water level was artesian when observed. Numerical value not measured.
(b) - No data recorded for well MCF-07 in May 2006.
(c) - One well in the pair was recently installed. Water levels not yet stabilized after well development. Value will be calculated once water level measurement is completed.
Groundwater density (pi) values calculated from TDS and temperature data at http://www.earthwardconsulting.com/density_calculator.htm.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/REPORTS/FIG08_EASTSIDE_VERTICAL_GRADIENT_WELLS.MXD 901221

~1 foot
MCF-08B
MCF-08A
~13 feet
AA-08

~18 feet
MCF-28A
~28 feet
MCF-28B
PC-56

HMW-08
~12 feet
MCF-29B
~9 feet
MCF-29A

MCF-30A
~18 feet
MCF-30B
~16 feet
AA-30

MCF-08A
MCF-08B-R
~37 feet

~26 feet
~13 feet
MW-4
MCF-31B
MCF-31A

AA-10
MCF-10B
~24 feet
~23 feet
MCF-10A

MCF-06B
~16 feet
MCF-06C

West ditch
Northwest ditch

DBMW-2
~17 feet
MCF-19A

~16 feet
MCF-07
AA-07

Alpha ditch

MCF-11
AA-11
~16 feet

MCF-12B
~13 feet
MCF-12C
MCF-12A
~16 feet

Storm drain swale

MCF-09B
~23 feet
AA-09
~23 feet
MCF-09A

MCF-16C
MCF-16B
~21 feet
~19 feet
MCF-16A

MCF-01B
~20 feet
~17 feet
MCF-01A
AA-1

~18 feet
AA-27
MCF-27

~59 feet
BEC-6
~13 feet
MCF-32A
MCF-32B

MCF-03B
MCF-03A
~23 feet

~16 feet
MCF-02A
MCF-02B

~87 feet
MCF-24A
MCF-24B

N
0 1000 2000 Feet

Explanation

- MCF-16C — Shallow zone well
- MCF-16B — Middle zone well
- MCF-16A — Deep zone well
- Site AOC3 boundary

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE C-1
EASTSIDE AREA VERTICAL GRADIENT WELLS

Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-21-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/REPORTS/EASTSIDE_VERTICAL_GRADIENT_WELLS.MXD 907121

Daniel B. Stephens & Associates, Inc.

Appendix D

Isoconcentration Plots (Shallow/Middle/Deep Zone)

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-1_ARSENIC_2009_SHALLOW.MXD 908221

WMW5.58SI 33
WMW5.58SS 5.6
WMW5.58SD 7.8 14.1
PC-90 119
PC-88 102
PC-80 85.4
PC-81 126
PC-79 89.4
PC-76 54.6
AA-21 84.9
AA-08 56.1
AMPAC Re-Injection Area
Tronox Seep Pumping Station
COH-2A 51.9
HMW-08 59.4
PC-94 65.5
HMW-09 45.8
AA-30 40.9
MW-3 106
MW-15 131
DBMW-20 37.1
MW-13 36
City of Henderson Landfill
MW-4 62.9
AA-26 37.8
DBMW-22 48.7
PC-108 151
West ditch
AA-23-R 32.2
AA-22 15.4
DBMW-19 52.1
PC-4 64
City of Henderson Northern Rib Ponds
Tuscany Village
AA-10 44.7
PC-2 103
DBMW-4 96.9
DBMW-5 129
MCF-06B 17.3
MCF-06C 48.3
AA-07 67.9
DBMW-2 88.9
DBMW-1 105
AMPAC Athens Pen Extraction Area
DBMW-7 32
DBMW-3 98.6
AA-20 107
DBMW-8 32.8
DBMW-10 57.2
DBMW-12 44.3
DBMW-14 103
DBMW-16 44.1
DBMW-17 54.7
DBMW-15 155
BEC-9 77.8
DBMW-9 83.7
DBMW-11 25.6
DBMW-13 53.1
AA-18 31.5
MCF-12B 77.5
PC-24 96.2
MCF-16C 16.3
Beta ditch
Spray Wheel
AA-UW6 161
PC-28 235
POD2-R 62.2
POD8 67.8
BEC-6 50.2
Storm drain swale
PC-67 165
Alpha ditch
AA-09 108
Upper ponds area 1964
AA-13 57
AA-UW5 13.7
DM-1 21.8
HMWWT-6 26.3
POU3 84.6
City of Henderson Southern Rib Ponds
MCF-03B 48.1
MCF-01B 78
AA-01 91
AA-UW4 90.4
AA-UW1 90.3
AA-27 44.3
AA-UW2 37.1
AA-UW3 13.3
50
100
150
200

N

0 1000 2000 Feet

Explanation

- Shallow Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- Concentration contour (dashed where inferred)
- AA-27 / 44.3 Monitoring well designation / Result (µg/L)

Notes:
MCL = 10 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-1
Arsenic - Shallow Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS | Date 12-28-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/ARSENIC_2009_SHALLOW.MXD 906121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-2_ARSENIC_2009_MIDDLE.MXD 908221

COH-1
25.3 J

Tronox Seep
Pumping Station

COH-2
33.8 J

MCF-29B
30.2 J

MCF-30B
26.4 J

City of Henderson Landfill

MCF-31B
17.7 J

AMPAC
Re-Injection Area

MCF-08B-R
13.8 J

MCF-28B
18.7 J

West ditch

City of Henderson
Northern Rib Ponds

Tuscany Village

MCF-10B
18.4 J

AMPAC
Athens Pen
Extraction Area

MCF-05
< 21 U

MCF-12C
100

MCF-16B
6.4 J

MCF-24B
3.3 J

MCF-11
1.3 J

Spray Wheel

Baja ditch

Alpha ditch

MCF-32B
65.5

Storm drain swale

MCF-09B
27.8 J

Upper ponds area 1964

City of Henderson
Southern Rib Ponds

MCF-02B
35.1 J

N

0 1000 2000 Feet

Explanation

- Middle Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- MCF-09B 27.8 Monitoring well designation Result (µg/L)

Notes:
MCL = 10 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-2
Arsenic -
Middle Zone

Basic Remediation COMPANY

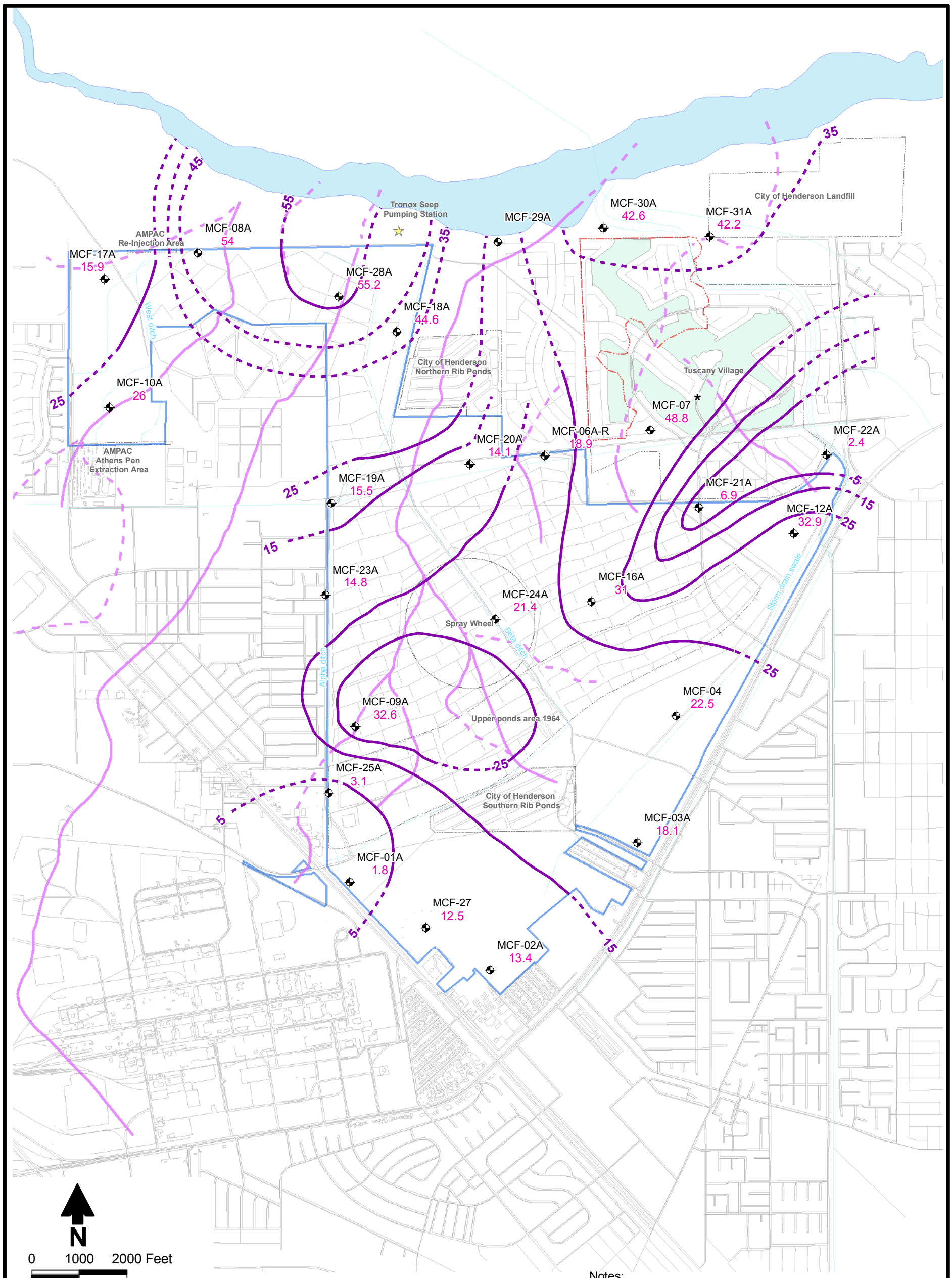
Prepared by: DBS&A CRS

Date 12-28-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/ARSENIC_2009_MIDDLE.MXD 906121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-3_ARSENIC_2009_DEEP.MXD 908221



Explanation

- Deep Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- Concentration contour (dashed where inferred)
- MCF-04 / 22.5 Monitoring well designation / Result (µg/L)

Notes:
1. MCL = 10 ug/L
2. * - Data rejected due to potential field sampling error – result pending final determination.

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-3
Arsenic -
Deep Zone

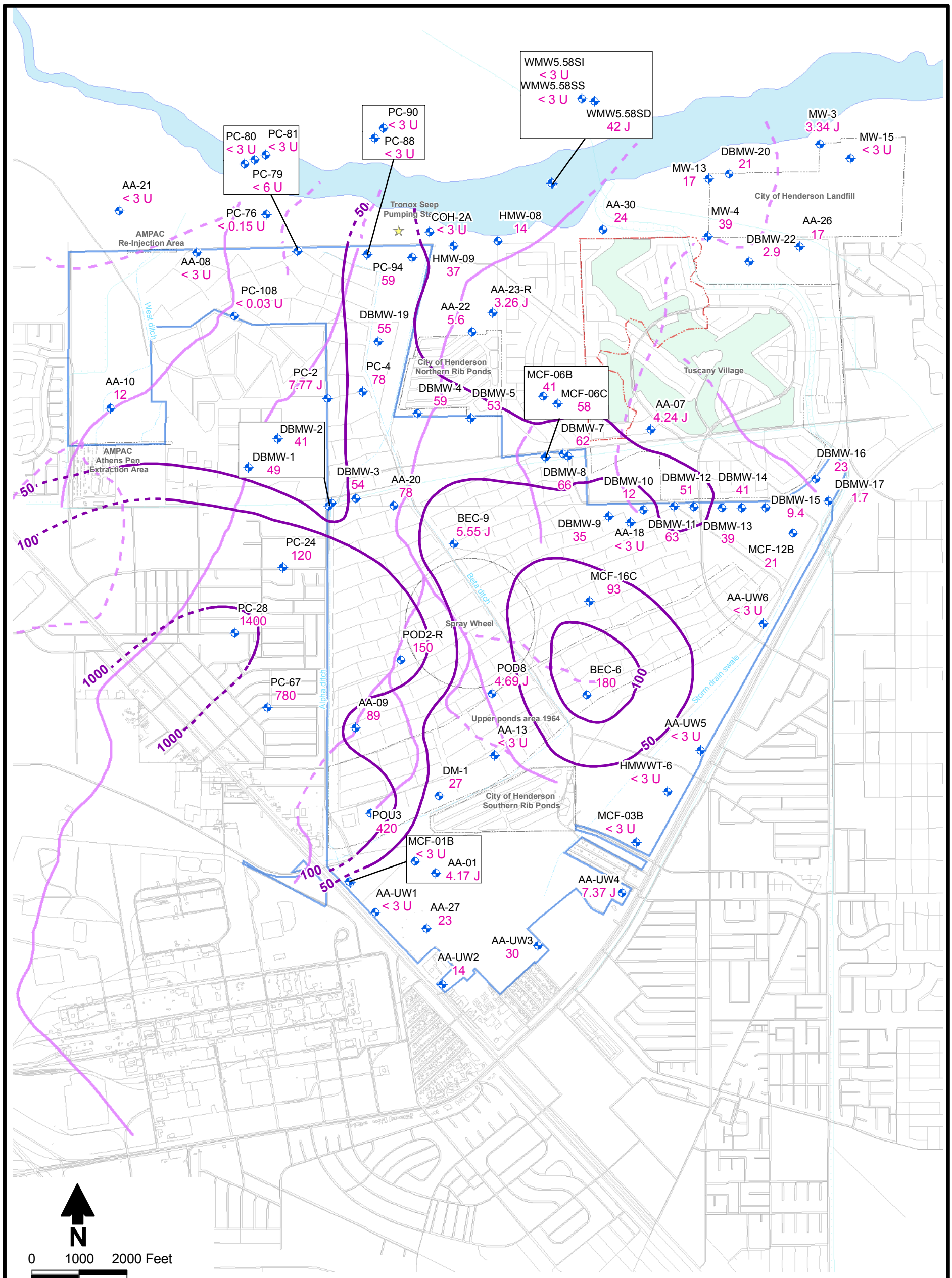
Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-16-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/ARSENIC_2009_DEEP.MXD 906121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-4_CRVI_2009_SHALLOW.MXD 908221



Explanation

- Shallow Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- Concentration contour (dashed where inferred)
- AA-27 / 23 — Monitoring well designation / Result (µg/L)

Notes:
MCL for total chromium = 100 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-4
Hexavalent Chromium (Cr VI) - Shallow Zone

Basic Remediation Company

Prepared by: DBS&A CRS Date 12-18-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/CRVI_2009_SHALLOW.MXD 906121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-5_CRVI_2009_MIDDLE.MXD 908221

COH-1
< 1.5 U

Tronox Seep
Pumping Station

COH-2
< 6 U

MCF-30B
< 1.5 U

City of Henderson Landfill

AMPAC
Re-Injection Area

MCF-08B-R
< 15 U

MCF-28B
< 1.5 U

West ditch

City of Henderson
Northern Rib Ponds

Tuscany Village

MCF-10B
< 3 U

AMPAC
Athens Pen
Extraction Area

MCF-05
< 3 U

MCF-12C
5.21 J

MCF-16B
< 0.75 U

MCF-24B
< 0.75 U

MCF-11
< 3 U

Spray Wheel

Beta ditch

MCF-32B
< 0.06 U

Alpha ditch

Storm drain swale

MCF-09B
< 3 U

Upper ponds area 1964

City of Henderson
Southern Rib Ponds

MCF-02B
4.71 J

N

0 1000 2000 Feet

Explanation

- Middle Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- MCF-09B < 3U — Monitoring well designation, Result (µg/L)

Notes:
MCL for total chromium = 100 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-5
Hexavalent Chromium (Cr VI) - Middle Zone

Basic Remediation COMPANY

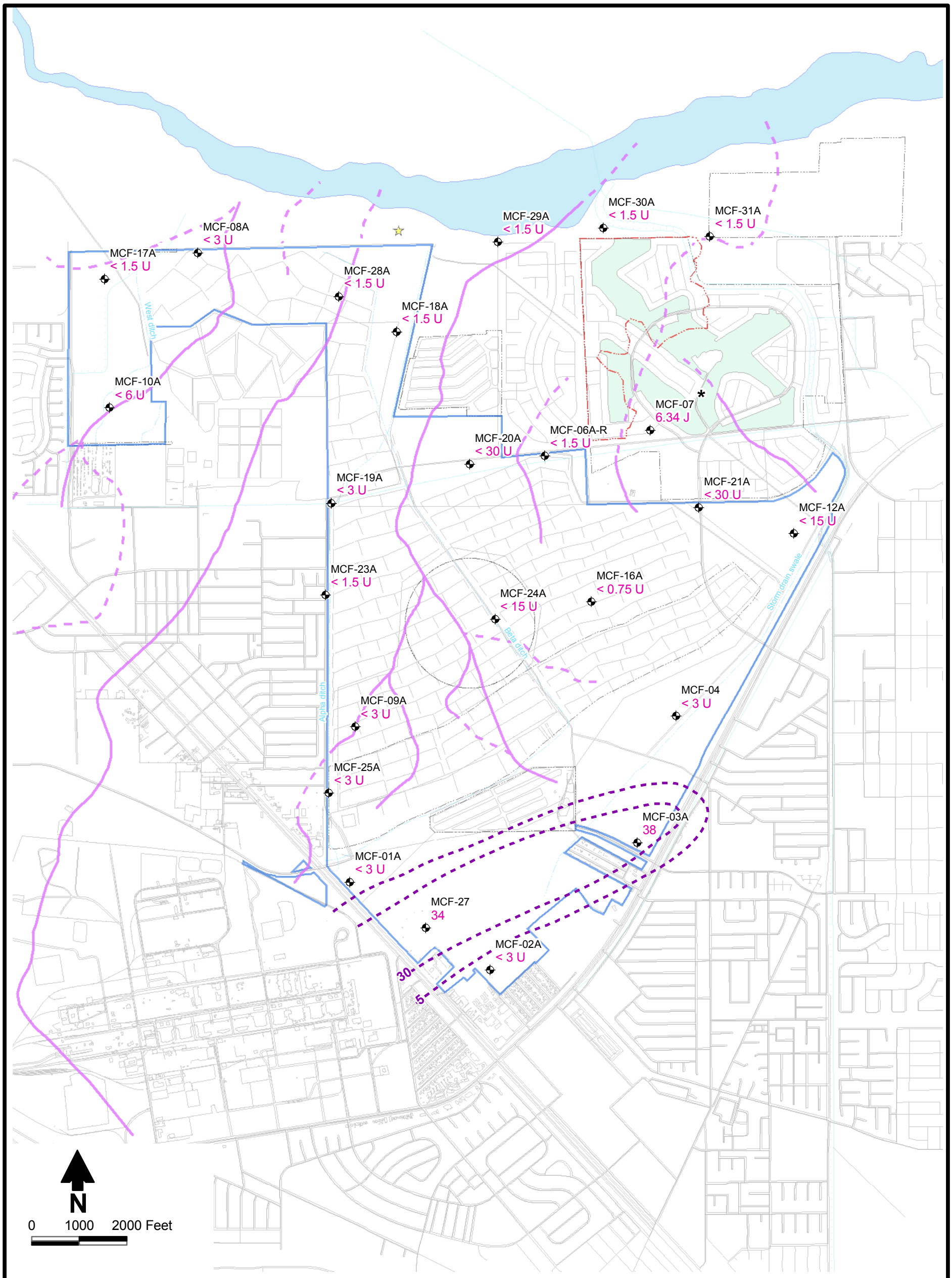
Prepared by: DBS&A CRS

Date 12-16-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/CRVI_2009_MIDDLE.MXD 906121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-6_CRVI_DEEP.MXD 908221



Explanation

- Deep zone monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Concentration contour (dashed where inferred)
- MCF-24A / < 15 U — Monitoring well designation / Result (µg/L)

Notes:
1. MCL for total chromium = 100 ug/L
2. * - Data rejected due to potential field sampling error – result pending final determination.

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-6
Hexavalent Chromium (Cr VI) - Deep Zone

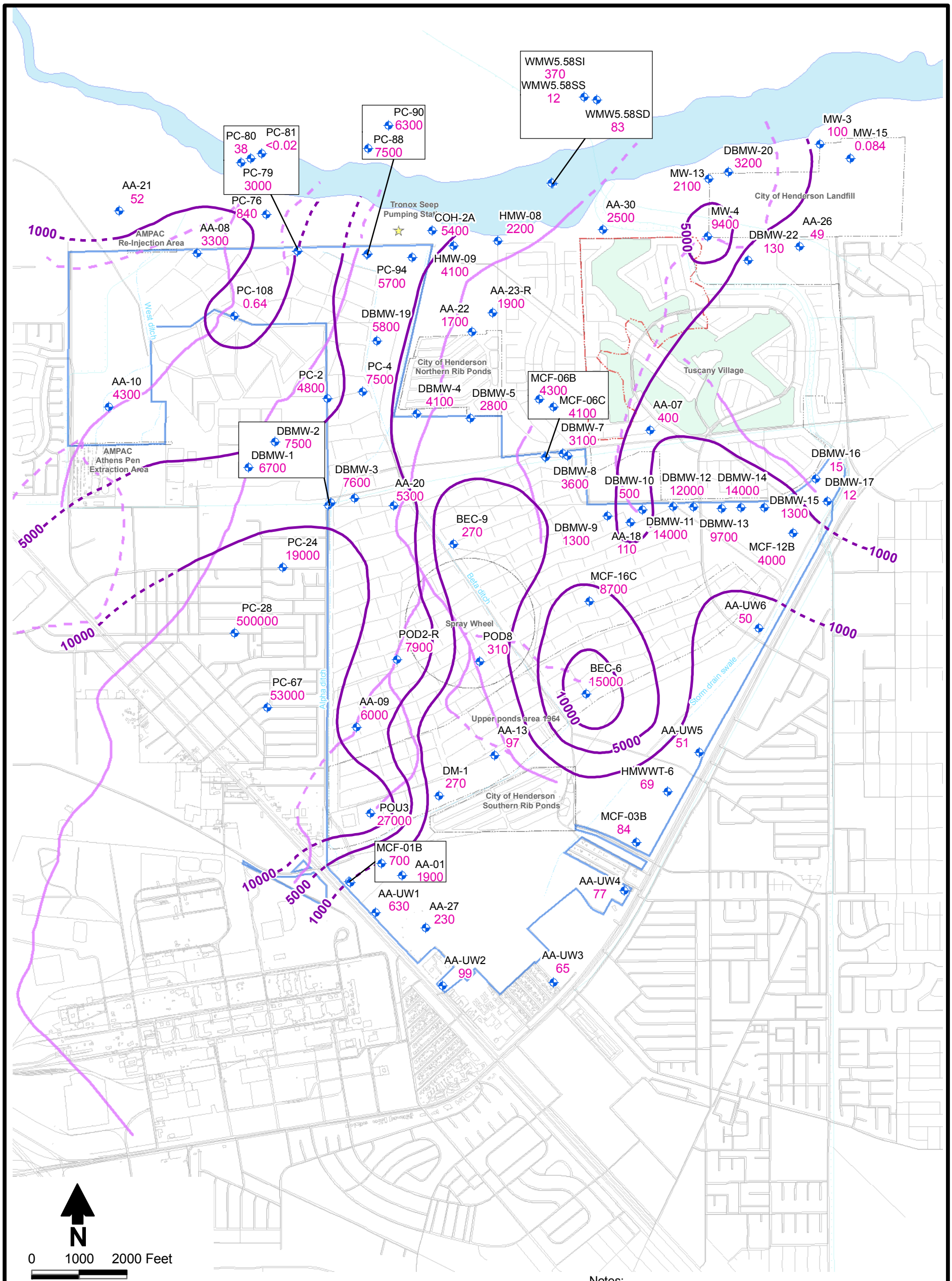
Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-28-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_Pre_CSM_tasks/GIS/MXDS/CHEMISTRY/CrVI_DEEP.MXD 905011

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-7_PERCHL_2009_SHALLOW.MXD 908221



Explanation

- Shallow Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- Concentration contour (dashed where inferred)
- AA-27 / 230 — Monitoring well designation / Result (µg/L)

Notes:
1. NDEP Provisional AL = 18 ug/L
2. USEPA Drinking Water Equivalent Level (DWEL) = 24.5 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-7
Perchlorate - Shallow Zone

Basic Remediation Company

Prepared by: DBS&A CRS Date 12-18-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/PERCHL_2009_SHALLOW.MXD 906121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-8_PERCHL_2009_MIDDLE.MXD 908221

COH-1
< 2 U

Tronox Seep
Pumping Station

COH-2
< 0.2 UJ

MCF-29B
< 0.4 UJ

MCF-30B
< 2 U

City of Henderson Landfill

MCF-31B
< 0.4 UJ

AMPAC
Re-Injection Area

MCF-08B-R
0.13 J

MCF-28B
< 2 UJ

West ditch

City of Henderson
Northern Rib Ponds

Tuscany Village

MCF-10B
0.32 J

AMPAC
Athens Pen
Extraction Area

MCF-05
< 0.4 UJ

MCF-12C
430

MCF-16B
< 2 U

MCF-24B
4.5 J+

MCF-11
< 0.1 U

Spray Wheel

Baja ditch

Alpha ditch

MCF-32B
19

Storm drain swale

MCF-09B
< 0.1 U

Upper ponds area 1964

City of Henderson
Southern Rib Ponds

MCF-02B
0.13 J

N

0 1000 2000 Feet

Notes:
1. NDEP Provisional AL = 18 ug/L
2. USEPA Drinking Water Equivalent Level (DWEL) = 24.5 ug/L

Explanation

- Middle Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- MCF-09B / < 0.1 — Monitoring well designation / Result (µg/L)

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-8
Perchlorate - Middle Zone

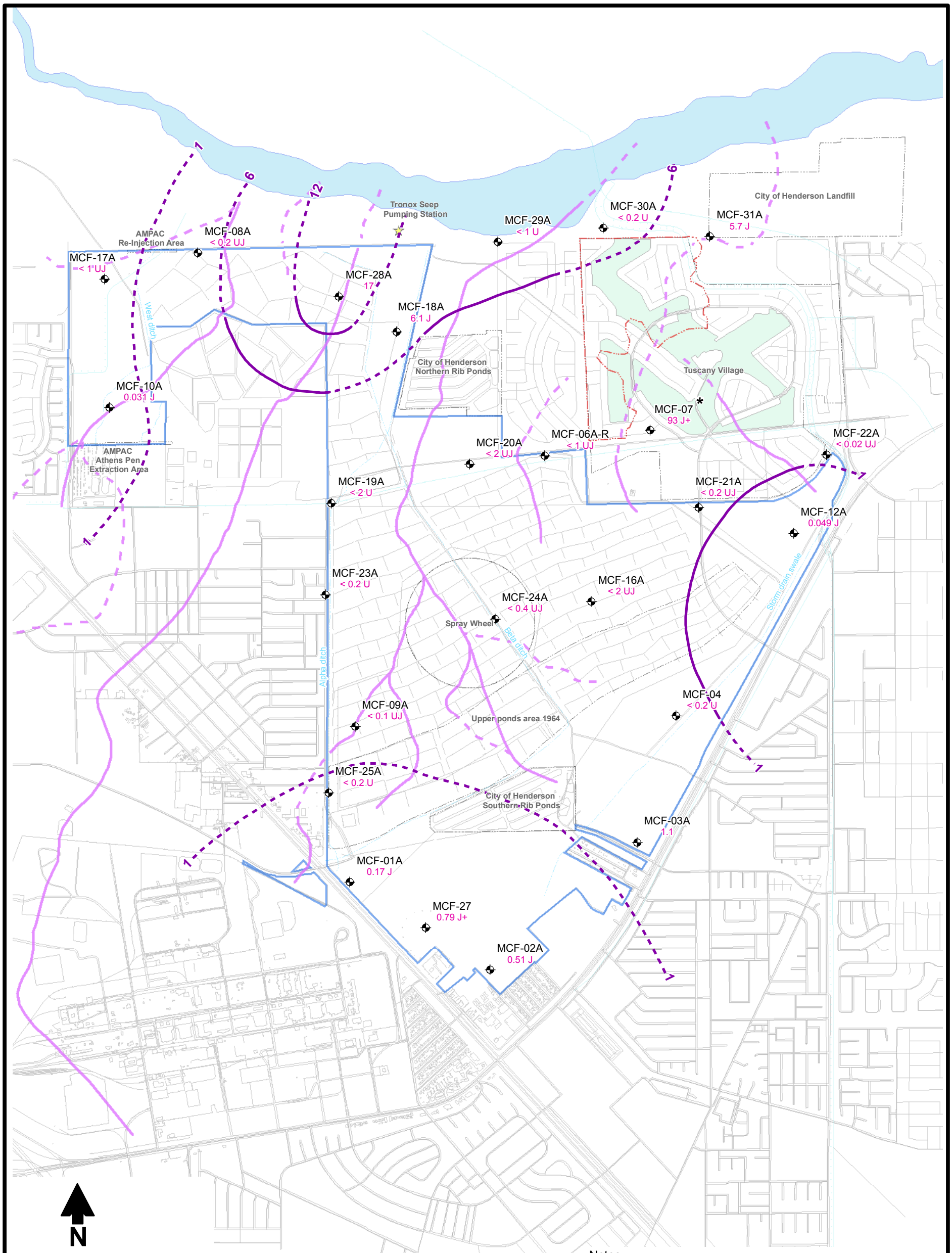
Basic Remediation COMPANY

Prepared by: DBS&A CRS
Date 12-16-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/PERCHL_2009_MIDDLE.MXD 906121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-9_PERCHL_2009_DEEP.MXD 908221



Explanation

- Deep Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- Concentration contour (dashed where inferred)
- MCF-09B / < 0.1 — Monitoring well designation / Result (µg/L)

Notes:
1. NDEP Provisional AL = 18 ug/L
2. USEPA Drinking Water Equivalent Level (DWEL) = 24.5 ug/L
3. * - Data rejected due to potential field sampling error – result pending final determination.

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-9
Perchlorate - Deep Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS
Date 12-21-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/PERCHL_2009_DEEP.MXD 906121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-10_RA226_228_2009_SHALLOW.MXD 908221

WMW5.58SI 1.55
WMW5.58SS 0.417 U
WMW5.58SD 7.88
PC-90 1.25 U
PC-88 1.41
PC-80 4.86
PC-81 3.54
PC-79 1.2
MW-3 3.24
MW-15 2.35
DBMW-20 2.2
MW-13 0.196
AA-21 0.942 U
Tronox Seep Pumping Station
COH-2A 1.27
HMW-08 3.86
AA-30 1.88
City of Henderson Landfill
MW-4 8.45
AA-26 0.747
DBMW-22 3.68
AMPAC Re-Injection Area
PC-76 2.68
AA-08 2.49
PC-94 1.27 U
HMW-09 2.81
PC-108 2.9
AA-23-R 3.15
AA-22 4.34
DBMW-19 2.9
Westditch
PC-4 2.99
City of Henderson Northern Rib Ponds
MCF-06B 16.1
MCF-06C 4.49
Tuscany Village
AA-10 2.12
PC-2 3.62
AA-07 2.01
DBMW-2 3.38
DBMW-1 0.728 U
DBMW-4 5.48
DBMW-5 9.21
DBMW-7 1.77
AMPAC Athens Pen Extraction Area
DBMW-3 7.04
AA-20 1.99
DBMW-8 1.75
DBMW-10 3.07
DBMW-12 12.7
DBMW-14 4.03
DBMW-16 2.45
DBMW-17 2.21
DBMW-15 1.25 U
BEC-9 2.58
DBMW-9 5.05
AA-18 2.27
DBMW-11 3.67
DBMW-13 2.62
MCF-12B 3.46
PC-24 2.6
MCF-16C 1.87
Bala ditch
AA-UW6 2.57
PC-28 4.77
Spray Wheel
POD2-R 6.43
POD8 2.71
BEC-6 2.58
Storm drain swale
PC-67 4.05
Alpha ditch
AA-09 1.16
Upper ponds area 1964
AA-13 2.26
AA-UW5 2.17
DM-1 2.29 U
HMWWT-6 2.94
City of Henderson Southern Rib Ponds
POU3 3.32
MCF-03B 1.9
MCF-01B 0.647
AA-01 1.12
AA-UW4 1.57
AA-UW1 3.32
AA-27 2
AA-UW3 3.41
AA-UW2 1.84

N

0 1000 2000 Feet

Explanation

- Shallow Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- Concentration contour (dashed where inferred)
- AA-27 / 2 — Monitoring well designation / Result (pCi/L)

Notes:
MCL = 5.0 pCi/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-10
Radium 226+228 - Shallow Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-18-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/RA226_228_2009_SHALLOW.MXD 907121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-11_RA226_228_2009_MIDDLE.MXD 908221

COH-1
4.37
Tronox Seep
Pumping Station
COH-2
4.34
MCF-29B
7.3
MCF-30B
12.9
City of Henderson Landfill
MCF-31B
3.57
AMPAC
Re-Injection Area
MCF-08B-R
2.6
MCF-28B
3.55
West ditch
City of Henderson
Northern Rib Ponds
Tuscany Village
MCF-10B
1.83
AMPAC
Athens Pen
Extraction Area
MCF-05
3.72
MCF-12C
2.23
MCF-16B
9.35
MCF-24B
1.85
MCF-11
2.85
Spray Wheel
Beta ditch
Alpha ditch
MCF-32B
4.47
Storm drain swale
MCF-09B
3.28
Upper ponds area 1964
City of Henderson
Southern Rib Ponds
MCF-02B
1.82

N

0 1000 2000 Feet

Explanation

- Middle Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- MCF-09B / 3.28 — Monitoring well designation / Result (pCi/L)

Notes:
MCL = 5.0 pCi/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-11
Radium 226+228 - Middle Zone

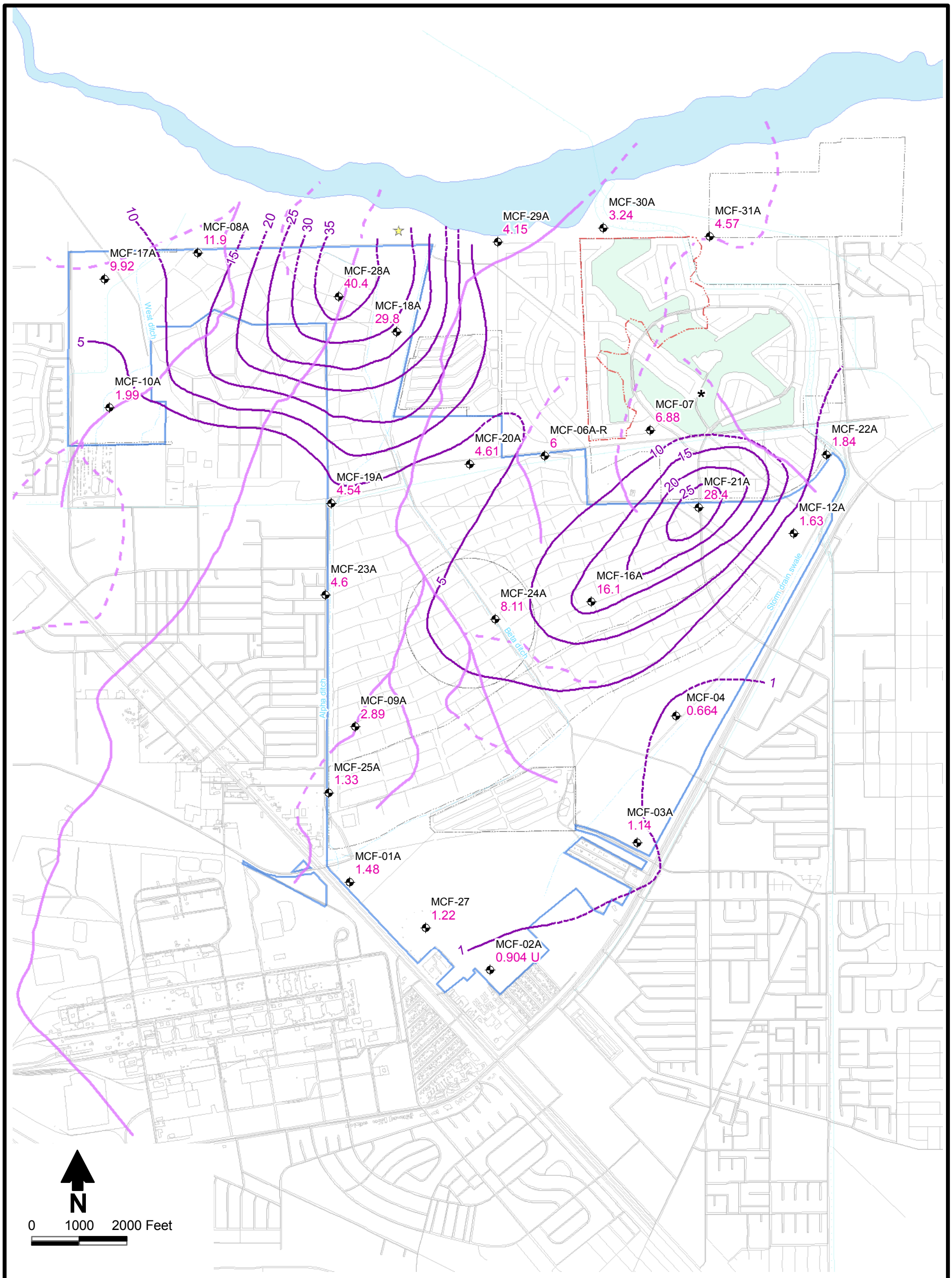
Basic Remediation COMPANY

Prepared by: DBS&A CRS
Date 12-16-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/RA226_228_2009_MIDDLE.MXD 907121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-12_RA226_228_DEEP.MXD 908221



Explanation

- Deep zone monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Concentration contour (dashed where inferred)
- MCF-24A 8.11 Monitoring well designation Result (pCi/L)

Notes:
1. MCL = 5.0 pCi/L
2. * - Data rejected due to potential field sampling error – result pending final determination.

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-12
Radium 226+228 - Deep Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-28-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_Pre_CSM_tasks/GIS/MXDS/CHEMISTRY/Ra226+228_DEEP.MXD 905011

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-13_PCE_2009_SHALLOW.MXD 908221

WMW5.58SI
< 0.065 U
WMW5.58SS
< 0.065 U
WMW5.58SD
< 0.065 U

PC-80
0.067 J
PC-81
< 0.065 U
PC-79
2.5

PC-90
0.18 J
PC-88
0.12 J

MW-3
0.65 J
MW-15
7.7
DBMW-20
0.53 J+
MW-13
0.53 J

AA-21
< 0.065 U

Tronox Seep
Pumping Station

City of Henderson Landfill

AA-30
0.69 J
MW-4
< 0.065 U
AA-26
< 0.065 U

PC-76
< 0.065 UJ
COH-2A
0.29 J
HMW-08
0.28 J

AMPAC
Re-Injection Area

AA-08
< 0.065 U

PC-94
1.3
HMW-09
1.2

DBMW-22
< 0.065 U

PC-108
< 0.065 U

AA-23-R
0.33 J

West ditch

DBMW-19
0.43 J

AA-22
< 0.065 U

City of Henderson
Northern Rib Ponds

Tuscany Village

PC-4
0.082 J

AA-10
0.54 J+

MCF-06B
0.11 J
MCF-06C
0.95 J

AA-07
< 0.065 U

PC-2
< 0.065 U

DBMW-4
3.5

DBMW-5
1.8 J+

DBMW-7
1

DBMW-1
< 0.065 U
DBMW-2
< 0.065 U

AMPAC
Athens Pen
Extraction Area

DBMW-3
< 0.065 U

AA-20
4

DBMW-8
2.3 J+

DBMW-10
0.23 J
DBMW-12
0.38 J
DBMW-14
0.066 J

DBMW-16
< 0.065 U

DBMW-15
0.16 J+
DBMW-17
< 0.065 U

BEC-9
0.15 J

DBMW-9
0.67 J
DBMW-11
0.74 J
DBMW-13
0.52 J

AA-18
< 0.065 U

MCF-12B
< 0.065 U

PC-24
1.8

MCF-16C
0.69 J

Beta ditch

AA-UW6
< 0.065 U

PC-28
< 0.065 U

Spray Wheel

POD2-R
3.6

POD8
< 0.065 U

BEC-6
0.24 J

Storm drain swale

PC-67
13

Alpha ditch

AA-09
4 J+

Upper ponds area 1964

AA-13
< 0.065 U

AA-UW5
0.92 J

DM-1
0.16 J

HMWWT-6
0.4 J

City of Henderson
Southern Rib Ponds

POU3
9

MCF-03B
< 0.065 U

MCF-01B
24 J+
AA-01
73 J

AA-UW4
0.12 J

AA-UW1
53 J

AA-27
< 0.065 U

AA-UW3
< 0.065 U

AA-UW2
< 0.065 U

1
5
10
15

N

0 1000 2000 Feet

Explanation

- Shallow Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- Concentration contour (dashed where inferred)
- AA-27 / < 0.065 U — Monitoring well designation / Result (µg/L)

Notes:
MCL = 5.0 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-13
Tetrachloroethene (PCE) - Shallow Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS
Date 12-18-09

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Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-14_PCE_2009_MIDDLE.MXD 908221

COH-1
< 0.065 U

Tronox Seep
Pumping Station

COH-2
< 0.065 U

MCF-29B
< 0.065 U

MCF-30B
< 0.065 U

MCF-31B
< 0.065 UJ

City of Henderson Landfill

AMPAC
Re-Injection Area

MCF-08B-R
< 0.065 U

MCF-28B
< 0.065 U

West ditch

City of Henderson
Northern Rib Ponds

Tuscany Village

MCF-10B
< 0.065 U

AMPAC
Athens Pen
Extraction Area

MCF-05
< 0.065 U

MCF-12C
< 0.065 U

MCF-16B
< 0.065 U

MCF-24B
< 0.065 U

MCF-11
< 0.065 U

Spray Wheel

Baja ditch

Alpha ditch

MCF-32B
< 0.065 U

Storm drain swale

MCF-09B
< 0.065 U

Upper ponds area 1964

City of Henderson
Southern Rib Ponds

MCF-02B
< 0.065 U

N

0 1000 2000 Feet

Explanation

- Middle Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- MCF-09B Monitoring well designation
- < 0.065 U Result (µg/L)

Notes:
MCL = 5.0 ug/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-14
Tetrachloroethene (PCE) - Middle Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS

Date 12-16-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/PCE_2009_MIDDLE.MXD 906121

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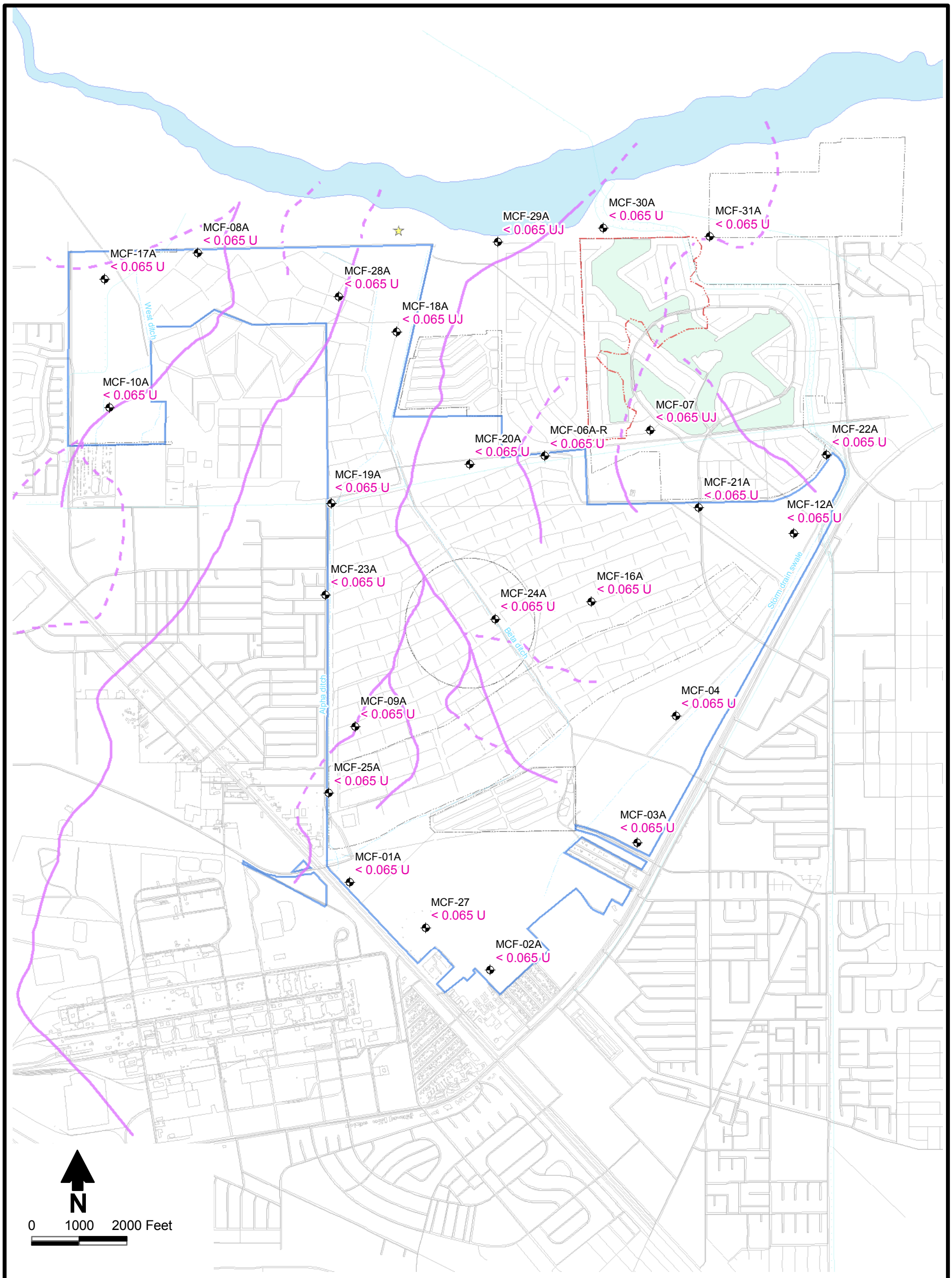
S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-15_PCE_DEEP.MXD 908221



Notes:
MCL = 5.0 ug/L

Explanation

- Deep zone monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- MCF-24A Monitoring well designation
- < 0.065 U Result (µg/L)

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-15
Tetrachloroethene (PCE) - Deep Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS
Date 12-14-09

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Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-16_TDS_2009_SHALLOW.MXD 908221

WMW5.58SI
R-CAB&TDS
WMW5.58SS
1000 J-TDS
WMW5.58SD
142000 J-TDS
PC-90
2100 J-TDS
PC-88
5700 J-TDS
PC-80
2500 J-CAB&TDS
PC-81
1300 J-TDS
PC-79
4400 J-TDS
MW-3
3100 J-TDS
MW-15
4300 J-TDS
DBMW-20
4100 J-TDS
MW-13
3700 J-TDS
City of Henderson Landfill
AA-21
5600
Tronox Seep
Pumping Station
COH-2A
3300 J-TDS
HMW-08
R-CAB&TDS
AA-30
5000 J-TDS
MW-4
14400 J-CAB&TDS
AA-26
600 J-TDS
AMPAC
Re-injection Area
PC-76
4400
AA-08
3500 J-TDS
HMW-09
7800 J-TDS
DBMW-22
5000 J-TDS
PC-94
3100 J-TDS
5000
PC-108
1700 J-TDS
AA-23-R
2400 J-TDS
West ditch
DBMW-19
4300 J-TDS
AA-22
3600 J-TDS
10000
5000
AA-10
4110 J-TDS
PC-2
6000
PC-4
7400
City of Henderson
Northern Rib Ponds
MCF-06B
11500 J-TDS
MCF-06C
6200
Tuscany Village
AA-07
2500 J-TDS
DBMW-2
6400
DBMW-1
8600 J-TDS
DBMW-4
4400 J-TDS
DBMW-5
4300 J-TDS
DBMW-7
6900 J-TDS
DBMW-14
7100 J-TDS
AMPAC
Athens Pen
Extraction Area
DBMW-12
6600 J-TDS
DBMW-16
1070 J-CAB&TDS
DBMW-3
6600 J-TDS
AA-20
6400
DBMW-8
8000 J-TDS
5000
DBMW-10
3300 J-TDS
DBMW-15
3700
DBMW-17
700 J-TDS
BEC-9
5300
DBMW-9
< 350 UJ
DBMW-11
5400 J-TDS
DBMW-13
7400 J-TDS
AA-18
< 350 U
MCF-12B
2900
PC-24
9800
MCF-16C
11500 J-CAB&TDS
Beta ditch
AA-UW6
3700
PC-28
6600
Spray Wheel
POD2-R
5500 J-TDS
10000
POD8
900 J-TDS
BEC-6
R-CAB&TDS
Storm drain swale
PC-67
11000 J-TDS
AA-09
6600
Upper ponds area 1964
AA-13
1800 J-TDS
AA-UW5
R-CAB&TDS
10000
10000
Alpha ditch
DM-1
2400 J-TDS
HMWWT-6
1600 J-TDS
City of Henderson
Southern Rib Ponds
POU3
7600 J-CAB&TDS
MCF-03B
1900 J-TDS
MCF-01B
1990
AA-01
3800
5000
AA-UW4
4300 J-TDS
AA-UW1
3100 J-TDS
AA-27
3300 J-TDS
AA-UW3
3500 J-TDS
AA-UW2
4200

N

0 1000 2000 Feet

Explanation

- Shallow Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- Concentration contour (dashed where inferred)
- AA-27 / 3300 J-TDS — Monitoring well designation / Result (mg/L)

Notes:
USEPA MCL = 500 mg/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-16
Total Dissolved Solids (TDS) - Shallow Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-18-09

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Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-17_TDS_2009_MIDDLE.MXD 908221

COH-1
117000

Tronox Seep
Pumping Station

COH-2
89900

MCF-29B
119000 J-TDS

MCF-30B
168000 J-CAB&TDS

MCF-31B
89700 J-TDS

City of Henderson Landfill

AMPAC
Re-Injection Area

MCF-08B-R
24800 J-TDS

MCF-28B
45300 J-TDS

West ditch

City of Henderson
Northern Rib Ponds

Tuscany Village

MCF-10B
2200

AMPAC
Athens Pen
Extraction Area

MCF-05
180000 J-TDS

MCF-12C
1000 J-TDS

MCF-16B
64300 J-CAB&TDS

MCF-24B
27500 J-TDS

MCF-11
2700 J-TDS

Spray Wheel

Beta ditch

Alpha ditch

MCF-32B
2900 J-CAB&TDS

Storm drain swale

MCF-09B
3000 J-TDS

Upper ponds area 1964

City of Henderson
Southern Rib Ponds

MCF-02B
2200 J-TDS

N

0 1000 2000 Feet

Explanation

- Middle Zone Monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Streets
- MCF-09B / 3000 J-TDS — Monitoring well designation / Result (mg/L)

Notes:
USEPA MCL = 500 mg/L

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-17
Total Dissolved Solids (TDS) - Middle Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS

Date 12-16-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/TDS_2009_MIDDLE.MXD 906121

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S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/CHEMISTRY/D-18_TDS_DEEP.MXD 908221

MCF-08A
99800 J-CAB&TDS

MCF-17A
72700

MCF-28A
188000 J-CAB

MCF-18A
163000 J-TDS

MCF-29A
161000

MCF-30A
175000 J-CAB&TDS

MCF-31A
185000 J-TDS

MCF-10A
R-CAB&TDS

MCF-07
166000 J-TDS

MCF-20A
R-CAB&TDS

MCF-06A-R
178000 J-TDS

MCF-22A
R-CAB&TDS

MCF-19A
115000 J-CAB&TDS

MCF-21A
119000 J-TDS

MCF-12A
7300

MCF-23A
77300 J-CAB&TDS

MCF-24A
5300 J-TDS

MCF-16A
78800 J-CAB&TDS

MCF-09A
22100 J-CAB&TDS

MCF-04
64700

MCF-25A
148000 J-TDS

MCF-03A
700

MCF-01A
3900

MCF-27
R-CAB&TDS

MCF-02A
1100 J-TDS

West ditch
Alpha ditch
Beta ditch
Storm drain swale

100000
150000
50000

N

0 1000 2000 Feet

Notes:
1. USEPA MCL = 500 mg/L
2. * - Data rejected due to potential field sampling error – result pending final determination.

Explanation

- Deep zone monitoring well
- Site boundary
- Gravel pit circa 1976. Source: aerial photograph dated 1976
- Las Vegas wash
- Streets
- Concentration contour (dashed where inferred)
- MCF-24A / < 15 U — Monitoring well designation / Result (mg/L)

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE D-18
Total Dissolved Solids (TDS) - Deep Zone

Basic Remediation COMPANY

Prepared by: DBS&A CRS
Date 12-28-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_Pre_CSM_tasks/GIS/MXDS/CHEMISTRY/TDS_DEEP.MXD 905011

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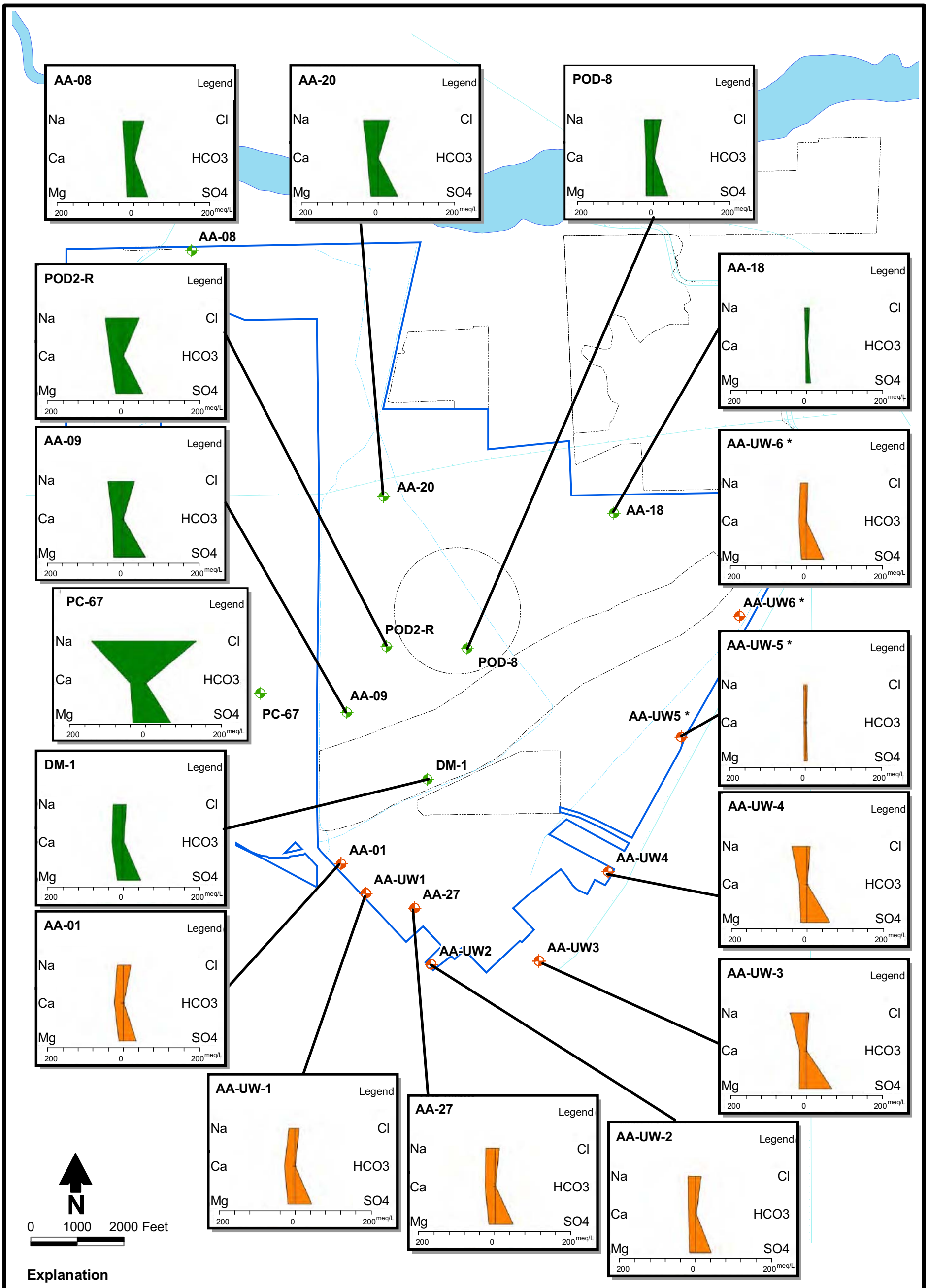
Appendix E

Stiff Diagrams (Shallow/Middle/Deep Zone)

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/REPORTS/D-1_STIFF.MXD 901221



Explanation

- Upgradient wells
- Onsite wells
- Site AOC3 boundary
- meq/L Milliequivalents per liter

Note: 1. Data from 6th Round sampling event (2009).
2. * = Cation-anion balance check does not pass; TDS measured/sum and/or TDS:EC ratio check do not pass

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE E-1
Stiff Polygonal Diagrams
Upgradient Wells and Selected
Onsite (Shallow Zone) Wells

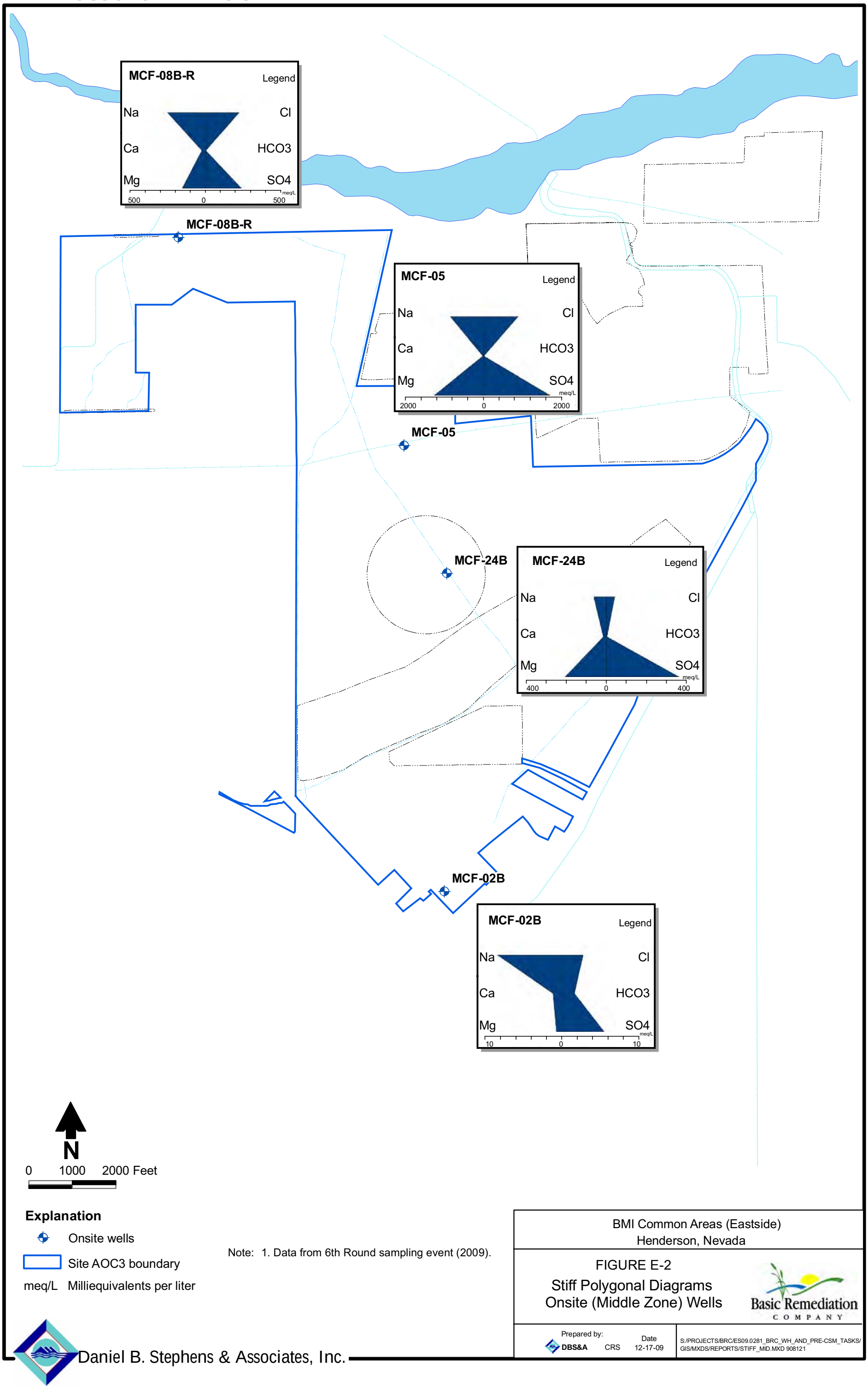
Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-17-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/REPORTS/STIFF.MXD 907121

Daniel B. Stephens & Associates, Inc.

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/REPORTS/D-2_STIFF_MID.MXD 901221



Explanation

- Onsite wells
- Site AOC3 boundary
- meq/L Milliequivalents per liter

Note: 1. Data from 6th Round sampling event (2009).

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE E-2
Stiff Polygonal Diagrams
Onsite (Middle Zone) Wells

Basic Remediation COMPANY

Daniel B. Stephens & Associates, Inc.

Prepared by: DBS&A CRS Date 12-17-09

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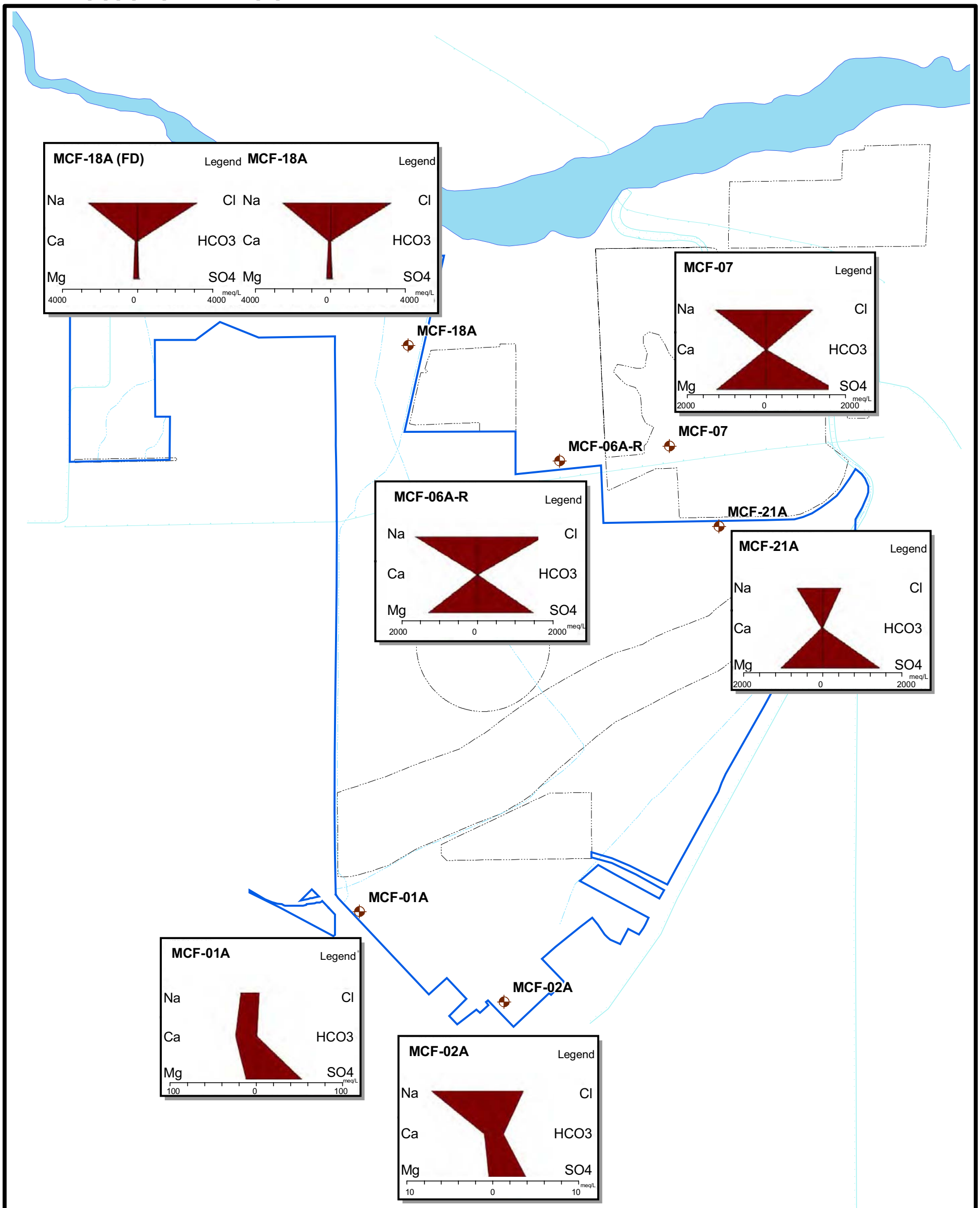
S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/REPORTS/D-3_STIFF_DEEP.MXD 901221



Explanation

- Onsite wells
- Site AOC3 boundary
- meq/L Milliequivalents per liter

Note: 1. Data from 6th Round sampling event (2009).

BMI Common Areas (Eastside)
Henderson, Nevada

FIGURE E-3
Stiff Polygonal Diagrams
Onsite (Deep Zone) Wells

Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 12-17-09

S:/PROJECTS/BRC/ES09.0281_BRC_WH_AND_PRE-CSM_TASKS/GIS/MXDS/REPORTS/STIFF_DEEP.MXD 908121

Daniel B. Stephens & Associates, Inc.