MEMORANDUM

TO: Ranajit Sahu, PhD, Basic Remediation Company

FROM: Stephen J. Cullen, PhD, PG, CEM, Daniel B. Stephens & Associates, Inc.

CC: John J. Dodge, PG, Daniel B. Stephens & Associates, Inc.

DATE: July 30, 2009

SUBJECT: Technical Memorandum – Work Plan for Evaluation of Arsenic Detections in the Western Hook Area Soils, BMI Common Areas (Eastside) Site, Clark County, Nevada (rev 2)

INTRODUCTION AND OBJECTIVES

The Western Hook Development sub-area ("Western Hook Area" or "Site") is one of several sub-areas of the BMI Common Areas (Eastside) located in Clark County, Nevada (Figure 1). The Site encompasses an area of approximately 227 acres (Figure 1). The Site formerly included unexcavated ponds, previously excavated ponds, three ditches and areas that were not used for any known waste disposal (BRC *et al*. 2007).

In August 2008, Basic Remediation Company (BRC) prepared a Sampling and Analysis Plan (SAP) for the Western Hook Area. The purpose of the SAP was to evaluate soil and soil vapor conditions that may have been impacted at the Site from former activities and adjoining lands. As described in the SAP, planned clearing activities were completed prior to collecting soil samples throughout the Site on a systematic sampling basis. Samples were collected over a regular grid overlay across the property with a randomly placed sample within each grid cell. Additional biased sampling locations were selected within or near small-scale contamination points of interests, including but not limited to previous debris locations, ponds, berm walls near previously excavated ponds, and conveyance ditches.

This procedure was planned to provide enough samples for completion of a statistically robust assessment of potential contaminant distribution, and to provide a robust data set upon which to perform a human health risk assessment in support a no further action determination (NFAD) for this area (BRC 2008). The scope of the SAP was limited to soil and soil vapor flux sampling in an effort to assess issues that might directly impact Site development potential consistent with the Closure Plan (BRC *et al*. 2007).

Soil samples were analyzed for a broad suite of analytes, including metals. This work plan addresses the detected concentrations of arsenic (As) in Western Hook Area soils. Arsenic was detected in several surface and subsurface soil samples above the shallow soil background arsenic concentration of 7.2 milligrams per kilogram (mg/kg) (BRC 2009) (Figure 2, Figure 3). (For reference only, the data were also compared to the upper Tertiary Muddy Creek formation

(UMCf) background arsenic concentration of 24.8 mg/kg. Three surface soil samples and four subsurface soil samples exceed 24.8 mg/kg.)

The detected arsenic is considered to be potentially naturally occurring due to its relatively widespread and regular distribution across the Western Hook Area. This work plan outlines BRC's proposal to review and assess the arsenic data in detail concurrent with a review of historical and current site conditions to determine if the detections are site-related (anthropogenic) or naturally occurring. Supplemental laboratory data, described below, will also be collected as part of the analysis. If the impacts are determined to be anthropogenic, then remediation will be required. BRC will implement the scope of work proposed in the work plan across all portions of the Western Hook Area, including the Open Space sub-area (shown on Figure 1). Some areas are already planned for remediation (Figure 2, Figure 3), so additional work due to arsenic may not be proposed at these locations. This plan also addresses comments from the Nevada Division of Environmental Protection (NDEP), dated June 23, 2009 to the work plan dated June 19, 2009 (Appendix A).

PROPOSED SCOPE OF WORK

BRC proposes to complete the following tasks to investigate the arsenic detections in Western Hook Area soils:

- Summarize and evaluate site geology (including pedogenic, hydrogeologic and geochemical site conditions);
- Summarize and evaluate site use history (including potential anthropogenic sources and potential arsenic mobilization and/or accumulation mechanisms); and
- Complete supplemental laboratory analyses.

Task 1 - Site Geology

BRC will summarize the local geology of the area to determine if natural geologic sources of arsenic are present in the area, such as areas of arsenopyrite mineral occurrence or the presence of other arsenic-bearing rocks, minerals or formations. Soil type maps and pedogenic

information from the Natural Resources Conservation Service (NACRES) will be also obtained and reviewed. Available boring logs and analytical data for the existing Site soil samples will be summarized and reviewed to evaluate whether soil appears to be geologically or geochemically unique in this area. Available field logging data (such as moisture content; field pH; color; presence of mottling, gleying, iron nodules/concretions, etc.) will be summarized for inspection.

BRC will also assess the direction of groundwater flow in the area and the variation in depth to groundwater relative to the occurrence of gleying or soil mottling which may indicate poor drainage, low oxidation-reduction potential (redox) conditions, anaerobic or low oxygen conditions, or wetland occurrence.

Task 2 - Site Use History

BRC will review historical aerial photographs for the Site area to delineate the current and past site uses in the area, including buildings, roads, pits, ponds, wetlands, streams, and other site features of interest, such as gravel mining pits and surface water bodies. This task will also include a summary and analysis of the potential impact from the historical discharge from the City of Henderson Wastewater treatment plant (WWTP) ponds. Potential natural and anthropogenic sources and mechanisms of arsenic mobilization and/or accumulation will be reviewed, including:

- Potential past use of arsenic compounds at the BMI plants area and adjacent facilities;
- Ores imported and processed at the BMI plants area;
- Potential regional application of arsenic compounds in a pesticide formulation;
- Subdrains associated with housing or other construction and/or redevelopment projects;
- Potential fill application;
- Past regional surface water drainage patterns;
- Historical gravel pits and mines;

In addition, BRC recognizes that Tamarisk leaf litter could also potentially be a source of relatively high arsenic detected in soil. Arsenic could potentially be bioaccumulated in Tamarisk leaves and redistributed onto soil through leaf litter deposition. A field sampling task will be

completed to address this potential source, as discussed below.

Task 3 - Laboratory Analyses

BRC retained the following soil samples from the prior round of sampling at the Site (Figure 2, Figure 3:

- WHC1-BG05-0
- WHC1-BM06-0
- WHC1-BO10-0
- WHC1-BP04-0
- WHC1-D11-0
- WHC1-P14-0
- WHC1-BH05-10
- WHC1-BK03-12
- WHC1-BN01-12
- WHC1-BO10-10
- WHC1-BP03-11
- WHC1-P10-10

These samples were retained due to their relatively high detected arsenic concentrations. Where data are not already available, selected soil samples from this group will be resubmitted to BRC's contracted analytical laboratory for the following supplemental analyses (Table 1):

- Moisture content (to assist in the evaluation of potential mineral dissolution);
- Grain size (to evaluate the potential presence of clay minerals or re-worked UMCf sediments that may contain a naturally higher concentration of background arsenic);
- pH (to assist in the evaluation of potential mineral dissolution or arsenic speciation);
- Total As (to confirm elevated arsenic detections)
- arsenate (to assist in the evaluation of arsenic speciation and potential vadose zone transport);
- Arsenite (to assist in the evaluation of arsenic speciation and potential vadose zone transport);
- Phosphate (to assist in the evaluation of soil conditions, oxidation-reduction potential, arsenic speciation, and potential vadose zone transport);
- Orthophosphate (to assist in the evaluation of soil conditions, oxidation-reduction potential, arsenic speciation, and potential vadose zone transport);
- Total organic carbon (to assist in the evaluation of potential vadose zone transport);
- Sulfide (to assist in the evaluation of soil conditions, oxidation-reduction potential, arsenic speciation, and potential vadose zone transport);
- Sulfate (to assist in the evaluation of soil conditions, oxidation-reduction potential, arsenic speciation, and potential vadose zone transport);
- Major ions (to assist in the evaluation of soil conditions, oxidation-reduction potential, arsenic speciation, and potential vadose zone transport);
- Monosodium-methylarsonate (CH_3AsO_3HNa) (to assist in the evaluation of arsenic speciation and potential vadose zone transport); and

- Sodium-dimethylarsinate ($(CH_3)_2AsO_2Na$) (to assist in the evaluation of organic arsenic speciation and potential vadose zone transport).

BRC will also complete electron dot mapping for As on the mineral grains from selected soil samples to determine if As-bearing minerals are present. Electron dot mapping is a technique that utilizes scanning electron microscopy (SEM) and energy-dispersive x-ray (EDX) spectrometry to identify the presence of As in a particulate sample. Once the presence of As is confirmed and As is mapped across the soil sample, EDX can be used again at selected points of high As in the sample to determine what other elements are present. An As-bearing mineral species is then inferred from the simultaneous presence of several elements. Available soil samples with the highest As concentrations will be selected for the SEM/EDX analysis.

The results of the supplemental analyses will be evaluated together with the site geology and site use history to try and identify the source(s) of the elevated arsenic detections, as discussed below.

Tamarisk Sampling

BRC will identify an existing live stand of Tamarisk near the Western Hook area so that live leaf and leaf litter sampling can be completed. One sample of live leaves will be collected and a separate sample of leaf litter from the ground will be collected for laboratory analysis. The two samples will be shipped to the laboratory for arsenic analysis. BRC will utilize the data in the interpretation of the origin of the relatively high concentrations of arsenic detected in the Western Hook area soils.

Data Interpretation

BRC will compile the information on area geology from Task 1, the site use history from Task 2, the analytical data from Task 3, and the data from Tamarisk sampling and analysis to develop a conceptual understanding of the arsenic detections in the Western Hook Area. BRC will

interpret the data using multiple, consistent lines of evidence to evaluate if the arsenic detections are naturally occurring or anthropogenic. Data interpretation will be consistent with an approach utilized by Nelson et al (2007) for arsenic detections in groundwater. In Nelson (2007), the following multiple lines of evidence were used to determine whether elevated concentrations of arsenic were due to natural dissolution of arsenic-bearing minerals:

- Historical site use information that did not support any use or disposal of arsenic-bearing materials;
- Available geologic mapping demonstrating the potential presence of arsenic-bearing minerals;
- Microprobe analyses (SEM/EDX) indicating the presence of arsenic-bearing minerals; and
- An evaluation of geochemical data indicating the potential for arsenic mineral dissolution.

BRC will also utilize a multiple-lines-of-evidence approach to evaluate if the arsenic detections are anthropogenic. For example, the following multiple lines of evidence may indicate that the arsenic detections are not naturally occurring:

- Evidence of historical use or disposal of arsenic-bearing materials or products, such as pesticides or treated lumber that are geographically coincident with elevated arsenic detections;
- Evidence of the presence of former unpaved roads or other infrastructure that is geographically coincident with elevated arsenic detections;
- Evidence of past industrial or mining site use in the area that may have concentrated arsenic-bearing materials, such as mine waste tailings or tailings ponds that are geographically coincident with elevated arsenic detections; and
- Evidence of the use of imported fill (geographically coincident with elevated arsenic detections) that may have originally contained elevated arsenic from the fill source.

Reporting

An arsenic evaluation report will be prepared to document the methods and results of the tasks completed for this project. The regional and local geology will be summarized with hydrogeologic and pedogenic information obtained in Task 1. Site use history information obtained in Task 2 will also be summarized and presented in the report with the results of the analytical lab work completed for Task 3. The report will also present the interpretations and conclusions regarding the origin of the relatively high arsenic detections in Western Hook Area soils.

References

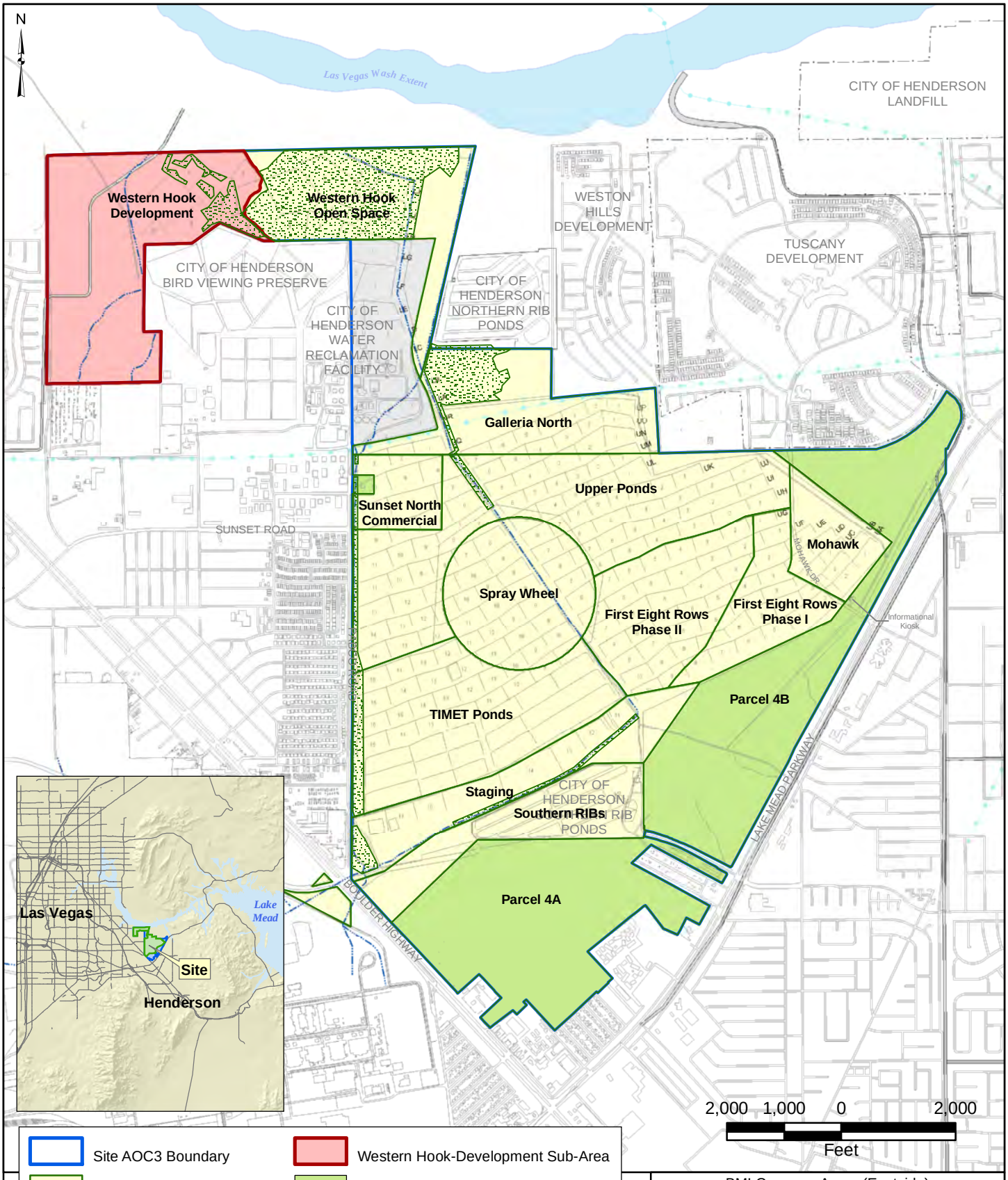
Basic Remediation Company (BRC), Environmental Resources Management (ERM), and Daniel B. Stephens & Associates, Inc. (DBS&A). 2007. Closure plan, BMI Common Areas, Clark County, Nevada. Prepared for Basic Remediation Company (BRC), Henderson, Nevada. May.

BRC. 2008. Sampling and Analysis Plan for the Western Hook Development Sub-Area. BMI Common Areas (Eastside), Clark County, Nevada. August.

BRC. 2009. Draft (in preparation) Soil Background Metals Report, BMI Common Areas (Eastside), Clark County, Nevada.

Nelson, John R., P.G., Gail L. Batchelder, Ph.D., P.G., L.E.P., Mark E. Radville, P.G.1, and Sherry A. Albert, P.E. 2007. Using Multiple Lines of Evidence to Demonstrate that Elevated Arsenic Groundwater Concentrations are Naturally Occurring, in: Kostecki, Paul T., Edward J. Calabrese, and James Dragun, eds. 2007. Annual International Conference on Soil, Sediments and Water, Volume 12 Contaminated Soils, Sediments and Water, Annual International Conference on Soil, Sediments and Water Environmental Health Sciences Department, School of Public Health and Health Sciences, University of Massachusetts, Amherst.

Figures



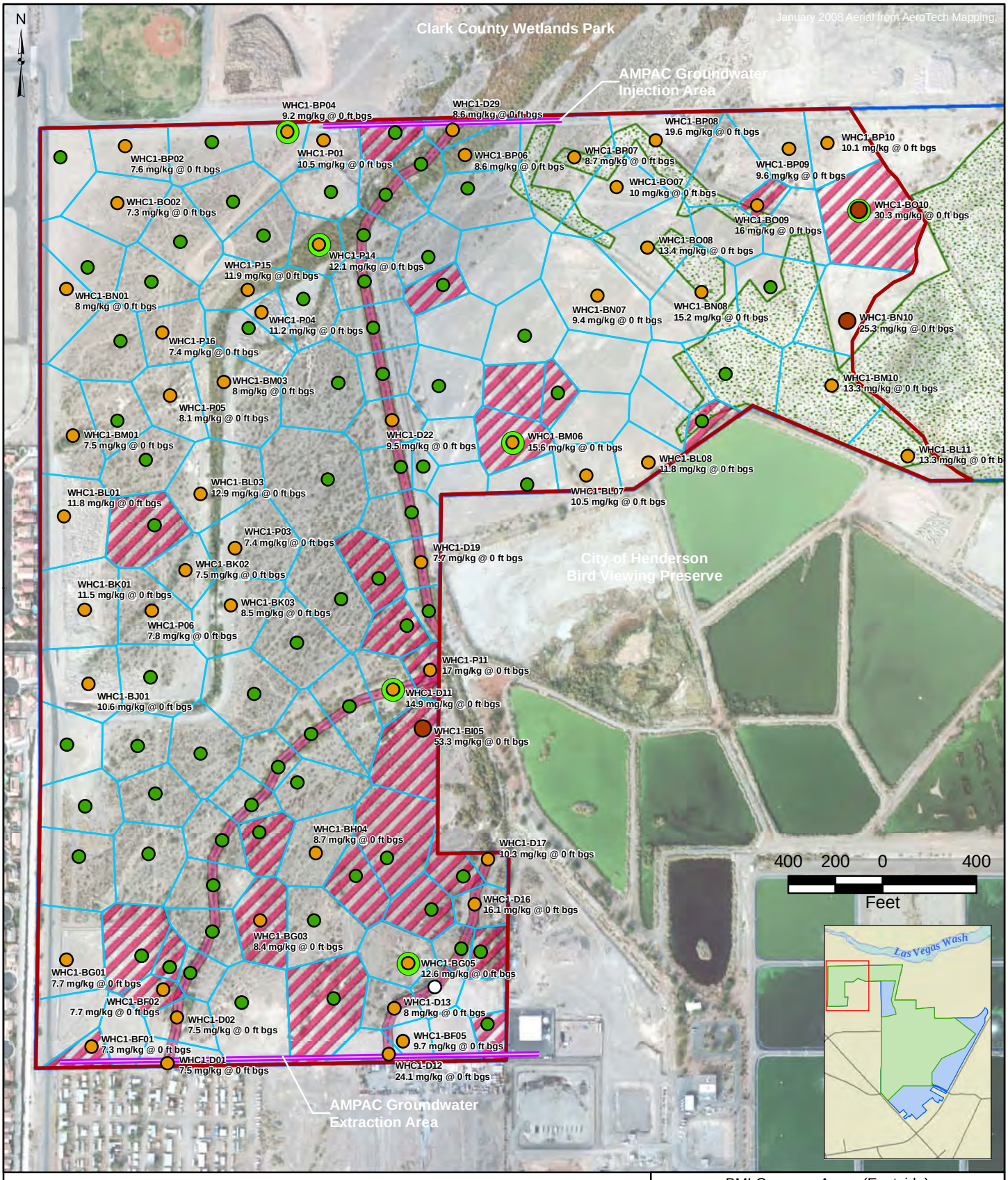
BMI Common Areas (Eastside)
Clark County, Nevada

FIGURE 1

WESTERN HOOK DEVELOPMENT SUB-AREA LOCATION

Basic Remediation Company

Prepared by	Date	JOB No. 0064276
MKJ (ERM)	06/10/09	FILE: GIS/BRC/WH-DEVELOP_SAP/FIGURE_1.MXD



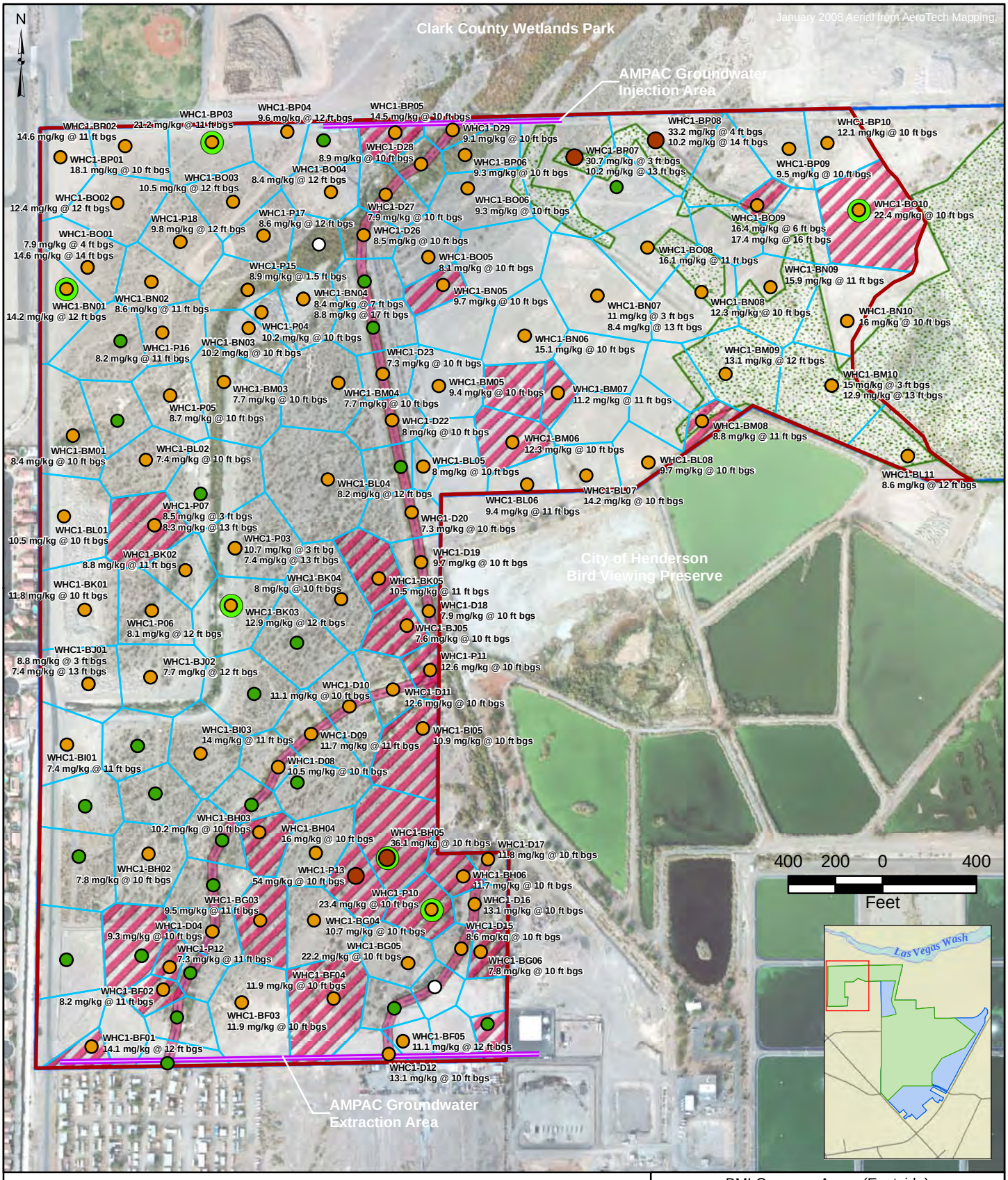
BMI Common Areas (Eastside)
Clark County, Nevada

FIGURE 2

PRELIMINARY ARSENIC RESULTS (SURFACE SOIL)

Basic Remediation Company

Prepared by MKJ (ERM) | Date 06/10/09 | JOB No. 0064276
FILE: GIS/BRC/WH-DEVELOP/FIGURES2-3.MXD



Western Hook-Development Sub-Area
Site AOC3 Boundary
Tamarisk Removal Areas
Preliminary Remediation Areas
Ditch Remediation Areas

Samples Retained for Further Lab Analysis

Arsenic Results

- No Data
- <= 7.2 mg/kg (Shallow Back. Max.)
- <= 24.8 mg/kg (UMCf Back. Max.)
- > 24.8 mg/kg

BMI Common Areas (Eastside)
Clark County, Nevada

FIGURE 3

PRELIMINARY ARSENIC RESULTS (SUBSURFACE SOIL)

Basic Remediation Company

Prepared by MKJ (ERM) | Date 06/10/09 | JOB No. 0064276 | FILE: GIS/BRC/WH-DEVELOP/FIGURES2-3.MXD

Table

Table 1. Soil Analytical Specifications
Western Hook Area Arsenic Evaluation

Parameter of Interest	Analytical Method	Compound List	CAS Number
Ions	EPA 300.0A	Bromide	24959-67-9
		Chlorate	14866-68-3
		Chloride	16887-00-6
		Chlorine (soluble)	7782-50-5
		Chlorite	14998-27-7
		Fluoride	16984-48-8
		Nitrate (as N)	14797-55-8
		Nitrite (as N)	14797-65-0
		Orthophosphate	14265-44-2
		Phosphate	14265-44-2
		Sulfate	14808-79-8
	EPA M1632	Arsenate ion	25537-06-8
	EPA M1632	Arsenite ion	28380-38-3
General Chemistry Parameters	EPA 9040B	pH in soil	pH
	ASTM D2216	Percent moisture	%MOISTURE
	EPA 376.1/376.2	Sulfide	18496-25-8
	ASTM D2216 Method C	Total organic carbon (TOC)	7440-44-0
Metals	EPA 6020/6010B collision cell ICP/MS	Arsenic	7440-38-2
Grain size	ASTM D422	grain size (sieve and hydrometer)	NA
Organic species of Arsenic	EPA M1632	Monosodium methylarsonate (CH_3AsO_3HNa)	2163-80-6
	EPA M1632	Sodium dimethylarsinate ((CH3)2AsO2Na)	124-65-2
As-bearing particles	SEM/EDX	As and other elements	NA

NA - not applicable
SEM/EDX - scanning electron microscopy/energy-dispersive x-ray spectrometry

Appendix A

Responses to Nevada Division of Environmental Protection (NDEP) Comments, dated June 23 2009, to *Technical Memorandum – Work Plan for Evaluation of Arsenic Detections in the Western Hook Area Soils, BMI Common Areas (Eastside) Site (rev 1)*, dated June 19, 2009
NDEP Facility ID# H-000688

1. General comment, based upon BRC's responses and the revised text of the document it is still not clear how BRC will be able to differentiate between naturally occurring arsenic in soils/groundwater and anthropogenic impacts in soils/groundwater. This must be explicitly addressed in the revised document.

Response: The revised document contains a new section entitled, "Data Interpretation" that addresses these issues.

2. General comment, BRC has still not addressed how the scope of work may be applied to the adjacent Open Space sub-area. This must be explicitly addressed in the revised document.

Response: The workplan text has been revised to include this statement in the Introduction and Objectives section: "BRC will implement the scope of work proposed in the work plan across all portions of the Western Hook Area, including the Open Space sub-area (shown on Figure 1)."

3. Introduction, page 3, last paragraph, BRC states "If the impacts are determined to be anthropogenic, then remediation may be required." Please note that this is not a proper statement as the hypothesis should assume that the Site will require remediation to be consistent with the United States Environmental Protection Agency (USEPA) data quality objectives (DQO) process.

Response: The work plan has been edited to include this revision.

4. Appendix A, response-to-comments (RTC), NDEP has the following comments:
    a. Please note that some of the NDEP's comments on BRC's responses are addressed above and will not be repeated herein.

Response: Comment noted.

    b. RTC 3.b., BRC indicates that a meeting will be held to meet with its consultant regarding sampling of Tamarisk leaf litter (and presumably the underlying soils). Since BRC's hypothesis is partially predicated on evapo-concentration of contaminated groundwater it is not clear how this issue can be deferred. In addition, there is no schedule identified to close out this item. This issue must be addressed.

Response: BRC has discussed this issue with Dr. Dale Devitt from the University of Nevada Las Vegas (UNLV). The revised document includes tamarisk leaf and leaf litter sampling to evaluate this potential source.

    c. RTC 4.b., BRC has not fully responded to NDEP's original comment. Thus, NDEP is not clear regarding the purpose of each of the supplemental analyses. Please clarify this matter in the revised document.

Response: The revised document (under Task 3) contains additional text that describes the anticipated output from each of the supplemental analyses.