Atlantic Richfield Company

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January 8, 2016

Lynda Deschambault
Remedial Project Manager, Superfund Division
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street, 10th Street (SFD 7-1)
San Francisco, California 94105

Subject: Response to U.S. EPA Comments on East Fork Carson River Sediment Quality Triad (SQT) Investigation and Transmittal of Draft Off-Property Focused Remedial Investigation Work Plan Addendum No. 4 – Task Sampling and Analysis Plan for Fluvial Deposits Sampling in the East Fork Carson River
Leviathan Mine Site
Alpine County, California

Dear Ms. Deschambault:

Atlantic Richfield Company (Atlantic Richfield) submits this letter in response to comments provided by the U.S. Environmental Protection Agency (U.S. EPA) on the East Fork Carson River (EFCR) Sediment Quality Triad (SQT) Investigation. In addition, this letter transmits Off-Property Focused Remedial Investigation Work Plan, Addendum No. 4 – Task Sampling and Analysis Plan for Fluvial Deposits Sampling in the East Fork Carson River. The previous EFCR SQT investigation and the proposed sampling of fluvial deposits in the EFCR described in the enclosed TSAP are being performed in partial fulfillment of the requirements of the Statement of Work attached to the Administrative Order for Remedial Investigation and Feasibility Study (Unilateral Administrative Order), Comprehensive Environmental Response, Compensation, and Liability Act Docket No. 2008-18 issued by the U.S. Environmental Protection Agency (U.S. EPA) on June 23, 2008.

Atlantic Richfield submitted the results of the EFCR SQT investigation in a Technical Memorandum[1] dated January 30, 2015. The U.S. EPA transmitted comments on the investigation in a letter dated August 19, 2015, and requested that Atlantic Richfield perform "*a geomorphic analysis of sediment accumulation areas along the EFCR sufficient to identify bed load deposits downstream to at least the Ruhenstroth Dam site.*" In addition, the U.S. EPA requested that Atlantic Richfield provide written responses to their August 19 comments along with the results of the geomorphic analysis and recommendations for sampling. In a letter dated

[1] Atlantic Richfield, 2015, Technical Memorandum – Sediment Quality Triad Investigation, Leviathan Mine Site, Alpine County, California. Prepared by AMEC Environment and Infrastructure, Inc., January 30.

October 19, 2015, Atlantic Richfield indicated that they would submit responses to U.S. EPA comments and a Task Sampling and Analysis Plan (TSAP) containing the results of the geomorphic analysis and recommendations for additional sediment sampling based upon the geomorphic analysis. The TSAP for the additional sampling is enclosed with this letter as Addendum No. 4 to the Off-Property Focused Remedial Investigation Work Plan. Responses to U.S. EPA comments on the Technical Memorandum describing the EFCR SQT investigation are repeated below and are followed by Atlantic Richfield's responses in bold font.

U.S. EPA General Comment:

G1. Nature and Extent: As noted in the comments repeated above, EPA agreed to the SQT sampling as a preliminary evaluation of potential Leviathan Mine impacts to EFCR. The findings in the report represent the upper 10 cm (4 inches) of sediment. While suitable for assessing the current impacts (if any) of this active sediment layer on benthic macroinvertebrates, these existing data do not allow evaluation of deeper accumulated bed load sediment that likely includes material from Leviathan Mine deposited between 1952 and the present.

Please provide a geomorphic analysis of sediment accumulation areas along EFCR sufficient to identify bed load deposits downstream to at least the Ruhenstroth Dam site. For example, evaluate a series of aerial images made through time to identify those bed forms (such as point bars and longitudinal bars) that were present since 1952, and conduct field reconnaissance to confirm their presence and assess field sampling conditions. The analysis should consider EFCR both up- and downstream from areas potentially affected by Leviathan Mine. Additional characterization of the sediment accumulation areas per the RI statement of work (Section IA2 e. and f.) should be conducted to determine the impacts of Leviathan Mine on EFCR sediment.

Response:

Atlantic Richfield has prepared the enclosed TSAP for additional sampling of fluvial deposits in the EFCR to address this comment and the other broader requirements of the Statement of Work (specifically Sections IA2 e. and f). The scope of work described in the TSAP includes the sampling of deeper fluvial deposits identified through a geomorphic analysis of bedforms in the EFCR using historic aerial photographs as requested by the U.S. EPA. This geomorphic analysis is presented in Appendix B of the enclosed TSAP.

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Response:

Comment acknowledged; the shaded cells on Table 5 highlight p-values of < 0.05 which reflect a significant difference between the populations being compared. The notes on Table 5 and tables in future data submittals will be corrected accordingly.

If you have any questions or comments, please feel free to contact me at (714) 228-6770 or anthony.brown@bp.com.

Sincerely,

Anthony R. Brown
Project Manager, Mining

[Enclosure/Attachment]

cc: Gary Riley, U.S. Environmental Protection Agency, Region 9 – via electronic copy
John Hillenbrand, U.S. Environmental Protection Agency, Region 9 – via electronic copy
Douglas Carey, Lahontan Regional Water Quality Control Board – via electronic copy
Nathan Block, Esq., BP – via electronic copy
Adam Cohen, Esq., Davis Graham & Stubbs, LLP – via electronic copy
Sandy Riese, EnSci, Inc. – via electronic copy
Marc Lombardi, Amec Foster Wheeler Environment & Infrastructure, Inc. – via electronic copy
Grant Ohland, Ohland HydroGeo, LLC – via electronic copy
Dave McCarthy, Copper Environmental Consulting – via electronic copy
Cory Koger, U.S. Army Corps of Engineers – via electronic copy
Greg Reller, Burleson Consulting – via electronic copy
Ken Maas, U.S. Forest Service, Humboldt-Toiyabe National Forest – via electronic copy and hard copy
Lynelle Hartway, Esq., Washoe Tribe of California and Nevada – via electronic copy

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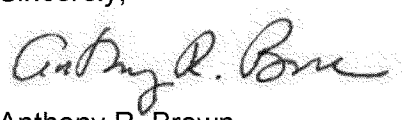

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DRAFT

OFF-PROPERTY AREA FOCUSED REMEDIAL INVESTIGATION WORK PLAN ADDENDUM NO. 4 – TASK SAMPLING AND ANALYSIS PLAN FOR FLUVIAL DEPOSITS SAMPLING IN THE EAST FORK CARSON RIVER

Leviathan Mine Site

Alpine County, California

Submitted to:

Atlantic Richfield Company
La Palma, California

Submitted by:

Amec Foster Wheeler
Environment & Infrastructure, Inc.
Rancho Cordova, California

January 8, 2016

Project No. 0013091150

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LIST OF ABBREVIATIONS AND ACRONYMS

Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
APE	Area of Potential Effect
Atlantic Richfield	Atlantic Richfield Company
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chain of custody
^{137}Cs	Cesium 137
DQO	Data Quality Objective
EFCR	East Fork Carson River
FRI	focused remedial investigation
GPS	global positioning system
HSSE	Health, Safety, Security, and Environmental
mL	milliliter
MS/MSD	matrix spike/matrix spike duplicate
NHPA	National Historic Preservation Act
PA	Programmatic Agreement
QAPP	Quality Assurance Project Plan
^{210}Pb	Lead 210
RI/FS	Remedial Investigation and Feasibility Study
^{222}Rn	Radon 222
SAP	Sampling and Analysis Plan
SHPO	State Historic Preservation Office/Officer
SOP	standard operating procedure
SOW	Scope of Work
SQT	Sediment Quality Triad
TRA	task risk assessment
TOC	total organic carbon
TSAP	Task Sampling and Analysis Plan
UAO	Unilateral Administrative Order
U.S. EPA	U.S. Environmental Protection Agency
USCS	Unified Soil Classification System

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OFF-PROPERTY AREA FOCUSED REMEDIAL INVESTIGATION WORK PLAN ADDENDUM NO. 4 – TASK SAMPLING AND ANALYSIS PLAN FLUVIAL DEPOSITS SAMPLING IN THE EAST FORK CARSON RIVER

Leviathan Mine Site
Alpine County, California

1.0 INTRODUCTION

Atlantic Richfield Company (Atlantic Richfield) has prepared this Off-Property Focused Remedial Investigation Work Plan (Off-Property FRI Work Plan) Addendum No. 4 to guide sampling and analysis activities for characterizing fluvial deposits along the East Fork Carson River (EFCR) (Figure 1). Fluvial deposits are defined for the purpose of this document as bedforms, terraces, abandoned channel features, and other unconsolidated material within the high stage of the EFCR. Conditions in a reach of EFCR downstream from the Leviathan Mine Site (site), that is between the remnants of the former Ruhenstroth Dam and the confluence with Bryant Creek (Downstream Reach), will be compared to conditions in a reach of the EFCR upstream from the potential influence of runoff, from the confluence with Bryant Creek and the River Ranch property (Upstream Reach), as part of an evaluation of potential effects of the site on the EFCR (Figure 1). Addendum No. 4 was prepared in response to comments and requests from the U.S. Environmental Protection Agency (U.S. EPA) in an August 10, 2015 letter titled *EPA Comments on Draft Technical Review of January 30, 2015, East Fork Carson River Sediment Quality Triad Investigation and Response to Request for Sediment Quality Triad Memorandum, Leviathan Mine Site, Alpine County, California*. The Off-Property FRI Work Plan (Atlantic Richfield, 2012) is being implemented in partial fulfillment of the requirements of the Statement of Work (SOW) attached to the Administrative Order for Remedial Investigation and Feasibility Study (RI/FS) (Unilateral Administrative Order [UAO]), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Docket No. 2008-18 issued by the U.S. EPA on June 23, 2008 (U.S. EPA, 2008).

Characterization activities described in the Off-Property FRI Work Plan Addendum No. 2 (Atlantic Richfield, 2013) are being amended by the investigation activities described in this Addendum No. 4 to the Off-Property FRI Work Plan. Addendum No. 4 presents the plan for characterizing fluvial deposits in the Downstream and Upstream Reaches of the EFCR and serves as the Task Sampling and Analysis Plan (TSAP) for the investigation activities described herein.

2.0 PURPOSE

The SOW attached to the UAO states that "existing programs [should be reviewed] to characterize surface water bodies in the Study Area and design additional work to fill data gaps. " Section 2e of the SOW states that characterization of sediment and depositional areas in the EFCR downstream from the Leviathan Mine Site should include the following:

I. Deposition area (including distance downstream and flood plain/bank deposition);

II. Thickness profile;

III. Physical and chemical parameters including grain size, density, organic carbon content, pH, contaminant concentration such as metals and arsenic;

IV. Contaminant mobility, bioavailability, transport potential and acid generation potential for in-stream sediment and flood plain deposits.

Section 2f of the SOW addresses evaluation of sediments at the former Ruhenstroth Dam site, stating that:

> "…coring, age dating and chemical analyses of these sediments would allow evaluation of sediment chemistry through time from the pre-open pit mining to post open pit mining periods at Leviathan Mine. This information shall be used to evaluate impacts of Leviathan Mine on the EFCR sediments and the potential for Leviathan Mine pollutants in other depositional areas in the watershed below Leviathan Mine. "

Section 2f further states that characterization of these sediments shall include:

I. Measurement of stratigraphic sections;

II. Age dating of sediments;

III. Chemical analysis of sediments;

IV. Visual description of the sediments

V. The U.S. EPA also suggested that it may be possible to develop geochemical indicators of Leviathan Mine waste impacts on sediment in the EFCR.

Atlantic Richfield conducted a Sediment Quality Triad (SQT) investigation in 2012 and 2013 to supplement and update a prior EFCR evaluation prepared by Gradient Corporation in 2002 (Gradient, 2002). The 2002 study was conducted as part of the assessment work completed in response to the Administrative Order for Early Response Actions and Remedial Investigation

and Feasibility Study, CERCLA Docket No. 2001-05. The U.S. EPA provided comments on the SQT study in their August 10, 2015 letter and indicated that the U.S. EPA regarded the SQT investigation as a preliminary evaluation of potential effects of Leviathan Mine on the EFCR. U.S. EPA requested Atlantic Richfield to identify fluvial deposit structures within the river that would potentially contain sediments present since 1952, after the onset of open pit mining.

In its August 2015 letter, the U.S. EPA requested the following:

> "Please provide a geomorphic analysis of sediment accumulation areas along EFCR sufficient to identify bed load deposits downstream to at least the former Ruhenstroth Dam site. For example, evaluate a series of aerial images made through time to identify those bed forms (such as point bars and longitudinal bars) that were present since 1952, and conduct field reconnaissance to confirm their presence and assess field sampling conditions. The analysis should consider EFCR both up- and downstream from areas potentially affected by Leviathan Mine. Additional characterization of the sediment accumulation areas per the RI statement of work (Section IA2 e. and f.) should be conducted to determine the impacts of Leviathan Mine on EFCR sediment. "

The activities described in this TSAP address the U.S. EPA's requirements identified in the UAO SOW and their August 10, 2015 letter.

3.0 PREVIOUS STUDIES

Numerous studies have evaluated concentrations of metals in water, fluvial deposits, stream sediment, animal tissue, and/or plant tissue in the Bryant Creek watershed and the EFCR. These studies include:

- Draft Technical Memorandum – East Fork Carson River Sediment Quality Triad Investigation (Atlantic Richfield, 2015a)
- Leviathan Mine Floodplain Soil and Riparian Vegetation Study (Evans and JBR, 2004)
- Preliminary Human Health and Ecological Risk Evaluations – East Fork Carson River near Bryant Creek (Gradient, 2002)
- Methylmercury in Water and Bottom Sediment along the Carson River System (Hoffman and Thomas, 2000)
- Data on Stream-Water and Bed-Sediment Quality in the Vicinity of Leviathan Mine (Thomas and Lico, 2000)

- Data Report for the Leviathan Mine Study Area: Water and Sediment Toxicity Testing and Benthic Community Data (ENSR, 1999a)
- Assessment of the Leviathan Mine Study Area, Appendix F: Toxicity of Whole Sediment from the Leviathan Mine Study Area to Hyalella azteca Under Static-Renewal Conditions (ENSR, 1999b)
- Trace-element Enrichment in Streambed Sediment and Crayfish, Carson and Truckee Rivers (Lawrence, 1997)

The media investigated, the methods employed, and the areas investigated varied between these previous studies. In spite of the differences between these studies, the results generally show that:

- Concentrations of some analytes were higher at some locations downstream from the site than in reference areas, but there was not a consistent pattern between all analytes and all downstream locations.
- The inputs of constituents of potential concern from the site do not have a detectable effect on stream sediment chemistry, toxicity to aquatic organisms, or on the benthic community in EFCR.
- Concentrations of metals are typically greater in fine-textured material than in coarse textured material.

The investigation described in this TSAP will evaluate fluvial deposits in the EFCR, as opposed to localized stream sediment sampling that was conducted in support of the Sediment Quality Triad investigation. For the purposes of this TSAP, stream sediment refers to saturated sediment in the currently active river channel. Fluvial deposits refer to material within the relatively recent stream channel that are outside of the saturated sediment in the currently active river channel. Sample collection activities will focus on fine textured material at all sampling locations. Fine textured materials are likely to have higher concentration of metals, based on historical studies, and are considered more representative than coarse textured materials for ecological risk assessment. Characterizing fluvial deposits using samples that have similar texture at all sampling locations will improve the degree that samples from different locations are comparable to each other.

4.0 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) (Table A1, Appendix A) developed for this investigation are consistent with the DQOs developed for On-Property fluvial deposits sampling in On-Property FRI Work Plan Amendment Nos. 8 and 10 (Atlantic Richfield, 2015 a, b) and address present conditions along the EFCR. The DQOs are consistent with the format and content agreed upon in discussions between the U.S. EPA, their consultants, and Atlantic Richfield during a multi-day

meeting held in September 2012. The DQOs in Table A1 were developed using the seven-step process described in *Guidance on Systematic Planning Using the Data Quality Objectives Process* (U.S. EPA 2006).

The investigation described in this TSAP is designed primarily to evaluate potential differences in concentrations of RI/FS metals[1], total organic carbon, acid-base account (ABA), acid volatile sulfides/sequentially extracted metals (AVS/SEM), and pH in fluvial deposits between Upstream and Downstream Reaches of the EFCR.

Based upon its location in the EFCR watershed, the Upstream Reach is not potentially affected by materials derived from the Leviathan Mine. The Downstream Reach of the EFCR is below (downstream from) where Bryant Creek flows into the EFCR. Leviathan Mine is located within the Bryant Creek watershed. Hence, materials (water, solutes, and solids) derived from the Leviathan Mine could potentially be transported via Bryant Creek and its tributaries to the EFCR. Mines or mineralized deposits upstream from the confluence of Bryant Creek with the EFCR could also contribute to deposits in the Downstream Reach.

If concentrations of metals and other constituents in the Downstream Reach are the same as or lower than in the Upstream Reach, then that finding would indicate that the Leviathan Mine and other sources in the Bryant Creek watershed have not adversely affected fluvial deposits in the Downstream Reach. If concentrations are higher in the Downstream Reach than in the Upstream Reach, then that would indicate that materials derived from some source(s) in the Bryant Creek watershed contribute to the elevated concentrations. The source may or may not be the Leviathan Mine, and additional information from Bryant Creek and its tributaries would be needed to evaluate the relative importance of the Leviathan Mine and other potential sources (e.g. mineralized areas or other mines).

5.0 SCOPE OF WORK AND APPROACH

This section describes the scope of work to be performed to meet the objectives described in Section 4.0. When spring flows in EFCR have receded sufficiently to allow safe access to proposed sampling locations, sample collection and characterization can proceed. An aerial imagery evaluation performed to select general sampling locations is discussed in the following sections.

[1] Aluminum, antimony, arsenic, barium, beryllium, cadmium, total chromium, hexavalent chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, thallium, vanadium, and zinc (AMEC Geomatrix, Inc., 2010).

5.1 OVERVIEW OF APPROACH

The overall goal of the characterization activities described herein is to provide information for assessing possible effects of sediment transport and chemical precipitation from surface water flows originating at the LMS on the EFCR Downstream Reach. Bryant Creek drains the watershed in which the LMS is located and hence is a pathway by which material may be transported from the LMS to the EFCR. Therefore, potentially significant effects of the LMS on the EFCR would be confined to the reach downstream from where Bryant Creek enters the EFCR. The Downstream Reach extends downstream to the former Ruhenstroth Dam site. The dam was damaged by floods beginning in 1937, and only remnants of the dam remain. Deposits likely accumulated in the reservoir that formerly existed upstream from the dam, and may still be present in terrace deposits upstream from the dam site. The UAO-SOW requires that sediments at the former Ruhenstroth Dam site be characterized, as well as material farther upstream from the dam site.

The more focused objective of the activities described in this TSAP is to characterize concentrations of RI/FS metals potentially derived from the LMS (i.e. solutes adsorbed onto fluvial particles, chemical precipitate from surface water (e.g., *yellow boy*), and solids transported from the LMS via Aspen, Leviathan, and Bryant Creeks and discharged into the EFCR) ultimately residing in in fluvial deposits in the Downstream Reach. For comparison purposes, concentrations in the Upstream Reach that could not be affected by the LMS will also be characterized. RI/FS metals concentrations will be compared between downstream and upstream locations. If concentrations in Upstream and Downstream Reaches are not significantly different, or lower concentrations are present in the Downstream Reach, these results would indicate that the LMS had no significant effect on the EFCR. In contrast, significantly higher concentrations in the Downstream Reach would suggest that the LMS or other upstream sources had a significant effect on the EFCR. Additional investigations in the Bryant Creek watershed would be required to rule out other potential sources (such as other mines or mineralized areas) to support a conclusion that the LMS was the cause of increased concentrations of RI/FS metals in the Downstream Reach.

The Downstream Reach extends from Bryant Creek downstream to the former Ruhenstroth Dam. The Upstream Reach extends from the vicinity of Markleeville, California downstream to approximately Cottonwood Creek. The downstream limit of this reach is well upstream from Bryant Creek and the River Ranch; hence, it is possible that irrigation return flow could have introduced LMS-derived materials into the EFCR upstream from the Bryant Creek confluence.

The general activities associated with performing the investigation are listed below. The sections of the SOW relevant to each bullet are listed parenthetically:

- Evaluate historical aerial imagery to identify fluvial bedforms and select potential sampling locations in the Upstream and Downstream Reaches (SOW 2e I);
- Conduct field reconnaissance along the EFCR to evaluate geologic interpretations based upon aerial imagery, to evaluate access and other field constraints, and to finalize selection of sampling locations (SOW 2e I);
- Collect and analyze samples to characterize concentrations of RI/FS metals and other constituents in EFCR fluvial deposits in the Upstream and Downstream Reaches (SOW 2e III, 2f III);
- Characterize the stratigraphy of fluvial deposits near the former Ruhenstroth Dam (SOW 2e II, 2f I, 2f IV);
- Perform radiometric dating on selected fluvial deposits samples near the former Ruhenstroth Dam site, and if possible, identify fluvial deposit locations deposited after open pit mining began at the site (SOW 2f II);
- Perform a statistical analysis of analyte concentrations in fluvial deposits samples from the Upstream Reach to establish reference concentrations for the EFCR fluvial deposits (2e IV); and,
- Compare analyte concentrations in fluvial deposits samples from the Downstream Reach to reference concentrations in the Upstream Reach, and draw conclusions regarding analyte concentrations in the Downstream Reach relative to those in the Upstream Reach. Conclusions would include results from evaluation of potential mobility, transport potential, and acid generation potential of the fluvial deposits (2e IV).

The fluvial deposit chemistry, toxicity, and bioavailability will be evaluated. Atlantic Richfield's approach for analyzing and characterizing sediment chemistry, toxicity, and bioavailability was thoroughly discussed in the Triad Technical Memorandum (Atlantic Richfield, 2015a). The same approach will be used in this EFCR Fluvial Deposits Investigation. The AVS/SEM analytical method uses the concentration of acid volatile sulfide (AVS) to predict the potential toxicity of divalent metals in sediment (Di Toro et al. , 1992; Ankley et al. , 1996). The rationale is that the AVS present in sediment reacts with the simultaneously extracted metal (SEM). This reaction forms an insoluble metal sulfide that is not available for uptake by benthic organisms. The ratio of sum of the molar concentration of SEM divalent metals (ΣSEM) divided by the molar concentration of AVS provides a measure of whether divalent metals are bioavailable. If the ΣSEM:AVS ratio is less than 1, there is no excess ΣSEM available to cause toxicity. If the ratio is greater than 1, divalent metals are bioavailable, but the prediction of effects upon benthic organisms depends upon the magnitude of the bioavailable fraction. Based upon a compilation of laboratory spiked sediment studies and field studies, McGrath et al. (2002) reported that no effects were observed at ΣSEM:AVS ratios less than 1; prediction of effects is uncertain for ratio values between 2 and 40; and ratio values above 40 often showed effects.

The AVS/SEM data will be used to supplement prediction of toxicity based on total metals concentrations. If the total concentration of a divalent metal is greater than the sediment probable effect level (PEL) for benthic invertebrates and the ΣSEM:AVS ratio is greater than 2, then we would conclude that there is potential for toxicity to benthic organisms that reside in that sediment due to that metal. However, if the ΣSEM:AVS ratio is less than 2, then it would be concluded that the >PEL concentration for that metal would not be toxic to benthic organisms. If the total concentration of a divalent metal is greater than the sediment PEL for benthic invertebrates and the ΣSEM:AVS ratio is greater than 40, then we would conclude that potential adverse effects to benthic organisms are likely. As described in the Ecological Risk Assessment Work Plan (Atlantic Richfield, 2015d), Atlantic Richfield is also planning to assess metals toxicity in sediments using a weight of evidence (i.e., sediment quality triad) approach utilizing data on bulk sediment chemistry, bioassay testing, and benthic macroinvertebrate community monitoring at selected locations downstream of the Leviathan Mine site.

5.2 PRELIMINARY SELECTION OF SAMPLING LOCATIONS

Historical and recent aerial imagery was evaluated to identify fluvial bedforms along the EFCR for potential sampling locations. The results of the geomorphic evaluation of historical aerial images are presented in Appendix B of this TSAP. The imagery evaluation was performed to identify locations where bedforms have been present since approximately 1952 (beginning of site open pit mining) as these areas could potentially contain mine-related materials.

Spatial variation in constituent concentrations in natural geologic materials such as fluvial deposits is strongly influenced by local lithology. The Geologic Atlas of California (Department of Conservation, 2015) shows that the lithology along the subject reaches of the EFCR consists of Pliocene volcanic rocks, primarily andesite, except near the upper reaches of Markleeville Creek and Pleasant Valley Creek, where the terrain is dominated by Mesozoic granitic rocks. However, the Upstream Reach will not extend upstream from the Pliocene volcanic terrain so that fluvial deposits samples collected from the Upstream and Downstream Reaches will be comparable; both are in volcanic terrain.

Aerial imagery was analyzed by comparing large bedforms in and near the EFCR from 1954 to 2015 to identify three types of features as potential sampling locations:

- Fluvial terrace deposits immediately upstream from the former Ruhenstroth Dam.
- Former channels in the downstream reach that have been abandoned since 1952 (due to the river changing its course) and, hence, may contain some material deposited after 1952 as they were slowly filled in during periodic high flow events.

- Fluvial bedforms in the Upstream Reach of EFCR that have been present for decades.

Fluvial deposits immediately upstream from the former Ruhenstroth Dam may contain material that was deposited in the reservoir formed by the dam. The upper terrace is assumed to contain sediments deposited before the dam was damaged during the 1937 flood. The lower terrace is assumed to correspond the greatly reduced pooling level before the nearly complete destruction of the dam in the 1997 flood and subsequent demolition later that year. If these terraces represent reservoir deposits, this material will likely have finer texture than fluvial deposits deposited elsewhere along EFCR due to the lower flow velocity that would have existed in the reservoir. Fine texture soil will be targeted for characterization because concentrations of metals are typically higher in the fine texture fraction of deposits than in the coarse fraction.

Stream channels that were abandoned since 1952 have likely been partially filled by fluvial material deposited during periodic high flow events. Hence, shallower material in abandoned channels, particularly finely textured material, is likely of fairly recent origin.

In the Upstream Reach, there is no need to preferentially sample more recent material, although the bedforms and texture of material sampled in the Upstream and Downstream Reaches should be similar. Stable fluvial bedforms in the Upstream Reach likely contain fluvial deposits that were deposited over a relatively long period – decades to centuries – in the interior of the feature, and material that was more recently deposited along the margins. Many large point bars and longitudinal bars appear to be quite stable and may long predate excavation of the Leviathan Mine Pit. Although sediment transport is extremely active in this river (Katzer and Bennett, 1980), the apparent stability of these large bars suggests that either these large bars exist in dynamic equilibrium with the river (actual sediments may change while the overall bedform is stable), or that redistribution of sediments is limited primarily to the margins of these features. The primary reason for identifying stable bedforms in the Upstream Reach is to facilitate planning a sampling program; features that have been stable for long periods are likely to remain stable over the time scale in which a characterization plan can be developed and implemented.

In the Downstream Reach, two sampling transects were identified slightly upstream from the former Ruhenstroth Dam site (Figure 2), and two sampling transects were identified in abandoned channels (Figure 3). In the Upstream Reach, two sampling transects were identified at a stable bar near the mouth of Cottonwood Creek (Figure 4), and two sampling transects were identified at a stable bar near Markleeville, California (Figure 5). Samples will be collected at approximately both ends and the middle of each transect. Transect locations and sampling

locations on each transect will be adjusted as appropriate based upon field conditions and possible identification of fluvial structures during field reconnaissance.

5.3 FIELD RECONNAISSANCE

Field reconnaissance will be performed to evaluate the preliminary sampling transect locations identified based upon aerial imagery evaluation. Field personnel will drive to the nearest access points and proceed along the river on foot to reconnoiter specific sampling locations.

The preliminary sampling locations identified based upon evaluation of aerial imagery (Section 5.1) will be examined during field reconnaissance. The preliminary locations will be accepted or revised based upon access considerations and geologic conditions. The most protected, low energy environment locations along a given bedform deposit will be sought as collection points, if these can be discerned, because these locations should yield finer-grained sediments that are targeted for sampling. As previously stated, concentrations of metals are typically greater in fine-grained sediments than in coarse-grained sediments. This pattern was observed in previous studies of sediment/fluvial deposits in the EFCR and the Bryant Creek watershed. Hence, preferentially targeting fine-grain sediments for sampling and analysis in this investigation will provide information representative of the potential highest metal concentrations.

In general, transects will start approximately 5 to 10 feet from the active channel and run perpendicular to the main channel to a point where topography begins to obviously increase in elevation by several feet. Three sampling locations will be chosen along each transect, at both the ends and the midpoint. Although efforts will be made to choose similar types of upstream and downstream sampling locations, there is no reference area (upstream) analogue to the reservoir that formerly existed behind the former Ruhenstroth Dam.

5.4 FLUVIAL DEPOSITS SAMPLE COLLECTION

The approach to the collection of samples of fluvial deposits in the EFCR is as follows:

- At every sampling location, collect continuous soil core samples from ground surface to a maximum depth of 6 feet or drilling refusal, whichever is shallower. This maximum depth is based upon historical reporting that almost all of the sediment behind the former Ruhenstroth Dam was scoured during the 1997 flood on the EFCR (Las Vegas Sun, 1997).

- Examine the core sample, classify the lithologic units according to the Unified Soil Classification System (USCS) using visual/manual methods. Record the results on a separate log for each corehole.

- If possible based upon visual/manual soil classification, identify stratigraphic units that have finer texture than other units in the core.

- Collect discrete soil samples at each sampling location at depths of approximately 0 to 0.5 feet, 1.5 to 2.0 feet, and 5 to 6 feet, or to refusal if shallower than 6 feet. If fine-textured material has been identified based upon visual/manual methods, then collect samples from the fine-textured units instead of sampling at the fixed depth increments.

- Collect one sample at each transect for grain size analysis.

- Except for samples to be analyzed for grain size and radiometric dating, field sieve discrete samples with 2 mm mesh and discard the fraction greater than 2 mm so that Upstream and Downstream Reaches samples are more comparable.

- Except for samples to be analyzed for grain size and radiometric dating, direct the laboratory to sieve discrete samples with 63 micrometer mesh. The bulk fraction will be defined as the unsieved (i.e., less than 2 mm grain size). The fine fraction will be defined as the less than 63 micro meter grain size.

- Except for samples to be analyzed for grain size and radiometric dating, conduct laboratory analysis on the bulk and fine fractions of the discrete samples for constituents listed in Tables 1 and 2 to support geochemical characterization of fluvial deposits. The locations, numbers of samples, and methods for analysis are described in Section 6.0. Sample identifiers, analytical methods, and the associated sample containers, sample volumes, preservation requirements are identified in Table 2.

- At one sampling location on a sampling transect near the former Ruhenstroth Dam site, collect samples for radiometric analysis to estimate the apparent age of the samples. The radioisotopes to be used for evaluating depositional age have been selected because their radioactive decay half-lives are consistent with the ages of interest for the fluvial deposits being characterized. The laboratory will select the intervals for analysis in consultation with Atlantic Richfield based upon visual examination of the cores and field logs provided.

- At one sampling location on a sampling transect in the Upstream Reach, collect samples for radiometric analysis to estimate the apparent age of the samples.

Coring methods may consist of using a hand auger, manual soil probe (e.g., AMS Multi-Stage Soil Core Sampler, or similar), a hand-held mechanized coring device, or other mechanized means commensurate with the particular sampling locations and ability to sample safely. The specific methods and equipment will be selected using professional judgement based upon field conditions consisting of access, terrain, and vegetation constraints; on safely mobilizing equipment and materials; and the ability of soil to support mechanized equipment.

5.5 FLUVIAL DEPOSITS AND STRATIGRAPHY CHARACTERIZATION

A field geologist will examine each core sample and classify the lithologic units using the USCS visual/manual methods. The information will be recorded on a separate log for each corehole. Information from coreholes will be used to interpret the stratigraphy for the fluvial deposits near the former Ruhenstroth Dam, other transects in the Downstream Reach, and in the Upstream Reach. One stratigraphic column will be constructed that summarizes the stratigraphy of the fluvial deposits for the Downstream Reach.

5.6 FLUVIAL DEPOSITS DATING

Open pit mining and related surface disturbances at the Leviathan Mine commenced in 1952. Visual/manual methods that will be used in the field to describe core samples cannot differentiate between fluvial material deposited before or after the onset of open pit mining in 1952. Therefore, an alternative method of characterizing the age of fluvial horizons along EFCR may be useful to exclude intervals below some depths as potentially influenced by materials (water, solutes, and solids) derived from the Leviathan Mine.

As noted in Section 2.0, U.S. EPA directed Atlantic Richfield to characterize the age of sediment deposited in the vicinity of the former Ruhenstroth Dam. Atlantic Richfield assumes that the rationale for dating fluvial deposits is to differentiate between materials deposited before versus after the onset of open pit mining at LMS. Differentiating pre- and post-mining age materials would provide a basis for comparing material that is young enough to have been potentially impacted by activities at LMS with older material that could not have been affected by LMS. This comparison would be part of an evaluation of the potential effects of LMS on the EFCR.

Radiometric dating will be conducted using an established technique for dating lacustrine (lake) and marine (ocean) sediments in environments where they are stable (i.e. not reworked) after deposition. In a stable depositional environment, shallower material is younger than deeper material. The floodplain soil deposited slightly upstream from the former Ruhenstroth Dam may

be lacustrine material deposited in the reservoir that formerly existed behind the former dam, and may have been stable since deposition. Similarly, deposits in the Upstream Reach may have been deposited incrementally over time and not reworked afterwards. If so, the established lacustrine sediment dating technique may provide a profile of age since deposition as a function of depth, and allow material deposited before and after open pit mining at LMS to be differentiated.

Alternatively, the material near the former Ruhenstroth Dam may be a fluvial (riverine) deposit, and it may have been reworked since initial deposition. The materials in the Upstream Reach were deposited in a fluvial environment. Fluvial deposits are typically reworked during annual high streamflow and flood events. Reworking blends material from different depths, and mixes constituents (both those used to determine the depositional age and components potentially derived from LMS or other recent sources) in recently-deposited material with those in older material. This mixing homogenizes constituent concentrations and makes it impossible to identify a profile of depositional age as a function of depth using the techniques developed for lacustrine and marine environments. Although it is likely that an age:depth profile may not be identifiable in the material deposited near the former Ruhenstroth Dam or in the Upstream Reach, samples will be collected and analyzed in an attempt to develop age:depth profiles at these two locations.

The dating techniques developed for lacustrine and marine sediments that will be applied for EFCR materials are based upon measuring profiles of cesium-137 (^{137}Cs) and lead-210 (^{210}Pb) concentrations as a function of depth. Both ^{137}Cs and ^{210}Pb in sediment are derived from the atmosphere; and hence, concentrations in sediment are related to atmospheric concentration at and slightly before the time that the sediment was deposited, and subsequently modified by radioactive decay after sediment deposition. Understanding the source of and variations in atmospheric concentrations of ^{137}Cs and ^{210}Pb are critical to using concentration in sediment and inferring depositional age.

The radioisotope ^{137}Cs is formed solely by nuclear fission: nuclear weapons detonation and nuclear reactor operation are the only sources on Earth. Atmospheric testing of nuclear weapons, mainly in 1950s and1960s, released ^{137}Cs into the atmosphere and caused concentrations in the atmosphere to peak in 1963, followed by a rapid decline as atmospheric weapons testing largely ceased. ^{137}Cs is removed from the atmosphere via precipitation or direct fallout and is strongly sorbed by mineral surfaces in soil or sediment grains, which immobilizes it except for bulk movement of the grains. Deposition of atmospheric ^{137}Cs directly into water bodies, erosion of terrestrial soil, transport, and deposition as subaqueous sediment cause sediment to have ^{137}Cs concentrations related to atmospheric concentrations slightly

preceding when the sediment was deposited. Concentrations in sediment lag behind atmospheric concentrations due to the time required for soil to be eroded and transported into water bodies. In sediment profiles that have not been reworked after deposition, vertical variation of concentration with depth preserves a record of temporal variation in atmospheric concentration. The depth of maximum ^{137}Cs concentration is a marker for material deposited soon after the 1963 atmospheric peak. In studies of lacustrine and marine environments, the depth of the peak concentration has been used to calculate the average sediment deposition rate. In environments where sediment is reworked after deposition, processes that mix sediment from different depths (e.g., burrowing organisms or fluvial scour/redeposition) obliterate the 1963 peak. The resulting mixing would make it impossible to calculate an average post-1963 deposition rate.

Regardless of whether sediment was reworked after deposition, the presence of detectable ^{137}Cs would indicate that at least some of the sediment was deposited after 1954 (when significant atmospheric concentrations of ^{137}Cs first occurred). Coincidentally, atmospheric concentrations of ^{137}Cs became significant only about two years after open pit mining operations at LMS commenced; and hence, a detectable ^{137}Cs concentration in a sediment sample would indicate that at least some of that sediment was deposited after open pit mining at LMS began.

In contrast to the anthropogenic source of ^{137}Cs, ^{210}Pb is formed naturally by radioactive decay of uranium-238 (^{238}U). The radioisotope ^{238}U is widely distributed in the subsurface and decays through a series of intermediates (daughter products) to radon-222 (^{222}Rn), a gas, some of which migrates from the shallow subsurface into the atmosphere. The ^{222}Rn subsequently decays via intermediates to non-volatile ^{210}Pb. The ^{210}Pb formed in the atmosphere is removed via precipitation and direct fallout and is then incorporated into soil or sediment. In contrast to the temporally variable atmospheric concentration of ^{137}Cs, the atmospheric concentration of ^{210}Pb is fairly constant in time. After ^{210}Pb incorporated into sediment is buried such that the atmospheric input ceases, the concentration in that sediment decreases via radioactive decay. The activity of ^{210}Pb in sediment is the sum of the amount created by decay of ^{222}Rn in situ (referred to as "background") and the amount derived from the atmosphere (referred to as "excess"). For radiometric dating of sediments, it is assumed that the background activity of ^{210}Pb is in equilibrium with the in situ activity of ^{238}U and is constant over time, but the excess activity declines over time via radioactive decay (half-life approximately 23 years) after the sediment was deposited. In a sediment column that has not been reworked since it was deposited, the youngest sediment would be present at the top and deeper sediments would be older; hence, the activity of ^{210}Pb would be greatest at the surface and decrease with depth as a result of radioactive decay of excess ^{210}Pb, declining to the background value at some depth. The age:depth profile can be determined for a core sample that extends to a depth where all of

the excess ^{210}Pb has decayed, which is approximately 160 years after deposition. In contrast to a stable depositional profile, in an environment where the sediment column was reworked after deposition, mixing of younger and older sediment would homogenize ^{210}Pb concentrations and make it impossible to determine an age:depth profile.

The ^{137}Cs and ^{210}Pb radiometric dating methods are well established for environments in which sediments are stable after deposition, and concentration:depth profiles have characteristic shapes in these environments. The age:depth profile is determined from the concentration:depth profile. In the high-energy fluvial environment of the EFCR, it is likely that sediments are scoured, transported, and deposited farther downstream on a frequent basis, particularly during annual high flow events and occasional flood events. This reworking of sediment would obliterate the ^{137}Cs and ^{210}Pb concentration:depth profiles characteristic of stable depositional environments. Hence, it is unlikely that ^{137}Cs and ^{210}Pb concentration profiles can be used to evaluate depositional age profiles in reworked fluvial deposits in the EFCR. Furthermore, in environments in which sediments are frequently reworked, the concept of sediment age is highly questionable.

Although measuring ^{137}Cs and ^{210}Pb concentration profiles may not produce information that can be interpreted as a depositional age profile, one core for radiometric dating will be collected near the former Ruhenstroth Dam in the Downstream Reach, and a second core will be collected in the Upstream Reach. The vertical variation of ^{137}Cs and ^{210}Pb concentrations will be used to assess if the deposits have been stable or reworked since approximately the 1950s. If the deposit has been stable, then the age:depth profile will be used to identify material that is contemporaneous with open pit mining at LMS. Regardless of whether ^{137}Cs and/or ^{210}Pb profiles indicate that sediments have been stable or reworked since deposition, samples that contain detectable ^{137}Cs will be interpreted as having been deposited after 1954, and therefore, represent material that was at least partially deposited after the onset of open pit mining at LMS.

One core for radiometric dating will be collected at one downstream location in terrace deposits near Ruhenstroth Dam. The vertical variation of apparent age will be used to assess if the fluvial deposits have been stable or reworked since approximately the 1950sIf a deposit has been stable, then the apparent age as a function of depth will be used to estimate the depth of material that is contemporaneous with surface mining at the site. Another core for radiometric dating will be collected in the Upstream Reach. The results from radiometric dating for the upstream core will be compared to those for the downstream core as another line of evidence for comparability between the Upstream and Downstream Reaches. These data will provide information about the stability of fluvial deposits in the EFCR.

6.0 SAMPLING AND ANALYSIS PLAN

The Off-Property FRI Sampling and Analysis Plan (SAP) (presented in Appendix C of the Off-Property FRI Work Plan [Atlantic Richfield, 2012]), the Reference Area FRI SAP (presented in Appendix E of the Reference Area FRI Work Plan [Atlantic Richfield, 2015b]), and the RI/FS Quality Assurance Project Plan, Revision No. 1 (revised RI/FS QAPP)(Atlantic Richfield, 2015c) together address the field methods and quality assurance and quality control procedures for conducting environmental sampling consistent with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. EPA, 1988). For the effort described herein, the sampling and analysis activities conducted by Atlantic Richfield will be governed by these procedures and those described in this section. This section addresses the field sampling, data collection activities, and field and laboratory analyses such that the data will meet the objectives of this plan.

The sampling activities for this work plan addendum are summarized in Table 1, which includes general information about the sampling locations, depths, sampling methods, laboratory analyses, and rationale for performing the work. Detailed information related to the various components of the sampling activities are summarized in Tables 1 and 2.

6.1 QUALITY ASSURANCE AND QUALITY CONTROL

The revised RI/FS QAPP (Atlantic Richfield, 2015c) provides a standard reference for all RI/FS activities including those described in this TSAP. The general procedures outlined revised RI/FS QAPP govern the acquisition of environmental samples and reporting of data further detailed in the Off-Property Area and Reference Study Area FRI Work Plans and addendums, including field requirements for sample collection, laboratory requirements for sample testing, quality assurance and quality control measures, data review, record management, and reconciliation with data quality objectives. This plan provides the additional QA/QC requirements for the activities to be performed for the described investigation and together with the Off-Property FRI and Reference Area SAPs adequately address the sampling and analysis requirements to meet the project objectives.

Tables 1 and 2 summarize the task-specific sample collection requirements, contract laboratories, laboratory methods, and quality control samples necessary to complete this characterization task and are incorporated herein by reference to the RI/FS QAPP and the Off-Property FRI Work Plan.

6.2 STANDARD OPERATING PROCEDURES

Atlantic Richfield has developed the necessary Standard Operating Procedures (SOPs) to describe field procedures, equipment, and documentation that will be used for collecting samples for analytical testing purposes. These SOPs replace earlier versions and are incorporated herein by reference to the Off-Property FRI Work Plan SAP. A subset of the SOPs were also included in the Reference Area FRI Work Plan.

The following SOPs are presented in Appendix C and will govern the field activities for sample collection:

- SOP 1.0 – General Preparation and Mobilization Requirements
- SOP 2.0 – Basic Health and Safety For Field Operations
- SOP 3.0 – Field Documentation and Sample Handling
- SOP 4.0 – Sample Collection Techniques and Data Collection Strategies
- SOP 7.0 – Equipment Decontamination
- SOP 9.0 – Investigation Derived Waste Disposal
- SOP 11.0 – Soil and Rock Logging
- SOP 14.0 – Soil Sampling
- SOP 30.0 – Hand-Held Global Positioning System (GPS) Device

Each field team member is required to review and understand each of the above SOPs prior to beginning field activities. The first step in the SOP review is to confirm that the current version of the SOP is being used. Current SOPs are attached to this document for reference during all field activities and are available to all staff on the AMEC Sacramento server at P:\Project\13000s\13091 Leviathan\5000 Field Operations\5070 RIFS\2015_SOPs; Copies also are maintained in the field office.

6.3 SAMPLING LOCATIONS

The following sections describe the proposed fluvial deposit sampling locations for this investigation.

The rationale for selecting preliminary sampling locations is described in Section 5.2, and Section 5. 3 describes how the sampling locations will be finalized using field reconnaissance. The preliminary sampling locations at four transects in the Downstream Reach (two transects immediately upstream from the Ruhenstroth Dam and two transects located farther upstream

but downstream from Bryant Creek) and four transects in the Upstream Reach (two near the mouth of Cottonwood Creek and two farther upstream) are shown on Figures 2 through 5.

As described in Section 5. 3, preliminary fluvial deposits sampling locations will be finalized in the field during implementation. The sampling locations listed herein are approximate and may vary based upon the final location of the eight transects. These approximate locations will be modified by the field team as necessary to accommodate access limitations caused by terrain, vegetation, or other conditions that interfere with safe access, and to ensure sampling of representative fluvial deposits on a respective transect. The actual sampling locations will be surveyed by a hand held global positioning system (GPS) instrument and documented in accordance with SOP 30.0 – Hand-Held GPS Device.

Samples will be collected from three locations along each transect; at the ends and at the approximate midpoint. At one transect near Ruhenstroth Dam, one additional corehole will be advanced to provide samples for radiometric dating analysis.

Each sampling location will be marked with a flag or wooden stake. After sample collection is completed, the flag or wooden stake will be removed. If a sampling location must be moved greater than two feet after the location has been surveyed because of obstructions or avoidance of Historic Properties or their contributing elements, GPS coordinates of the revised location will be recorded using the GPS device and so noted on the GPS Log form (SOP 30.0 - Hand-Held GPS Device).

6.4 SAMPLE COLLECTION

Sample collection procedures, quality control samples, and naming conventions are discussed in this section.

A total of four downstream and four upstream transects will be sampled. Discrete-depth samples will be collected in accordance with SOP 4.0 – Sample Collection Techniques and Data Collection Strategies at depth intervals of 0 to 0.5, 1.5 to 2.0, and 5 to 6 feet below ground surface (bgs) (or at refusal), if possible, as shown on Tables 1 and 2. This will yield a total of 36 downstream and 36 reference area fluvial deposits samples (4 transects x 3 locations per transect x 3 sample depths) if all of the deep samples can be collected. Twelve samples from each depth interval meet the minimum number of samples for statistical analysis recommended in ProUCL statistical software.

Fluvial deposits samples for radiometric dating analysis will be collected from cores separate from those for other fluvial deposit samples. Core samples for radiometric dating analysis will

be collected in transparent plastic liners or metal liners, and the entire core will be shipped in its entirety to a laboratory for analysis. The laboratory will select and analyze subsamples from the cores, and provide a report that interprets the age of sediment as a function of depth. These results will be used to the extent possible to identify material deposited before and after the onset of surface mining at Leviathan Mine.

The analytical parameters and methods are provided in Tables 1 and 2. All samples will be shipped for laboratory analysis. Other than visual/manual classification of soil and field sieving of discrete samples with a 2 mm mesh, no processing or analysis of samples will be conducted in the field.

6.4.1 Sample Collection Schedule

Low river levels are most conducive to fluvial deposits sampling, so sampling will not commence before most snowmelt runoff has occurred in the Upstream Reach, and high spring flows have subsided in the EFCR. May through September is the likely sample collection period but will depend on specific conditions in 2016.

6.4.2 Quality Control Sample Collection

QC samples to be collected for fluvial deposit investigations along the EFCR are summarized in Table 2. Further details about sampling and analysis of QC samples are described below.

Pursuant to the Off-Property FRI work plan, field QC samples collected in conjunction with soil sampling (fluvial deposit sampling in this case) include field equipment blanks and field duplicates. In addition, laboratory quality control samples will include matrix spike/matrix spike duplicate (MS/MSD) and laboratory duplicate samples. Measurement quality control criteria for soil samples are included in Table 2. The criteria included in Table 2 will be used to assess accuracy and precision of the sample results during subsequent data review as described in the RI/FS QAPP. If quality control criteria are met as summarized in Table 2, then the data will be deemed acceptable without qualification, otherwise data may be qualified for consideration of usefulness in future evaluations. Additional details about each QC sample type are as follows:

- Field equipment (rinsate) blanks will be collected from non-disposable fluvial deposits sampling equipment at a frequency of 10 percent. Field equipment blank sampling locations have been randomly assigned to the primary sample locations listed in Table 2. Field equipment blank samples will be analyzed for RI/FS metals using the same analytical methods as the primary fluvial deposits samples. Field equipment blanks are not required for analysis of soil pH, total organic carbon (TOC) or grain size distribution because equipment blanks are water samples that are not amenable to the respective testing procedures. Each field equipment blank is collected unfiltered into one 250 milliliter (mL) polyethylene bottle preserved with

nitric acid and one 250 mL unpreserved polyethylene bottle. Field equipment blanks should be collected after 12:00 PM to accommodate the hexavalent chromium analysis short (24 hour) hold time. For similar reasons, field equipment blanks will not be collected on Fridays.

- Collocated fluvial deposits field duplicates will be collected at a frequency of 10 percent. Field duplicate sampling locations have been randomly assigned to the primary sample locations listed in Table 2.
- Additional volume for MS/MSD analyses will be collected at a frequency of five percent at the primary fluvial deposit sampling locations listed in Table 2. MS/MSD samples are not required for the analysis of soil pH or grain size distribution, as these QC sample types are not amenable to the respective testing procedures. The requested MS/MSD analyses will be indicated on the Chain of Custody (COC) form.

If the QC sampling locations listed in Table 2 are changed, field personnel will keep track of the number of each QC sample type that have been collected and will select alternative sampling locations to ensure that at least the minimum required frequency of QC samples is collected.

6.4.3 Sample Identification

Each sample will be assigned a unique, blind identification code according to sampling location and date. The sample time should be recorded as the time when sampling commences. The sample ID will consist of four parts.

1. Sample Matrix Type – floodplain soil (SS)
2. Study Area Designation -- Supplemental Study Area (S)
3. Date – Expressed as a two-digit month, day and year (MMDDYY); and
4. A continuous sequence number will be used for each discrete samples in each of the designated sampling areas (e.g., 01, 02). Sequential numbering will restart at 01 on a given sampling day, in a given sampling area.

The four parts of the sample ID will not be separated by any symbols, characters or spaces. For example, if the 2nd fluvial deposits sample of the day is collected in the Upper (reference) reach on July 29, 2016 sample ID will be SSS07291502. Each unique blind sample ID for both primary and quality assurance samples and the corresponding sampling location will be recorded on the data sheet and the Sample Control Log.

If multiple crews are sampling, division of IDs and times will be discussed beforehand and via radio communication, if needed.

6.5 FIELD MEASUREMENTS

Fluvial deposit descriptions and analytical procedures for this investigation are described in the following sections, along with specific sampling protocols. No measurements or analysis of samples using instruments will be conducted in the field.

6.5.1 Soil Descriptions

The fluvial deposit from each interval will be described using the Unified Soil Classification System as described in SOP 11.0 - Soil and/or Rock Logging. The fluvial deposit description should include whether the material is reactive with dilute hydrochloric acid.

6.5.2 Fluvial Deposits Thickness and Stratigraphic Sections

A composite stratigraphic section across the former reservoir at the Ruhenstroth dam site will be constructed based upon visible layering and relationships between geologic features.

6.6 LABORATORY ANALYSES

The laboratories, analytical methods, hold times, preservation requirements, and sample containers for fluvial deposits samples are summarized in Table 2. All fluvial deposits samples will be analyzed for RI/FS metals, ABA, acid volatile sulfides/sequentially extracted metals (AVS/SEM), TOC, and soil pH. One sample from each transect will be analyzed for grain size analysis.

Samples collected for ABA analysis will be analyzed by SVL Analytical, Inc. in Kellogg, Idaho. Samples for radiometric dating will be analyzed by Flett Research, Ltd. in Winnipeg, Manitoba, Canada. Samples collected for grain size analysis will be analyzed by Amec Foster Wheeler, Inc. in Elko, Nevada. Duplicate samples for AVS/SEM analysis will be analyzed by Test America Laboratory, in Irvine, CA. Samples collected for all other analyses will be analyzed by ALS Environmental in Kelso, Washington.

The COC forms will be prepared, sample labels will be completed and affixed to each sample container, and laboratory contacts will be notified of sample shipments following SOP 3.0 – Sample Handling and Documentation. The sampling personnel responsible for the sample collection will complete the COC form on a daily basis and sign the form when samples have been relinquished. The original COC form will be placed in a sealed, watertight, plastic zip top bag and included with the sample shipment, or stored with any samples held pending shipment.

7.0 HEALTH AND SAFETY PROCEDURES

All activities will be conducted following the procedures and reporting requirements provided in the Leviathan Mine Site Health, Safety, Security, and Environmental (HSSE) Program Document (Amec Foster Wheeler, 2015). All tasks described herein will also be performed in accordance with the HSSE, the Task Specific Health and Safety Plan (TSHASP), and the Work Risk Assessment or Task Risk Assessment (TRA) prepared by Atlantic Richfield contractors. The appropriate risk analyses, TRAs, safety related SOPs, and clearances will be completed prior to conducting any planned activities.

8.0 REGULATORY COMPLIANCE

This section addresses requirements and access permission for the proposed sampling effort.

8.1 NATIONAL HISTORIC PRESERVATION ACT

U.S. EPA has been developing the draft National Historic Preservation Act (NHPA) Programmatic Agreement (PA) since fall 2013 to cover RI activities in areas that were not surveyed within the existing Area of Potential Effects (APE) or in areas that are outside of the existing APE. Until recently, Atlantic Richfield had assumed the PA would be executed no later than May 30, 2016, thus allowing for completion of the remaining RI field activities in 2016. Recent comments made by the California and Nevada State Historic Preservation Officers (SHPOs) suggest that it will not be possible to finalize the PA in that time frame, if at all. Accordingly, U.S. EPA requested that Atlantic Richfield move forward with planning 2016 RI field activities, assuming that Section 106 consultation will be needed for field activities occurring outside previously surveyed areas and the existing APE

Although Atlantic Richfield intends to perform the required Class I Survey (record search) in First Quarter 2015, the earliest the Class III Survey (pedestrian surveys) can reasonably begin is early May 2016, depending on weather and road conditions. Based on previous experience, Atlantic Richfield conservatively estimates the entire consultation process from starting the Class III surveys through obtaining the SHPOs' concurrence will take approximately 6 months, or until early November 2016. This will in turn push EFCR sampling activities into 2017.

8.2 PERMIT REQUIREMENTS

The Leviathan Mine Site Remedial Investigation, including the investigation activities described in this TSAP, is being implemented pursuant to CERCLA in accordance with EPA's 2008 Administrative Order for RI/FS (CERCLA Docket No. 2008-18). Consequently, under CERCLA Section 121(e), 42 U.S. C. § 9621(e), federal, state, and local permits are not required,

although the substantive applicable or relevant and appropriate requirements associated with such permits may need to be implemented.

8.3 ACCESS PERMISSION

Access to sampling locations along EFCR will be dependent to a large degree upon flow and stages in the river and to constraints from property owners along the reaches. Typical spring high streamflow and stage conditions in EFCR will preclude safe access to sampling locations, so sampling will need to occur in late spring, summer, or early fall. Figure 6 shows proposed transect locations and associated property boundaries and owners.

Reasonable efforts will be made to obtain written permission from private landowners and/or managers of public land, as appropriate, to cross private and/or public land to access the sampling transects and to conduct sampling activities.

9.0 REPORTING

The activities described in this plan will be reported in the Annual RI/FS Data Summary report. This report will document the methodology employed and data collected during the described sampling and analysis activities. In addition, Atlantic Richfield will provide status updates in quarterly RI/FS progress reports and monthly conference calls with the U.S. EPA representatives. Atlantic Richfield will prepare and submit a Technical Memorandum to the U.S. EPA to present preliminary sampling results.

10.0 SCHEDULE

Non-intrusive field reconnaissance will be performed during the 2016 field season. Unless otherwise directed by U.S. EPA, commencement of sampling collection is contingent on U.S. EPA approval of this document and completion of a NHPA Section 106 Consultation. In addition, the field schedule is dependent on favorable weather and streamflow conditions, HSSE considerations, and project priorities.

11.0 REFERENCES

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TABLES

TABLE 1
FIELD SAMPLING PLAN SUMMARY
SAMPLING AND ANALYSIS PLAN
Leviathan Mine Site
Alpine County, California

Media[1,2]	Transect Location	Sampling Locations	Location Description	Sample Depth (bgs)	Sampling Method	Rationale	Sample Testing
Fluvial Deposits	TR-35 through TR-42	3 per transect (24 total)	Locations will be approximately at the ends and midpoints of transects. Locations with finer material will be preferentially targeted.	0 - 0.5 ft 1.5 - 2 ft 5 - 6 ft	Hand core or mechanised device used to collect discrete samples.	Geochemical characterization to evaluate COPCs/COPECs in fluvial deposits.	- RI/FS Metals[3] - ABA - Total Organic Carbon - Grain Size - Soil pH - AVS/SEM
Downstream Fluvial Deposits	TR-35 or TR-36	1 core in ~6-inch sleeves	The location of the deepest apparent soil profile will be targeted.	0 - 6 ft	Hand core or mechanised device used to collect discrete samples.	Radiometric dating of soil profile.	Radiometric Dating (^{137}Cs & ^{210}Pb)
Upstream Fluvial Deposits	One transect from TR-39 through TR-42	1 core in ~6-inch sleeves	The location of the deepest apparent soil profile will be targeted.	0 - 6 ft	Hand core or mechanised device used to collect discrete samples.	Radiometric dating of soil profile.	Radiometric Dating (^{137}Cs & ^{210}Pb)

Notes:
1. Discrete samples segregated to -2mm in field.
2. Material <63 um segregated in laboratory. Sample fractions >63um and <63um both analyzed.
3. RI/FS metals include: aluminum, antimony, arsenic, barium, beryllium, cadmium, hexavalent chromium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver, selenium, thallium, vanadium, and zinc.

Abbreviations:
ABA = acid base account
bgs = below ground surface
cm = centimeters
ft = feet
RI/FS = remedial investigation/feasibility study

TABLE 2
SAMPLING REQUIREMENTS
Leviathan Mine Site
Alpine County, California

				RI/FS Metals									QC Samples			
				Metals[1, 2, 3]	Mercury[2, 3]	Hexavalent chromium[2, 3]	% Solids[2, 3]	TOC[2, 3]	Soil pH	AVS/SEM (Cd, Cu, Hg, Ni, Pb, Zn)	Grain Size[4]	ABA				
			Method	EPA 6010B/6020	EPA 7471B	EPA 7196A	EPA 160.1Mod.	EPA 9060A/ Lloyd Khan or equivalent	EPA 9045D	EPA 821/R91-100	ASTM D422 (sieve only)	Modified Sobek	Equipment Blanks[5]		Field Duplicates[6]	MS/MSD[7] or Laboratory Duplicate
			Containers	1 x 4 oz WMP						1 x 4 oz WMP (no headspace)	1 x 1 gal ziptop bags	1 x 4 oz WMP	1 x 250mL HDPE	1 x 250mL HDPE	1 x 4 oz WMP	1 x 4 oz WMP
			Minimum Volume	10 g	10 g	20 g	50 g	20 g	50 g	200 g	2 kg	200 g	200 mL	100 mL	50 g	100 g
			Preservative[8]	None									HNO3 pH<2	None	None	None
			Holding Time	6 mo	28 d	30d	7 d	28 d	7 d	7 d	None	None	14 d	24 h	28 d	28 d
			Laboratory	ALS						ALS & TAL	AmecFW	SVL	Same as primary samples[6]			
Area	Transect ID	Location ID[9]	Depth (feet bgs)													
Fluvial Deposit Borehole Investigation																
Downstream Reach	TR-35	FPS-178 through FPS-180	0 - 0.5	X	X	X	X	X	X	X	X	X	X	X	X	X
			1.5 - 2	X	X	X	X	X	X	X		X				
			5 - 6	X	X	X	X	X	X	X		X				
	TR-36	FPS-181 through FPS-183	0 - 0.5	X	X	X	X	X	X	X	X	X	X	X	X	
			1.5 - 2	X	X	X	X	X	X	X		X				
			5 - 6	X	X	X	X	X	X	X		X				
	TR-37	FPS-184 through FPS-186	0 - 0.5	X	X	X	X	X	X	X	X	X				
			1.5 - 2	X	X	X	X	X	X	X		X	X	X	X	X
			5 - 6	X	X	X	X	X	X	X		X				
	TR-38	FPS-187 through FPS-189	0 - 0.5	X	X	X	X	X	X	X	X	X				
			1.5 - 2	X	X	X	X	X	X	X		X	X	X	X	
			5 - 6	X	X	X	X	X	X	X		X				
Upstream Reach	TR-39	FPS-190 through FPS-192	0 - 0.5	X	X	X	X	X	X	X	X	X	X	X	X	X
			1.5 - 2	X	X	X	X	X	X	X		X				
			5 - 6	X	X	X	X	X	X	X		X				
	TR-40	FPS-193 through FPS-195	0 - 0.5	X	X	X	X	X	X	X	X	X	X	X	X	
			1.5 - 2	X	X	X	X	X	X	X		X				
			5 - 6	X	X	X	X	X	X	X		X				
	TR-41	FPS-196 through FPS-198	0 - 0.5	X	X	X	X	X	X	X	X	X				
			1.5 - 2	X	X	X	X	X	X	X		X	X	X	X	
			5 - 6	X	X	X	X	X	X	X		X				
	TR-42	FPS-199 through FPS-201	0 - 0.5	X	X	X	X	X	X	X	X	X				
			1.5 - 2	X	X	X	X	X	X	X		X	X	X	X	X
			5 - 6	X	X	X	X	X	X	X		X				
			Estimated Floodplain Samples	72	72	72	72	72	72	72	8	72	8	8	8	4

Notes:
1. Metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, thallium, vanadium, and zinc.
2. Discrete samples segregated to <2mm in field.
3. Material <63 υm segreagated in laboratory. Samples >63υm and <63υm both analyzed.
4. One sample per transect.
5. Field equipment blanks are only to be analyzed for RI/FS metals. Each field equipment blank is collected unfiltered into 1 x 250 mL HDPE with HNO3 and 1 x 250 mL HDPE unpreserved. The analytical methods are the same as for the RI/FS metals for soil samples.
6. Field duplicates will be collected at a frequency of 10% (one co-located sample per transect) and analyzed for the same parameters as the primary samples. In addition to the field duplicate, a split sample will also be collected and submitted to TAL for confirmatory analysis of AVS.
7. MS/MSD not applicable to soil pH, ABA or grain size testing. Collected at a frequency of 5% (one per two transects). Lab duplicates will be anlayzed in lieu of MS/MSD where MS/MSD is not ammenable to the methods.
8. All samples shipped/stored to be cooled to a temperature of 0° - 6°C except for those to be analyzed for ABA and physical parameter testing.
9. Precise sample locations along each transect will be selected in the field based on access, grain size, etc.

Sample IDs:
SSSMMDDYYXX — Use for all samples collected from cores advanced in fluvial deposits, consecutively, for a given date.

Abbreviations:
% = percent
ABA = acid-base account
ALS = ALS Global Laboratory
AmecFW = Amec Foster Wheeler
ASTM = ASTM International
AVS = acid volatile sulfide
cm = centimeters
d = days
EPA = United States Environmental Protection Agency
feet bgs = feet below ground surface
FPS = floodplain soil matrix
g = grams
h = hours
HDPE = high density polyethylene
ID = identification
kg = kilogram
mo = month
MS = matrix spike
MSD = matrix spike duplicate
oz = ounces
QC = quality control
RI/FS = remedial investigation/feasibility study
SED = sediment matrix
SEM = simultaneously extracted metals
SVL = SVL Analytical, Inc.
TAL = TestAmerica Laboratory
TOC = total organic carbon
TR = transect
WMP = wide-mouth polyethylene jar

FIGURES

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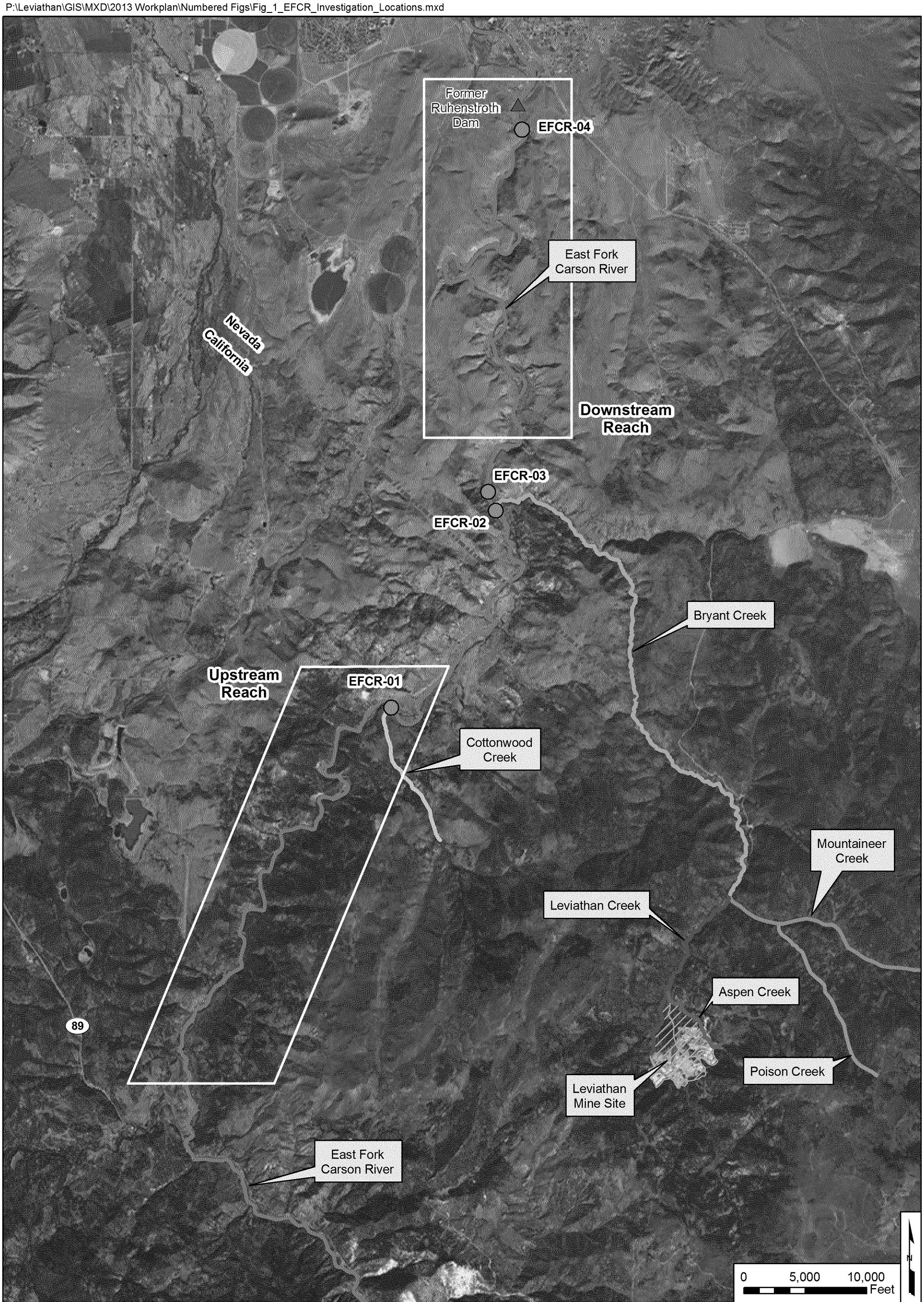

Explanation:

- Former Ruhenstroth Dam
- EFCR Sampling Locations
- Aspen Creek
- Bryant Creek
- Leviathan Creek
- Cottonwood Creek
- East Fork Carson River
- Mountaineer Creek
- Poison Creek
- StudyArea_update
- State Line

Notes:
1. National Hydrography Dataset Flowlines are stream thalweg delineations provided by the USGS, but are not necessarily accurate on a localized scale.
2. All locations and boundaries are approximate.
3. Background imagery is from ESRI World Imagery (2014).

EAST FORK CARSON RIVER
INVESTIGATION LOCATION MAP
Leviathan Mine Site
Alpine County, California

amec foster wheeler

Date: 01/08/2016
By: DMC

Project No. 0013091

Figure 1

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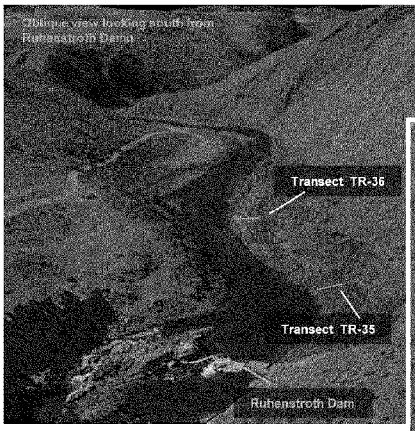

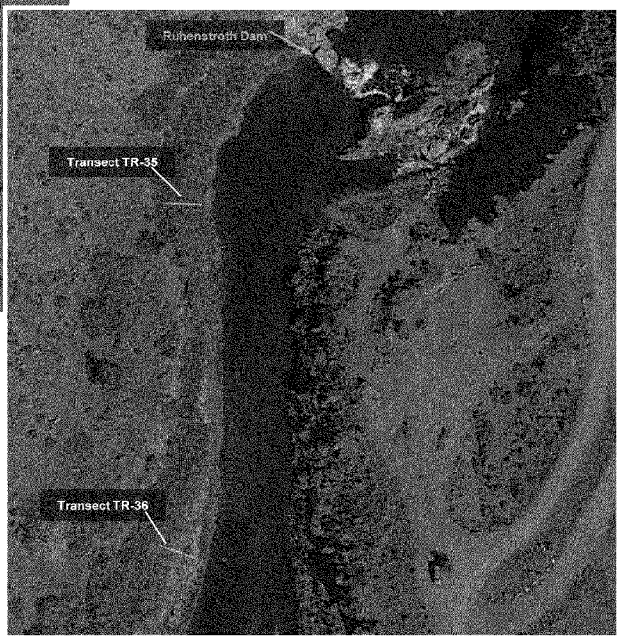

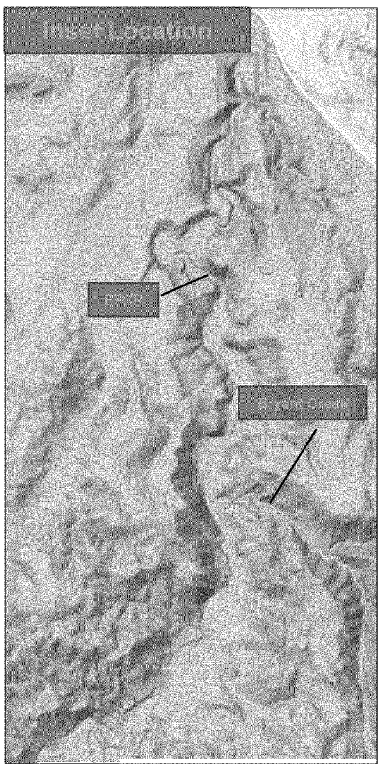

Images from Google Earth
Image date – April 2015

PROPOSED SAMPLE TRANSECTS
NEAR RUHENSTROTH DAM
Leviathan Mine Site
Alpine County, California

amec foster wheeler

By: DPV
Date: 01/08/2016

Project No. 0013091

Figure 2

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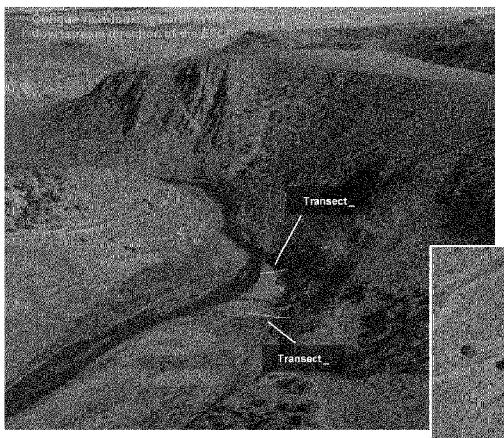

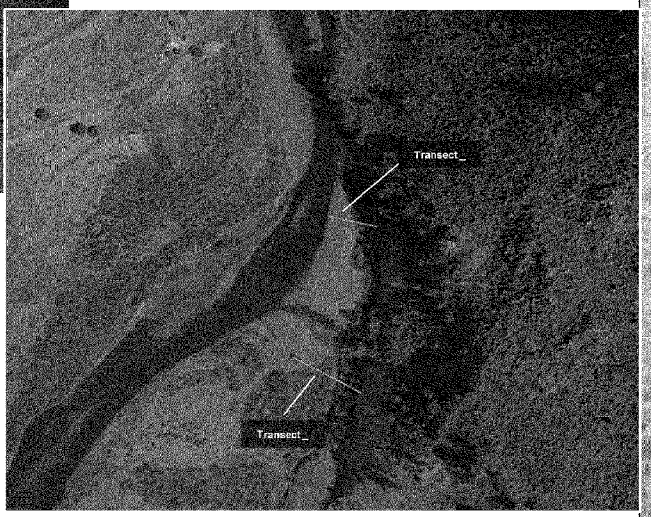

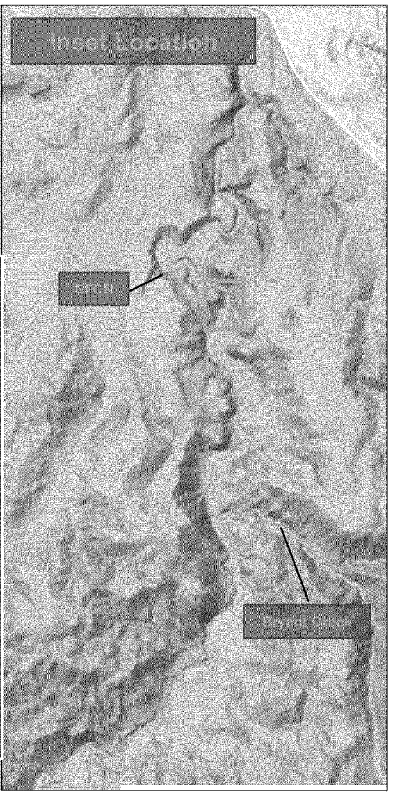

Images from Google Earth
Image date – April 2015

PROPOSED SAMPLE TRANSECTS
DOWNSTREAM OF BRYANT CREEK
Leviathan Mine Site
Alpine County, California

amec foster wheeler

By: DPV
Date: 01/08/2016

Project No. 0013091

Figure 3

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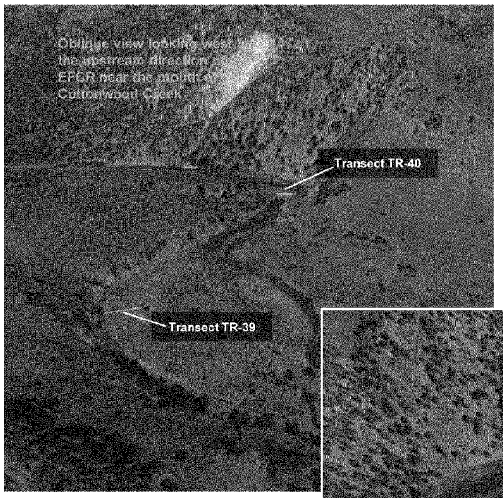

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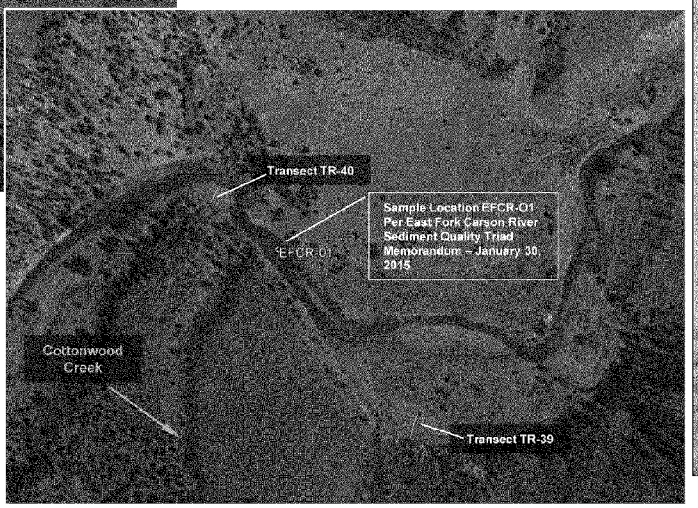

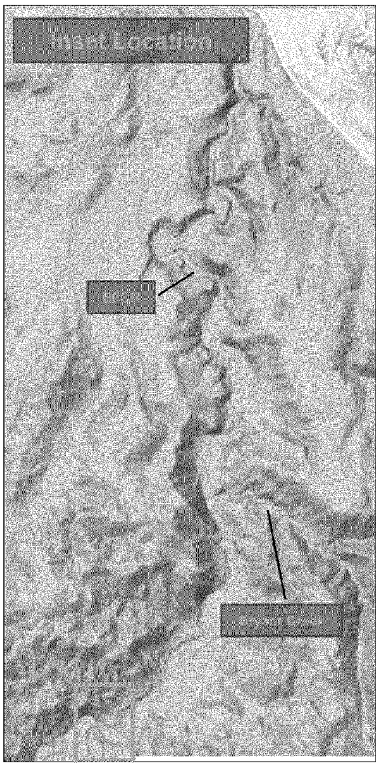

PROPOSED SAMPLE TRANSECTS
COTTONWOOD CREEK AREA
Leviathan Mine Site
Alpine County, California

amec foster wheeler

By: DPV
Date: 01/08/2016

Project No. 0013091

Figure 4

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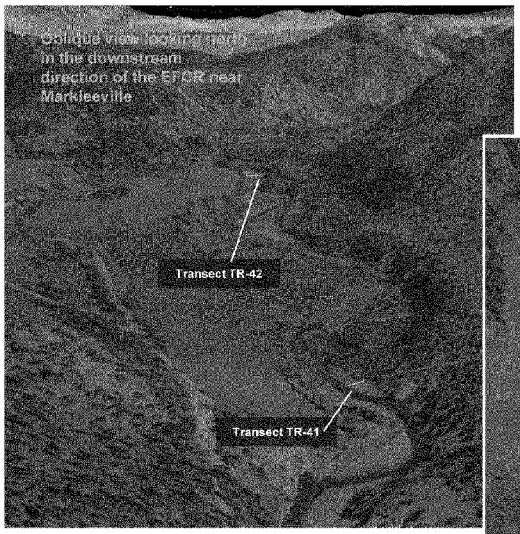

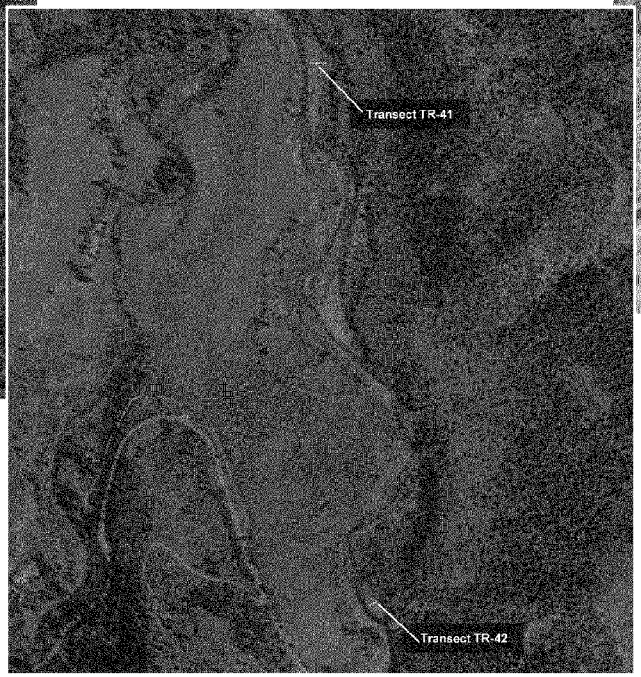

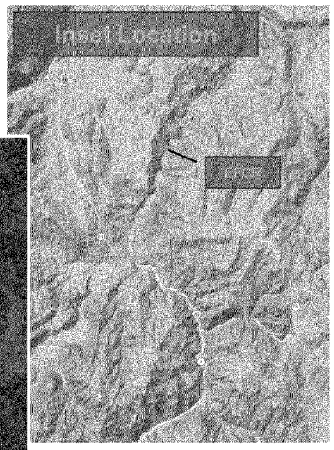

Images from Google Earth
Image date – April 2015

PROPOSED SAMPLE TRANSECTS
UPSTREAM OF COTTONWOOD
CREEK AREA
Leviathan Mine Site
Alpine County, California

amec foster wheeler

By: DPV
Date: 01/08/2016

Project No. 0013091

Figure
5

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Explanation

- SQT Sample Location
- Proposed Sample Transect Location
- Residential/Commercial/Industrial
- Agricultural Preserve
- Right of Way
- Institutional
- State of California
- US Forest Service
- Bureau of Indian Affairs
- Bureau of Land Management
- California Department of Fish and Game
- Alpine County/Douglas County
- Unknown

0 5,000 Feet

PROPERTY BOUNDARIES
EAST FORK CARSON RIVER
Leviathan Mine Site
Alpine County, California

amec foster wheeler

Date: 01/08/2016 | Project No. 0013091

Figure 6

APPENDIX A

OFF-PROPERTY STUDY AREA DQOs SUMMARY No. 15
FLUVIAL DEPOSIT CHARACTERIZATION IN EAST FORK CARSON RIVER UPSTREAM FROM RUHENSTROTH DAM – As of 01/08/16[1]

Leviathan Mine Site
Alpine County, California

Step 1 – State the Problem	Step 2 – Identify the Goals of the Study	Step-3 – Information Inputs	Step 4 – Define Boundaries	Step 5 – Analytic Approach	Step 6 – Specify Acceptance Criteria	Step 7 – Develop the Plan
Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
Problem Statement 1: Fluvially deposited material, solutes adsorbed to particles, and chemical precipitates originating from the Leviathan Mine may be present in the floodplain of the reach of the East Fork Carson River (EFCR) between the former Ruhenstroth Dam and the confluence with Bryant Creek (Downstream Reach). That material, if present, may contribute to potential risks to ecological receptors.	**Study Question 1.** Can fluvial deposits potentially originating from the Leviathan Mine within the Downstream Reach be differentiated from fluvial deposits from other sources using field-based, manual/visual logging methods and dating techniques? **Alternative Outcomes** 1. Fluvial deposits potentially originating from the Leviathan Mine present in the floodplain of the Downstream Reach can be differentiated from deposits from other sources using field-based manual/visual logging methods and dating techniques. 2. Fluvial deposits potentially originating from the Leviathan Mine in the floodplain of the Downstream Reach cannot be differentiated from deposits from other sources using field-based manual/visual logging methods and dating techniques. **Decision Statement:** Determine if fluvial deposits potentially originating from the Leviathan Mine within the Downstream Reach can be differentiated from deposits from other sources using geologic field characterization methods, such as evaluation of texture, structure, mineralogy, and dating techniques in core samples. 1. If fluvial deposits potentially originating from the Leviathan	**Existing Information** • Existing reports • Existing data (aerial photography, hyperspectral and LIDAR data) • Results from geomorphic imagery evaluation **Material Identification** • Relative depositional ages of fluvial deposits • Soil classification, physical properties • Bank configuration (stability, topography) • Depositional environment • Vegetation, if present Lithology and stratigraphy that can be visually observed in undisturbed core samples of fluvial deposits within the Downstream Reach. Visually-apparent differences in properties (texture, bedding, mineralogy) that can be seen in core samples will be used, if possible, to characterize fluvial deposits within the Downstream Reach. Transects will be established approximately perpendicular to the thalweg of the EFCR to characterize the material deposited in the Downstream Reach using field-based, manual/visual logging methods.	**Material Identification** Target Population – unconsolidated, medium to fine texture (sand and finer grain size) fluvial deposits within the Downstream Reach. Spatial Limits – The Downstream Reach is the spatial limit of this problem statement. Longitudinal limit is the Downstream Reach. Transverse limit is width of recently active EFCR channel. Vertical sampling limit is from ground surface down to a maximum depth of investigation of 6 feet. This maximum investigation depth is based upon historical reporting that almost all of the sediment behind the former Ruhenstroth Dam was scoured during the 1997 flood on the EFCR and preliminary sediment scour depth calculations under stream conditions similar to the 1997 flood. Sampling Unit –visible extent of fluvially deposited material within the area of the Downstream Reach Temporal Limits – one or more field seasons Practical Constraints – access limitations imposed by the presence of steep slopes along river canyons. The steepness of hillside slopes impairs safe access to the floodplain that is needed to conduct the sampling activities. Permission to travel overland on private property may inhibit access to the	**Material Identification** A geologist with site-specific experience will rely on professional judgment to decide if the fluvial deposits can be differentiated. **Depositional Age** Boreholes will be cored and samples collected for radiometric dating. The radiometric dates will be used to characterize the age(s) of the fluvial deposits in the Downstream Reach.	**Material Identification** Identification of the contact(s) between fluvial deposits within the Downstream Reach will be based upon the professional expertise of experienced field geologists who are familiar with subsurface conditions at Leviathan Mine Site. Field geologists will visually examine sample properties (texture, bedding, mineralogy) and identify whether the material can be differentiated into different groups based upon manual/visual techniques. If differences in the fluvial deposits can be visually recognized, then samples will be collected of each material within a borehole. If differences in the fluvial deposits cannot be visually recognized, then samples will be collected of the undifferentiated material so that shallow, medium, and deeper samples are collected from each borehole. The consequence of not being able to adequately visually differentiate fluvial deposits will be minimal because samples will be collected for laboratory analysis whether the materials are differentiated or undifferentiated.	**Material Identification and Lateral and Vertical Extent** Obtain access and U.S. EPA authorization (subject to NHPA requirements) to perform field reconnaissance and sampling activities. Use professional judgment following the process outlined in Problem Statement 2, Step 7 and based upon the geomorphic imagery evaluation and supplemented by reconnaissance of current conditions, to select transect across the fluvial deposited material within the Downstream Reach. Use geomorphic imagery evaluation and aerial mapping results, field reconnaissance, and professional judgment to select locations where potential mine-related fluvial deposits have the highest likelihood of occurrence. Use GPS to document the horizontal location and ground surface elevation of sample locations on each transect. Advance boreholes using manual methods and/or mechanized techniques. Collect core samples to a

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Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
	Mine within the Downstream Reach can be differentiated from deposits from other sources, then proceed with characterizing the fluvial deposits as separate stratigraphic units. 2. If fluvial deposits from other sources within the Downstream Reach cannot be differentiated using conventional geologic methods, then characterize the fluvial deposits as an undifferentiated unit.	Location and ground surface elevation of boreholes along transects. **Fluvial Deposit Age** The age of fluvial deposits can be quantified using relative and radiometric dating techniques. Analysis of fluvial deposits using cesium-137 (^{137}Cs) and lead-210 (^{210}Pb) techniques can be used to date materials within the target age.	floodplain. Historic properties or their contributing elements may also inhibit access to the floodplain. The access routes and floodplain sampling locations will have to be surveyed in accordance with the National Historic Preservation Act requirements. Drilling and sampling techniques are limited to manual methods or very small mechanized rigs. There is the potential that differences in the character of fluvial deposits cannot be characterized visually. Hence, it may not be possible to differentiate between fluvial deposits using field methods. Regardless of whether the material can be differentiated, characterization of fluvial deposits will be conducted. **Fluvial Deposits Age** There is the potential that the radiometric dating results may be inconclusive due to homogenization of the material from fluvial processes, especially in areas influenced by high energy flows such as flood events. Hence, it may not be possible to obtain non-homogenized ages for the fluvial deposits.		**Ages of Fluvial Deposits** If radiometric ages from a core are dissimilar, then the material may be differentiated. If radiometric ages from a core suggest homogenous fluvial deposits, then the material will be considered undifferentiated.	maximum depth of 6 feet. Log core samples using visual/manual methods, and identify the contacts between fluvial deposits if possible. Collect one core for radiometric dating upstream from the former Ruhenstroth Dam in the Downstream Reach. Submit core for laboratory radiometric dating.
Problem Statement 2: Concentrations of COPCs/COPECs in the fluvial deposits within the Downstream Reach are not sufficiently understood to make comparisons to reference (Upstream Reach) concentrations	**Study Question 1:** Is the chemistry of fluvial deposits in the Downstream Reach sufficiently characterized for the purposes of supporting ecological risk evaluation, comparison to reference concentrations and ARARs, and evaluation of remedial alternatives if necessary? **Alternative Outcomes**	**Information Inputs** • Existing data (aerial photography, hyperspectral and LiDAR data) • Geologic setting • Location and extent of current fluvial deposits • Relative and radiometric soil ages • Soil classification, grain size, mineralogy	**Exposure to Fluvial Deposits Within the Downstream Reach** Soil Sampling and Analysis: Target Population – COPCs/COPECs in fluvial deposits within the Downstream Reach to a maximum depth of approximately 6 feet. Spatial Limits – The Downstream Reach. Longitudinal limit is the Downstream	**Exposure to Fluvial Deposits Within the Downstream Reach** Mapping/Field Verification • Location of fluvial bedforms targeted for sampling within the Downstream Reach ○ Parameter: Physical characteristics of bedforms ○ Inference: Evaluate	To limit uncertainty in obtained environmental data, criteria for the precision, accuracy, representativeness, completeness, comparability parameters and reporting limits for the parameters have been developed and presented in the SAP/QAPP (Off-Property FRI Work Plan Appendix C) in accordance with U.S. EPA	Collect samples regardless of whether fluvial deposits can be differentiated. Locate fluvial deposits samples along 4 transects approximately perpendicular to the stream channel along the Downstream Reach. Finalize transect locations in the field using results from

Step 1 – State the Problem	Step 2 – Identify the Goals of the Study	Step-3 – Information Inputs	Step 4 – Define Boundaries	Step 5 – Analytic Approach	Step 6 – Specify Acceptance Criteria	Step 7 – Develop the Plan
Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
or to evaluate risk to ecological receptors, compliance with ARARs, or the need for future remedial actions.	1. Available chemical data for fluvial deposits in the Downstream Reach are sufficient to support ecological risk evaluation, comparison to reference concentrations and ARARs, and the evaluation of remedial alternatives if necessary. 2. Available chemical data for fluvial deposits in the Downstream Reach are not sufficient to support ecological risk evaluation, comparison to reference concentrations and ARARs, and the evaluation of remedial alternatives if necessary. **Decision Statement 1:** Determine whether chemical data for fluvial deposits in the Downstream Reach are sufficient to support comparison to reference concentrations and ARARs, ecological risk evaluation, and evaluation of remedial alternatives if necessary. 1. If the chemistry of fluvial deposits in the Downstream Reach is sufficiently characterized, then complete the comparison to reference concentrations and ARARs, ecological risk evaluation, and the evaluation of remedial alternatives if necessary. 2. If the chemistry of fluvial deposits in the Downstream Reach is not sufficiently characterized, then collect additional data to fill data gaps.	• Bank configuration (stability, topography) • Depositional environment (fluvial/colluvial) • Topography (relief) • Supported vegetation **Exposure to Fluvial Deposits the Downstream Reach** • Results from geomorphic imagery evaluation • Soil sampling and analysis • Preliminary chemical-specific ARARs • Screening level risk benchmarks	Reach. Transverse limit is width of recently active EFCR channel. Vertical limit is from ground surface down to a maximum depth of investigation of approximately 6 feet. Sampling Unit – visible extent of fluvial deposits within the Downstream Reach Temporal Limits – one or more field seasons Practical Constraints —access limitations imposed by the presence of steep slopes along river canyons. The steepness of hillside slopes impairs safe access to the floodplain that is needed to conduct the sampling activities. Permission to travel overland on private property may inhibit access to the floodplain. Historic properties or their contributing elements may also inhibit access to the floodplain. The access routes and floodplain sampling locations will have to be surveyed in accordance with the National Historic Preservation Act requirements. Drilling and sampling techniques are limited to manual methods or very small mechanized rigs. It may not be possible to differentiate fluvial deposits using field methods. Regardless, characterization of fluvial deposits will be conducted. **Physical Characteristics** Target Population -- Fluvial deposits within the Downstream Reach to a maximum	appropriateness of sampling locations within the Downstream Reach Fluvial Deposits Sampling and Analysis • RI/FS metals[2] • ABA and AVS/SEM • Total Organic Carbon (TOC) • Grain Size • Soil pH. ○ Parameter: concentration and distribution ○ Inference: receptor risk and metal mobility of RI/FS metals in fluvial deposits within the Downstream Reach	guidance. Measurement errors will be controlled by using the appropriate sampling and analytical methods, and having data validation/review to verify laboratory processes. Data that meet these criteria will be considered of definitive quality. Data collection goal is to characterize range and distribution of concentrations and other general chemistry parameters in fluvial deposits along the Downstream Reach. Professional judgment supported by statistical methods will be used to evaluate data using a multiple lines of evidence approach to assess spatial trends and variability in fluvial deposits chemistry data. Data will be used to evaluate whether applicable exposure pathways are complete and the data set is adequate for risk evaluation and decision making purposes.	geomorphic imagery evaluation, field reconnaissance, and professional judgment where fluvial deposits exist. Locate transects in areas of relative finer grain size material because finer-grained material typically contains higher metals content and may be more bioavailable than coarser material. For bedforms adjacent to the EFCR, locate transects starting at approximately 5 to 10 feet from the current edge of the river and continuing away from the river to the edge of the floodplain. For abandoned channels, locate transects to span approximately perpendicular across the abandoned channel. Identify discrete fluvial deposits sample locations along each transect so that river terraces (breaks in elevation) identified along a transect may be sampled. If river terraces cannot be identified, then finalize sampling locations at the approximate beginning, middle and end of each transect. Finalize the transects and fluvial deposits sample locations in the field using

Step 1 – State the Problem	Step 2 – Identify the Goals of the Study	Step-3 – Information Inputs	Step 4 – Define Boundaries	Step 5 – Analytic Approach	Step 6 – Specify Acceptance Criteria	Step 7 – Develop the Plan
Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
	Decision Statement 2. Determine whether concentrations of RI/FS metals in fluvial deposits within the Downstream Reach exceed risk-based thresholds and/or reference concentrations. 1. If concentrations of RI/FS metals in fluvial deposits within the Downstream Reach exceed risk-based thresholds and/or reference concentrations, then further evaluation is required. 2. If concentrations of RI/FS metals in fluvial deposits within the Downstream Reach do not exceed risk-based thresholds and/or reference concentrations, then further evaluation is not required.		depth of approximately 6 feet. Spatial Limits – The Downstream Reach. Longitudinal limit is the Investigation Reach. Transverse limit is width of floodplain Vertical sampling limit is from ground surface down to a maximum depth of investigation of 6 feet. Sampling Unit – visible extent of fluvial deposits within the Investigation Reach Temporal Limits – one or more field seasons Practical Constraints – limited access limitations imposed by the presence of steep slopes along river canyons. Steep slopes may impair safe access to the floodplain that is needed to conduct the sampling activities. Permission to travel overland on private property may inhibit safe access to the floodplain. Historic properties or their contributing elements may also inhibit access to the floodplain. The access routes and floodplain sampling locations will have to be surveyed in accordance with the National Historic Preservation Act requirements.			professional judgement considering visually estimated average grain size, relationship between bedform and recently active stream, and other factors encountered in the field that may enhance sample representativeness of finer-grained fluvial deposits. Collect discrete fluvial deposits samples at approximately 0 to 0.5 feet and 1.5 to 2.0 feet below ground surface (bgs) at each sample location on each transect. Sieve to minus 2 mm in the field and ship samples to the laboratory. Have laboratory sieve the sample into fractions greater and less than 63 microns. Analyze both size fractions of the shallow fluvial deposits samples for RI/FS metals, ABA, AVS/SEM, TOC, and soil pH. Collect fluvial deposits samples at approximately 5.0 to 6.0 feet, or drilling refusal, whichever is shallower. Sample depths can be adjusted +/- 2 feet to preferentially sample differentiated material, if it can be identified based upon field logging results.

Step 1 – State the Problem	Step 2 – Identify the Goals of the Study	Step-3 – Information Inputs	Step 4 – Define Boundaries	Step 5 – Analytic Approach	Step 6 – Specify Acceptance Criteria	Step 7 – Develop the Plan
Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
						Sieve to minus 2 mm in the field and ship samples to the laboratory. Have laboratory sieve the sample into fractions greater and less than 63 microns. Analyze both size fractions of the fluvial deposits samples from deeper than 2 feet bgs for RI/FS metals, ABA, AVS/SEM, TOC, and soil pH. Collect one non-sieved sample per transect and have it analyzed for grain size.
Problem Statement 3: In order to determine the extent of potential site-related impacts to the Downstream Reach, COPC/COPEC concentrations in fluvial deposits in reference areas that approximate ambient conditions are needed to support comparisons to affected areas and ecological risk evaluation (including estimates of incremental risk above ambient conditions); sampling results will also be used in remedy selection decision making if necessary.	**Study Question 1** Are fluvial deposits within the reach of the EFCR upstream from the potential influence of runoff from the areas of the River Ranch property and the confluence with Bryant Creek (Upstream Reach) sufficiently similar to fluvial deposits in potentially affected areas of the Downstream Reach to support the collection of comparable (analog) data sets and the development of reasonable estimates of reference concentrations of RI/FS metals in fluvial deposits in the Upstream Reach? **Alternative outcomes** 1. Stream reaches identified in the Upstream Reach are determined to contain fluvial deposits sufficiently similar to deposits in	**Information Inputs** • Existing data (aerial photography, hyperspectral and LiDAR data) • Geologic setting • Location and extent of current fluvial deposits • Relative and radiometric soil ages • Soil classification, grain size, mineralogy • Bank configuration (stability, topography) • Depositional environment (fluvial/colluvial) • Topography (relief) • Supported vegetation **Fluvial Deposit Age** The age of fluvial deposits can be quantified using relative and	**Target Population** Fluvial deposits along the Upstream Reach. **Spatial Limits** The Upstream Reach fluvial deposits will be selected from the most representative bedforms based upon a geomorphic imagery evaluation described in the Off-Property Focused Remedial Investigation Work Plan, Addendum 4 dated January 8, 2015 and followed by field reconnaissance. **Temporal Limits** One or more field seasons. **Practical Constraints** Access limitations imposed by the presence of steep slopes along river canyons. The steepness of hillside slopes impairs safe access to the floodplain that is	**Fluvial Deposit Classification** • Parameters: Physical characteristics of bedforms, relative and radiometric ages, soil classification, grain size distribution, mineralogic composition, parent material, supported vegetation. • Inference: General comparability of bedforms targeted for sampling in the Upstream Reach fluvial deposits to bedforms targeted for sampling in the Downstream Reach. **Depositional Age** Boreholes will be cored and samples collected for radiometric dating. The radiometric dates will be used to characterize the age(s) of the fluvial deposits in the Upstream Reach.	**Material Identification** Identification of the contact(s) between fluvial deposits within the Upstream Reach will be based upon the professional expertise of experienced field geologists who are familiar with subsurface conditions at Leviathan Mine Site. The field geologists will visually examine sample properties (texture, bedding, mineralogy) and identify whether the material can be differentiated into different groups based upon manual/visual techniques. If differences in the fluvial deposits can be visually recognized, then samples will be collected of each material within a borehole.	**Sampling Plan** Perform a geomorphic imagery analysis of the Upstream Reach and Downstream Reach. Obtain access and U.S. EPA authorization (subject to NHPA requirements) to perform field reconnaissance and sampling activities. Compare bedforms in the Upstream and Downstream Reaches and identify proposed sampling locations for fluvial deposits using professional judgement incorporating multiple lines of evidence. Perform field reconnaissance and finalize sampling locations using

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Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
	the Downstream Reach to support the collection of reference data sets for comparison to concentrations of RI/FS metals in fluvial deposits in the Downstream Reach. 2. Stream reaches identified in the Upstream Reach are determined not to contain fluvial deposits sufficiently similar to deposits along the Downstream Reach to support the collection of reference data sets for comparison to concentrations of RI/FS metals in fluvial deposits in the Downstream Reach. **Decision Statement 1** Determine if the bedforms in the Upstream Reach contains fluvial deposits sufficiently similar to the deposits in the Downstream Reach to support the collection of reference data for fluvial deposits.. If bedforms in the Upstream Reach are determined to contain fluvial deposits sufficiently similar to fluvial deposits in the Downstream Reach, sampling designs will be developed and implemented to collect reference concentrations of RI/FS metals for fluvial deposits. If bedforms in the Upstream Reach are determined not to contain fluvial deposits sufficiently similar to fluvial deposits in the Downstream Reach, then identify	radiometric dating techniques. Analysis of fluvial deposits using cesium 137 (^{137}Cs) and lead 210 (^{210}Pb) techniques can be used to date materials within the target age.	needed to conduct the sampling activities. Permission to travel overland on private property may inhibit safe access to the floodplain. Historic properties or their contributing elements may also inhibit access to the floodplain. The access routes and floodplain sampling locations will have to be surveyed in accordance with the National Historic Preservation Act requirements. **Fluvial Deposits Age** There is the potential that the radiometric dating results may be inconclusive due to homogenization of the material from fluvial processes, especially in areas influenced by high energy flows such as flood events. Hence, it may not be possible to obtain non-homogenized ages for the fluvial deposits.		If differences in the fluvial deposit material cannot be visually recognized, then samples will be collected of the undifferentiated material so that shallow, medium, and deeper samples are collected from each borehole. The consequence of not being able to adequately segregate fluvial deposit material will be minimal because samples will be collected for laboratory analysis whether the materials are differentiated or undifferentiated. **Ages of Fluvial Deposits** If radiometric ages from a core are dissimilar, then the material may be differentiated. If radiometric ages from a core suggest homogenous fluvial deposits, then the material will be considered undifferentiated. **Comparison of Fluvial Deposits** No statistical hypothesis tests are proposed for fluvial deposit investigations associated with this decision statement. Professional judgment incorporating multiple lines of evidence will be used to assess comparability of fluvial deposits along the Upstream Reach. The comparisons will be designed	process outlined in Problem Statement 2, Step 7. If analog sampling locations cannot be identified in the Upstream Reach, then widen the geomorphic imagery evaluation and field reconnaissance efforts upstream in EFCR, sample additional fluvial deposits, and compare the results to identify analogs. Advance boreholes using manual methods and/or mechanized techniques. Collect core samples to a maximum depth of 6 feet. Log core samples using visual/manual methods, and identify the contacts between fluvial deposits if possible. Collect one core for radiometric dating in the Upstream Reach. Submit core for laboratory radiometric dating. **Comparison of Fluvial Deposited Material** Compare the RI/FS Metals concentrations for Upstream Reach and Downstream Reach by calculating their respective mean concentrations using appropriate statistic based upon the data distribution.

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Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
	other potential reference bedforms with comparable fluvial deposits or alternative approaches to estimate reference concentrations for RI/FS metals for fluvial deposits in the EFCR.				once sufficient, useable data sets from both reaches are obtained.	
	Study Question 2 Is the chemistry of fluvial deposits sufficiently characterized in the Upstream Reach for the purposes of estimating reference concentrations of RI/FS metals for comparison to the chemistry of fluvial deposits in the Downstream Reach and to support ecological risk evaluation (including estimates of incremental risk above ambient conditions) and remedial action decision making? **Alternative outcomes** 1. Available chemical data for fluvial deposits in the EFCR Upstream Reach are sufficient for estimating reference concentrations of RI/FS metals for comparison to the chemistry of fluvial deposits in the Downstream Reach and to support ecological risk evaluation and remedial action decision making if necessary. 2. Available chemical data for fluvial deposits in the EFCR Upstream Reach are not sufficient for estimating reference concentrations of RI/FS metals for comparison to the chemistry of fluvial deposits in the Downstream Reach and to support ecological	**Information Inputs** • RI/FS metals[1] concentrations, ABA, AVS/SEM, TOC, grain size distribution, and soil pH in fluvial deposits • Relative and radiometric age of fluvial material • Available literature on elemental concentrations in similar materials and surficial geologic materials • Screening level benchmarks for potential ecological exposures	**Target Population** RI/FS metals, ABA, AVS/SEM, TOC, grain size distribution, soil pH, and relative and radiometric age in fluvial deposits in the Upstream Reach **Spatial Limits** EFCR Reach fluvial deposits identified during the evaluation of fluvial bedforms described under Study Question 1 **Temporal Limits** One or more field seasons. **Practical Constraints** Access limitations imposed by the presence of steep slopes along river canyons. The steepness of hillside slopes impairs safe access to the floodplain that is needed to conduct the sampling activities. Permission to travel overland on private property may inhibit safe access to the floodplain. Historic properties or their contributing elements may also inhibit access to the floodplain. The access routes and floodplain sampling locations will have to be surveyed in accordance with the National Historic Preservation Act requirements.	**Fluvial Deposit Chemistry** • Parameters: RI/FS metals, ABA, AVS/SEM, TOC, grain size distribution of fluvial materials • Inference: Provide fluvial deposit chemical data along the EFCR Upstream Reach for evaluation of ecological risk. If representative RI/FS metals, ABA, AVS/SEM, TOC, grain size distribution, and radiometric age of fluvial deposits from the EFCR Upstream Reach are obtained, these data can be compared to potentially impacted fluvial material in the Downstream Reach and used in support of the evaluation of ecological risk and remedial action decision making.	To limit uncertainty in obtained environmental data, criteria for the precision, accuracy, representativeness, completeness, comparability parameters and reporting limits for the parameters have been developed and presented in the QAPP/SAP in accordance with U.S. EPA guidance. Measurement errors will be controlled by using the appropriate sampling and analytical methods, and having data validation/review to verify laboratory processes. Data that meet these criteria will be considered of definitive quality. Data collection goal is to characterize range and distribution of RI/FS metals concentrations and other general chemistry parameters. Professional judgment supported by statistical methods will be used to evaluate data using a multiple lines of evidence approach to assess spatial trends and variability in stream sediment chemistry data.	**Material Identification** Based upon the geomorphic imagery evaluation, supplemented by field reconnaissance, use professional judgment to select transect locations where there is likely to be 2 feet or more of fine-grained fluvial deposit material. Focus on finer-grained material as these typically contain higher metal concentrations and may be bioavailable. Use GPS to document the horizontal location and ground surface elevation of transects and sample locations. **Sampling and Analysis** For bedforms adjacent to the EFCR, locate transects starting at approximately 5 to 10 feet from the current edge of the river and continuing away from the river to the edge of the floodplain. For abandoned channels, locate transects to span approximately perpendicular across the

Step 1 – State the Problem	Step 2 – Identify the Goals of the Study	Step-3 – Information Inputs	Step 4 – Define Boundaries	Step 5 – Analytic Approach	Step 6 – Specify Acceptance Criteria	Step 7 – Develop the Plan
Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
	risk evaluation and remedial action decision making if necessary. **Decision Statement 2** Determine whether chemical data for fluvial deposits in the EFCR Upstream Reach are sufficient to estimate reference concentrations of RI/FS metals for comparison to the chemistry of fluvial deposits in the Downstream Reach and to support ecological risk evaluation and remedial action decision making if necessary. If the chemistry of fluvial deposits in the EFCR Upstream Reach is sufficiently characterized for estimating reference concentrations of RI/FS metals for comparison to the chemistry of fluvial deposits in the Downstream Reach, then proceed with the comparisons and risk assessments. If the chemistry of fluvial deposits in the EFCR Upstream Reach is not sufficiently characterized for estimating reference concentrations of RI/FS metals in the fluvial deposits in the Downstream Reach, then collect additional chemistry data to fill data gaps.					abandoned channel. Collect discrete fluvial deposit samples at approximately 0 to 0.5 feet and 1.5 to 2.0 feet below ground surface (bgs) at each sample location on each transect. Sieve to minus 2 mm in the field and ship samples to the laboratory. Have laboratory sieve the sample into fractions greater and less than 63 microns. Analyze both size fractions of the shallow fluvial deposit samples for RI/FS metals, ABA, AVS/SEM, TOC, and soil pH. Collect fluvial deposit samples at approximately 5.0 to 6.0 feet, or drilling refusal, whichever is shallower. Sample depths can be adjusted +/- 2 feet to preferentially sample differentiated material, if it can be identified based upon field logging results. Sieve to minus 2 mm in the field and ship samples to the laboratory. Have laboratory sieve the sample into fractions greater and less than 63 microns. Analyze both size fractions of the fluvial deposit samples

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Give a concise description of the problem that necessitates the study.	*Identify principal study question, consider alternative outcomes, develop decision statements, organize multiple decisions.*	*Identify types and sources of information needed to answer study questions, identify the basis of information, and select appropriate sampling and analysis methods for generating the information.*	*Specify the target population, determine spatial and temporal limits, identify practical constraints, and define the scale of inference.*	*Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from the findings.*	*Specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors.*	*Select the resource-effective sampling and analysis plan that meets the performance or acceptance criteria.*
						from deeper than 2 feet bgs for RI/FS metals, ABA, AVS/SEM, TOC, and soil pH. Collect one non-sieved sample per transect and have it analyzed for grain size.

Notes:
[1] First presented in Off-Property Focused Remedial Investigation Work Plan Addendum No. 4 submitted January 8, 2015.
[2]RI/FS metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium VI, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver, selenium, thallium, vanadium, and zinc.

Abbreviations:
AVS = acid volatile sulfide
ARARs = Applicable or Relevant and Appropriate Requirements
EFCR = East Fork of the Carson River
COPC/ COPEC = chemical of potential concern/ chemical of potential ecological concern
Cr-VI = chromium VI
FRI = Focused Remedial Investigation
FS = Feasibility Study
QAPP = Quality Assurance Project Plan
RI = Remedial Investigation
SAP = Sampling Analysis Plan
SEM = simultaneously extracted metals

U.S. EPA = U.S. Environmental Protection Agency

APPENDIX B

APPENDIX B
EAST FORK CARSON RIVER
GEOMORPHIC IMAGERY EVALUATION
TECHNICAL MEMORANDUM
Leviathan Mine Site
Alpine County, California

Submitted to:
Atlantic Richfield Company
La Palma, California

Submitted by:
Amec Foster Wheeler
Environment & Infrastructure, Inc.
Rancho Cordova, California

January 8, 2016

Project No. 0013091150

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LIST OF ABBREVIATIONS AND ACRONYMS

Atlantic Richfield	Atlantic Richfield Company
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EFCR	East Fork Carson River
EROS	Earth Resources Observation Systems
RI/FS	remedial investigation/feasibility study
SQT	Sediment Quality Triad
SOW	Scope of Work
TSAP	Task Sampling and Analysis Plan
UAO	Unilateral Administrative Order
U.S. EPA	U.S. Environmental Protection Agency
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey

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APPENDIX B
EAST FORK CARSON RIVER
GEOMORPHIC IMAGERY EVALUATION
TECHNICAL MEMORANDUM
Leviathan Mine Site
Alpine County, California

1.0 INTRODUCTION

This Technical Memorandum is Appendix B of Addendum No. 4 to the Off-Property Focused Remedial Investigation Work Plan (Off-Property FRI Work Plan) (Atlantic Richfield, 2012). The Off-Property FRI Work Plan is being implemented in partial fulfillment of the requirements of the Statement of Work (SOW) attached to the Administrative Order for Remedial Investigation and Feasibility Study (RI/FS) (Unilateral Administrative Order [UAO]), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Docket No. 2008-18 issued by the U.S. Environmental Protection Agency (U.S. EPA) on June 23, 2008 (U.S. EPA, 2008).

This memorandum provides results from an aerial imagery evaluation of fluvial bedforms along the East Fork of the Carson River (EFCR) as a geomorphic analysis of sediment accumulation along the EFCR. The evaluation focused on a reach of EFCR downstream from the Leviathan Mine Site (site), that is between the remnants of the former Ruhenstroth Dam and the confluence with Bryant Creek (Downstream Reach), and a reach of the EFCR upstream from the potential influence of runoff, from the confluence with Bryant Creek and the River Ranch property (Upstream Reach). This study was conducted to address the U.S. EPA comments in an August 10, 2015 letter on the East Fork Carson River Sediment Quality Triad (SQT) Technical Memorandum (Atlantic Richfield, 2015). In their letter, U.S. EPA requested that Atlantic Richfield Company (Atlantic Richfield) perform *"a geomorphic analysis of sediment accumulation areas along the EFCR sufficient to identify bed load deposits downstream to at least the Ruhenstroth Dam site"*. This geomorphic imagery evaluation is the first step to address the U.S. EPA's requirements identified in their August 10, 2015 letter and in the SOW.

The SOW states that "existing programs [should be reviewed] to characterize surface water bodies in the Study Area and design additional work to fill data gaps." Section 2e in the SOW states that characterization of sediment and depositional areas in EFCR downstream from the Leviathan Mine Site should include the following:

I. Deposition area (including distance downstream and flood plain/bank deposition);

II. Thickness profile;

III. Physical and chemical parameters including grain size, density, organic carbon content, pH, contaminant concentration such as metals and arsenic;

IV. Contaminant mobility, bioavailability, transport potential and acid generation potential for in-stream sediment and flood plain deposits.

Section 2f in the SOW states that characterization of these sediments at the former Ruhenstroth Dam Site shall include:

I. Measurement of stratigraphic sections;

II. Age dating of sediments;

III. Chemical analysis of sediments;

IV. Visual description of the sediments.

The objective of this aerial imagery evaluation is to identify potential locations for the sampling of fluvial deposits along the EFCR so that material between the former Ruhenstroth Dam site and the confluence with Bryant Creek may be compared to fluvial deposits upstream of possible influences from Leviathan Mine. Atlantic Richfield has separately prepared a Task Sampling and Analysis Plan (TSAP) based upon the results of the aerial image evaluation. The TSAP proposes locations for sampling fluvial deposits to characterize selected reaches of the EFCR. The results of this geomorphic imagery evaluation are described in the remainder of this Technical Memorandum.

2.0 AERIAL IMAGERY

A search of various commercial sources and governmental agencies was performed in investigation reaches along the EFCR (defined in Section 2.1) to find aerial images that might provide information on the location and movement of medium-scale (mesoform) and large scale (macroform) fluvial bedforms in and near the EFCR. Macroforms (point bars, braid bars, unit bars, and composite bars) are relatively insensitive to significant rearrangement during individual flood events, and generally are not fully submerged except during the largest flood events (Smith, 2009). Mesoforms, such as bedload sheets and transverse bars, are often superimposed on macroforms (Bridge, 1993) and are more easily modified by streamflow. Relevant images (Tables 1 and 2) were purchased or downloaded, and then further manipulated to better allow comparisons between images, as discussed in the following sections.

2.1 INVESTIGATION AREAS

Images from two investigation areas were identified. The northern downstream area, located in Nevada (Figure B1), extends between the former Ruhenstroth Dam site and the confluence with Bryant Creek, termed herein as the Downstream Reach. This reach of the EFCR is downstream from Bryant Creek, Leviathan Creek, and the Leviathan Mine site. Mine-related material that originated at the Leviathan Mine could potentially have been transported in Leviathan and Bryant Creeks and deposited in the EFCR.

The second investigation area, located in California, encompasses an upstream reach of the EFCR between the potential influence from runoff over the areas of the River Ranch property (River Ranch) and the upstream town of Markleeville, California, termed herein the Upstream Reach. This reach is upstream from where sediment derived from Leviathan Mine could potentially enter EFCR via discharge from Bryant Creek or return flow from River Ranch; hence, fluvial deposit samples from the Upstream Reach will serve to provide information on characteristics of alluvial deposits in the EFCR that were not influenced by mine-related sediment transported from the Leviathan Mine site.

2.2 IMAGE ACQUISITION

Surface mining disturbances at the Leviathan Mine site occurred predominantly in the 1950's and early 1960s, so the search for aerial imagery was focused from before this time period until the present. Tables B1 and B2 list images acquired for the Downstream and Upstream Reaches, respectively. The following entities are the sources of images acquired for this report:

- United States Geological Survey (USGS, 2015) High Resolution Orthoimagery (HRO) collection
- Aerial Photography Field Office of the United States Department of Agriculture (USDA) Farm Services Agency (USDA, 2015)
- Space and Intelligence Systems/Harris Corporation, 2015, Lone Tree Colorado (Mapmart)
- Google Earth™

High resolution, orthorectified images combine image characteristics of an aerial photograph with the geometric qualities of a map, and have uniform-scale and corrections made for feature displacement (e.g. building tilt and scale variations caused by terrain relief, sensor geometry, and camera tilt). A digital orthoimage may be created from multiple black-and-white, natural color, or color infrared photographs. Orthoimagery resolution refers to the distance on the ground represented by each image pixel and may be 1-meter or finer. Digital orthoimages were obtained from the sources described in the Subsections 2.2.1 through 2.2.3.

2.2.1 U.S. Geological Survey Images

The U.S. Geological Survey (USGS) High Resolution Orthoimagery collection was acquired through contracts, partnerships with other Federal, state, tribal, or regional agencies, and direct purchases from private industry vendors. Because data comes from a variety of sources, the resolution, area of coverage, file size, and projection varies by dataset. The USGS Earth Resources Observation Systems (EROS) Center manages and distributes this orthoimagery, which are available in a Georeferenced Tagged Image File Format (GeoTIFF).

High and medium resolution images with the largest scales (best resolution) available were downloaded from the EROS Center website (eros.usgs.gov). USGS images ranged in dates from 1954 to 1994. Scales of acquired images range from 1:24,000 to 1:80,000. Image quality was variable from good to poor. No images from before 1954 were found.

2.2.2 Farm Service Agency Images

Digital image scans and quarter quadrangles along the EFCR were obtained from the U.S. Department of Agriculture Farm Service Agency (FSA) web site (apfo.usda.gov). A scan consists of film burned onto an optical disc at a resolution of 12.5 microns, or more than 2000 DPI (Dots per Inch). The quarter quadrangles are digital images taken at resolutions of 1 or 2 meters, depending upon the year in which the image was taken.

FSA images along the EFCR from 1980 to 2009 were obtained. These images were generally of high quality and postdated most of the USGS images.

2.2.3 Mapmart Images

Recently acquired images were purchased from the Harris Corporation (Mapmart) to provide high resolution baseline data. A 2014 image that was acquired is a WorldView-2 panchromatic image with 0.5 meter resolution. A 2010 image is WorldView-1 with similar resolution. Each of these images covered both study areas along the EFCR. Aside from Google Earth information, they provided the most recent images of fluvial bedforms within the reaches of the EFCR of interest to this evaluation.

2.2.4 Google Earth Images

Google Earth is a virtual globe, map and geographical information program. It uses superposition of satellite imagery, aerial photography, and geographic information system (GIS) data to produce three dimensional global maps. Google Earth displays images of varying resolution that the user may view from perpendicular or oblique angles. Most land areas are covered at a resolution of at least 15 meters. Some areas within the Google Earth platform have approximately 15 centimeter resolution.

The most recent available 2015 Google Earth images were used to discern EFCR fluvial bedform features and to select sample transects. Oblique views of transect locations were also provided to give more perspective to the local topography.

2.3 IMAGE ANALYSIS

Aerial images were analyzed by comparing large bedform deposits in and near the river over the period of available imagery. These include large river bars, abandoned stream channels, and apparent terrace deposits near the former Ruhenstroth Dam. Bedforms and depositional features in the Upstream and Downstream Reaches that may be suitable for sample transects are discussed in Section 2.3.2.

2.3.1 Streamflow Data

To reduce the number of images to be evaluated and focus this evaluation of aerial imagery, peak streamflow data from the USGS gauging station on the EFCR near Gardnerville, Nevada were plotted and flood events since 1950 were evaluated (Figure B2). Flood events generally produce the deepest scour and displacement of stream sediments and fluvial deposits and would tend to mobilize and redistribute mine–related material if it were present.

The largest flood on the EFCR since 1950 (and in the 20th century) occurred in January 1997 with peak flow exceeding 20,000 ft^3/second. This flood completed the natural destruction of the former Ruhenstroth Dam, which was partially destroyed by a flood in 1937. The dam was dynamited after the 1997 flood when remnants were deemed to be a hazard (Las Vegas Sun, 1997). Other large floods occurred in 1950, 1955, and 1963. Large flood events are listed in chronological order in Tables B1 and B2. The best images before and after large flood events were the primary images used for subsequent evaluation of imagery.

2.3.2 Results

Selected images were loaded into Groundwater Modeling System (GMS) software and georeferenced when necessary. All images were referenced to the California State Plane 402 NAD 83 horizontal coordinate system so they could be overlain and rapidly compared.

Many large bars in EFCR appear to be quite stable in overall location, shape, and dimension over a span of at least 60 years. No images before 1950 were found, but these large bedforms are likely to predate surface mining activities at the Leviathan Mine site. Sediment transport is extremely active in EFCR. Katzer and Bennett (1980) estimated that sediment transport into EFCR during a 50-day study period (spring 1978) was approximately 60,000 tons, with 14,000 tons transported out of EFCR into the Carson River Valley and about 46,000 tons (920 tons/day) of deposition in EFCR. Flow during this period was approximately 117 percent of the

47 year record average. Maximum deposition and scour were both around 2 feet based on measurements of riverbed elevation at 31 stream profile locations (Katzer and Bennett, 1980).

Despite the high volume of sediment transport in EFCR, many large bar macroforms may never, or only rarely, be fully submerged. Redistribution of sediments likely occurs primarily along the margins of these features. These apparently stable bars would be expected to consist of more recent sediments along the margins to older sediments toward the center of the bedform. Figure B3 shows a chronology of stable bedforms near the former Ruhenstroth Dam and Figure B4 outlines these features on a 2014 image.

Figure B5 shows fluvial deposits interpreted as terrace deposits directly upstream of the remains of the former Ruhenstroth Dam. These sediments presumably correspond to the original reservoir behind the former Ruhenstroth Dam, and the greatly reduced extent of water that pooled behind the remains of the dam after the 1937 flood. In this case, only the lower terrace postdates surface mining activities at the Leviathan Mine site. Two sample transects are therefore proposed in the lower terrace.

Figures B6 through B8 show significant bedforms along the EFCR a few miles upstream from the former Ruhenstroth Dam and downstream from Bryant Creek. Channel migration between former channels and the current channel is evident. The channel, which was against the mountain to the east, shifted to the west sometime after 1980 leaving an abandoned bar and channel that may contain older residual deposits. Because this abandoned channel was flowing during the time period of active surface mining at the Leviathan Mine site, it is possible that Leviathan Mine-related sediment may have been deposited in these features (Figures B7 and B8).

Figures B9 through B13 show large bedforms along the Upstream Reach that appear similar in physical characteristics to those in the Downstream Reach. As a result, these bedforms appear to represent suitable analogs for reference sampling. Figure B9 shows a chronology of bedforms along this reach. Two stable features are delineated in Figure B10 and proposed transect locations are shown on Figure B11.

Figures B12 and B13 show EFCR bedforms farther upstream near Highway 89 in the vicinity of Markleeville, CA. The best images available show bedforms on the reach in 1954 and 1973. Transects on bedform features within this reach (Figure B13) present since 1954 may also be suitable analogs for bedforms in the Downstream Reach and thus would be appropriate for reference sampling.

3.0 SUMMARY AND RECOMMENDATIONS

Fluvial depositional bedforms in EFCR were evaluated using aerial imagery, and features were selected as potential sampling locations to characterize fluvial deposits. Two investigation areas along the EFCR consist of a Downstream Reach and an Upstream Reach.

Three features are proposed for sampling to satisfy the requirements of the Statement of Work as outlined in Section 1.0. These features consist of: 1) terrace deposits near the former Ruhenstroth Dam, 2) medium- or large-scale fluvial bedforms, and 3) abandoned stream channels. The rationale for sampling these features is presented below:

- The terrace deposits proposed for sampling near the former Ruhenstroth Dam consist of the lower terrace materials which are inferred to correspond to the residual reservoir that existed behind the remains of the former Ruhenstroth Dam after the 1937 flood. This feature has also been a stable bedform as discussed below. Two sampling transects are recommended in the lower terrace (Figure B4) to characterize fluvial deposits near the former Ruhenstroth Dam.
- Medium- or large-scale fluvial bedforms in the Downstream and Upstream Reaches are proposed for sampling to characterize fluvial deposits for evidence of potentially mine-related material that might have originated from the Leviathan Mine site. These bedforms are targeted for sampling as they are thought to have the highest likelihood of remaining stable since commencement of surface mining at the Leviathan Mine site. These apparently stable bars would be expected to consist of more recent sediments along the margins to older sediments toward the center of the bedform. As a result, sampling is recommended along transects extending from near the margin towards the center of some of these apparently stable river bars (Figures B10 and B12).
- Abandoned channels in the EFCR floodplain may be locations where mine-related material could be present. Channels that are visible in 1954 images (Figure B4) but were subsequently abandoned and, hence, where post-1954 fluvial materials have been deposited, are recommended locations for sampling transects (Figure B6).

Final sample locations will be selected in the field based upon field reconnaissance and river flow and stage conditions to ensure safe access and appropriate characteristics of the fluvial deposits to be sampled.

4.0 REFERENCES

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TABLES

TABLE No. B1
Aerial Images Downstream Reach
Leviathan Mine Site
Alpine County, California

Date	Source	Image/Aerial Photo	Scale	Area	Peak Flow	Comment
11/28/2014	MM	WorldView-2 Image 0.5 meter panchromatic Accuracy: 3.5 meter CE90 (at nadir) Acquisition Date: November 28th, 2014 Projection/Datum: UTM WGS84		Both		
6/6/2010		FLOOD EVENT			6-Jun	
4/8/2010	MM	WorldView-1 Imagery. Res: 0.5m. Accuracy: 6.5 meter CE90 (at nadir) Acquisition Date: April 8th, 2010 Projection/Datum: UTM WGS84		Both		
6/22/2009	FSA	m_3811911_nw_11_1_20090622		DR		
6/22/2009	FSA	m_3811911_se_11_1_20090622		DR		
6/22/2009	FSA	m_3811911_sw_11_1_20090622		DR		
7/8/2006	FSA	NAIP06_03033_53		DR		not oriented
8/23/2005	FSA	n_3811911_nw_11_1_20050823		DR		south?
8/25/2005	FSA	n_3811911_se_11_1_20050825		DR		location?
8/23/2005	FSA	n_3811911_sw_11_1_20050823		DR		central
12/31/2005		FLOOD EVENT			31-Dec	
6/3/2003	FSA	NAIP03_06001_106		DR		good quality, not oriented
6/3/2003	FSA	NAIP03_06001_108		DR		
6/3/2003	FSA	NAIP03_06001_110		DR		northern end
9/18/1998	FSA	NAPP_10564_252		DR		south?
9/19/1998	FSA	NAPP_10565_153		DR		north
9/19/1998	FSA	NAPP_10565_155		DR		central
1/3/1997		FLOOD EVENT			3-Jan	
7/19/1993	FSA	NAPP_6307_14		DR		north
7/19/1993	FSA	NAPP_6307_16		DR		central
7/19/1993	FSA	NAPP_6307_18		DR		south?
7/6/1990	FSA	NAPP_2791_64_1990		DR		not oriented
5/9/1990	FSA	NAPP_2778_24_1990		DR		good image & coverage
5/9/1990	FSA	NAPP_2778_26		DR		far north
7/11/1987	FSA	NAPP_485_85		DR		not oriented
7/11/1987	FSA	NAPP_485_87		DR		good image & coverage
7/11/1987	FSA	NAPP_485_89		DR		cover Ruhenstroth
2/19/1986		FLOOD EVENT			19-Feb	
9/7/1984	USGS	Entity ID: AR5840034027376 Coordinates: 38.814789 , -119.683215 Acquisition Date: 07-SEP-84	80,000	DR		
5/29/1983		FLOOD EVENT			29-May	
1/13/1980		FLOOD EVENT			13-Jan	
1/1/1980	FSA	HAP_179_106		DR		northern DR
1/1/1980	FSA	HAP_179_108		DR		s. DR, includes Cottonwood
1/1/1980	FSA	HAP_179_109		DR		SE of area
6/21/1979	USGS	Entity ID: AR5790027750151 Coordinates: 38. , -119. Acquisition Date: 21-JUN-79	80,000	DR		
6/21/1979	USGS	Entity ID: AR5790027750150 Coordinates: 38.831 , -119.68965 Acquisition Date: 21-JUN-79	80,000	DR		
7/1/1976	USGS	Entity ID: AR1VEGS00010009 Coordinates: 38.745018 , -119.690233 Acquisition Date: 01-JUL-76	80,000	DR		
8/1/1973	USGS	Entity ID: AR1VDGL00020068 Coordinates: 38.798153 , -119.685226 Acquisition Date: 01-AUG-73	32,000	DR		
8/1/1973	USGS	Entity ID: AR1VDGL00020067 Coordinates: 38.825861 , -119.684149 Acquisition Date: 01-AUG-73	32,000	DR		optional (between floods)
8/1/1973	USGS	Entity ID: AR1VDGL00020066 Coordinates: 38.854414 , -119.684416 Acquisition Date: 01-AUG-73	32,000	DR		optional (between floods)
8/1/1973	USGS	Entity ID: AR1VDGL00020065 Coordinates: 38.88195 , -119.685052 Acquisition Date: 01-AUG-73	32,000	DR		
8/1/1973	USGS	Entity ID: AR1VDGL00020058 Coordinates: 38.832138 , -119.731661 Acquisition Date: 01-AUG-73	32,000	DR		
8/1/1973	USGS	Entity ID: AR1VDGL00020057 Coordinates: 38.802946 , -119.732193 Acquisition Date: 01-AUG-73	32,000	DR		
7/10/1967	USGS	Entity ID: AR1VBTC00010113 Coordinates: 38.840739 , -119.65308 Acquisition Date: 10-JUL-67	34,000	DR		
7/10/1967	USGS	Entity ID: AR1VBTC00010112 Coordinates: 38.810615 , -119.65373 Acquisition Date: 10-JUL-67	34,000	DR		

TABLE No. B1
Aerial Images Downstream Reach
Leviathan Mine Site
Alpine County, California

7/10/1967	USGS	Entity ID: AR1VBTC00010110 Coordinates: 38.815302 , -119.69892 Acquisition Date: 10-JUL-67	34,000	DR		
7/10/1967	USGS	Entity ID: AR1VBTC00010109 Coordinates: 38.843416 , -119.69927 Acquisition Date: 10-JUL-67	34,000	DR		
7/10/1967	USGS	Entity ID: AR1VBTC00010108 Coordinates: 38.87325 , -119.698847 Acquisition Date: 10-JUL-67	34,000	DR		
7/10/1967	USGS	Entity ID: AR1VBTC00010063 Coordinates: 38.832786 , -119.696911 Acquisition Date: 10-JUL-67	24,000	DR		
7/10/1967	USGS	Entity ID: AR1VBTC00010062 Coordinates: 38.85278 , -119.697492 Acquisition Date: 10-JUL-67	24,000	DR		DR north
7/10/1967	USGS	Entity ID: AR1VBTC00010061 Coordinates: 38.872912 , -119.694569 Acquisition Date: 10-JUL-67	24,000	DR		DR south
1966	FSA	1966 Not covered		DR		
12/23/1964		FLOOD EVENT			23-Dec	
2/1/1963		FLOOD EVENT			1-Feb	
10/17/1956	USGS	Entity ID: ARMPTF164041034 Coordinates: 38.807445 , -119.672718 Acquisition Date: 17-OCT-56	32,500	DR		DR south
10/17/1956	USGS	Entity ID: ARMPTF164041033 Coordinates: 38.834805 , -119.694583 Acquisition Date: 17-OCT-56	32,500	DR		DR north
10/17/1956	USGS	Entity ID: ARMPTF164041032 Coordinates: 38.862416 , -119.716649 Acquisition Date: 17-OCT-56	32,500	DR		DR way north
12/13/1955		FLOOD EVENT			23-Dec	
9/6/1954	USGS	Entity ID: AR1VEV000030130 Coordinates: 38.84203 , -119.72548 Acquisition Date: 06-SEP-54	47,200	DR		central
9/6/1954	USGS	Entity ID: AR1VEV000030108 Coordinates: 38.81589 , -119.64687 Acquisition Date: 06-SEP-54	47,200	DR		
9/5/1954	USGS	Entity ID: AR1VEV000010166 Coordinates: 38.82082 , -119.67875 Acquisition Date: 05-SEP-54	37,400	DR		north
11/21/1950		FLOOD EVENT			21-Nov	

Abbreviations and Color Coding

Use for Analysis
Both = Downstream Reach and Upstream Reach
DR = Downstream Reach
FSA = Farm Service Agency
ID = Identification
MM = Map Mart (Harris Corp.)
UR = Upstream Reach
USGS = United States Geological Service

TABLE B2
Aerial Images Upstream Reach
Leviathan Mine Site
Alpine County, California

Date	Source	Image/Aerial Photo	Scale	Area	Peak Flow	Comment
11/28/2014	MM	WorldView-2 Image 0.5 meter panchromatic AURuracy: 3.5 meter CE90 (at nadir) Acquisition Date: November 28th, 2014 Projection/Datum: UTM WGS84		Both		
6/6/2010		FLOOD EVENT			6-Jun	
4/8/2010	MM	WorldView-1 Imagery. Res: 0.5m. AURuracy: 6.5 meter CE90 (at nadir) Acquisition Date: April 8th, 2010 Projection/Datum: UTM WGS84		Both		
2006	FSA	3 quarter quads		UR		
2006	FSA	2006 1 photo		UR		
12/31/2005		FLOOD EVENT			31-Dec	
2005	FSA	2005 3 quarter quads		UR		
2003	FSA	2003 2 photos		UR		
1998	FSA	2 photos (9-19-98)		UR		
1998	FSA	1998 2 photos (9-18-98		UR		
1/3/1997		FLOOD EVENT			3-Jan	
2/25/1994	USGS	Entity ID: AR5940047003608 Coordinates: 38.725946 , -119.730508 Acquisition Date: 25-FEB-94	60,000	UR		
5/25/1993	USGS	Entity ID: AR5930045627783 Coordinates: 38.772601 , -119.74154 Acquisition Date: 25-MAY-93	65,000	SUR		south of Cottonwood Creek
1993	FSA	1993 2 photos		UR		
1990	FSA	1990 2 photos		UR		
1987	FSA	1987 2 photos		UR		
2/19/1986		FLOOD EVENT			19-Feb	
5/29/1983		FLOOD EVENT			29-May	
1/13/1980		FLOOD EVENT			13-Jan	
1980	FSA	1980 2 photos		UR		
8/1/1973	USGS	Entity ID: AR1VDGL00020069 Coordinates: 38.768393 , -119.683665 Acquisition Date: 01-AUG-73	32,000	UR		
8/1/1973	USGS	Entity ID: AR1VDGL00020056 Coordinates: 38.775398 , -119.730214 Acquisition Date: 01-AUG-73	32,000	UR		
8/1/1973	USGS	Entity ID: AR1VDGL00020055 Coordinates: 38.745695 , -119.726449 Acquisition Date: 01-AUG-73	32,000	UR		
8/1/1973	USGS	Entity ID: AR1VDGL00020054 Coordinates: 38.719013 , -119.729541 Acquisition Date: 01-AUG-73	32,000	SUR		south of Cottonwood Creek
7/10/1967	USGS	Entity ID: AR1VBTC00010111 Coordinates: 38.786185 , -119.698905 Acquisition Date: 10-JUL-67	34,000	UR		
12/23/1964		FLOOD EVENT			23-Dec	
2/1/1963		FLOOD EVENT			1-Feb	
10/17/1956	USGS	Entity ID: ARMPTF164041035 Coordinates: 38.780335 , -119.651058 Acquisition Date: 17-OCT-56	32,500	UR		
12/13/1955		FLOOD EVENT			23-Dec	
9/1/1955	USGS	Entity ID: AR1VJM000010171 Coordinates: 38.775022 , -119.754889 Acquisition Date: 01-SEP-55	47,000	UR		
9/1/1955	USGS	Entity ID: AR1VJM000010170 Coordinates: 38.728918 , -119.756113 Acquisition Date: 01-SEP-55	47,000	SUR		south of Cottonwood Creek
9/6/1954	USGS	Entity ID: AR1VEV000030127 Coordinates: 38.71758 , -119.71924 Acquisition Date: 06-SEP-54	47,200	SUR		south of Cottonwood Creek
9/5/1954	USGS	Entity ID: AR1VEV000030128 Coordinates: 38.75921 , -119.72066 Acquisition Date: 06-SEP-54	47,200	UR		
9/5/1954	USGS	Entity ID: AR1VEV000010176 Coordinates: 38.77894 , -119.73577 Acquisition Date: 05-SEP-54	37,400	UR		
9/5/1954	USGS	Entity ID: AR1VEV000010175 Coordinates: 38.74807 , -119.73466 Acquisition Date: 05-SEP-54	37,400	UR		
11/21/1950		FLOOD EVENT			21-Nov	

Abbreviations and Color Coding

Use for Analysis
Both = Downstream Reach and Upstream Reach
DR = Downstream Reach
FSA = Farm Service Agency
ID = Identification
MM = Map Mart (Harris Corp.)
UR = Upstream Reach
USGS = United States Geological Service

FIGURES

EFCR Geomorphic Analysis – EFCR Study Areas

amec foster wheeler

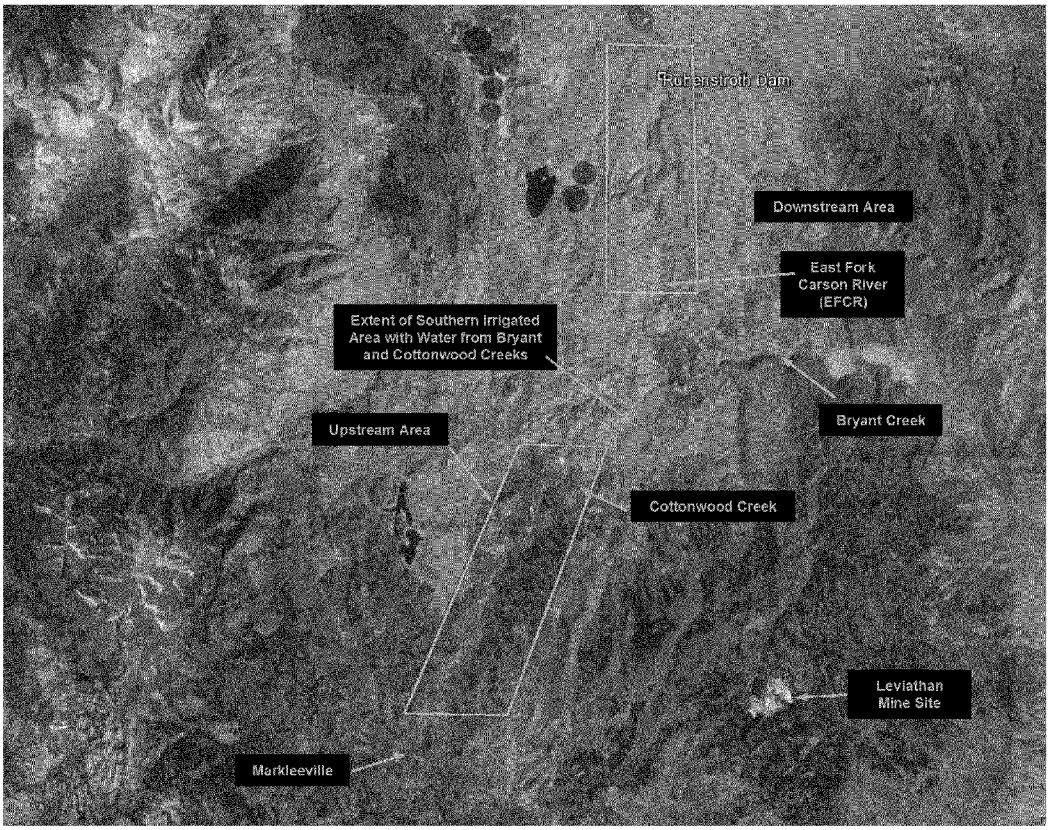


Figure B1

ED_001709_00000321-00072

EFCR Geomorphic Analysis – Peak Flows on EFCR

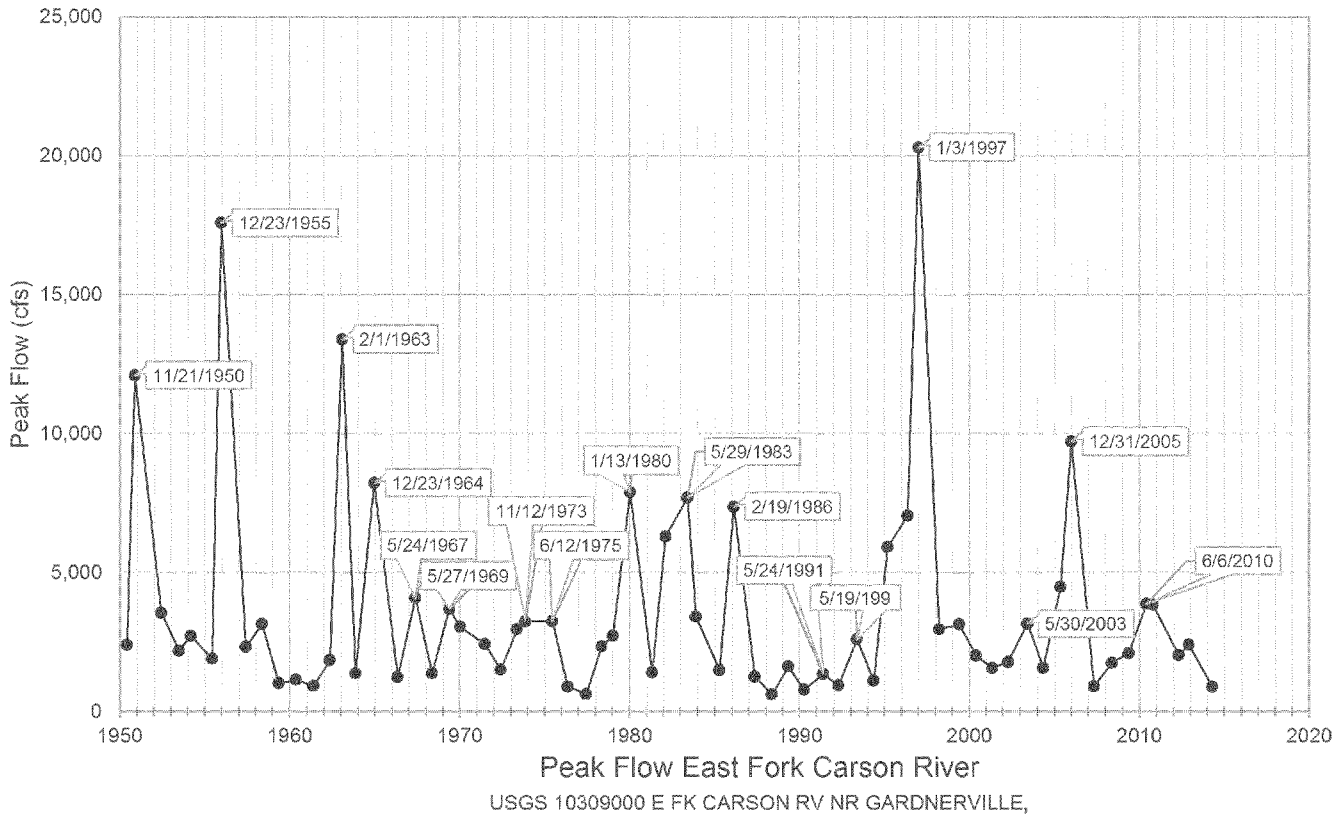
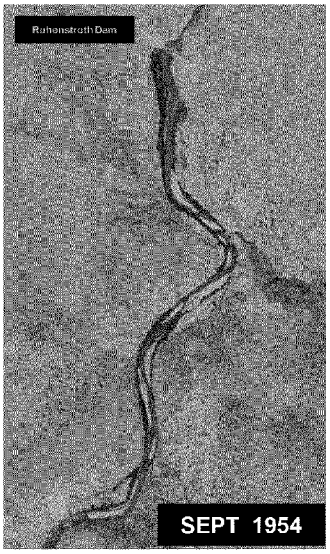


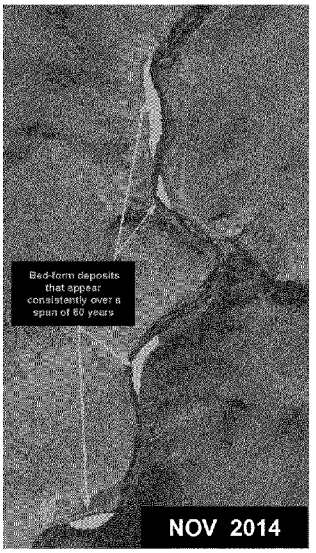
Figure B2

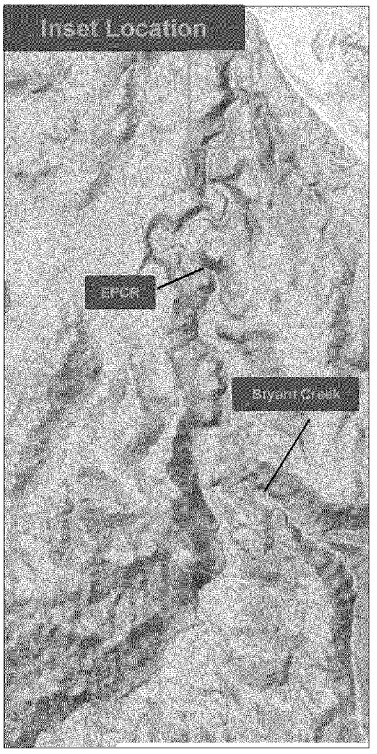
ED_001709_00000321-00073

EFCR Geomorphic Analysis– Bedform Chronology Upstream Of Ruhenstroth Dam

amec foster wheeler







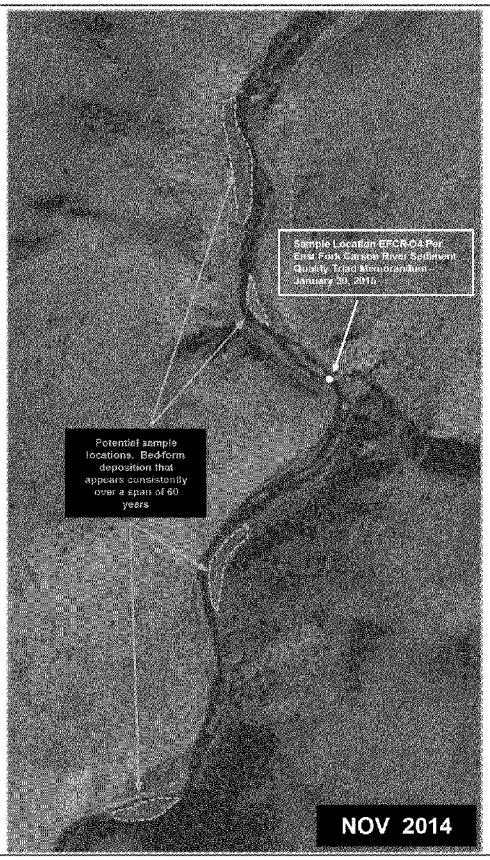
Generally consistent bed-form deposition in the relatively narrow and steep canyon of the upper reaches of the EFCR, upstream from Ruhenstroth Dam

Figure B3

ED_001709_00000321-00074

EFCR Geomorphic Analysis– Potential Sampling Locations Upstream Of Ruhenstroth Dam

amec foster wheeler



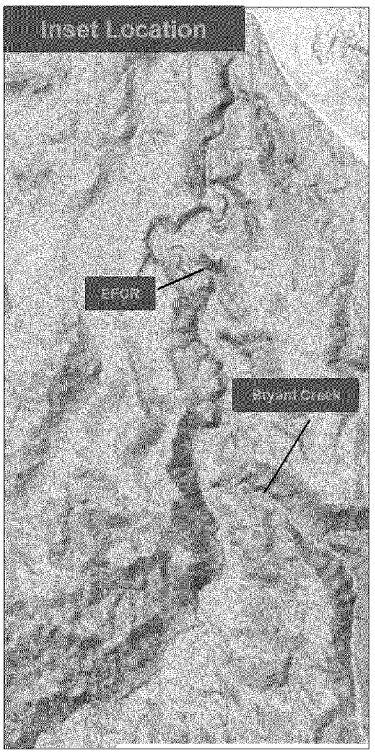
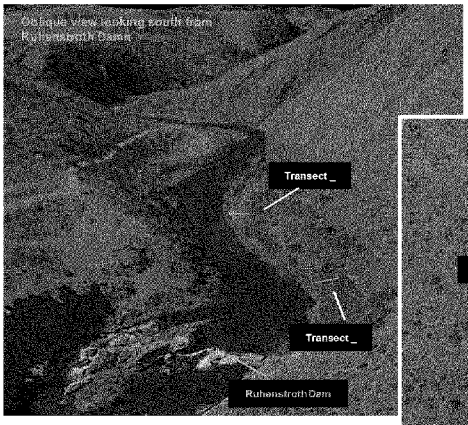


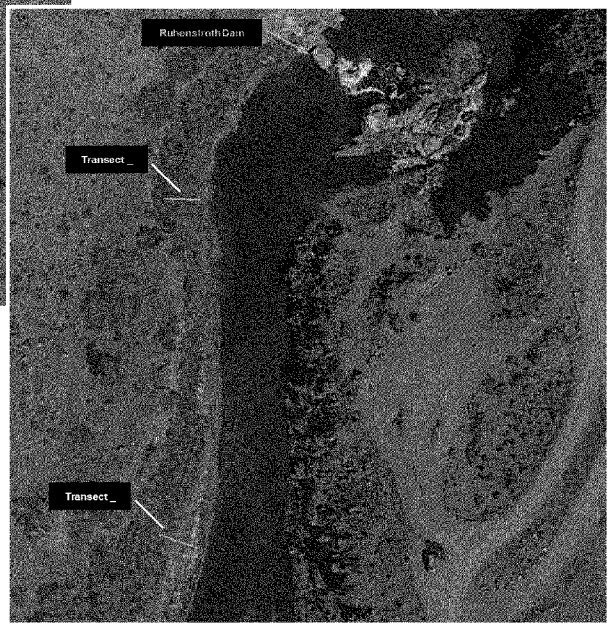
Figure B4

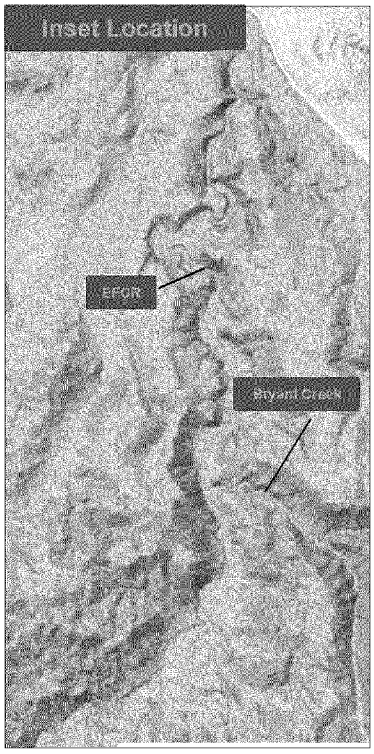
ED_001709_00000321-00075

EFCR Geomorphic Analysis – Proposed Sample Transects Near Ruhenstroth Dam

amec foster wheeler







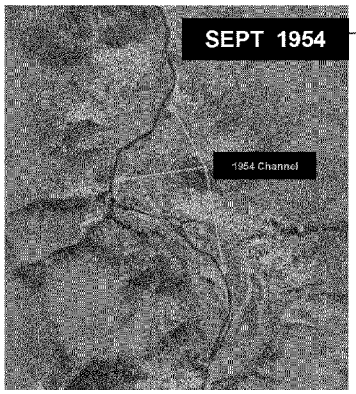
Images from Google Earth
Image date – April 2015

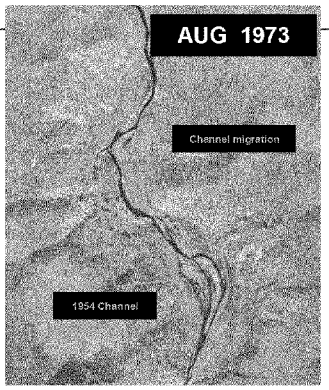
Figure B5

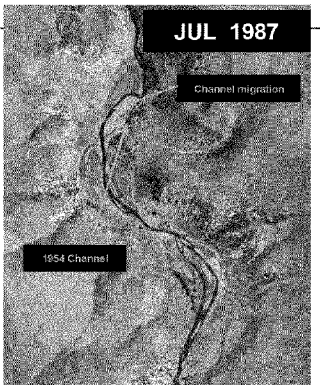
ED_001709_00000321-00076

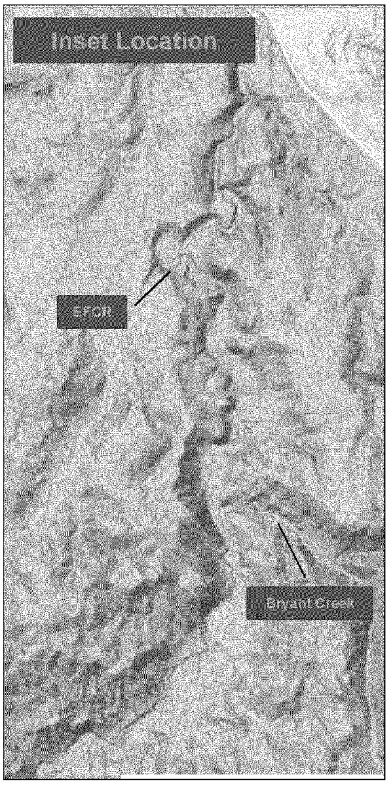
EFCR Geomorphic Analysis – Bedform Chronology Downstream of Bryant Creek

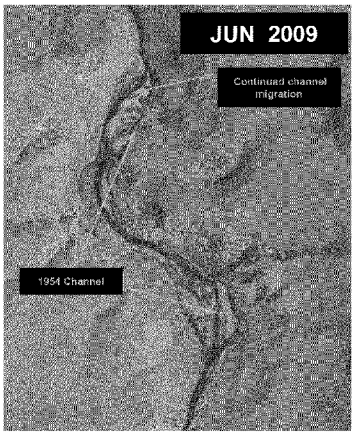
amec foster wheeler











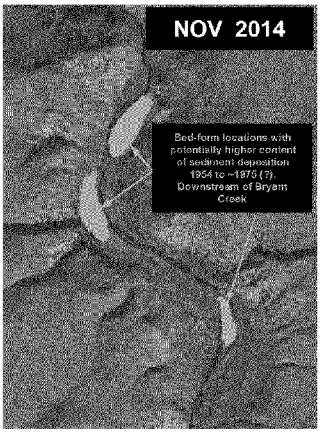
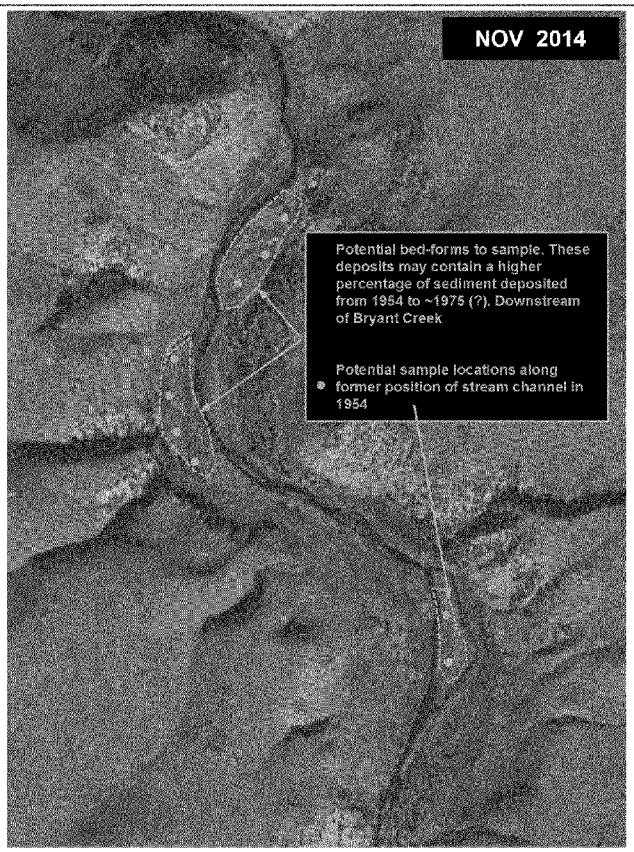


Figure B6

ED_001709_00000321-00077

EFCR Geomorphic Analysis– Potential Sampling Locations Downstream of Bryant Creek

amec foster wheeler



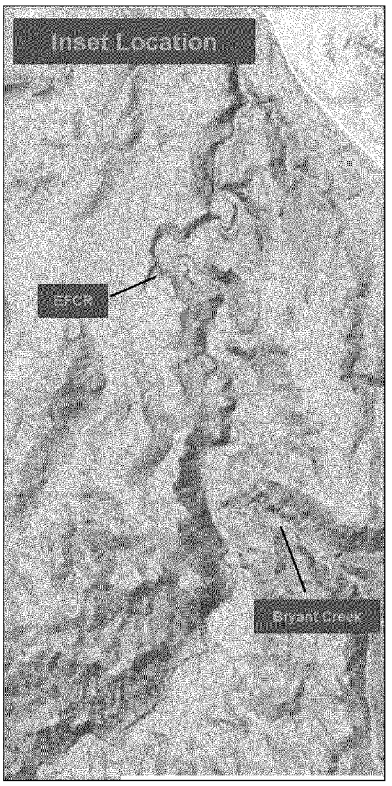
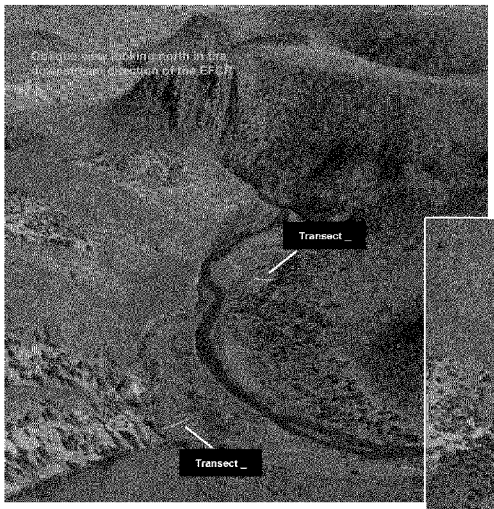
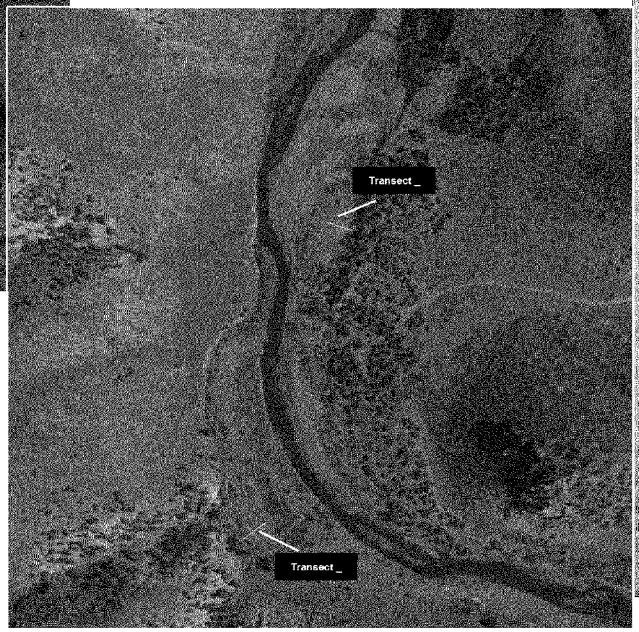


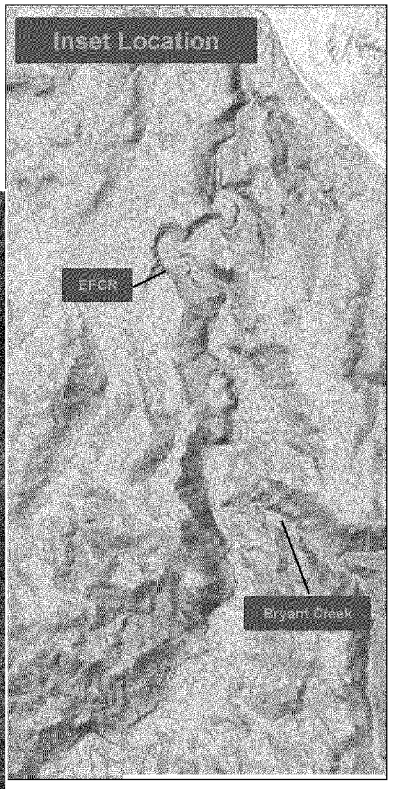
Figure B7

ED_001709_00000321-00078

EFCR Geomorphic Analysis– Proposed Sample Transects Downstream of Bryant Creek







Images from Google Earth
Image date – April 2015

Figure B8

ED_001709_00000321-00079

EFCR Geomorphic Analysis– Bedform Chronology
Cottonwood Creek Area

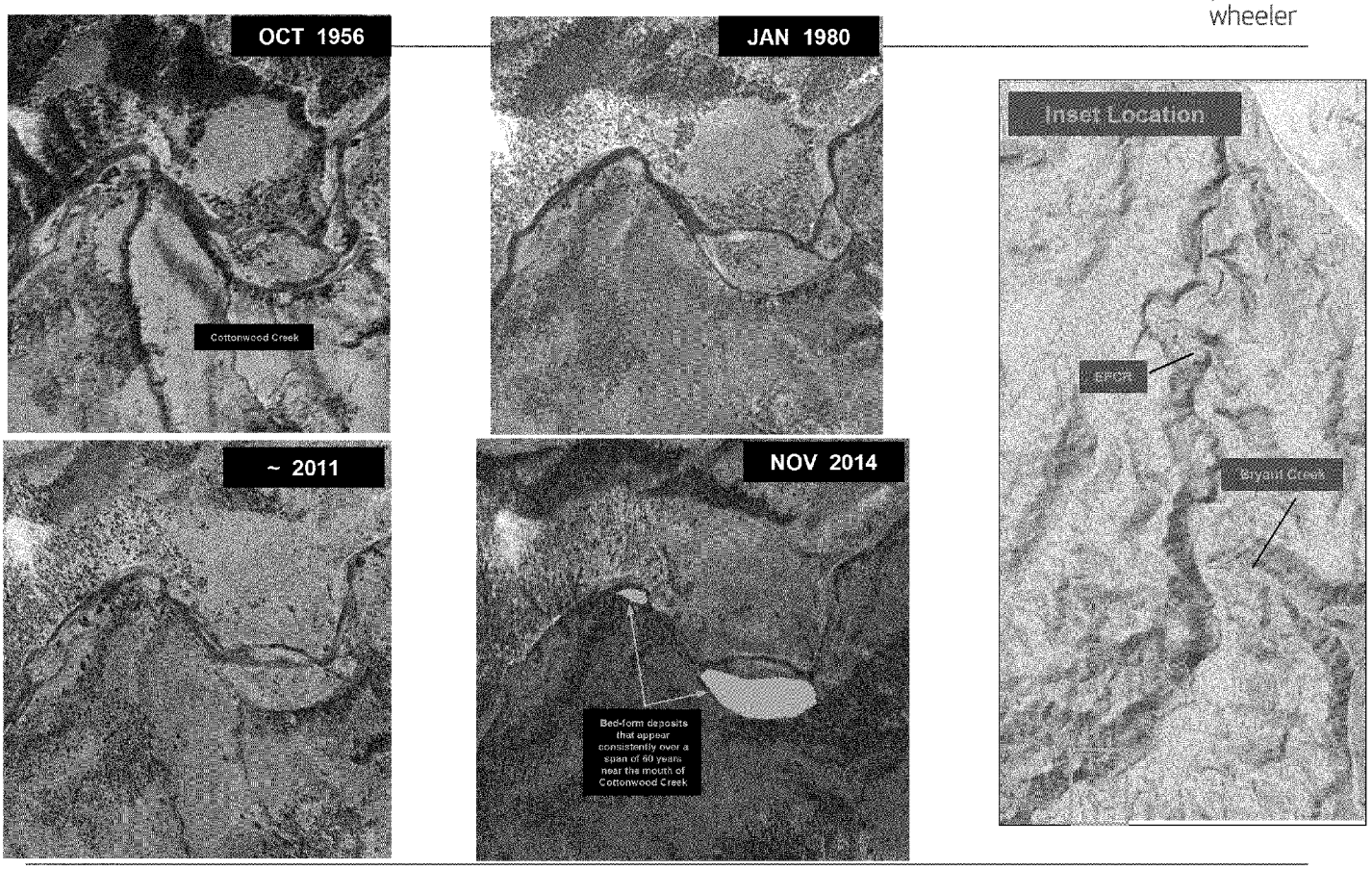


Figure B9

ED_001709_00000321-00080

EFCR Geomorphic Analysis– Potential Reference Sampling Locations Cottonwood Creek Area

amec foster wheeler

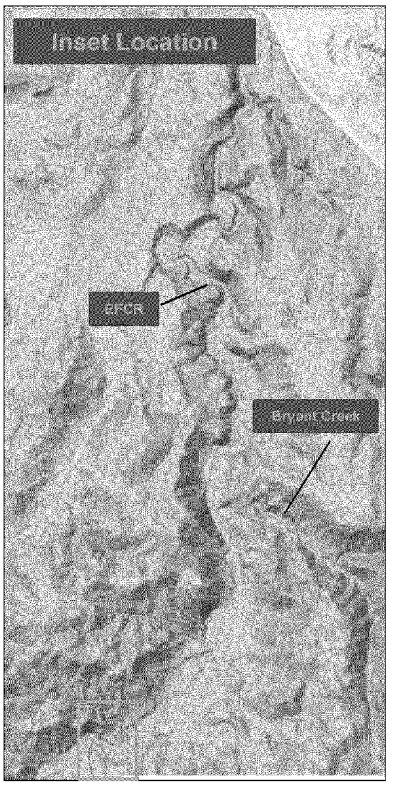
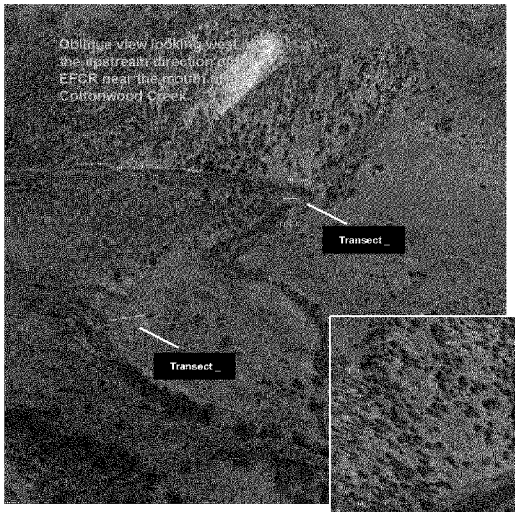


Figure B10

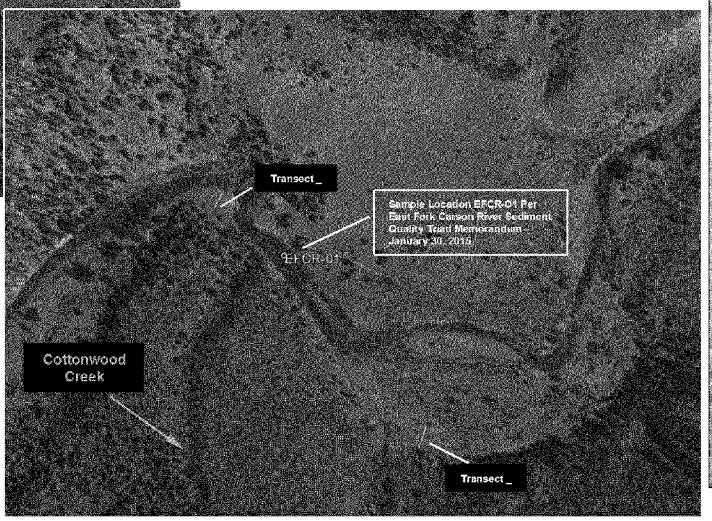
ED_001709_00000321-00081

EFCR Geomorphic Analysis– Proposed Sample Transects Cottonwood Creek Area

amec foster wheeler



Images from Google Earth
Image date – April 2015



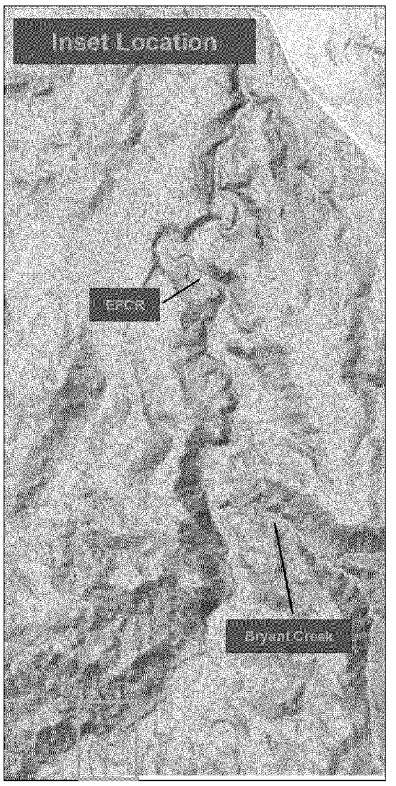
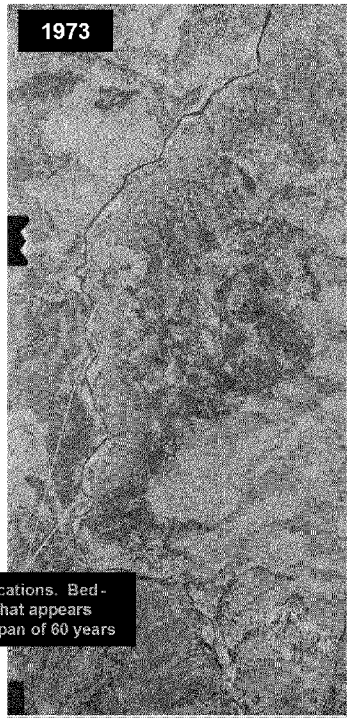


Figure B11

ED_001709_00000321-00082

EFCR Geomorphic Analysis– Bedform Chronology Upstream of Cottonwood Creek Area

amec foster wheeler



Potential sample locations. Bed-form deposition that appears consistently over a span of 60 years

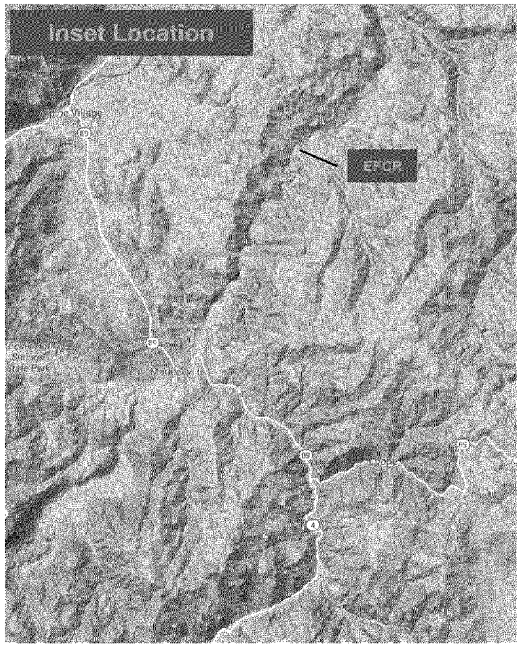
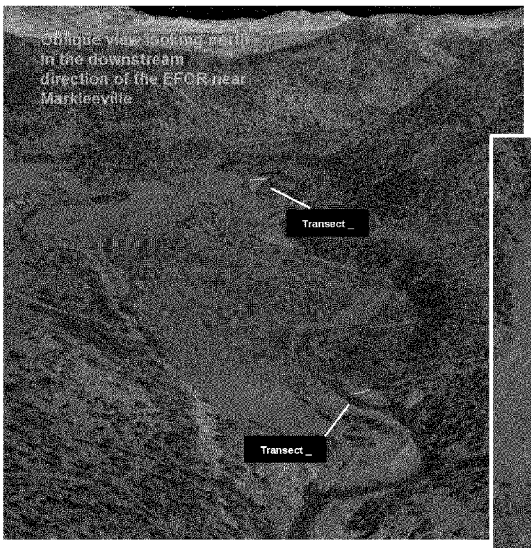


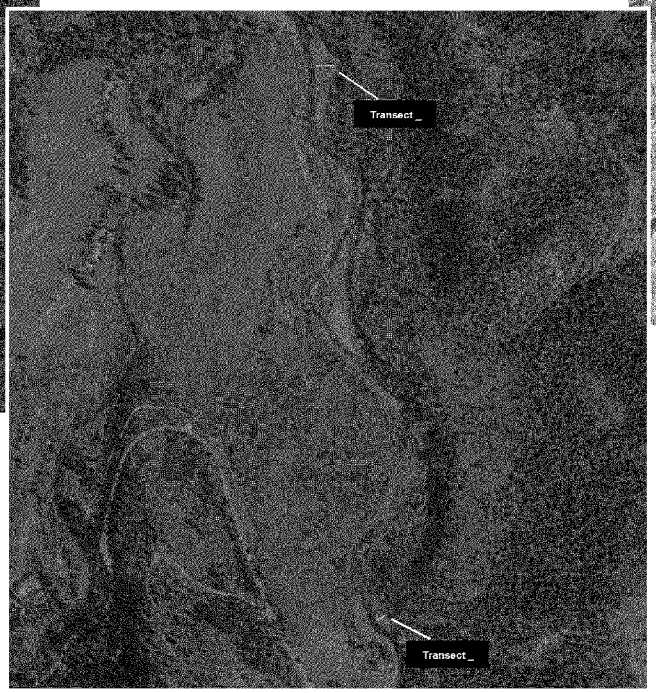
Figure B12

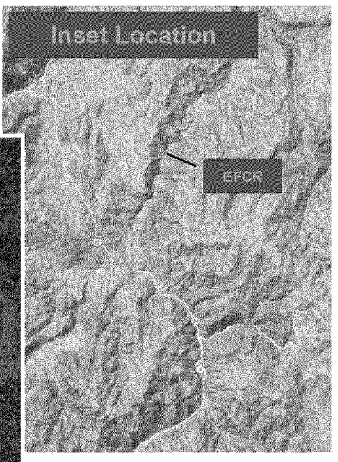
ED_001709_00000321-00083

EFCR Geomorphic Analysis– Proposed Sample Transects Upstream of Cottonwood Creek Area

amec foster wheeler







Images from Google Earth
Image date – April 2015

Figure B13

ED_001709_00000321-00084

APPENDIX C

1.0 – GENERAL PREPARATION AND MOBILIZATION REQUIREMENTS

Purpose and Scope: The purpose of this document is to present procedures that must be followed prior to all field operations. It includes a discussion of general preparation activities, mobilization, and site-specific training.

Equipment: The following items are needed in order to mobilize to the site:

- 4-wheel-drive truck or sport utility vehicle with all terrain tires
- Full size spare tire and car jack/tire changing tools
- Fire extinguisher and first aid kit
- Wheel chock
- Vehicle Emergency Backpack
- Level D personal protective equipment consisting of long-sleeve shirt, long pants, safety-toe boots, hard hat, safety glasses, high visibility vest (or a high visibility long sleeve shirt), and heavy work gloves.

Documentation: Remote Travel Checklist (attached)
First page of the U.S. Department of Agriculture Forest Service Road Use Permit (attached)
Emergency Contact Information Sheet (attached)
Hands on defensive driver course/commercial driver's license
Light Vehicle Operator permit
Fit for duty annual physical
40-hour Hazardous Waste and Operations (HAZWOPER) training certificate or 8-hour annual refresher training certificate (only if planning on working in HAZWOPER Areas)

This Standard Operating Procedure (SOP) is to be used in conjunction with the applicable Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. In addition to the SAP, the following SOPs should be consulted:

- SOP 2.0 – Basic Health and Safety for Field Operations

Also refer to the Leviathan Mine Site Health, Safety, Security and Environmental (HSSE) Program Document, the Task Specific Health and Safety Plan (TSHASP), and the Field Authorization Form (FAF), and the Task Risk Assessment (TRA).

1.1 GENERAL PREPARATION

Prior to the start of an investigation, the following general preparation activities should be performed:

- Obtain all appropriate Federal, State, and Local permits for the proposed work (if needed);
- If driving to the Site, the driver must have a current (within the last 3 years) "Hands on defensive driver course" or a commercial driver's license. The driver must also have an approved Light Vehicle Operator permit. Vehicles shall not be operated, in support of this project, without an approved permit. Additionally, if traveling to the Site for the first time, the driver must complete a Remote Travel Checklist (attached). If you are continuing to drive to the Site on a daily basis and your travel plans have been communicated to either the Site Administrator/Coordinator or Project Manager, the remote travel checklist is not required each day;
- Fill out Emergency Contact Information Sheet and provide to Site Coordinator;
- Review documents (Section 1.1.1);
- Perform notifications (Sections 1.1.2 and 1.1.3); and
- Obtain field equipment and documentation (Section 1.1.4);
- If subcontractors will be accessing the site, they may also be required to perform the above activities. Copies of insurance certificates, OSHA 40 hour HAZWOPER training certificates, and fit for duty documents must be obtained from subcontractors.

1.1.1 Document Review

Prior to mobilizing to the site, the most recent version of the following documents must be reviewed:

- Leviathan Mine Site HSSE Program Document;
- Task Specific Health and Safety Plan ;
- Leviathan Mine Road Operating Plan and attachments;
- Documentation showing verification of Defensive Driver Training;
- Applicable work plans and the respective SAP;
- Applicable Field Memo (FM), or other planning document, describing the planned field activities and task requirements; and
- Applicable SOPs.

1.1.2 Site Notification

Scheduling should begin a minimum of two weeks prior to initiation of each new field investigation by notifying the Field Coordinator. Notifications to the Field Coordinator must include the following information:

- Anticipated date and time of anticipated arrival;
- Access road in which you plan on using;
- Anticipated types and sizes of vehicles that will access the site;
- Anticipated duration of site access;
- Names and purpose for each personnel accessing the site;
- A copy of the approved work plan, including associated maps, tables and attachments;
- Equipment and chemicals to be brought onsite;
- Safety Data Sheets (SDS) for any chemicals to be brought onsite; and
- Requests to use site resources (e.g., water, power, etc.).

In addition, the Site Coordinator MUST be contacted 48 hours prior to mobilizing to the site to verify anticipated site conditions. If any of the above information changes after you have initially notified the Project Manager or Site Coordinator, you must notify them by e-mail or by phone (Do NOT call while driving).

1.1.3 Laboratory Notification and Sample Container Request

The laboratory must be notified of the anticipated sampling schedule which includes:

- anticipated soil or water sampling dates;
- anticipated quantity of samples; and
- anticipated soil or water sampling test methods;
- if applicable, anticipated rapid turnaround times for soil or water samples.

The analytical laboratory must be contacted to request the appropriate number of sample containers and sample coolers. Upon receipt of the shipment from the laboratory, the sample containers must be inspected. The laboratory must be notified of any missing, broken, or leaking containers which will be replaced as soon as possible.

1.1.4 Field Equipment

Field equipment and/or meters required by the work plan will either be purchased or rented. Upon receipt, equipment and/or meters, it will be inspected and calibrated to appropriate standards, batteries will be charged, and replacement batteries will be purchased. Refer to each SOP for specific equipment to be used. The operation of equipment shall always follow the manufacturer's recommendations.

1.1.5 Field Documentation

General field documentation procedures are described in SOP 3.0 – Field Documentation and Sample Handling. Specific field documentation procedures are described in the Field Documentation Procedures Memo (attachment in SOP 3.0). Additional field documents may be required depending on the type of investigation. These are discussed in the individual SOPs.

1.2 MOBILIZATION

This section discusses the procedures to follow when mobilizing to the site. It includes driving directions and worker, visitor, and truck driver access restrictions.

1.2.1 Driving Directions

Site Access via Hwy 89 or Monitor Pass (California Entrance): From HWY 89, turn on Leviathan Mine Road and drive approximately 3 miles on a dirt road until you come to a silver locked gate. This access is limited to vehicles and vehicles with trailers less than 30 feet total length. Do **NOT** attempt to access the site via this route with any vehicle longer than 30 feet or truck and trailer longer than 30 feet.

Site Access via HWY 395 (Nevada Entrance): From HWY 395, turn on Leviathan Mine Road and drive approximately 10 miles on a dirt road until you come to a green cattle gate. Go through the cattle gate and proceed until you arrive at a silver locked gate. This access is for all vehicles including Semi-trucks hauling trailers more than 30 feet total length.

Note: When two vehicles meet on a steep road where neither can pass, the vehicle facing downhill must yield the right of way by backing up until the vehicle going uphill can pass. The

vehicle facing downhill has the greater amount of control when backing. When a large truck and a smaller vehicle meet on a narrow road where neither can pass, the smaller vehicle will back up to the nearest wide spot.

1.2.2 Worker, Visitor, and Truck Driver Access

The following is a list of guidelines and rules for accessing the site:

- There is no access to the site prior to 6:30 AM. The current code for all the gates will be given on an as needed basis. It is always a good idea to confirm the current gate code prior to accessing the site as it may change several times throughout the year.
- Unless actively passing through the gate, the gates must remain closed and locked at all times (no dummy locking). The **ONLY** exception is when there is traffic control personnel posted at the gate.
- Upon first entry of the day through the north or south silver gates into the site, use the hand sanitizer at the gate to reduce the potential for outside disease exposure to the site.
- If you encounter a gate that is open and no one is around, then it is your responsibility to close and lock the gate. The only exception to this is the green cattle gate at the Nevada Entrance which is usually left open. If you find the green gate closed then please close it behind you.
- Outside the gates, the roads are open to the public. The roads can be very busy and the public doesn't always follow the signs on the road or the direction of the traffic control personnel.
- Workers, delivery drivers, or visitors shall **NOT** talk on their cell phone while driving to and on the site.
- Travel with lights turned on.
- Ensure that all passengers are wearing seatbelts at all times.
- Watch and follow traffic signs and signals from traffic control personnel (**STOP or SLOW**).
- Just because traffic control is present, it does not mean that there is no oncoming traffic.
- Travel only as fast as conditions allow and go slow around blind corners.

- Drive at a speed that will keep dust to a minimum. However, speeds must not exceed the recommended posted speed limit outside the gates or 15 mph inside the gates of the mine.
- Once entering the site, proceed directly to the Pond 4 area.
- Parking for small cars, trucks, and SUVs is available on the south side of Pond 4.
- When parking, always back into your spot and use a spotter if possible while backing. Always set the parking brake and place a wheel chock under the front side of the rear passenger tire.
- Trucks delivering materials and/or equipment must stop at the sign that says (all trucks stop here) and set the parking break.
- After parking your vehicle or truck, follow the signs and walk directly to the main office stationed at the entrance to Pond 4. This is where you will sign in and get further instructions.
- When entering the Pond 4 area by vehicle or foot, be aware of truck traffic and heavy equipment operations.
- When you are ready to move your vehicle, do a walk around to make sure your path of travel is clear, and remove the wheel chock.
- Vehicles will not be left at the site overnight.
- **Before leaving each day, remember to sign out at the Main office. This is very important!!!!!!**

If you are scheduled to access the site during times of inclement weather, you will be notified by the Site Coordinator of the status of site access. The Inclement Weather Plan is presented in the Leviathan Mine Site HSSE Program Document.

1.3 SITE SPECIFIC TRAINING

Once onsite, visitors and new workers must attend a site orientation training session. This training presentation is required once each year and covers the following:

- Site Overview;
- Site Documentation;
- Emergency Evacuation;

- General Site Requirements;
- Site Specific Hazards; and
- Remediation Management (RM) Specific Requirements.

If necessary, hydrogen sulfide training will be provided to visitors and new workers at this time.

Upon completion of these training presentations, workers and visitors will be allowed to begin site access or site work.

1.3 REVISION LOG

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
1	Britt Jones	Removed references to the HSSE Program Document and RI/FS TSHASP (1.0) and replaced JSA with WRA or TSEA (1.0, 1.1).		8/12/10
2	Kristi Jones/Kent Parrish	Added Wheel Chock to equipment list (1.0). Added Leviathan Mine Driving Policy to documents list (1.0, Attachments). Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. Added revision log (1.3). Added Emergency Contact Information Sheet as attachment. Added use of hand sanitizer upon first entry of the day (1.2.2). Format Changes		5/7/12
	Jon Browning			12/10/13
	Britt Jones	Added vehicle emergency backpack to Equipment Section, clarified that HAZWOPER is only needed when working in a HAZWOPER designated		3/14/14

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
		area, removed references to the driving policy, and traffic management plan since any documents regarding the road are now all part of the road operating plan. Changed RI/FS Coordinator to Jon Browning, changed Michelle's contact e-mail. Removed before you go as an attachment	Kent Parrish	4/16/14
3	Jon Browning	Technical review and editorial changes.	Lynda Lombardi	2/16/2015 2/25/2015

ATTACHMENTS

- Remote Travel Checklist
- First page of the USDA Forest Service Road Use Permit
- Emergency Contact Information Sheet

REMOTE TRAVEL CHECKLIST
Leviathan Mine Site
Alpine County, California

Planning

- ☐ Journey Map / route available
- ☐ Weather forecast:

If weather is not favorable then follow the inclement weather plan or call your site contact for instruction?

- ☐ Rest breaks planned (minimum 15 mins every 2 hrs)
- ☐ Time of travel impact considered (fatigue, sun glare, animals, traffic)
- ☐ Phone number and Contact person: _____
- ☐ What time are you expected to arrive? _____
- ☐ Will I exceed the 14-hour maximum working hours within a rolling 24-hour period?
- ☐ Names of other passengers: _____

Vehicle

- ☐ Oil Levels (engine, brake, power steering) - try to check every month
  Date of the last time the oil was replaced or checked: _____
- ☐ Battery Fluid
- ☐ Radiator Fluid
- ☐ Windscreen Water / Detergent
- ☐ Fuel (circle the appropriate tank level) 1/4 1/2 3/4 Full
- ☐ Car Jack / Toolkit
- ☐ Tires (wear, pressure, spare tire)
- ☐ Lights (headlights, brake lights)

Personal Equipment

- ☐ Mobile Phone / Satellite Phone with suitable coverage for trip (charged)
- ☐ Flashlight
- ☐ GPS and EPIRB (Emergency Position Indicating Radio Beacon)
- ☐ Drinking water and lunch or food snacks
- ☐ ABC fire extinguisher, first aid kit, sunscreen, insect repellent, disposable camera
- ☐ Spare clothes

Other Journey Risks

Risk	Mitigation

+

FS-7700-41(12/06)
OMB 0596-0016

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

ROAD USE PERMIT

AUTHORITY:

Section 4 and Section 6 of the National Forest Roads and Trails Act
16 U.S.C. 535 and 537

Atlantic Richfield Company (4 Centerpointe Drive, La Palma, CA 90623) is hereby guaranteed use of the following roads or road segments and related transportation facilities (hereinafter "roads") on the Carson Ranger District, Humboldt-Toiyabe National Forest, for commercial hauling (transportation of goods and supplies), subject to the terms and conditions of this permit:

Leviathan Mine Road aka FS Road 10052; extending approximately 9 miles between Highway 395 and the Leviathan Mine site (Site) to the east and approximately 5 miles from the Site to Highway 89 on the west. This permit includes the portion of the 10052 road extending east past the 10348 road, to the Aspen Seep bioreactor. The roads are shown on the attached Appendix C.

APPENDICES

A – Annual Operating Plan
B – Maintenance Requirements
C – Map

TERMS AND CONDITIONS

I. GENERAL TERMS

A. AUTHORITY. This permit is issued pursuant to the National Forest Roads and Trails Act, 16 U.S.C. 535 and 537, and 36 CFR Part 212, Subpart A, as amended, and is subject to their provisions.

B. RESPONSIBLE OFFICIAL. The responsible official is the Forest Supervisor, Humboldt-Toiyabe National Forest, pursuant to Forest Service Handbook 7709.59.20.42.

C. TERM. This permit shall expire at midnight on December 31, 2018, approximately five years from the date of issuance. Expiration of this permit shall not require notice, a decision document, or any environmental analysis or other documentation.

D. RENEWAL. This permit is not renewable. Prior to expiration of this permit, the holder may apply for a new permit that would renew the use authorized by this permit. Renewal of the use shall be at the sole discretion of the responsible official.

E. AMENDMENT. This permit may be amended in whole or in part by the Forest Service when, at the discretion of the responsible official, this action is deemed necessary or desirable to incorporate new terms that may be required by law, regulation, directive, the applicable land management plan, or projects and activities implementing a land management plan pursuant to 36 CFR part 215.

F. COMPLIANCE WITH LAWS, REGULATIONS, AND OTHER LEGAL REQUIREMENTS. In exercising the rights and privileges granted by this permit, the holder shall comply with all present and future federal laws and regulations and all present and future state, county, and municipal laws, regulations, and other legal requirements, including state traffic laws, that apply to the permit area, to the extent they do not conflict with

amec foster wheeler

Leviathan Mine

Emergency Contact Information

(Please Print)

Date: _____

Employee Name: _____

Company Name: _____

Office Phone #: _____

Home Address: _____

Home Phone #: _____

In case of Emergency, contact:

Name of Person: _____

Relationship: _____

Phone #: _____

Alternate Phone #: _____

Name of Alternate Person: _____

Relationship: _____

Phone #: _____

Alternate Phone #: _____

Medical Information

Do you have medical conditions or allergies (bee stings, diabetes, high blood pressure etc...) that could affect you while at the Leviathan site:

_____

_____

_____

_____

If yes, do you have medication that you take with you (i.e. epinephrine for bee stings, Insulin etc.):

_____

Doctor's Name and Phone Number: _____

2.0 – BASIC HEALTH AND SAFETY FOR FIELD OPERATIONS

Purpose and Scope: The purpose of this document is to outline basic safety requirements that must be followed during all field operations. It describes basic daily safety requirements such as the Field Authorization Form, Task Risk Assessment (TRA) form, and the Amec Foster Wheeler Environment and Infrastructure, Inc. (Amec Foster Wheeler) Functional Disciplines.

Equipment: The following equipment is needed on site:

- 4-wheel-drive truck or sport utility vehicle
- Minimum Site Personal Protective Equipment (PPE)
- Satellite Phone, two-way radio and two-way Satellite Communicator
- Hydrogen sulfide monitors and/or escape respirators for some areas of the site

Documentation: Field Authorization Form (attached)
Task Risk Assessment form (attached)

This Standard Operating Procedure (SOP) is to be used in conjunction with the applicable Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. In addition, SOP 1.0 – General Preparation and Mobilization Requirements should be reviewed.

Also refer to the most recent version of the Leviathan Mine Site Health Safety, Security and Environmental (HSSE) Program Document, the Task Specific Health and Safety Plan (TSHASP), the Amec Foster Wheeler Corporate Safety, Health, and Environment (SHE) Manual, Volumes I through VII, and any applicable Amec Foster Wheeler Functional Disciplines. If you are unsure of the most recent version of any of the above documents, see the HSSE Coordinator, Program Coordinator or HSSE Site Coordinator.

During review of the above documents, special attention should be paid to Leviathan Mine Site specific procedures, and hazards associated with the work, PPE, air monitoring, and emergency response.

2.1 DAILY TOOLBOX MEETING

The daily toolbox meeting is held at the start of each work day or task change that is designed to help a field work crew comply with Amec Foster Wheeler Control of Work (CoW) Functional Disciplines The Functional Disciplines are available onsite. The meeting shall review the

planned work activities for the day, discuss and resolve the risks and mitigations, discuss HSSE concerns and raise the HSSE consciousness of each worker before they start work. These meetings shall include, but are not limited to:

- Reviewing relevant TSHASP elements to be performed and any applicable TSHASP updates;
- Reviewing Hazard Communication (HAZCOM) procedures;
- Addressing the risks of any issues arising from the Site work area including equipment and materials;
- Completing a TRA (discussed in Section 2.2) and documenting the information on a FAF;
- Completing and reviewing the applicable permit(s);
- Reviewing the right and obligation to 'STOP WORK';
- Implementing the controls set forth in the TRA and verifying that all parties on Site have a complete understanding of the work and controls that are in place;
- Reviewing the Simultaneous Operations (SIMOPS) that will be occurring within the work area; and
- Allocating resources.

All personnel (including subcontractors) involved with the work will be engaged in the safety meeting including discussions of appropriate PPE, training required for the tasks and procedures to be performed in the event of an emergency.

The Toolbox Safety Meeting will be conducted by the issuing authority (IA) or performing authority (PA) as described in the Control of Work Functional Discipline of the HSSE Program document. The IA or PA is also responsible for all completing all applicable records of the meeting.

2.2 TASK RISK ASSESSMENT

An adequate TRA meeting the requirements of the RM Hazard Identification and Task Risk Assessment (HITRA) Defined Practice and the Amec Foster Wheeler Work Risk Assessment Functional Disciplines shall be performed prior to all activities, regardless of frequency or classification as routine or non-routine. If potential hazards exist, the TRA must discuss

potential elimination, substitution, engineering, administrative, and/or PPE controls that will be implemented during field work to ensure the safety of all individuals. A TRA is an acceptable form of risk assessment; otherwise, if the job or task is routine, a risk-assessed SOP may be used if the job or task does not vary in the scope of work, execution, or risk assessment. The TRA is a part of the SOP.

2.3 CONTROL OF WORK PERMIT

Control of Work permits may be required prior to starting any field work. Currently there are nine permits used at the Site and include:

- Confined Space Entry
- Energy Isolation (LOTO)
- Ground Disturbance
- Hot Work
- Lifting Operations
- Overhead Utilities
- Accessing the Manholes at the Aspen Seep Bioreactor
- Working at Heights
- Tractor-Trailer Type Delivery Trucks

Also, all drivers must have an approved Light Vehicle Operator permit **before driving to the Site**. Vehicles shall not be operated, in support of this project, without this approved permit. More permits may be added. If there is any question as to whether the planned work activities will require one of the above permits, contact the Project Manager or Site HSSE Coordinator. If a permit is required, it must be filled out and approved by an appropriate IA and PA. Follow the guidance contained in the CoW and specific activity Functional Disciplines.

2.4 PERFORMING THE WORK

Work must be performed using the correct tools for the job and watching out for unforeseen hazards. Conduct air monitoring as necessary and know what the limits are of the contaminants of concern. If the work changes, new hazards emerge, or an emergency situation develops: **Stop Work**. Take necessary actions, revise the FAF and TRA, and go over the changes with the work crew prior to reentering the work area.

Once the work is completed, clean the jobsite up, store all equipment (including safety equipment), and discuss with the crew any improvements from a safety standpoint that could be implemented the next time the work is performed. The FAF will be used to document best practices observed during work, including lessons learned, incidents, near-miss reports, any other HSSE concerns or observations, and any planned and unplanned 'Stop Work interventions. Sign-out times and signatures will also be documented on the FAF unless personnel have been affected by an incident or received first aid, which should also be documented.

2.5 REVISION LOG

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
1	Britt Jones	Removed references to the HSSE Program Document and RI/FS TSHASP (2.0) Replaced JSA with WRA or TSEA (2.0). Remove former section 2.0 (Authorization to Work, Job Safety Analysis, and BP Permits. Added new sections 2.1 (Daily Toolbox Meeting), 2.2 (Work Risk Assessment), 2.3 (Work Risk Assessment), 2.3 (Control of Work Permit). Removed former section 2.3 (Safety Meeting). In attachments, removed authorization to work (ATW) form and JSA form. Added Daily Toolbox and TSEA forms.		8/12/10
2	Kristi Jones/Kent Parrish	Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. on multiple pages. Added "A review of SIMOPS" to the bullet list (2.1). Added revision log (2.5).		5/7/12
	Jon Browning	Format changes.		12/10/13
		Made several typographical/grammar revisions. Added citation of Light Vehicle Operator permit requirement.		03/14/14
			Kent Parrish	04/16/14
3	Jon Browning	Annual update and editorial changes		2/9/15
			Kent Parrish	2/26/15

ATTACHMENTS

- 2a - Field Authorization Form
- 2b - Task Risk Assessment (TRA) Forms

FIELD AUTHORIZATION FORM

Site/Project:	On-site Specific Location (NA for small sites):
Date:	Document Control #:

Name and Phone of AA or PO:	Name and Phone of Person Controlling Work Activity:
Note: Include the names of IAs and PAs on the specific Permit and/or Permit Cover Sheet	

RM SIMOPS or Multi-crew Activity (non-RM SIMOPs requires a work plan)	☐ Yes	☐ No	If yes, describe SIMOPS:
Has the SIMOPS work plan been communicated to all workforce?		☐ Yes	☐ No
SIMOPS PIC:		Phone Number:	

Safety Discussion Topics:_____

Emergency Response Plan and Health & Safety Plan reviewed and available? ☐ Yes ☐ No

Muster Point Location / Comments: _____

Permitted Activities? ☐ Yes ☐ No
(Confirm permit document control number is documented below)

Task Risk Assessment (TRA) Document Control

Work Title	Level 1 or 2?	Document Control #	Associated Permit DC# (for Level 2)	Person Responsible for Controls

(Person responsible shall be competent in the Task and Control)

Field Identified Risks

Use Level 1 or Level 2 TRA to document (hand writing is acceptable) previously unidentified field hazards that could impact the work or task previously risk assessed via a Level 1 or Level 2 TRA form. (i.e.: muddy walkway, local flooding, down tree limbs). These hazard and control additions shall be approved (verbal approval is acceptable) by a Level 1 TRA Risk Assessor or Level 2 TRA Team Leader as appropriate.Update the electronic version of the TRA only if the risks anticipated for future events.

Task Risk Assessment Authorization

PPE meets specification for the task, has been inspected, and is suitable for the intended purpose: ☐ Yes ☐ No – **STOP WORK**

Equipment Inspections are Complete and routine maintenance has been conducted: ☐ NA ☐ Yes ☐ No – **STOP WORK**

MoC Requirements been met: ☐ NA ☐ Yes ☐ No – **STOP WORK**

The workforce using the prepared or site-created TRA documents shall review, discuss and edit if necessary the Level 1 and Level 2 TRAs. The field workforce may be different from the workforce that created the TRA as documented on the TRA cover sheet. The following section for Workforce Signatures documents the TRA Review and Acceptance by the workforce conducting the task.

The master of this document is controlled electronically. Printed copies of this document are not controlled. Document users are responsible for ensuring printed copies are valid prior to use.

FIELD AUTHORIZATION FORM

Workforce Signatures

By signing below, you are stating the following: 1) You are aware that all tasks must be risk assessed and you understand and will comply with the requirements of the TRA. 2) You are aware of your obligation to **Stop Work**, 3) You arrived **fit for duty** and are leaving in the same condition (if injured you have reported the injury).

Name	Signature	Initials & Sign In/Out Time	
		In & Fit	Out & Fit

Before the task is authorized to start, the person controlling the work activity should confirm that:

- All the prerequisite controls are in place.
- The persons allocated to perform the task are competent to initiate and manage the supplementary controls.
- The output from the risk assessment has been "communicated in writing and signed off by all involved in the task" on the FAF.

Person Controlling Work Activity signs to Authorize Work to start: _____

OPTIONAL: Site Manager/Representative (i.e. Station Manager) has been briefed on work to be conducted?)
☐ Yes ☐ No ☐ N/A

Signature of Site Manager/Representative: _____

Visitor Log – Site Visitors not involved in the work activities

Name and Signature	Company	Initials & Sign In/Out Time	
		In & Fit	Out & Fit

Post Daily Review

At the conclusion of the day, I certify that the work site has been inspected and is being left in a safe and clean condition and any incidents have been properly reported.

Person Controlling Work Activity: _____

OPTIONAL: Signature of Site Manager/Representative: _____

Best Practice Reported: ☐ Yes ☐ No If yes, describe:	**HSSE Concerns / Incidents / Near MissesReported?:** ☐ Yes ☐ No If yes, describe:
Were there any 'Stop Work' interventions? ☐ Yes ☐ No If yes, describe:	**Have additional hazards and risk controls been identified for future work?** ☐ Yes ☐ No: If yes, add hazards and controls to the applicable TRA and update TRA revision log.

The master of this document is controlled electronically. Printed copies of this document are not controlled. Document users are responsible for ensuring printed copies are valid prior to use.

BP Remediation Management
TASK RISK ASSESSMENT (TRA) Cover Sheet

Work Title:			Brief Description of Work:
Site:			
TRA Date:			
TRA Document No:			
Contractor JSA/JHA No:			Is this Routine Work: Yes / No (circle one)

TRA Team Members

Name / Position	Company	Signature	Date

We confirm we have been instructed in the TRA process and understand our role in this process. We agree with the residual risk levels and control measures required to perform the tasks based on the identified tasks and hazards, and therefore recommend the task for the appropriate approval.

List of Tasks Involved in Performing Work:

Tasks	Task Level

Complete the Level 1 (L1) or Level 2 (L2) TRA based on the task risk level determined from the Task Risk Assessment Table (TRAT) or by members of the workforce.

Level 1 TRA Approval

Approver Name	Position / Title	Date	Signature

I agree with the residual risk levels and control measures required to perform the tasks based on the identified tasks and hazards and approve the use of this Level 1 TRA (signed approval required which can be recorded with use of fax, email or other electronic means).

Level 2 TRA Approval

Approver Name	Position / Title	Date	Signature

I agree with the residual risk levels and control measures required to perform the tasks based on the identified tasks and hazards and approve the use of this Level 2 TRA (signed approval required which can be recorded with use of fax, email or other electronic means). Details of the Approver of the Highest Residual Risk required below as per RM Level 2 Approval Table.

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BP Remediation Management
LEVEL 1 TASK RISK ASSESSMENT (TRA) Form

Work Title:	
Site:	
TRA Date:	
TRA Document Control No:	
Contractor JSA/JHA No:	

Brief Description of Task:

Risk Assessment

TASK	SOURCE OF ENERGY / HARM	HAZARD	Initial Risk Ranking	CONTROL	Residual Risk Ranking	RESPONSIBLE ROLE
List the task(s) to be completed. (You may list more than one task on each form)	Select the relevant Source of Energy / Harm	Describe all hazards identified for each ASK. Consider Task Hazards, Job site hazards, Process hazards, SIMOP's, Human Factors and Weather	Risk Ranking = Low, Medium, High **BEFORE** Controls Risk Level	Describe all controls applicable for each hazard. Use the hierarchy of Controls located on the following page.	Risk Ranking = Low, Medium, High **AFTER** Controls Risk Level	Who is responsible to implement the control measure identified? Position Required

BP Remediation Management
LEVEL 2 TASK RISK ASSESSMENT (TRA) Form

Work Title:			Brief Description of Task:
Site:			
TRA Date:			
TRA Document No:			
Contractor JSA/SWMS No:			
Permit No:			

Level 2 TRA Team Leader

Name	Company	Signature	Date

I agree with the residual risk levels and control measures required to perform the tasks based on the identified tasks and hazards. I have instructed the TRA Team Members in the TRA process and their roles and have verified that the team understands the assessment process and what the process is trying to achieve. Additionally, I attest that the members of the TRA team have visited the job site to identify and document hazards associated with the physical layout of the area which are pertinent to the permit related tasks to be performed.

Risk Assessment

TASK	SOURCE OF ENERGY / HARM	HAZARD	INITIAL RISK			CONTROL	RESIDUAL RISK			RESPONSIBLE ROLE
List the task(s) to be completed. (You may list more than one task on each form)	Select the relevant Source of Energy / Harm	Describe all hazards identified for each TASK. Consider Task Hazards, Job site hazards, Process hazards, SIMOP's, Human Factors and Weather	Decide on the Level of Risk using the Level 2 TRA Risk Matrix			Describe all controls applicable for each hazard. Use the Hierarchy of Controls located on the following page	Decide on the Level of Risk using the Level 2 TRA Risk Matrix. **Is the Task safe to do?**			Who is responsible to implement the control measure identified? Position Required
			C	P	Risk Level		C	P	Risk Level	

TASK	SOURCE OF ENERGY / HARM	HAZARD	INITIAL RISK			CONTROL	RESIDUAL RISK			RESPONSIBLE ROLE
List the task(s) to be completed. (You may list more than one task on each form)	Select the relevant Source of Energy / Harm	Describe all hazards identified for each TASK. Consider Task Hazards, Job site hazards, Process hazards, SIMOPS, Human Factors and Weather.	Decide on the Level of Risk using the Level 2 TRA Risk Matrix			Describe all controls applicable for each hazard. Use the Hierarchy of Controls located on the following page.	Decide on the Level of Risk using the Level 2 TRA Risk Matrix. Is the Task safe to do?			Who is responsible to implement the control measure identified? Position Required
			C	P	Risk Level		C	P	Risk Level	

C = Consequence
P = Probability

	1. Biological - covers the many sources of energy in life forms, including wildlife and viruses or bacteria, (e.g., as found in sewage systems, drain lines, cooling towers).
	2. Body Mechanics - human strength and agility applied to a task involving lifting, pushing, pulling, climbing or positioning.
	3. Chemical - energy in the form of reactive or life-threatening gases, liquids, solids, e.g., water, methane, nitrogen, process chemicals, etc. (e.g. cleaning agents; inks; dust; asbestos; toxins to air, water or ground).
	4. Electrical - - includes all types and voltages of electricity including high voltage power systems (Alternating Current (AC), battery systems (Direct Current (DC)) and static. Consideration should be given to whether the task: • Requires equipment related to the task or in the area of the task to be isolated. • Involves electricity powered equipment. • Is in an area where there is vulnerable electrical equipment such as insulated cabling, un-insulated overheads power lines, etc. • Involves transfer of fluids, powers, etc. or friction between non-conducting materials which could generate static electrical charges. Are systems and equipment where this could occur adequately grounded and / or bonded (e.g., wiring, motors, transformers, electrocution, underground utilities, and electrical storms).
	5. Gravity - a naturally occurring energy that causes tools, equipment or people to fall or move. This affects lifting task, work at height and potential dropped objects (e.g., falling objects, people falling, lifting).
	6 Mechanical - includes mobile equipment, hand and power tools, as well as moving parts on stationary equipment and rotating equipment. Even though items are non-powered, their momentum as they are moved may crush or cut people or vulnerable equipment. This also includes sharp edges of tools and/or equipment.

	7. Noise - A form of pressure energy. Consideration should be given to whether the task is in a high noise area, whether noisy tools or equipment will be used, or if noise could cause communication problems, including in any emergency.
	8. Pressure - air, water, pneumatics, springs, gases are all possible sources of significant pressure energy. Consideration should be given to: • Non-Return Valves (NRVs) where system contents may be trapped between the NRV and an isolation point. • Section of equipment in which trapped or undrained contents may remain. • General equipment / line condition, e.g., area of corrosion, where a pressured leak is foreseeable. • Reaction forces from a pressure leak, which may move an unrestrained item, such as a hose, cylinder or pipe segment. (e.g., hydraulic pressure, air pressure, gas pressure, oil pressure).
	9. Radiation - in the form of sunlight, radio waves or ionizing radiation (radioactivity), (e.g., ultraviolet radiation, electromagnetic radiation).
	10. Thermal - energy associated with hot or cold surfaces and fluids, undesired chemical reactions and / or ambient temperatures. (e.g., cold weather, hot weather, cold pressure lines, hot or cold product lines or equipment, heat or cold stress).
	11. Human Factors – Personal and/or health conditions that could distract impede or affect an individual's performance and increase the risk level while carrying out a task. This could also include external human factors such as other people, pedestrians, and security issues.
	12. Simultaneous operations – Separate activities or works, taking place at the same time, with the potential to impact on each other, e.g., a lifting job that involves machinery being lifted over the job-site.
	13. Weather – Any weather conditions heat/cold/wind/rain/ice that could adversely affect the safe execution of the task.

Consequence impact level	Health and safety	Environment	Non-financial impact
D (Inclusive of A, B & C)	3 or more fatalities (or onset of life - threatening health effects) 30 or more injuries or health effects, either permanent or requiring hospitalisation for more than 24 hours.	Future impact as below or greater - Extensive damage to a non -sensitive environment o r localized damage to a sensitive environment, all of which can be restored to an equivalent capability in a period of around 1 year. Widespread damage to a non -sensitive environment or extensive damage to a sensitive environment, all of which can be restored to an equivalent capability in a period of months.	Severe enforcement action or loss of licence to operate, in respect of a material asset in any market, or any asset or in a major market (US, European Union (EU), Russia) or the threat of global loss of licence to operate. Interventions from governments. Public or investor outrage. 'Interest group' outrage in a major market. Prolonged adverse national or international media attention. Widespread adverse social impact. Damage to relationships with key stakeholders of benefit to the Group or segment.
E	1 or 2 fatalities 10 or more injuries or health effects, either permanent or requiring hospital treatment for more than 24 hours.	Future impact - Localized damage or extensive damage to a non-sensitive environment, which can be restored to an equivalent capability in a period of around 1 year, or a period of months, respectively. Localized damage or extensive damage to a sensitive environment, which can be restored to an equivalent capability in a period of months, or a period of days or weeks respectively.	Other adverse enforcement action by regulators. Limited 'interest -group' outrage. Short-term adverse national or international media coverage. Damage to relationships with key stakeholders of benefit to the Strategic Performance Unit (SPU).
F	Permanent partial disability(ies) Several non-permanent injuries or health impacts. DAFWC (Days Away From Work Case)	Future impact - Localized damage to a non -sensitive environment or an immediate area damage to a sensitive environment all of which can be restored to an equivalent capability in a period of months. Extensive damage to a non -sensitive environment or localized damage to a sensitive environment all of which can be restored to an equivalent capability in a period of days or weeks.	Regulatory compliance issue that does not lead to regulatory or other higher severity level Consequence. Prolonged local media coverage. Local adverse social impact. Damage to relationships with key stakeholders of benefit to the Pe rformance Unit (PU).
G	Single or multiple recordable injury or health effects from common source/event.	Future impact - Immediate area damage or localized damage to a non -sensitive environment, which can be restored to an equivalent capability in a period of months or in a period of days or weeks, respectively. Future impact with localized damage to a non-sensitive environment and that may be restored to an equivalent capability. Immediate area damage to a sensitive environment that can be restored to an equivalent capability in a period of days or weeks.	Short-term local media coverage. Some disruption to local operations, e.g., loss of single road access less than 24 hours.
H	First aid Single or multiple over -exposures causing noticeable irritation but no actual health effects	Future impact with immediate area damage to a non-sensitive environment that can be restored to an equivalent capability in a period of days or weeks.	Isolated and short -term complaints from neighbours, (e.g., complaints about specif ic noise episode).

		Probability				
		1	2	3	4	5
	Impact Level	Remote possibility - A similar event has not yet occurred in our industry	Similar event has occurred somewhere in our industry and within the BP group	Likely to occur once or twice in lifetime of the site	Event likely to occur several times in the lifetime of the site	Common occurrence (at least annually) at the site
Consequence	D	6 Medium	8 High	10 Very High	11 Very High	12 Very High
	E	5 Low	7 Medium	9 High	10 Very High	11 Very High
	F	4 Low	6 Medium	8 High	9 High	10 Very High
	G	3 Low	5 Low	7 Medium	8 High	9 High
	H	2 Low	4 Low	6 Medium	7 Medium	8 High

Residual risk Level	Minimal Level of Approval*
10 – 12 Very High	Not Allowed
8 – 9 High	Remediation Operations Manager or Deputy Operations Manager
6 – 7 Medium	IA / AA
2 – 5 Low	IA / Level 2 TRA Team Leader

*Note: The minimum level of approval on the TRAT "Level 2" tab supersedes the minimum level of approval determined by this table.

Hierarchy of Controls

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Prevention

L1 Eliminate the hazard and eliminate the associated risk

L2 Substituting the hazard with a lesser risk that has less potential to cause harm

L3 Using engineering controls to permanently remove a hazard or place a permanent engineered barrier between the workforce and the hazard

Protection

L4 Isolating the hazard by temporarily containing the work environment or work process to interrupt the path between the workforce and the risk

L5 Applying administrative controls to confirm capability of the workforce

L6 Use PPE (e.g., gloves, goggles) as a last resort

Most effective

Least effective

3.0 – FIELD DOCUMENTATION AND SAMPLE HANDLING

Purpose and Scope: The purpose of this document is to present procedures for field documentation and sample handling. It includes a description of how to fill out a Daily Field Record (DFR), Sample Control Log, and Chain-of-Custody (COC). It also describes procedures for sample labeling, handling, preservation, packaging, and shipping.

Equipment: The following equipment will be needed depending on the specific task and will be used, as appropriate, when packing or shipping samples:

- Sample Bottles
- Sample Labels
- Custody Seals
- Fine Tipped Permanent Markers
- Nitrile gloves or other appropriate gloves
- Sealable storage bags
- Bubble wrap or appropriate packing materials
- Blue ice or double bagged ice
- Coolers suitable for sample shipment and holding ice
- Strapping/packaging tape and shipping labels, if needed
- Hand-Held Global Positioning System (GPS) device
- Camera with spare memory chip and batteries

Documentation: DFR (attached)
Sample Control Log (attached)
Atlantic Richfield COC Document (attached) or laboratory equivalent
Sampling Records
Maps/plot plan
Photograph Log (attached)
GPS log (attached)

This Standard Operating Procedure (SOP) is to be used in conjunction with the applicable Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. In addition, the following SOPs should be consulted:

- SOP 1.0 – General Preparation and Mobilization Requirements; and
- SOP 2.0 – Basic Health and Safety for Field Operations.

Also refer to the Leviathan Mine Site Health, Safety, Security and Environmental (HSSE) Program Document, the Task Specific Health and Safety Plan (TSHASP), the Field Authorization Form (FAF) and Task Risk Assessment (TRA).

3.1 FIELD DOCUMENTATION

Documentation of the conditions and procedures used to collect, treat, and handle samples and field data is one of the most important aspects of any monitoring program. Proper documentation provides sources to determine the integrity and applicability of the data.

Routine field documentation forms used during the collection of environmental samples include the following:

- Daily Field Record (DFR) (attached);
- Sampling Records
- Sample Control Logs
- Chain-of-Custody (COC) Form
- GPS Logs
- Photo Logs

In addition to the routine field documentation forms, supplemental task specific forms may be used in conjunction with the forms listed above (i.e. Sampling records can be specific to a given sample matrix and will be found in the applicable SOP.).

Changes to any field or sample documentation shall be made by drawing a single line through the incorrect material and initialing and dating the mark-out. However, the original information must stay legible. Do not try to write over the error with the correct information. Each page should be completely filled without any blank lines, if necessary write “Not Applicable” or “NA” on blank lines. The field logbook or field data sheets should be signed daily by the author of the entries. All forms will be reviewed for completeness by fellow field personnel, who will initial and date the bottom of each page to signify the review process is complete.

All original documentation will be retained in temporary field files until permanently placed into the project file at the project office. Any such field documentation will be scanned, placed on the server in the project office, and made available to the field personnel on site at their request.

Each field crew must fill out ALL of their paperwork – names, dates (on all pages), page number(s) out of total pages, etc. Paperwork should be completed using a blue or black pen; do not use a pencil when filling out paperwork. Paperwork will be reviewed by field managers before being filed in the temporary file folders that will be brought back to the project office.

Allow sufficient time at the end of the day for completing and reviewing all field forms and placing them in the correct location.

Use existing paperwork and forms. Do not modify the existing paperwork without prior approval. For electronic forms, make error corrections using strike through (i.e. track changes) and include the new date and your initials at the end of the file name. No forms are to be overwritten. Once a revised form is approved for use, the new file name will include the new date and a revision number. The old file will be placed in a trash folder.

All notes, drawings, calculations documented on graph paper or any other non-specific forms must be labeled, dated and page numbered. They should be hole-punched prior to writing on them and a ½ inch margin should be left empty so that pertinent data do not get removed or lost when the document is scanned.

At the end of each day, ALL original field records (DFRs, sampling records, calibration records, copies of COCs, subcontractor's dailies, etc.) will be placed in the task specific file folders in the project office. Sample control logs should be placed in these folders at the end of each week.

3.1.1 Safety Paperwork

All original FAF's, TRA's, and Permits should be turned in to the Site Coordinator or HSSE Site Coordinator at the end of each day. They do not get filed with the rest of the project paperwork.

3.1.2 Daily Field Record (DFR)

Carefully document all field activities on a DFR (attached) or in a field logbook. DFRs are preferred, but if field logbooks are used, they shall be bound with consecutively numbered pages and shall be written in with permanent blue or black ink. All field logbooks will be dedicated to the Leviathan Mine Site project. At the end of each field season, the original field log books will be kept in the project office. Field activities shall be recorded in sufficient detail so that field activities can later be reconstructed from the notes. A new DFR should be completed for each day or when a separate task is initiated.

The DFRs will include the following information:

- Project and task number
- Project name
- Location of field work
- Date
- Field activity
- Weather conditions at the start of the day and as weather conditions change throughout the day
- Personnel, company name, and time on-site/off-site
- Personal safety checklist
- Documents associated with day's work
- Description of work performed

Information written within the area delineated "Description of Work Performed" should include, but not limited to the following:

- Sampling information (if samples are collected)
  - Sample identification number(s)
  - Time of sample
  - Description of sample
  - Number and volume of samples (if unable to collect the full volume required by the work plan)
- Field observations including:
  - Unusual or unexpected circumstances should be documented and immediately communicated to the Program Coordinator.
  - Any decisions agreed upon with the Program Coordinator should be documented before proceeding with work.
  - Any encounters and conversations with the public or private property owners.
- Decontamination procedures

3.1.3 Photo Log

Photographs should be taken of pertinent activities that occur during the investigation. These should include capturing images that clearly demonstrate that the goals of the project are being

met. They should also be taken of any changes in procedures or unexpected findings that occur in the field. Items of scale should be included in the view of the photograph (i.e., ruler, clipboard, etc.). A running log of the photographs with a description of each photograph should be included on a photo log attached to the DFR. All photos should include the following information on the photo log: assigned camera number, ID number generated by the camera, file name for storing data records, date the photo was taken, initials of the photographer, location of the photo, direction of view and any additional comments or descriptions.

Prior to using a camera, the time and date programmed in the camera should be checked for accuracy. Adjust the programmed date and time to accurately reflect current conditions.

Photo logs should be completed every time a photograph is taken to document a specific task or site activities. This includes the ID number assigned by the camera (i.e. DSCN####) and a file name, which should be recorded when transferring the photos off the camera to the project file. The file name will have a 3 part format separated by "_". The first part will be the date expressed as a two-digit year, month, day (YYMMDD) (consistent with the project file naming protocol); the second part will be an approved task abbreviation (see table below); the third part will be a sequential number, starting with 1 (Note: the batch rename process will put parenthesis around the sequential number). If there is more than one crew using the same abbreviation on the same day, any subsequent crews to download photos should continue the sequential numbering where the previous crew left off. An example photo ID would be 120428_STWM_(1) for the first picture taken during storm water monitoring on the 28th of April 2012. A list of abbreviations used for various sampling tasks is included in Table 3-1 and attached to this SOP.

How to Batch Rename Photos:

- Copy (do not move) photos to the correct folder (see section 3.3 on electronic data below).
- Hit "Ctrl + A" to select all the photos.
- Right click on the 1st photo and select "Rename."
- Type in the file name of the first photo YYMMDD_task_(1). If there are already files with the same prefix, just use the next number in the sequence instead of 1.
- Hit "Enter."
- All the photos should now be sequentially numbered in parenthesis.

- Once the photos have been correctly renamed, the photos on the camera can be deleted.

3.1.4 GPS Log

If a GPS instrument is used to document sample locations, a GPS log should be filled out as described in SOP 30.0 – Use of Hand Held GPS Device.

3.1.5 Sample Control Log

If samples are collected during the field investigation, a sample control log must be filled out documenting the sample location, study area, sample matrix, sample ID, sample date, sample time, sample collector, sample depth, sample type (whether the sample is a normal environmental sample or a type of quality assurance/quality control [QA/QC] sample), sample method (whether the sample is a grab, composite, incremental, or autosampler), MS/MSD, additional notes (i.e. any anomalies or sample specific information) which laboratory the samples were sent to and the date they were shipped. Samples collected for archival purposes, or for field measurements and/or analysis only, will be tracked in a similar manner, but a note added to indicate “no lab analysis” was requested, “parameters only” or sample is on "hold", as applicable.

If a field blank or equipment blank is collected then a new line on the sample control log will be filled out. For a field blank, the sample location will be referenced as “FB”, and for an equipment blank, the sample location will be referenced as “EB”. A new “blind” sample ID and time will be given to the blank samples in the same manner as that used for primary and field duplicate samples (See below for details on assigning the “blind” sample identification). The sample matrix for either a FB or EB is water, abbreviated as “W” in the sample matrix column. The sample type is FB for field blanks or EB for equipment blanks. The other columns in the sample control log will be completed appropriately, and in the additional notes column the primary location where the field blank or equipment blank was collected will be noted, along with source water and/or type of equipment associated with the respective blank sample.

If a field duplicate is collected, then a new line on the sample control log will be filled out. The sample location will be the location where the duplicate sample will be collected. A new “blind” sample ID and time will be given to the duplicate sample. A FD will be indicated in the sample type column. The other columns will be completed similar to a primary sample, and in the additional notes column the sample ID in which the field duplicate corresponds to will be noted (i.e., Duplicate of SWD04231301).

Each field crew will start a new sample control log each work week beginning with Monday and will track samples collected through Sunday. If there are blank lines at the bottom of the log that are not filled out before the end of the week, the field crew must line through them, initial and date it so it is known that the lines were intentionally left blank.

Sample Control logs will be initially reviewed for completeness and accuracy by one of the field task members and then again by the field coordinator or field manager, and will be scanned with the corresponding COC(s) and emailed to the Data Management Team. They will **not** be forwarded to any laboratory.

3.1.6 Chain of Custody (COC)

During sampling activities, a "paper trail" of sample custody must be maintained from the time the samples are collected until laboratory data are issued. Information on the custody, transfer, handling, and shipping of samples should be recorded by the sampling personnel on an Atlantic Richfield COC form. If an Atlantic Richfield COC form is not available, an equivalent form provided by the destination laboratory can be used instead. A COC form will be completed for each set of samples collected daily. At a minimum, every COC will contain the following information:

- Sampling Personnel's name and signature
- Project name
- Date and time of collection (corresponding to the respective field sampling record and sample control log)
- Field sample identification code and sample matrix (Note: Matrix types on the COC are limited to "soil/solid", "water/liquid", or "air/vapor" and do not reflect project defined matrix types.)
- Analyses/Methods requested
- Number of containers and any preservative used
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times (exclusive of FedEx, UPS or similar service)
- Method of shipment

- Shipping tracking number/waybill identification number (as appropriate)

Additional Atlantic Richfield project tracking information to be completed on the COC includes the following:

- Name of the lead regulatory agency
- Name and contact information of the environmental business manager
- Name and contact information of the consultant and Project Manager
- Enfos proposal number and the stage and activity level of the project
- Level of data package requested

An example COC is provided as an attachment and should be strictly followed as it is important that COCs are completed with consistent information. A copy of each COC form will be retained in the project files.

At the end of each sampling day, the field crew(s) will have all COCs initially reviewed for completeness and accuracy by one of the field task members and then again by the field coordinator, field manager or their designee. The COC will be scanned and copied. The copy will go in the file folder in the project office. The Field Coordinator will email the scan to the respective laboratory and to the data management team.

Items to double-check for completeness before scanning:

- Page _ of _
- Sample description, date and time
- Sample matrix
- Number of containers and their preservatives, if any
- Requested analysis
- **Line through blank space with initials and date**
- Sampler's name and company
- Shipment method, date and shipping addresses, and tracking number

3.1.7 Sampling Records

Sampling records, for the purpose of sample collection, have been customized for each type of sampling activity (e.g., groundwater from a well, grab groundwater from a boring, surface water, storm water and storm sediment) and are included in the task-specific SOPs. The associated sampling record should be filled out during the sampling process. Pertinent information varies with each type of sampling, but at a minimum, the following information should be filled out for each sample:

- Project name
- Project task description
- Location of sample
- Field sample identification code (Sample ID)
- Time of sample
- Results of any field measurements, such as depth to water, pH, temperature, specific electrical conductance, dissolved oxygen, turbidity, discharge, etc.
- Any QA/QC samples that were collected
- Field observations, such as color, odor or texture of the sample, etc.
- Method of sampling
- Name and signature of sampler

3.1.8 Significant Figures and Rounding Rules

Field measurements and field calculations will follow a standard set of rules to address the counting of significant figures and for rounding off numbers. For some field measurements, the appropriate number of significant figures may be designated in the respective planning documents (e.g., SAP, QAPP). In the absence of such requirements, the rules for rounding and significant figures must be used.

Often, measuring equipment readings or calculations performed using field data result in a greater number of digits than the result should possess and it is necessary to "round off" the number. Use the rules provided in the attached "Significant Figures and Rounding Instructions".

3.2 SAMPLE HANDLING

General sample handling procedures shall include the following:

- Always make field measurements on a separate sub-sample, not on the sample that is sent to the laboratory for analysis. Discard the sub-sample after the measurements have been made.
- Do not use containers that have been used in the laboratory to store concentrated reagents or have been previously used as sample containers. Use only new containers that are certified clean by the manufacturer or laboratory for sample collection.
- For water samples, do not allow the inner portion of sample containers and caps to come into contact with bare hands, gloves, tubing or other objects.
- Keep sample containers in a clean environment away from dust, dirt, and fumes. Field personnel shall wear disposable nitrile gloves when collecting water samples. Gloves must be changed and the used pair discarded between each water sample collected.
- Do not let any samples (e.g., including water, vegetation, or invertebrate samples) stand in the sun. Store all samples in coolers with blue or double bagged ice;
- Do not mix sediment and water samples in the same cooler, unless you are shipping associated blanks with sediment samples.
- COC procedures will be strictly adhered to during sample collection, transportation, and laboratory handling to assure the identity of the samples. Improper sample and data handling and inadequate COC procedures affect the credibility and acceptability of analytical results, regardless of their accuracy or precision. Chains of custody will document processing of the sample from the time of collection to the time of analysis.

If overnight storage of collected water or soil samples is required prior to shipment to a laboratory, the samples will be stored in accordance to procedures described in Section 3.2.4.

3.2.1 Sample Labeling

After sample collection, the samples will be labeled with self-adhesive labels that display all necessary information added using waterproof ink. Make sure the labels are completed so that the information is legible and consistent. At a minimum, each sample label must contain the following information:

- Project name

- Sample ID
- Date (mmddyy) and military (24 hour clock) time (tt:tt) of sample collection
- Analyses required
- Preservatives, if applicable
- Sampler's initials (only primary sampler initials as recorded on the sampling record)

The information on the sample label should match the respective record on the COC and sample control log.

Each sample, including QA/QC samples, will be assigned a unique identification code according to sample location and date for use in the project database. This Sample ID will typically consist of four parts. The four parts of the ID will not be separated by any symbols, characters, or spaces. The components of the sample ID are:

- Sample Prefix – groundwater (GW), soil boring (SB), surface water delineation (SD), stream sediment and related floodplain soil/sediment (SS), storm water sediment (STS), storm water/snow melt (STW), surface water (SW), waste sample (WS), plant sample (PS) plant sample, tissue sample (TS) , fish sample (FS).
- Study Area Designation – Aspen Creek Study Area (A), Leviathan Creek Study Area (L), Pit Study Area (P), Downstream Study Area (D), Reference Study Area (R), or Supplemental Study Area (S).
- Date – Expressed as a two-digit month, day, and year (MMDDYY).
- Continuous sequence number for each day of sampling in each of the designated sampling areas. Sequential numbering will restart at 01 on a given sampling day, in a given sampling area.

For example, if the 99th sample taken for a groundwater sample in the Leviathan Creek Study Area on February 5, 2010, the sample ID will be *"GWL02051099"*. Waste characterization samples will be designated by respective Study Area. For example, if investigation derived waste (soils or water) from the Pit Study Area is collected on January 1, 2010, the sample ID will be *"WSP01011001"*. Refer to Section 3.4.2 for discussion on handling and labeling laboratory quality control samples.

Field blanks and duplicates shall be labeled so as not to indicate the identity of the sample to the lab and will follow the labeling convention (using the appropriate number sequence) in place

of calling the sample “blank” or “Dup". The identity of field QC samples will be traceable through the sample control log.

3.2.2 Sample Preservation

Sample preservation will depend on the analytical method to be performed and the sample matrix. Preservation methods and preservatives for each analytical method and matrix will be presented in the respective planning documents. The planned sample preservation activities, sample container size and type, and analytical methods should be confirmed with the laboratory well in advance of collecting samples.

For all water samples and select solid samples, the laboratory will supply clean, unused, and pre-preserved sample containers, as appropriate. Preservatives can also be added in the field according to specific project or manufacturer’s instructions. Do not rinse out sample containers. The preservative (lab or field) will be documented on the sample label and COC. Soil or water samples collected using non disposable equipment such as split spoon, direct push, drive, or grab methods, will be decontaminated prior to use in accordance to procedures described in SOP 7.0- Equipment Decontamination

If a chemical or physical change is noted (i.e. changes color, becomes cloudy, turbid, effervesces, or a precipitate forms) upon exposing the sample to air, filtering, adding acid preservatives, etc., then the sample should not be collected in the specified manner and an alternative sample collection procedure be used (e.g., no field filtering, no field preservation, etc). The field coordinator should be notified and an alternate method of collecting the sample will be decided and the laboratory notified as necessary.

3.2.3 Sample Packaging and Shipping

If samples are required to be chilled, they will be stored during the day, or overnight, in ice-cooled containers.

Samples collected during the morning may be temporarily stored in a temperature controlled, refrigerator (if available) until shipment in the afternoon. All samples stored in the coolers or the refrigerator will be documented on the sample control log. When samples are being packaged for shipment, the procedures listed below will be followed.

1. Field personnel will visually screen each sample in the cooler for loose surface contamination, and confirm that each sample is listed on the sample control log and the COC.

2. Samples will be packed with abundant packaging material to minimize the potential for damage during shipment. If samples need to be chilled, they will be placed in sealable plastic bags and immediately placed on ice in an insulated cooler. Insulated coolers can be provided by the contract laboratories. Sample containers will be placed right side up within 2 large trash bags in a cooler with double bagged ice for delivery to the laboratory.

3. The completed COC will be signed, scanned and emailed to the lab to inform them about the sample(s) they will be receiving. The carrier waybill number will be recorded on the original COC. Commercial carriers are not required to sign the COCs. However, we do need to sign over custody to the courier (if using a courier to deliver the samples to a commercial carrier) and have the courier sign over custody for the approximate time he will relinquish the samples. The scans will be saved for project records. Then, the COC will be placed in a plastic sealable storage bag which will be taped to the inside cover of the cooler. The COC form will be shipped with the cooler and serve as the legal documentation of sample custody for the field and laboratory.

4. If samples are to be transported overnight via Federal Express or United Parcel Service, all ice must be double bagged to prevent leakage. The lid of the cooler must be taped shut with custody seals. The cooler will then be taped shut using clear shipping tape. Failure to seal all potential leaks may result in rejection of delivery by the courier. If samples are shipped under special circumstances (e.g., First Overnight, Saturday Delivery) make sure to check the appropriate delivery method on the shipping papers and affix the appropriate labels on the top and/or sides of the cooler.

5. Samples will typically be shipped to the laboratory daily. Copies of the completed COCs will be kept in the designated field binder for the project files. Scans of the COCs will be emailed to the laboratory to notify them of expected samples for arrival.

6. Sample shipment will be scheduled to prevent exceeding any required holding period. Failure to submit samples for analysis within the required holding times will prompt appropriate corrective and preventive action measures.

3.2.4 Overnight Storage

If the hold time allows, samples may be stored overnight as long as they are properly packaged, labeled, and placed in a secure location. If chemical analysis is to be performed on the sample, it must be stored at no more than 6°C or 39°F, but above freezing. Samples will be kept in a cooler or refrigerator locked in a secure location and shipped the following day. When placing samples into the refrigerator, make sure the refrigerator is plugged in and turned on and set at the appropriate temperature. Samples should not be kept for more than a week, or longer than analysis holding times allow. If samples are kept overnight, chain of custody procedures must still be followed.

3.3 ELECTRONIC FILE HANDLING

All photographs and electronic data files (including data downloads, GPS coordinates, etc.) should be saved to the project folder. File names should correspond to respective logs used to record the type of data file as described in this SOP (e.g., GPS Log, Photo Log, etc.). A group of files corresponding to a given date, or weekly beginning date of the sampling event for data evaluation purposes may also be used, given that each file in the group is appropriately named (i.e., "120521_Photos" or 120521_Data, for respective electronic files generated beginning the week of May 21, 2012).

3.4 FIELD REPORTS

A field report should be prepared for all tasks by a member of the field team unless a report summarizing methods and implementation will be prepared by a subcontractor. In some cases, a field summary may need to be prepared even if a contractor will be submitting a final report to document field scope changes or other difficulties implementing the work. The purpose of the field report is to document field methods implemented before moving on to another task. The field memo will be used as a base and modified to reflect what activities and methods were actually completed and/or used in the field.

For short term activities (less than 1 month), a field report should be prepared upon completion of field activities associated with the assigned task. For long term activities (e.g. drilling and storm water), a field report should be completed within one week of completion of a boring/well or piezometer installation for drilling activities, or after a given storm event. Also, the Well Installation Summary should be updated after each well completion.

In general, a field report should contain the following information if applicable:

- Summary of activities;
- Description of any variances or deviations from the planning documents;
- Summary of samples collected (if applicable);
- Lithology (soil borings)
- Logic and drawings for well completion (well installations);

- Amount of rainfall recorded (storm water monitoring)

The drilling field report should consist of the lithology and well completion drawing for each boring, a notation of any variances or deviations from the planning documents **and** the logic for well completion.

For storm water, the field report should consist of a summary of the samples collected and the amount of rain recorded at each station.

Once the field report has been completed, email it to the Program Coordinator and the Field Manager for review.

3.5 REVISION LOG

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
1	Britt Jones	Removed references to the HSSE Program Document and RI/FS TSHASP (3.0) and replaced JSA with WRA or TSEA (3.0). Add Hand-Held GPS device in the equipment list (3.0). Added SOP 30.0 to list of other SOPs to consult (3.0).		8/12/10
2	Kristi Jones/Kent Parrish	Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. Added "tubing" from the third bullet. Replaced "tracking form" with "control log" (3.5). Provided additional procedures for completing a COC (Paragraph 2) and for sealing the cooler for transport (3.5). Provided additional procedures for overnight storage (D3.6). Added revision log (3.7). Added Photograph Log form and RI/FS Field Documentation Procedures form (Attachments). Added GPS		5/7/12

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
		Log form as attachment. Added info regarding maintain samples overnight.		
3	Britt Jones Lynda Lombardi	Revised section 3.1.2 to reflect the recent changes to the Sample Control Log, changed Background (B) to Reference Study Area "(R)" in Section 3.2. Added column for reviewer. Additional edits to address instructions for completing documentation; provide documentation references; clarify sample nomenclature; sample tracking procedures.	Jill Jefferson	5/16/13
4	Jon Browning Kristi Hayward Britt Jones	Initial 2014 review. Added review of paperwork text to Section 3.1 and added description of out of the ordinary occurrences or visitors to the list of things to include in a DFR Section 3.1.1). Combined RI/FS Field Documentation Procedures (prior attachment 3e) with this SOP.	Kent Parrish	3/12/14 4/17/14
5	Kristi Hayward	Add note about physical changes to samples in section 3.2.2 Sample Preservation	Kent Parrish	7/10/2014
6	Jon Browning	Technical review and editorial changes. Added guidance on significant figures and rounding. Clarified file naming and moved		2/16/15

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
		investigation acronyms to an attached table.	Lynda Lombardi	2/25/15

ATTACHMENTS

- 3a - Daily Field Record (DFR)
- 3b - Sample Control Log
- 3c - Atlantic Richfield Chain-of-Custody (COC) Record
- 3d - Photograph Log
- 3e - GPS Log
- 3f - Significant Figures and Rounding
- 3g - Table 3-1 Investigation Acronymns for Naming Electronic Files

DAILY FIELD RECORD

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	Company	Time In	Time Out

PERSONAL SAFETY CHECKLIST					
			Radios		Satellite Phone
	Safety-toed Boots		Hard Hat		Bear Kit
	Nitrile/Leather Gloves		Safety Glasses		Ear Plugs

DOCUMENTS ASSOCIATED WITH TODAY'S WORK	

TIME	DESCRIPTION OF WORK PERFORMED

Form checked by (initials and date): _____

DAILY FIELD RECORD (continued)

Project and Task Number:	Date:

TIME	DESCRIPTION OF WORK PERFORMED

Form checked by (initials and date): _____

Page ___ of ___

SAMPLE CONTROL LOG

Project Name: Leviathan Mine RI/FS, Alpine County, CA Task Name: _____

Project & Task No.: _____ Crew: _____

Sample Location[1]	Study Area[2]	Sample Matrix[3]	Sample ID	Sampling Date	Sample Time	Sample Collector Initials	Sample Depth (units)	Code[4] / Method[5]	MS/ MSD collected? X=Yes	Additional Notes[6]	Lab[7]	Date Sent to Lab

1. Sample Locations include: EB or FB for blanks, Monitoring Well ID, Boring ID, or other defined sampling location as directed in sampling planning documents.
2. If applicable, study area examples are Aspen Creek Study Area (ACSA), Leviathan Creek Study Area (LCSA), Pit Study Area (PSA), Downstream Study Area (DSA), Reference Study Area (RSA) or Supplemental Study Area (SSA).
3. Sample matrices defined in project planning documents.
4. Sample Code includes: Normal Environmental (NE), Field Duplicate (FD), Field Blank (FB), and Equipment Blank (EB)
5. Sampling methods include: Grab, Composite (Comp), Incremental (Incr), or Autosampler (Auto)
6. Include notes such as: locations of blanks, parent sample identification for field duplicates, sample location details, handling notes, chain-of-custody remarks, etc.
7. Lab performing sample analyses identified in project planning documents.

Amec Foster Wheeler Environment and Infrastructure, Inc.

Form checked by (initials/date):_____

Atlantic Richfield Company
A BP affiliated company

Laboratory Management Program LaMP Chain of Custody Record

Page _____ of _____

BP/ARC Project Name: _____ **Req Due Date (mm/dd/yy):** _____ **Rush TAT:** Yes ____ No ____

BP/ARC Facility No: _____ **Lab Work Order Number:** _____

Lab Name:	BP/ARC Facility Address:	Consultant/Contractor:
Lab Address:	City, State, ZIP Code:	Consultant/Contractor Project No:
Lab PM:	Lead Regulatory Agency:	Address:
Lab Phone:	California Global ID No.:	Consultant/Contractor PM:
Lab Shipping Acct:	Enfos Proposal No:	Phone:
Lab Bottle Order No:	Accounting Mode: Provision ____ OOC-BU ____ OOC-RM ____	Email EDD To:
Other Info:	Stage: Activity:	Invoice To: BP/ARC ____ Contractor ____

BP/ARC EBM:

EBM Phone:

EBM Email:

Report Type & QC Level: Standard ____ Full Data Package ____

Lab No.	Sample Description	Date	Time	Matrix: Soil / Solid	Matrix: Water / Liquid	Matrix: Air / Vapor		No. Containers / Preservative: Total Number of Containers	Unpreserved	H_2SO_4	HNO_3	HCl	Methanol		Requested Analyses										Comments

Note: If sample not collected, indicate "No Sample" in comments and single-strike out and initial any preprinted sample description.

Sampler's Name:	Relinquished By / Affiliation	Date	Time	Accepted By / Affiliation	Date	Time
Sampler's Company:						
Shipment Method: Ship Date:						
Shipment Tracking No:						

Special Instructions:

THIS LINE - LAB USE ONLY: Custody Seals In Place: Yes / No	Temp Blank: Yes / No	Cooler Temp on Receipt: _____°F/C	Trip Blank: Yes / No	MS/MSD Sample Submitted: Yes / No

BP/ARC LaMP COC Rev. 6 01/01/2009

PHOTOGRAPH LOG

Project Name: _____ Task Name: _____

Project & Task No.: _____ Camera No: _____

Camera Assigned ID #	AMEC Assigned ID #[a]	Date	Photographer Initials	Location	Direction of View	Additional Comments

a. To be recorded when transfering photos to the electronic files to the project file.

Amec Foster Wheeler

Form checked by (initials and date): _____

GPS LOG

Project Name: Leviathan Mine RI/FS, Alpine County, CA

Task Name: _____

Project & Task No.: _____

Last 4 Digits of GPS Serial No.: _____

File Name	Comment (two digit sequencial #)	Point, Line or Area	Location Name[1]	Date	Associated Data[2]	Additional Comments/Description

1. Might be determined after all data has been gathered.
2. Associated Data includes: photographs, samples, parameters, etc.

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Form checked by (initials and date): _____

Page ___ of ___

P:\Project\13000s\13091 Leviathan\5000 Field Operations\5070 RIFS\2015_SOPs\SOP 3.0_Field Doc&Samples\3e_GPS Log_rev4_150227

SIGNIFICANT FIGURES AND ROUNDING INSTRUCTIONS

- Significant figures
  - General use
    - Zero counts as a sig fig if it comes between 2 other integers
      - Example: 20 has one sig fig but 205 has three sig figs
    - Leading zeros do not count as sig figs, they are just placeholders to indicate order of magnitude
      - Example: 0.0034 has 2 sig figs (not 4 or 5)
    - Trailing zeros only count as a sig fig if they are after a decimal
      - Example: 100 has 1 sig fig but 1.00 has 3 sig figs
      - The significance of trailing zeros without a decimal can only be identified using knowledge of the source of the value
        - Example: if our SOP states we calculate flow rate using a time unit of whole seconds, a 10 second bucket fill time would have 2 sig figs instead of just 1
    - Record all digits displayed on instruments, including trailing zeros unless otherwise instructed by an SOP
  - Calculations
    - Do not round numbers being used in a calculation, only the final result or value.
    - In multiplication or division, the result has no more sig figs than any number being used in the calculation
      - Example: 11.38 x 4.3 = 48.332 → 48 final result (since 4.3 has 2 sig figs)
    - In addition or subtraction, the result has no more decimal places than any number being used in the calculation
      - Example: 11.24 + 9.3 + 6.32 = 26.86 → 26.9 final result (since 9.3 has one decimal place, or only goes out to the tenths place)
      - Example: 926 – 923.4 = 2.6 → 3 (since 926 has only whole integers)
- Rounding
  - When rounding numbers, consider the digits beyond the last place being retained
  - Examples where 2 sig figs are being kept:

Digit(s) being considered:	Round Up or Round Down?	Example Starting Number	Example Rounded Number
<5	Round Down	2.4**3**	2.4
		2.4**3**9	2.4
>5 (or 5 followed by a digit other than zero)	Round Up	2.6**7**	2.7
		2.6**54**	2.7
Exactly 5 or 5 followed only by zeros (preceded by even number)	Round Down	2.6**5**	2.6 (final number is even)
		2.6**500**	2.6 (final number is even)
Exactly 5 or 5 followed only by zeros (preceded by odd number)	Round Up	2.7**5**	2.8 (final number is even)
		2.7**500**	2.8 (final number is even)

TABLE 1
INVESTIGATION ACRONYMS FOR NAMING ELECTRONIC DATA FILES
Leviathan Mine Site
Alpine County, California

amec foster wheeler

Leviathan RI Investigation Activities

Mine Waste Investigations.....MnWst
Plant & Soil Sampling.....PlantSoil
Stream Sediment Investigations.....StrmSed
Surface Water Investigations.....SfcWtr
Floodplain Soil Investigations.....FldSoil
Fish Surveys & Sampling.....Fish
Groundwater Monitoring.....GWM
Storm Water Monitoring & Maintenance.....STWM
Met Station Monitoring & Maintenance.....Met
Evap Monitoring & Maintenance.....Evap
Pond Water Level Monitoring & Maintenance.....PWL
Pond Underdrain Monitoring & Maintenance.....PUM
Investigation of Mine Features.....InvMF
Investigation of Acid Pond.....InvAP
Drilling & Well Installation.....Drill
Geotechnical Investigations.....Tech
Supplemental Study Areas – Leviathan Mine Rd.....LMRd

Supplemental Study Areas – River Ranch.....RR
Supplemental Study Areas – Ore Piles.....OP
Supplemental Study Areas – EFCR.....EFCR
Habitat Verification.....HabVer
Soil Investigations.....Soil
Doud Springs Mapping & Sampling.....DdSprgs

Cinnabar Canyon Sampling.....CinnCyn
CUD-Aspen Flow Gages.....Gages

4.0 – SAMPLE COLLECTION TECHNIQUES AND DATA COLLECTION STRATEGIES

Purpose and Scope: The purpose of this document is to describe considerations for general sampling techniques and data collection strategies and is intended to be used in conjunction with the applicable matrix specific procedure for collecting samples for analysis.

Equipment:
Nitrile gloves or other appropriate gloves
Measuring Wheel or Tape Measure
Flag markers
Hand-Held Global Positioning System (GPS) device
Camera
Marking flags
Marking paint
Wooden stakes

Documentation:
Daily Field Record (DFR)
Photo Log
GPS Log
Maps

This Standard Operating Procedure (SOP) is to be used in conjunction with the applicable Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. Specific sample techniques, strategies, locations and frequency will be presented in the planning documents. However, in the event that the planning documents require that sample collection techniques and data collection strategies must be determined in the field (e.g. pre-investigation planning, mapping, waste sampling), the procedures within this SOP should be followed.

In addition, the following SOPs should be consulted:

- SOP 1.0 – General Preparation and Mobilization Requirements
- SOP 2.0 – Basic Health and Safety for Field Operations
- SOP 3.0 – Field Documentation and Sample Handling
- SOP 7.0 – Equipment Decontamination
- SOP 30.0 – Hand-Held Global Positioning System (GPS)

Also refer to the Leviathan Mine Site Health, Safety, Security and Environmental (HSSE) Program Document, the Task Specific Health and Safety Plan (TSHASP), the Field Authorization Form (FAF), and Task Risk Assessment (TRA).

4.1 SAMPLE COLLECTION TECHNIQUES

Three basic types of sample collection techniques will be used: Grab, Composite, and Incremental Sampling Methodology (ISM). These techniques are described below:

- A grab sample is defined as a discrete sample representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease. Additional considerations for grab samples of a specific matrix are provided in the applicable SOPs.

- A composite sample is a non-discrete sample composed of more than one sample collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits. Additional considerations for composite samples of a specific matrix are provided in the applicable SOPs.

- ISM is a structured composite sampling protocol that reduces sampling error associated with compositional and distributional heterogeneity of the analyte of interest in soil or sediments. The ISM protocol consists of defining sampling or decision units, collecting a minimum of 30 individual soil samples from randomly selected locations within each unit, and submitting the samples to the laboratory for processing (drying, compositing, sieving, and sub-sampling) in a specified manner prior to laboratory analysis. Additional information on ISM is provided in SOP 31.0 – Incremental Sampling

4.2 DATA COLLECTION STRATEGIES

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling. Each of the strategies is explained in the following:

- Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site.

- Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established.

- Judgmental sampling involves collection of samples only from the portion of the site most likely to be contaminated.

A combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, and the level/type of information desired.

4.3 SAMPLE LOCATION DOCUMENTATION

Once a sample location is chosen and the sample has been collected, the location will be temporarily staked or marked until it has been surveyed. Additionally, photos of the location should be taken so the location is well documented. The photos should be documented on a photo log (SOP 3.0 – Field Documentation and Sample Handling).

Wooden stakes, steel fence posts with safety caps, survey whiskers, pin flags with the name of the location written in permanent marker, or survey whiskers can be driven into the ground to show the location. It is not recommended that spray paint be used to mark locations as it may get washed off or brushed over by dirt and rocks. Spray paint may be used as a temporary location marker; however, the spray paint marker should either be surveyed or replaced as soon as possible so the location is not lost.

For samples and activities that require high accuracy survey data such as the installation of borings for subsurface mapping, the installation of monitoring wells and piezometers for water level measurement, and the installation of surface monitoring monuments, survey activities will be subcontracted to a third party that has a current California survey license and is capable to surveying within a 100th of a foot. All surveys shall be completed using the most recent version of the State Plane Coordinate System. The surveyor will obtain accurate coordinates and elevations of the sample locations within several weeks after the installation activities.

If only sub-meter accuracy for vertical and horizontal survey information is needed, a hand-held GPS device (SOP 30.0 – Use of Hand Held GPS Device) may be used in place of a licensed surveyor to obtain general coordinates of locations and activities.

Coordinates of sample locations will be documented as described in SOP 30.0 (or similar third party surveying format) and added to the project database for any sample location.

4.3 QUALITY CONTROL SAMPLES

Required quality control (QC) samples may include the collection of equipment rinsate blanks, field blanks, and field duplicates. Project planning documents must be consulted for determining which QC sample types will be collected. The QC sample types are described in the following sections.

4.3.1 Field Equipment (Rinsate) Blank Samples

Field equipment blanks consist of contaminant-free water (e.g., deionized or distilled water) that is collected after equipment decontamination procedures as described in SOP 7.0 -Equipment Decontamination. A field equipment blank sample is collected in the same manner as other samples, utilizing any non-dedicated, decontaminated sampling equipment (sample tubing, filters, shovels, etc.). These samples are submitted blind to the laboratory for identical analyses as the respective primary samples. Field equipment blanks are used to evaluate decontamination procedures of sampling equipment. Field equipment blank samples are collected only in conjunction with non-dedicated field equipment and may apply to groundwater, surface water, storm water, sediment, and soil sampling activities. Field equipment blanks will not be collected in conjunction with sampling of plants or fish, as these test methods are typically performed using preparation methods not amenable to aqueous samples.

4.3.1 Field (Ambient) Blank Samples

A field blank sample is collected at the same time as the respective primary water samples by directly filling the sample containers with de-ionized water to simulate ambient sampling conditions in the field and identifies contamination that may occur in the sample processing or shipment to the laboratory. The field blanks are collected in the appropriate sample container, preserved as necessary, and handled in the same manner as the primary samples. Field blanks are not collected in conjunction with automated sampling methods and or other in-direct sampling devices. Field blanks are not amenable for comparison to non-aqueous samples (e.g., sediment, soil, plants, or fish) because sample processing and shipping methods differ from those required for aqueous samples, and therefore, are not collected in conjunction with non-aqueous samples.

4.3.3 Field Duplicate Samples

Field duplicate samples are collected to assess the precision and overall quality of the sampling and analytical procedures. Field duplicate samples are collected at the same time and from the same source as the original sample. Field duplicate samples are collected, numbered, packaged, and sealed in the same manner as other samples, and submitted blind to the

laboratory for identical analyses as the original sample. Certain sample types (e.g., composites, plants, or fish) do not lend themselves to this type of sampling due to difficulties in replicating "same sample" collection techniques.

4.4 REVISION LOG

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
1	Britt Jones	Removed references to the HSSE Program Document and RI/FS TSHASP (D4.0). Replaced JSA with WRA or TSEA (D4.0). Add Hand-Held GPS device in the equipment list (D4.0). Added SOP 30.0 to list of other SOPs to consult (D4.0).		8/12/10
2	Kristi Jones/Jill Jefferson Jon Browning Kristi Hayward	Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. Added revision log (D4.4). Added survey whiskers. Format changes. Changed IS (incremental sampling) to ISM (incremental sampling methodology) to be consistent with SOP 31.	 Kent Parrish	5/7/12 12/10/13
3	Jon Browning	Technical review and editorial changes. Added QC sample collection descriptions.	 Lynda Lombardi	2/18/15 2/25/15

7.0 – EQUIPMENT DECONTAMINATION

Purpose and Scope: The purpose of this document is to describe procedures for equipment decontamination. It describes decontamination methods and provides specific procedures for decontaminating drilling and excavation equipment, submersible pumps, decontamination for the collection of field equipment (rinsate) blanks, and water level meters.

Equipment:
Steam Cleaner
Four 5-gallon buckets with lids
Bucket labels
Brushes
Distilled water
Potable water
Spray or wash bottles
Paper towels
Liquinox® or other **Non-Phosphate** Cleaning Solution (not Alconox®)
10 mil visqueen
Sample containers for field equipment blanks (if required)

Documentation: Daily Field Record (DFR)

This Standard Operating Procedure (SOP) is to be used in conjunction with the applicable Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. In addition, the following SOPs should be consulted:

- SOP 1.0 – General Preparation and Mobilization Requirements
- SOP 2.0 – Basic Health and Safety for Field Operations
- SOP 3.0 – Field Documentation and Sample Handling
- SOP 9.0 – Investigation Derived Waste Disposal

Also refer to the Leviathan Mine Site Health, Safety, Security and Environmental (HSSE) Program Document, the Task Specific Health and Safety Plan (TSHASP), the Field Authorization Form (FAF), and the Task Risk Assessment (TRA).

7.1 DECONTAMINATION PROCEDURES

Decontamination procedures described in this section are applicable to non-dedicated, non-disposable sampling equipment. The following subsections describe the methods of decontamination and procedures for decontaminating specific types of sampling equipment.

7.1.1 Decontamination Methods

All sampling equipment must be decontaminated after it arrives onto the site and before each sampling operation. This includes subcontractor equipment. Decontamination onsite will use one of the methods below:

- Three-Step System
- Steam Cleaner

The procedures for decontamination using the three-step system or steam cleaner are described in the following subsections. The exception to using the three-step system or a steam cleaner for decontamination is when cleaning a water level meter. This is described in Section 7.1.2.4 of this SOP.

7.1.1.1 Three-Step System

The three step decontamination system consists of washing the sampling equipment: (1) in soapy water using a non-phosphate (Liquinox) solution, (2) rinsing with potable water and (3) rinsing again with distilled water. The Liquinox® solution will be mixed in accordance with the manufacturer's recommendations. ***Under NO circumstance is Alconox® or any other cleaning solution containing phosphate to be used.*** Equipment will be washed in a row of three containers. Depending on the equipment to be decontaminated, spray bottles containing the applicable solutions may be used. Hard bristle bottle brushes may be used to remove mud and debris prior to the three step system with an optional fourth container. Sample equipment should be allowed to drain dry after the final distilled water rise. Decontamination water will be disposed of according to procedures described in SOP 9.0 – Investigation Derived Waste Disposal. Sampling equipment (e.g., the shoe from a core sampler, hand auger, shovel, drive-sampler, etc.) will be decontaminated using the three-step system.

7.1.1.2 Steam Cleaner

The steam cleaner will be supplied by a subcontractor and operated according to the manufacturer's recommendations. It will be capable of generating a working pressure of approximately 1,500 to 2,000 pounds per square inch (psi), a discharge rate of 3 to 5 gallons

per minute (gpm), and an operating temperature of approximately 130 to 150 degrees Fahrenheit (˚F).

The steam cleaner will be used within a decontamination station designed to capture all of the water. The decontamination station may be mounted on a portable trailer or constructed onsite and will be supplied or built by a subcontractor. If constructed, the on-site decontamination area will be lined and bermed with two layers of 10 mil visqueen to contain rinsate from steam cleaning operations. If appropriate, the decontamination area will be designed to allow heavy equipment (backhoe, drilling rig, and support vehicles) to drive onto the visqueen. During operation of the steam cleaner, the field engineer or geologist will establish and maintain an exclusion zone. Decontamination water will be retained and disposed according to procedures described in SOP 9.0 – Investigation Derived Waste Disposal.

7.1.2 Sampling Equipment

The following subsections provide specific details for decontaminating drilling and excavation equipment, submersible pumps, water level meters. Document equipment decontamination activities on the Daily Field Record (DFR).

7.1.2.1 Drilling and Excavation Equipment

Drilling and excavating equipment, including backhoe buckets, drill bits, casing, augers, and tools or other equipment that have come in contact with potentially impacted soils or water will be cleaned between each location, as appropriate. After completion of each boring, drill casing, core barrel, augers, drill bits and drill rods will be transported by truck to the steam cleaning area. Drill casing and core barrel from the monitoring well drilling procedures will be lifted from the support truck and cleaned within the decontamination station. Heavy tooling with edges that can damage the visqueen lined decontamination pad area will be placed on lumber in the decontamination area for cleaning. Rinsate collected in the decontamination area will be retained and disposed according to SOP 9.0 – Investigation Derived Waste Disposal.

7.1.2.2 Submersible and Bladder Pumps

If a non-dedicated submersible pump is used, it will be cleaned prior to use and between sampling locations using the three-step system. First, the pump intake device will be submersed into non-phosphate cleaning solution (Liquinox) and recycled within a bucket for at least 30 seconds. Second, the pump will be submersed into a bucket containing potable water and recycled within the container for at least 30 seconds. The second step should be performed

to sufficiently rinse the suds from the pump. The third step involves rinsing the pump within a bucket filled with distilled water using the same method as described in Steps 1 and 2.

If a non-dedicated bladder pump is used, it will first be disassembled and decontaminated using the three-step system. If so equipped, the disposable bladder will be removed and replaced with a new bladder. The used bladder will be disposed using project procedures for disposing solid waste. Then, the bladder pump will be assembled and rinsed with distilled water.

7.1.2.3 Water Level Meters

Water level meters will be decontaminated using a two-step system. This system consists of a spray bottle containing non-phosphate detergent (Liquinox) mixed with water and a spray bottle containing distilled water. The Liquinox solution will be mixed in accordance with the manufacturer's recommendations. The soapy water will be sprayed on the portion of the water level meter that was submerged and then rinsed by spraying distilled water until all suds are removed. The submerged portion of the water level meter will then be wiped down with a paper towel. If residual dirt or other contaminants remain on the water level meter after being rinsed, the above steps will be repeated using a brush or paper towel to remove the remaining debris. Rinse water from the above procedures will be captured in a bucket or other appropriate container, labeled, and disposed in accordance with procedures described in SOP 9.0 – Investigation Derived Waste Disposal.

7.1.3 Field Equipment (Rinsate) Blanks

Field equipment blanks will be collected after decontamination of select non-dedicated, non-disposable sampling equipment during sampling activities to provide an additional check on possible sources of contamination related to field sampling instruments. A general description of field equipment blank samples is included in SOP 4.0 – Sample Collection Techniques and Data Collection Strategies. Following decontamination procedures for the given sampling equipment, distilled or de-ionized water is poured through or over the sampling device, transferred to an appropriate sample bottle, and submitted to the laboratory as a field sample. Typically, the field equipment blank is tested for the same suite of analyses as required for the associated primary samples. (Note: Because field equipment blanks are aqueous, the required containers and sample preservation techniques may differ from respective non-aqueous primary samples.) The field equipment blank should be collected immediately after the equipment has been decontaminated. Refer to SOP 3.0 – Field Documentation and Sample Handling for additional sample documentation procedures.

7.2 REVISION LOG

Revision Number	Author	Description of Change (Section Number)	Date
1	Britt Jones	Removed references to the HSSE Program Document and RI/FS TSHASP (D7.0). Replaced JSA with WRA or TSEA (D7.0).	8/12/10
2	Eric Morita/Kent Parrish	Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. Specify that the scope of this equipment decontamination SOP pertains to drilling, excavation equipment, pumps, decontamination for collecting blank samples, and water level meters (D7.0). Updated equipment list (D7.0). Revised section D7.1.1 heading. Added requirements that equipment must be decontaminated before being brought onsite and before each sample is collected, including subcontractor equipment (D7.1.1). Acceptable decontamination methods at the site updated to include either the Three-Step System or by using a Steam Cleaner (D7.1.1). Added procedures for decontaminating various types of equipment (D7.1.2.1 through D7.1.2.4). Added revision log (D7.2).	5/8/12

Revision Number	Author	Description of Change (Section Number)	Reviewed and Finalized	Date
3	Britt Jones	Updated revision log to indicate reviewer and date finalized.	Jill Jefferson	5/20/13
4	Jon Browning	Performed format changes.	Kent Parrish	12/10/13 04/16/14
5	Jon Browning	Technical review, format and editorial changes. Added procedures for collecting field equipment blanks.	Lynda Lombardi	2/19/15 2/25/15

9.0 – INVESTIGATION DERIVED WASTE DISPOSAL

Purpose and Scope: The purpose of this document is to present procedures for containment and disposal of investigation derived waste such as soil, water, and materials.

Equipment:
Buckets, containers with covers for soil and water
(e.g., 55-gallon drums, 20-yard roll-off bins, Baker Tanks™)
Waste disposal labels
Appropriate sample containers and sampling equipment
Miscellaneous tools
Safety Equipment

Documentation:
Daily Field Record (DFR)
Waste Tracking Log (attached)
Maps/plot plan
Camera

This Standard Operating Procedure (SOP) is to be used in conjunction with the applicable Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. In addition, the following SOPs should be consulted:

- SOP 1.0 – General Preparation and Mobilization Requirements
- SOP 2.0 – Basic Health and Safety for Field Operations
- SOP 3.0 – Field Documentation and Sample Handling
- SOP 6.0 – Equipment Decontamination
- SOP 13.0 – Drilling
- SOP 16.0 – Installation and Construction of Groundwater Monitoring Wells and Piezometers
- SOP 17.0 – Groundwater Sampling

Also refer to the Leviathan Mine Site Health, Safety, Security and Environmental (HSSE) Program Document, the RI/FS Task Specific Health and Safety Plan (TSHASP), the Field Authorization Form (FAF), and the Task Risk Assessment (TRA).

The procedures below are to be followed for investigation derived waste consisting of water, soil, or materials such as personal protective equipment (PPE) or disposable sampling equipment. Investigation derived groundwater will be generated from well development and purging activities. Investigation derived waste water will be generated during decontamination activities. Investigation derived soil will be generated from soil borings.

All waste containers will be kept closed and sealed at all times unless actively adding waste. Each container must have a visible and legible label present. Labels will be constructed of weather-resistant vinyl and waterproof ink markers will be used to add information in the field. All empty containers must have a label that indicates that the container is empty. Prior to filling any waste containers, the sampler will replace the empty label with a label that describes the source of the waste (e.g., well or boring ID), the contents (e.g., soil or water), date accumulation started, date accumulation finished, and a name and contact information of the RI/FS Coordinator. The location of the waste generated will be documented on a waste tracking log (attached).

9.1 WATER DISPOSAL PROCEDURES

Groundwater produced during the well development and purging activities will be discharged to the ground surface downslope of the well for evaporation and infiltration. Water will be discharged in a manner that prevents erosion, pooling of water, or migration to a surface water body and will be performed in accordance with the HSSE Program document and the TSHASP. Measures to prevent erosion or migration may consist of installing silt fencing down slope of discharge areas or transporting and land applying water in a more appropriate location. If surface discharge is not practicable, water may be transferred or containerized (e.g. in a pipe, hose, or drum) and transported to the on-site treatment systems at Pond 4 or the ASB. **Water shall not be placed in Ponds 1, 2N, 2S, or 3 or any other structure except Pond 4 or the ASB under any circumstance.** If water is to be placed in Pond 4 or the ASB, it must first be coordinated with the operator of those systems.

Waste water produced from decontamination activities will be disposed in the same manner as described above. This includes Liquinox® (a non-phosphate detergent) that is mixed with water using the manufacturer's recommendations. Alconox® or other detergents containing phosphates will not be used on site. If other cleaning agents are used during decontamination, the field engineer or geologist will contact the Project Manager for guidance on the proper disposal procedure.

It is not anticipated that investigation derived waste water will be transported off site. However, if necessary the waste water disposal activities will be performed in accordance with Section 9.3.

9.2 SOIL DISPOSAL PROCEDURES

It is anticipated that most soil investigations will be performed in areas that have previously disturbed unconsolidated material at the surface that was left behind from previous site activities (e.g., mining, construction, landslides). Any soil or mud developed during the drilling or excavation activities are expected to have similar characteristics as the disturbed material that exists in the vicinity of the investigation. Therefore, if disturbed material already exists at the surface, any soil or mud developed during the investigation will be spread evenly in the immediate vicinity. The material will be spread in a manner that has a low profile as to prevent windblown dust from occurring. These soil disposal activities will be performed in a manner that prevents migration to a surface water body and in accordance with the HSSE Program document and the TSHASP.

If soil and mud produced during the investigation is suspected to contain other contaminants (e.g., petroleum odors, ethanol odor), the field Engineer or Geologist will contact the Project Manager for guidance. Exceptions to the above soil disposal procedures will be addressed on a case-by-case basis.

9.3 MATERIAL DISPOSAL PROCEDURES

Used PPE (e.g., nitrile gloves) will be disposed in containers that are sealed and labeled. These containers will be stored overnight in the High Density Sludge (HDS) Plant to be later transported to an appropriate offsite disposal facility.

Used disposable sampling equipment which has come in contact with low pH water (e.g., bailers, sample bottles) will be rinsed, cut in half, and then placed in the on-site municipal solid waste trash receptacle. The disposable sampling equipment will be rinsed with neutral pH water (e.g., fresh water from the HDS Plant, distilled water, tap water) and the rinse water will be disposed of as specified in Section 9.1.

All other disposable equipment, including items such as rope and non-hazardous well construction materials will be disposed in the onsite municipal solid waste trash receptacle. The exception is for the disposal of equipment that has come in contact with contaminants that are suspected to be non-native to the area or those that are known to be hazardous (e.g., ethanol,

diesel fuel, etc.). If this situation exists, the field engineer or geologist will contact the Project Manager for guidance.

9.4 OFFSITE FACILITY DISPOSAL PROCEDURES

Offsite disposal of investigation derived waste is not expected. However in the event that it is needed, the location and quantity of the waste that is generated will be documented on a map and Waste Tracking Log (attached).

Offsite disposal of waste will be performed in accordance with appropriate Federal, State, and local regulations. A sample(s) of the waste to be disposed at an offsite facility will be collected and submitted to a laboratory for analysis. Analytical results of the sample(s) will then be sent to the disposal facility where a waste profile will be generated. The profile will be reviewed and signed by a designated Atlantic Richfield representative. The U.S. EPA will then be notified of all types and quantities of waste prior to its shipment off site.

Upon approval of the waste profile, an appropriate manifest (Hazardous or Non-Hazardous) will be completed. All waste manifests will be reviewed and signed by a designated Atlantic Richfield representative. The truck driver transporting the waste will also sign and keep the manifest in his presence at all times while transporting the container to the disposal facility. The truck driver will be responsible for adhering to all Department of Transport (DOT) rules and regulations for the transport of waste on public roads.

D9.5 REVISION LOG

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
1	Britt Jones	Removed references to the HSSE Program Document and RI/FS TSHASP (9.0). Replaced JSA with WRA or TSEA (9.0).		8/12/10

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
2	Eric Morita/Kent Parrish	Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. Renamed some section headings. Added procedures for installing silt fencing to control the land application of water (9.1). Specified that water shall not be placed in Ponds 1, 2N, 2S, or 3 (9.1). Added procedures for the disposal of decontamination water (9.1). Added procedures for the disposal of PPE, used sampling devices, and non-hazardous investigation derived waste (9.3). Added revision log (9.5).		5/7/12
3	Britt Jones	Updated revision log to indicate reviewer and date finalized.	Jill Jefferson	5/20/13
4	Jon Browning	Performed format changes	Kent Parrish	12/10/13 4/16/14
5	Jon Browning	Technical review and editorial changes.	Lynda Lombardi	2/19/15 2/25/2015

ATTACHMENT

- Waste Tracking Log

ED_001709_00000321-00156

Waste Tracking Log
Leviathan Mine Site
Alpine County, California

Date	Waste Type and Volume	Source Location	Container Type and Volume	Number of Containers	Storage Location

Amec Foster Wheeler
Form checked by (initials and date): _____

Page ___ of ___

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11.0 – SOIL AND/OR ROCK LOGGING

Purpose and Scope: The purpose of this document is to describe procedures for soil and/or rock logging. It describes the required equipment and forms, the information necessary to complete a borehole log or soil pedon description form, and methods for describing drill cuttings , soil, and rock cores.

Equipment:

Adhesive labels;
Binder clips;
Chisels;
Clip board;
Compass;
Core boxes;
Digital camera;
Dilute hydrochloric acid (10 percent HCl);
Engineers measuring tape;
Hack saw;
Hand-held Global Positioning System (GPS) device;
Hand lens;
Munsell soil and rock color charts;
Pen, pencil, and eraser;
Plastic tarp;
Putty knives;
Resealable plastic bags;
Rock hammer;
Sharpie markers;
Squirt bottle;
Straight edge;
Tables, chairs, and shade canopy;
Transparent glass jars;
Tripod;
Unified Soil Classification System (USCS) soil logging charts;
United States Department of Agriculture (USDA) soil logging chart;
Water level indicator;
White erase board and markers; and,
Wooden/foam blocks.

Documentation:

Borehole Log Explanation Sheet;
Daily Field Record;
Photograph Log;
Soil and Rock Borehole Log (attached); and
Soil Pedon Description Form (attached).

This Standard Operating Procedure (SOP) is to be used in conjunction with the Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. In addition to the SAP, the following SOPs should be consulted:

- SOP 1.0 – General Preparation and Mobilization Requirements
- SOP 2.0 – Basic Health and Safety for Field Operations
- SOP 3.0 – Field Documentation and Sample Handling
- SOP 4.0 – Sample Collection Techniques and Data Collection Strategies
- SOP 6.0 – Field Measurements – Water
- SOP 13.0 – Drilling
- SOP 14.0 – Soil and Rock Sampling
- SOP 16.0 – Installation and Construction of Groundwater Monitoring Wells and Piezometers
- SOP 30.0 – Hand-Held Global Positioning System (GPS)

Also refer to the Leviathan Mine Site Health, Safety, Security and Environmental (HSSE) Program Document. A daily Field Authorization Form (FAF) and Task Risk Assessment (TRA) will be prepared for the task.

All logging activities must be performed by appropriately trained field staff under the direct supervision of a California-licensed Professional Geologist in good standing.

11.1 BOREHOLE LOG PREPARATION

Every section in the Soil and Rock Borehole log will be completed. The information and level of detail shown on the borehole log will be consistent if one geologist or multiple geologists are preparing the logs. As such, the information summarized in this section will be followed to ensure that that logs are prepared consistently and with the correct level of detail. Ink will be used when preparing the borehole log. On the first page of the log for each borehole, in the header and footer sections, the geologist will record the following information (as shown on the Soil and Rock Borehole log):

- Project information including Project Name (e.g., Leviathan Mine Site), Location (e.g., Alpine County, California), Client Name (e.g., Atlantic Richfield Company);
- Borehole and monitoring well or piezometer identifier;
- Study area where the borehole is located (e.g., ACSA);
- Drilling contractor;
- Drilling equipment information (e.g., the model of the chassis and the drilling head, sampling equipment, and rig number, [if more than one on site]);
- Drilling method;
- Sampling method including hammer weight in pounds and drop height in feet (if using a drive sampler);
- The borehole diameter;
- Surveyed elevation and coordinates (northing and easting in CA state plane system; add after survey is performed by licensed surveyor);
- Date started and date finished (date finished is the date the last lift of grout was added to the borehole or annulus between the well casing and the borehole wall);
- Total depth of the borehole;
- Measuring point used during drilling (e.g., ground surface);
- Depth to water first encountered during drilling and after well or piezometer development;
- The monitoring well or piezometer screen interval;
- The top of casing (TOC) elevation measured by a licensed surveyor;
- Name of person conducting the logging and the responsible geologist or engineer; and
- The page and project numbers.

Each succeeding page of the borehole log should contain at a minimum in the header or footer:

- Project name and location;

- Client name;
- Borehole and monitoring well or piezometer identifier;
- Project number; and
- Page numbers (marked as page __ of __).

11.2 LOGGING PROCEDURES

Fill out the columns on the left side of the borehole log accurately and completely. If a column does not apply to the drilling and logging activities it will be left blank. The following information explains the type of information to document in each column on the left side of the borehole log:

- The depth in feet (in general, each hash mark will represent a 0.2 foot interval, but a shorter interval [e.g. 0.1 foot per hash mark] may be used if more room is required for the lithologic description).
- The blows/6 inches column, is used when assessing geotechnical properties of the soil/rock using a drive sampler. Typically, drive samplers used for this activity are Standard Penetration Test (SPT), California, and Modified California split spoon samplers. These types of samplers are usually 18-inches or 24-inches long. In the blows/6 inches column, record the number of blows it takes to advance the sampler in 6-inch increments until the drive sampler is fully advanced into the material. For example, if an 18-inch long drive sampler is used, there should be three numbers listed this column.
- In the run column, record the run number, start and end time, and depth interval. The length and time of each run will depend on the drilling method and sampler used.
- In the sample number column, write the alphanumeric sample identification at the corresponding depth. If there is insufficient space in this column to write the entire sample ID, then write the sample ID in the remarks column. SOP 3.0 – Field Documentation and Sample Handling describes the proper way to designate sample IDs.
- In the sample & recovery column, sketch the interval where the sample was collected and the overall interval cored during each run. The column should be divided in half vertically to show the sample interval (left side) and recovery interval (right side). Symbols for the sample interval and sampler type are provided in the borehole log explanation sheet attached. Abbreviations for the sampler types may also be used. The abbreviations for common sampler types are TW for thin-wall, P for piston, ST for Shelby Tube, SS for standard split spoon, CC for continuous core, GS for grab samples, SPT for a SPT sampler, CS for a California Sampler, and MCS for a

Modified California Sampler. Other types of samplers may be used and will be noted on the borehole logs (as appropriate). The sampler type may be written in the sampling method section at the top of the log or in the remarks section. A sample attempt where no sample is recovered will not be given a sample ID, but the attempt must be shown in the sample & recovery column and noted in the remarks section.

- In the depth to water column, indicate the first encountered and completed depth-to-water (DTW) below ground surface (bgs) using inverted triangles. First encountered groundwater is the depth where saturated conditions are observed in the soil or rock core (not the hydraulic head of the saturated material). The completed depth to water is measured inside the well or piezometer after it's been constructed, developed, and the water level has stabilized.

- For rock only, document the fracturing, hardness, strength, and weathering in the appropriate columns. Use the codes and definitions listed in Table 11-2. Leave these columns blank when drilling in soil.

  In the lithologic description column, describe the soil or rock strata encountered and all pertinent information regarding drilling operations and estimated soil, rock, and groundwater properties. Procedures for describing soil and rock are described in sections 11.3 and 11.4, respectively. The key terms used to describe soil and rock are presented on Tables 11-1 and 11-2, respectively. Table 11-1 presents the key terms to describe the geotechnical physical properties of soil. Table 11-2 presents the key terms to describe the geotechnical physical properties of rock. Mark abrupt soil or rock changes by a solid horizontal line at the appropriate depth; mark gradational or inferred contacts by a dashed line. Do not use diagonal lines.

- In the geologic materials column, define whether the material is *mine waste, native soil, colluvium, or bedrock. Mine waste has* been logged as a combination of sand, silt, clay and gravel with some cobbles or boulders. It has a mottled color and there is no apparent structure to the soil. In some cases, the mine was*te has a rotten egg odor. Native soil underlies mine waste and typical*ly has a uniform color that is dark brown or black. Native soil typically consists of sand, silt, clay and gravel with some cobbles and boulders. The upper portion of native soil typically contains organic material including roots, branches, and bark. Colluvium has a similar texture as the native soil but it does not have a dark brown or black color, does not contain organic material, and is typically more massive. Bedrock may underlie mine waste, native soil, or colluvium. Sedimentary and igneous rocks occur at the site. Descriptions of soil or rock units, developed by Herbst and Sciacca (1982) are attached to this SOP. If the field geologist is uncertain what the geologic material is, this column will remain blank and the information will be added following subsequent review of the borehole log and core materials.

- Comments or remarks are extremely important and should be included on the borehole log. Some important aspects of the drilling operation that should be recorded in the remarks column are as follows:

- Properties that could help assess fluid migration in the medium being described (e.g., clay films, precipitates, or other materials that plug pore spaces);
- The organic content of the soil and the depth of topsoil and roots;
- Any sudden change in the speed, sound, or penetration rate of the drill rig;
- Whether continuous samples or drill cuttings have been used to log the borehole;
- Whether a sample is suspected of having been disturbed, contaminated, or chemically or physically altered during the drilling process;
- The diameter and depth the borehole was advanced for underground utility clearance (if necessary);
- The drilling start and stop time during each shift;
- The drilling rate;
- Depth intervals where the potential presence of groundwater is identified. This includes, at a minimum, when drilling stopped, the open interval of the borehole, how much time elapsed before collecting a water level measurement, how much water was purged from the borehole (if necessary), the time and the water level measurement, and when drilling resumed;
- Grab groundwater sampling information including the sample ID as prescribed in the applicable SAP and a description of the sampling device;
- When the use of drilling water or drilling mud is initiated (and terminated);
- The color of return water;
- Loss of circulation;
- The borehole diameter(s) and intervals of casing used as the borehole is advanced;
- Driller comments;
- Drilling refusal and why the borehole could not be advanced any deeper; and,
- Other pertinent information important to understanding the nature of the materials encountered down hole.

Upon completion of each borehole, a standard completion note will be placed at the bottom of the last page of the borehole log. The note will include the depth of completion of the borehole

and backfill information if the borehole was not converted to a monitoring well or piezometer, and destroyed.

Field personnel will make specific arrangements for scanning and sending completed borehole logs to the Project Manager, or someone designated by the Project Manager. Field personnel will retain at least one copy of the borehole log in the field for reference throughout the job.

Supplemental information collected during drilling should be written on a DFR. This may include:

- The drilling start and stop time and down time due to equipment repairs, deliveries, or stop work because of safety concerns.
- Sampling information.
- How the borehole was secured overnight or when drilling is not being performed.

Refer to SOP 13.0 – Drilling for guidance on supplemental information to include in the DFR.

11.3 DESCRIPTION OF SOIL

This section presents the descriptive terms and general procedures that will be used to classify soil sampled in exploratory boreholes, test pits or trenches, and the general format for presenting the soil data that are recorded in the field. The classification terms, values, and definitions for soil descriptions are presented in Table 11-1.

The soil descriptions will be prepared in accordance with the Association for Soil Testing and Materials (ASTM) Method D2488-09a, Standard Method of Description and Identification of Soil (Visual-Manual Procedure) which is based on the USCS. The geologic unit name and USCS group name and symbol will be written in all capital letters. The remaining items will be lower case. The various components of the soil's lithologic description are listed below (with general instructions) in the order they should be written on the borehole log.

1. **Geologic Unit Name:** Indicate the geologic unit name in accordance with the nomenclature developed by Herbst and Sciacca (1982). Twenty seven different geologic units were identified at the site and are attached to this SOP along with a stratigraphic column. If the geologic unit name is uncertain it should be left blank pending further review of the borehole log and core.

2. **USCS Group Name and Symbol:** Indicate the group name (gravel, sand, silt, or clay) and gradation for coarse grained soil, and symbol (in parenthesis).

3. **Color:** Indicate the soil color using a Munsell soil color chart. The color should be recorded immediately after the sample has been removed from the borehole. The Munsell number is recorded after the color name in parenthesis. The color of mottling or conspicuous zones of weathering or alteration also should be noted.

4. **Moisture Content:** Indicate the moisture in the sample. The moisture should be assessed immediately after the sample has been removed from the borehole.

5. **Percent Distribution of Coarse and Fine Grained Material:** Indicate the approximate amount of coarse and fine grained material in the sample by volume percent. Include the grain size in the description. These values should be considered approximate and the "~" symbol will be shown before the value (i.e., ~40% fines).

6. **Particle Angularity:** Describe the angularity of coarse-grained particles.

7. **Plasticity and Dilatancy of Fines:** Describe the plasticity of the fine-grained soil particles. Only describe dilatancy if the unit is predominantly fine grained. Plasticity is assessed by rolling a thread of soil to its plastic limit and folding the thread onto itself. Dilatancy is assessed by saturating a lump of soil, flattening it, shaking it, and observing how water accumulates on the surface of the flattened lump.

8. **Apparent/Relative Density:** For coarse-grained soils, indicate if the soil is loose or dense.

9. **Consistency:** For fine-grained soils, indicate if the soil is soft, stiff, or hard.

10. **Dry strength**: Only describe dry strength if the unit is predominantly fine grained

11. **Cementation:** Indicate if the soil is cemented (e.g., the presence of caliche material)

12. **Structure:** Describe the soil structure. Examples are stratified, laminated, or blocky.

13. **Mineralogy:** If able to distinguish by eye, or using a hand lens, describe the mineralogy of the soil particles.

14. **Reaction with acid:** place a drop of dilute, 10 percent HCl on the soil sample to assess the presence of calcium carbonate.

15. **Odor or staining:** Indicate if an odor or stained soil is present.

16. Any other distinctive geologic features that will aid in correlation or interpretation of the geologic conditions.

Example:

CLAYEY SAND WITH GRAVEL (SC): light yellowish brown (2.5Y 6/3) with light gray (10YR 7/1) mottling, moist, ~60% fine to medium sand, ~20% fine gravel, ~20% medium plasticity fines, angular sand, subangular to angular gravel up to 1/2" diameter, loose, ~10% mafics: biotite, plagioclase, and hornblende, weak reaction to HCl, strong rotten egg odor

11.4 DESCRIPTION OF ROCK

This section presents the descriptive terms and general procedures that will be used to classify rock core sampled in exploratory boreholes, test pits or trenches, and the general format for presenting the rock core in the field. The classification terms, values, and definitions for rock descriptions are presented in Tables 11-2 and 11-3.

The geologic unit name and rock type will be written in all capital letters. The remaining items will be lower case. The various components of the rock's lithologic description are listed below (with general instructions) in the order they should be written on the borehole log.

1. **Geologic Unit Name:** Indicate the geologic unit name in accordance with the nomenclature developed by Herbst and Sciacca (1982). Twenty seven different geologic units were identified at the site and are attached to this SOP along with a stratigraphic column. If the geologic unit name is uncertain it should be left blank pending further review of the borehole log and core.

2. **Rock Type:** Examples are Lahar, Andesite, Silicified Breccia.

3. **Color:** Indicate the soil color using a Munsell geological rock color chart. The color should be recorded immediately after the sample has been removed from the borehole. The Munsell number is recorded after the color name in parenthesis. The color of mottling or conspicuous zones of weathering or alteration also should be noted.

4. **Moisture Content:** Indicate the moisture in the rock sample. The moisture should be assessed immediately after the sample has been removed from the borehole.

5. **Texture:** Textures vary for each rock type. Examples of general textures are crystalline, clastic, or glass.

6. **Mineralogy:** Describe the minerals (with estimated volume percentages) present in the sample using a hand lens, scratch tests, reaction with acid, or other field methods.

7. **Degree of alteration**: Described where applicable, include alteration products (i.e., argillic alteration to smectite).

8. **Bedding/Foliation/Flow Texture**. Note attitude(s) and describe any depositional features or structures (e.g., planar or cross bedding, laminated bedding, etc.).

9. **Contacts**: Contacts should be identified and their nature described.

10. **Reaction with acid:** place a drop of dilute, 10 percent HCl on the rock sample to assess the presence of calcium carbonate.

11. **Odor or staining:** Indicate if an odor or stained rock is present.

12. **Discontinuity Descriptions:** Discontinuities should only be described if they can be clearly seen in the rock sample. Some drilling methods mechanically destroy discontinuities making it impossible to assess them. If it is possible to see a discontinuity it will be described in the remarks section of the borehole log (which are to include the following, in order):

    a) Discontinuity type (i.e., bedding plane, joint, foliation, shear/fault, mechanical break, or vein) and dip angle.

    b) Aperture (i.e., tight, open, filled, or healed). Note presence and type of staining or coatings on fracture surfaces, fracture surface moisture conditions, amount of separation/filling, and type and hardness of filling.

    c) Surface shape (i.e., irregular, planar, and wavy or undulating)

    d) Roughness (i.e., stepped, rough, moderately rough, slightly rough, smooth, polished). Note the presence of slickensides or striations.

13. **Rock Quality Designation (RQD):** Indicate summation of run (i.e., fresh to only moderately weathered) core pieces over 4 inches in length (measured along the axis of the core) divided by the total length of the core run. RQD can be expressed as a ratio and/or a percentage

14. Any other distinctive geologic features that will aid in correlation or interpretation of the geologic conditions (e.g., the type and size of voids, fossils, cementation, slaking behavior in water, etc.).

Examples:

SANDSTONE (Trss):
dark gray (10 YR 5/2) with yellowish brown mottling (10YR 5/4), dry, medium to coarse sub angular sand clasts, well sorted, mostly quartz and lithics, hard, cannot be scratched, clasts are

subrounded to rounded, no bedding apparent, contacts not exposed, has local veinlets of quartz, no reaction to HCl, vugs to 0.3 feet, rapid slaking.

CLAYSTONE:
grayish brown (7.5 YR 3/3), wet, argillically altered, has thin (< 1 inch thick) sand stringers and fossiliferous beds (up to 1 foot thick), locally friable, exposed contacts appear depositional, weak reaction with HCl, slight rotten egg odor.

11.5 SOIL AND ROCK CORE CONTAINMENT

During drilling and coring the core samples will be stored in core boxes.. When core is sensitive to changes in moisture content, the core may be wrapped in plastic or shrink wrap to protect the core. Movement and transportation of core boxes should be minimized to reduce disturbance of the core.

Marking Core Boxes – Orient the core box horizontally with the core slots aligned left to right. The first core run shall be placed in the box beginning in the upper left corner, continuing to the right. Subsequent core runs shall be placed in the box with the top of the core run at the left end of the core box and the bottom of the run at the right end of the box until the box is full. The outside of the base and lid of each core box will be labeled. The labels will be applied to one end of the core box. On the label the borehole ID, depth interval, box number, and date collected will be indicated. This information will be applied to each core box using an adhesive label or by writing directly on the core box with a permanent marker. The depth of the top and bottom of the interval of core within each section will be indicated on the box. This can be done by writing directly on the top edges of the box with a marker, writing on a wooden or foam block and placing it in the core box, or placing an adhesive label on the side of the core box. If there is sufficient room, the borehole number and core run number will be indicated on the label. If the core sample is placed in a plastic bag, the depth interval it applies to can be written on the outside of the bag. The bag may then be placed in the core box at the appropriate depth interval.

Wooden or foam divider blocks will be placed in the core box to mark intervals where there is no recovery; it will be labeled with the run number and depth. If a sample of soil or rock is removed from the core, the sample ID and depth will be written on a block and placed in the core box at the corresponding depth. The core may have to be broken to fit it into the core box. Care should be used to minimize the disturbance of the core sample while breaking it. The lid of the core box should be labeled and fastened into place after the core box has been filled.

Storing Core Boxes – During drilling activities core boxes may be stored within the work area as long as they do not present a hazard (i.e., trip hazard, road block, tipping hazard, etc.). If feasible they may also be temporarily placed in the bed of the field truck and transported to a designated, long term storage area. Core boxes will not be stored in direct contact with the ground surface for an extended period of time to reduce exposure to moisture, and must be stored on a level surface. If it is necessary to store the core boxes on the ground for an extended period of time they should be placed on plastic. If core is collected over a period of several days, the core boxes should be covered with a plastic tarp at the end of each day to prevent the accumulation of moisture (i.e., dew or frost) or exposure to rainstorms. If a rainstorm occurs during drilling activities, the boxes shall be closed and covered with a plastic tarp for the duration of the rainfall event.

When drilling activities cease and core is no longer being collected from the borehole, the core boxes shall be moved to a core box storage area. The boxes may be transported within a truck bed, however care must be taken minimize the disturbance of the samples within the boxes. Once at the storage area, the core boxes will be stacked with either the top or front core box labels exposed. Core boxes containing core from the same boreholes shall be kept together with boxes containing samples from the shallowest depths at the top of the stack and deeper samples at the bottom of the stack.

Core Left in the Hole - Core sometimes is left in the hole when a run is made. This core is referred to as "stick up" and should be recovered during the next run. The procedure is to log the entire core in a given run. For example, if 5 feet are drilled and 1 foot is left in the hole (not ground up), the run is considered a 5-foot run, and all logging, percent of core recovery, etc., are computed on that basis. The next run may recover 1 foot previously drilled, but this 1 foot properly belongs with the previous run. This procedure may seem to be a minor item, but unless properly handled it can cause serious confusion. For example, suppose a 5 foot core barrel is being used and the run begins at a depth of 50 feet. At 55 feet, the barrel is removed from the hole, and instead of 5 feet of core, only 4 feet of core is recovered. Drilling starts again at 55 feet and the coring is stopped at 56 feet. The barrel contains 2 feet of core when the run is made. If properly recorded, there is 100 percent recovery for the 1 foot run and for the previous 5 foot run.

There are other techniques for determining "stick up". The stick up typically can be distinguished by excessive "tool marks" where the core barrel fit over the stick up. Care should be taken to ensure that the driller isn't "washing away" core at the tip.

Fine grained, plastic materials such as clay and silt may expand after they have been extruded from the core barrel. For example, the core barrel is advanced 5 feet, and after the core has been extruded into plastic bags the overall measured length of the core is 6 feet. The field geologist should communicate with the driller to ensure that he did not collect an additional foot of core. If core expansion is being observed the driller should measure the depth to the bottom of the borehole before and after a core run to confirm the actual depth interval of a core run.

Core Photographs – The core will be photographed immediately after it has been removed from the borehole and placed inside the core box. The core should be photographed prior to removing soil or rock from the core for chemical or physical testing and before it is placed in the storage area. The core may be wrapped to preserve moisture content. The material used to wrap the core may be temporarily removed to facilitate taking pictures of the core. The cores will be photographed using a high resolution digital camera. A white erase board presenting the project name, the project and task number, borehole ID, core depth interval, and date collected will be placed adjacent to the core being photographed. An engineer's measuring tape or ruler will be placed next to the core box to provide a scale. The core will be placed on a neutral, flat background (e.g., a piece of plywood) for photographing. Photos will be documented on a photograph log as described in SOP 3.0 – Field Documentation and Sample Handling.

11.6 DESCRIPTION OF SOIL BY USDA SOIL CLASSIFICATION PROCEDURES

Depending on the task, the properties of sampled soil may be morphologically described. Soil pedon descriptions will be developed using the procedures outlined in the U.S. Department of Agriculture (USDA), 1993, Soil Survey Manual, Soil Conservation Service, USDA Handbook 18. The level of information to be provided in the soil description may vary based upon the task, but in general should include soil morphological properties as well as the soil texture classification based on the numerical proportion of the sand, silt, and clay portions in the fine-grained fraction of the soil sample being described.

This section presents the descriptive terms and general procedures that will be used to describe soil morphological properties observed in the field. The classification terms, values, and definitions for USDA soil descriptions are presented in Table 11-4 and should be considered to be the minimum information that should be recorded in the field when describing the morphological properties/characteristics of a soil pedon. A soil pedon description form is attached to this SOP.

To assist with soil mapping, a standard system of soil classification will be employed. The USDA Soil Classification System will be used and is based on the five soil forming factors. Soils will be classified at least to the subgroup level and if possible (depending on subsurface conditions) to the family level. The family level of soil classification groups soil on pedological properties, mineralogical properties and particle size class of the soil profile. Classifying soils to the family level will provide useful information for interpreting laboratory results of future soil samples. To assist with classification, soil moisture regimes need to be determined and will vary depending on proximity to active drainage and stream channels. Given the conditions observed in the field, the soil moisture regimes will range from xeric (typical of Mediterranean climate with cool moist winters and warm dry summers, characterized by having long period s of drought in the summer) to aquic (soil is saturated for sufficient periods for evidence o f poor drainage or aeration to occur). The soil temperature is also key to classifying soils at the subgroup and family level and regimes will range from mesic on the lower elevations to frigid and possibly cryic at the upper elevations.

Soil pedons will be described using the procedures outlined in the NRCS – Field Book for Describing and Sampling Soils. In addition to information of soil profile development data will be collected as to landscape position of the pedon, elevation, aspect, slope, slope sha pe, drainage, flooding, soil moisture status, parent material, and erosion.

Prior to beginning field activities, the appropriate field equipment will need to be secured and organized for mobilization to the field. Field equipment should include:

- Appropriate air photo images for recording soil/landscape delineations.
- Soil investigation tool kit that includes a Munsell soil color chart, water bottle for soil texturing, dilute hydrochloric acid, sharpshooter digging spade, hand soil auger, digging bar, camera, field book for describing and sampling soils, notepad for collecting notes, and pedon description forms for describing soils within each Age Category delineation.
- NRCS – Field Book for Describing and Sampling Soils.
- GPS Device.

D11.7 REVISION LOG

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
1	Britt Jones	Removed references to the HSSE Program Document and RI/FS TSHASP (11.0). Replaced JSA with WRA or TSEA (11.0). Added Hand-Held GPS device in the equipment list (11.0). Added SOP 30.0 to list of other SOPs to consult (11.0). Specified the proper personnel for performing the sampling activities (11.0).		8/12/10
2	Britt Jones	Provided additional details or added equipment to the equipment list (11.0). Changed or added the following items are listed below: - Core Boxes, Sharpie Markers, Adhesive Labels, Camera; - Tables; - White Erase Board and Markers; Wooden Pallets; - Plastic Tarp; Wooden/Foam Blocks; - Hack Saw; Provided details in the Marking Core Boxes, Storing Core Boxes, and Core Photographs subsections (11.5).		5/8/11
3	Josh Klein	Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. Combined the soil and rock boring logs into a single form that can be used for both conditions. This change resulted in numerous changes throughout the SOP which includes: expansion of the equipment list, revision of soil and rock descriptions,		1/18/12

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
	Jon Browning	requirements for additional information provided on the boring logs, additional procedures for storing the core in boxes and photographing core. Added charts for classifying igneous and sedimentary rocks. Added "Boring Log Explanation Sheet" (Attachments). Added revision log (11.7). Added reviewed and finalized column to revision log. Updated footer to match current location. Added example boring log to SOP folder.		12/10/13
4	Joshua Klein Joe Gonzales	Added more items to the equipment list, reorganized description of components of borehole log in section 11.1, clarified sample documentation procedures, updated references, added description of colluvium to section 11.2, corrected references in table 11-1, added more categories for rock descriptions to section 11.4, corrected references in table 11-2. Updated section 11.6 with soil texture classification information.	Kent Parrish	4/16/14 10/16/14
5	Britt Jones Josh Klein	Updated section 11.6 with soil texture logging information. Added field form for describing soil pedons. Technical review and edits.	Kent Parrish	2/26/15 2/26/15

ATTACHMENTS

- Borehole Log Explanation Sheet
- Soil and Rock Logging Tables
- Geologic Units, Leviathan Sulfur Mine and Vicinity – Excerpted pages from Appendix A of the "Leviathan Mine Pollution Abatement Project" by Brown and Caldwell dated April 1983."
- Soil and Rock Borehole Log
- Stratigraphic Column of the Geologic Units Identified by Herbst an d Sciacca (1982).
- Soil Pedon Description Form

EXPLANATION OF BOREHOLE LOGS

USCS CLASSIFICATION

MAJOR DIVISIONS		LTR	DESCRIPTION	MAJOR DIVISIONS		LTR	DESCRIPTION
COARSE GRAINED SOILS	GRAVEL	GW	Well-graded gravels or gravel-sand mixtures, little or no fines	FINE GRAINED SOILS	SILTS AND CLAYS LL<50	ML	Inorganic silts and very fine sand, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
		GP	Poorly-graded gravels or gravel-sand mixture, little or no fines			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		GM	Silty gravels, gravel-sand-silt mixtures				
		GC	Clayey gravels, gravel-sand-clay mixtures			OL	Organic silts and organic silt-clays of low plasticity
	SAND	SW	Well-graded sands or sand with gravel, little or no fines		SILTS AND CLAYS LL>50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		SP	Poorly-graded sands or sand with gravel, little or no fines			CH	Inorganic clays of high plasticity, fat clays
		SM	Silty sands, sand-silt mixtures			OH	Organic clays of medium to high plasticity
		SC	Clayey sands, sand-clay mixtures	HIGHLY ORGANIC SOILS		PT	Peat and other highly organic soils

PHYSICAL CONDITION OF ROCKS

FRACTURING		STRENGTH		HARDNESS		WEATHERING	
VC	Very Close (<0.1')	Fr	Friable	So	Soft	Fr	Fresh
Cl	Close (0.1'-0.3')	We	Weak	Lo	Low	Sl	Slight
Mo	Moderate (0.3'-1')	Mo	Moderate	Mo	Moderate	Mo	Moderate
Wi	Wide (1'-3')	St	Strong	Ha	Hard	Se	Severe
VW	Very Wide (3'-10')	VS	Very Strong	VH	Very Hard		
EW	Extremely Wide (>10')	Ex	Extremely Strong				

DISCONTINUITY

TYPE		ROUGHNESS		APERTURE		SURFACE SHAPE	
Be	Bedding	St	Stepped	Ti	Tight	Ir	Irregular
Jo	Joint	Ro	Rough	Op	Open	Pl	Planar
Fo	Foliation	Mo	Moderately Rough	He	Healed	Wa	Wavy
Sh	Shear	Sl	Slightly Rough	Fi	Filled		
Me	Mechanical Break	Sm	Smooth				
Ve	Vein	Po	Polished				

EXPLANATION OF BOREHOLE LOGS

SAMPLE COLUMN SYMBOLS

- Continuous Soil or Rock Core Sample Interval
- No Recovery
- Split-Spoon Sample Interval
- Sample Interval
- Thin-Walled Sampler Interval

WELL COLUMN SYMBOLS

- Concrete
- Grout
- Bentonite
- Transition seal
- Filter pack material
- Well screen
- Well end cap

DESCRIPTION COLUMN SYMBOLS

------ Dashed lines separating strata represent inferred boundaries between sampled intervals or no recovery intervals and may be distinct or gradual transitions

—— Solid lines represent distinct boundaries observed within sampled intervals

Description right of bracket symbol represents conditions within the depth interval defined by the bracket length

Description right of arrow symbol represents conditions to the next deeper boundary line unless otherwise noted

Interpreted depth to first encountered groundwater at time of drilling

Depth of static water at time of well installation

NOTES

1. Soil descriptions are in accordance with the USCS as set forth by ASTM D2488-90 "Standard Practice for Description and Identification of Soil (Visual-Manual Procedure)."
2. Soil color described according to Munsell Soil Color Chart. Rock color described according to Munsell Rock Color Chart.
3. Soil and rock descriptions in these boreholes are generalized representations and based upon visual classification of cuttings and/or samples during drilling. Descriptions and related information in these boreholes depict subsurface conditions at the specific location and at the time of drilling only. Soil and rock conditions at other locations may differ from conditions observed at the borehole locations. Also, soil, rock, and groundwater conditions may change with time at these locations.
4. Refer to Herbst, C.M. and Sciacca, J.E., 1982, Geology of the Leviathan Sulfur Mine and Vicinity: State Water Resources Control Board, Division of Technical Services, October, for additional lithologic descriptions.

TABLE 11-1
TERMS USED TO DESCRIBE THE PHYSICAL PROPERTIES OF SOIL [1]

Generalized USCS Group Symbol, Group Name, and Description For Coarse-Grained Soils (<50% passes #200 sieve)

GW	Well-Graded gravels, gravel-sand mixtures, little or no fines
GP	Poorly-Graded gravels, gravel-sand mixtures, little or no fines
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures
SW	Well-graded sands, gravelly sands, little or no fines
SP	Poorly-graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly-graded sand-gravel-silt mixtures
SC	Clayey sands, poorly-graded sand-gravel-clay mixtures

Generalized USCS Group Symbol, Group Name, and Description for Fine-Grained Soils (>50% passes #200 sieve)

ML	Inorganic silts &very fine sands, silty or clayey fine sands, clayey silts with slight plasticity
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL	Organic silts & clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sand or silt
CH	Inorganic clays of high plasticity, fat clays
OH	Organic silts & clays of medium-to-high plasticity
PT	Peat, humus, swamp soils with high organic content

Refer to ASTM method D2488-09a for detailed flow charts used to designate soil group names and symbols.

COLOR

Use the Munsell Color Chart for soil color descriptions. Describe color when the soil sample is removed from the borehole. The Munsell number is recorded after the color name. The color of mottling or conspicuous zones of weathering or alteration also should be noted.

MOISTURE CONTENT

Dry	Absence of moisture, dusty, dry to touch
Moist	Damp but no visible water
Wet or Saturated	Visible free water, usually soil is below water table

GRAIN SIZE

Boulders	Larger than basketball-sized
Cobbles	Fist-sized to basketball-sized
Coarse Gravel	Thumb-sized to fist-sized
Fine Gravel	Pea-sized to thumb-sized
Coarse Sand	Rock salt-sized to pea-sized
Medium Sand	Sugar-sized to rock salt-sized
Fine Sand	Flour-sized to sugar-sized
Fines	Flour sized and smaller

ANGULARITY – COARSE-GRAINED PARTICLES

Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

PLASTICITY

Nonplastic	A 1/3-in (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

[1] Based on: AMEC, 2008, Geotechnical Manual for Employees of AMEC Earth and Environmental, June 6; U.S. Department of Interior Bureau of Reclamation, 1998, Engineering Geology Field Manual, Volume 1 (second edition);,ASTM, 2009, Designation: D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), June 15.

TABLE 11-1 (continued)
TERMS USED TO DESCRIBE THE PHYSICAL PROPERTIES OF SOIL

DILATANCY – FINE-GRAINED SOIL

None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly at the surface of the specimen during shaking and disappears quickly upon squeezing

APPARENT/RELATIVE DENSITY – COARSE-GRAINED SOIL

Very loose	Easily penetrated with ½-inch reinforcing rod pushed by hand
Loose	Difficult to penetrate with ½-inch reinforcing rod pushed by hand
Medium Dense	Easily penetrated a foot with ½-inch reinforcing rod driven with 5-lb. hammer
Dense	Difficult to penetrate a foot with ½-inch reinforcing rod driven with 5-lb. hammer
Very Dense	Penetrated only a few inches with ½-inch reinforcing rod driven with 5-lb. hammer

CONSISTENCY – FINE-GRAINED SOIL

Very soft	Thumb will penetrate soil more than 1 in. (25 mm) when squeezed in hand
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

DRY STRENGTH – FINE-GRAINED SOIL

None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface

CEMENTATION

Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

STRUCTURE

Stratified	Alternating layers of varying material or color with layers at least 6mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small annular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

REACTION WITH ACID

None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 11-2

TERMS USED TO DESCRIBE THE PHYSICAL CONDITION OF ROCKS [2]

FRACTURING

(VC) Very closely spaced (crushed)
(Cl) Closely spaced
(Mo) Moderately spaced
(Wi) Widely spaced
(VW) Very widely spaced
(Ex) Extremely wide

SPACING (True spacing)

Less than 0.1 ft (< 30 mm)
0.1 ft to 0.3 ft (30 to 100 mm)
0.3 ft to 1.0 ft (100 to 300 mm)
1.0 ft to 3.0 ft (300 mm to 1 m)
3.0 ft to 10.0 ft (1 to 3 m)
Greater than 10 ft (> 3 m)

BEDDING OR FLOW TEXTURE

(La) Laminated
(VTn) Very thinly
(Tn) Thinly
(Mo) Moderately
(Tk) Thickly
(VTk) Very thickly
(Ma) Massive

THICKNESS/SPACING

Less than 0.03 ft (3/8 in) (< 10 mm)
0.03 (3/8 in) to 0.1 ft (10 to 30 mm)
0.1 to 0.3 ft (30 to 100 mm)
0.3 to 1 ft (100 to 300 mm)
1.0 to 3.0 ft (300 mm to 1 m)
3.0 to 10.0 ft (1 to 3 m)
Greater than 10 ft (> 3 m)

HARDNESS - a measure of the resistance of a rock surface to scratching/abrasion.

(So) Soft	can be grooved or gouged easily with a knife, can be scratched with fingernail
(Lo) Low Hardness	can be grooved 1/16 inch (2 mm) deep with a knife with moderate or heavy pressure
(Mo) Moderately Hard	can be scratched with a knife with light or moderate pressure
(Ha) Hard	can be scratched with a knife with difficulty
(VH) Very Hard	cannot be scratched with a knife

STRENGTH - a measure of crushing resistance of rock.

(Fr) Friable	breaks with light to moderate manual pressure
(We) Weak	core or fragment breaks with light hammer blow or heavy manual pressure
(Mo) Moderately Strong	core or fragment breaks with moderate hammer blow
(St) Strong	heavy hammer blow required to break specimen
(VS) Very Strong	core or fragment breaks only with repeated heavy hammer blows
(Ex) Extremely Strong	core or fragment can only be chipped with repeated heavy hammer blows

WEATHERING - a measure of the physical and chemical alteration of a rock from its original "fresh" condition.

	DECOMPOSITION	DISCOLORATION	FRACTURES
(Fr) Fresh	Unaltered; cleavage surfaces glistening	No discoloration	No stains or coatings
(Sl) Slight	No megascopic alteration of minerals; no grain separations	Slight and localized	Few stains on fracture surfaces
(Mo) Moderate	Slight alternation of minerals; cleavage surfaces lusterless/stained; partial separation of grains visible	Moderate discoloration, usually throughout	Thin coatings or stains
(Se) Severe	Moderate to complete alteration of minerals; feldspars to clay, etc.; rock is friable	Discolored throughout	Extensively coated with oxides, carbonates, or clay

TEXTURE – the general texture for each rock type is indicated

Igneous Rock	Phaneritic	Grains large enough to see without hand lens (i.e., granite)
	Aphanitic	Grains cannot be seen with the naked eye (i.e., basalt)
	Porphyritic	Two distinct grain sizes, large grains are phenocrysts and the material surrounding the phenocrysts is the matrix (i.e., volcanic breccia)
	Glass	No crystal formation (i.e., obsidian)

[2] Based on: AMEC, 2008, Geotechnical Manual for Employees of AMEC Earth and Environmental, June 6; U.S. Department of Interior Bureau of Reclamation, 1998, Engineering Geology Field Manual, Volume 1 (second edition); ASTM, Designation D6032-08, Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core.

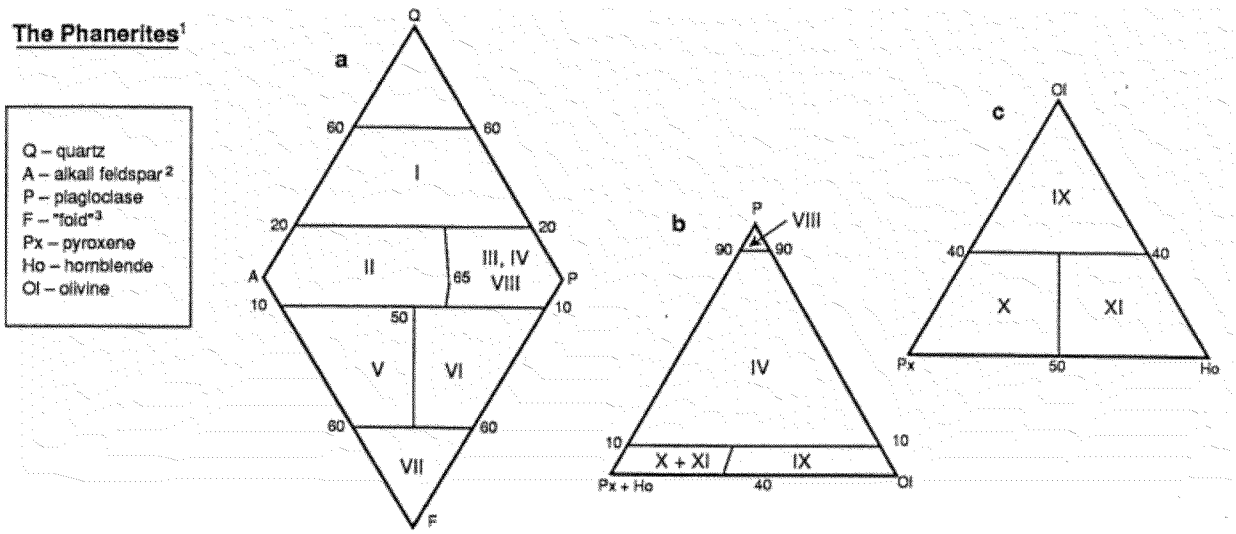
TABLE 11-2 (continued)

TERMS USED TO DESCRIBE THE PHYSICAL CONDITION OF ROCKS

Sedimentary Rock	Clastic	Contains clay or silt, sand, and gravel size clasts (i.e., sandstone)
	Chemical	Based on mineral composition (i.e., dolomite = dolostone)
	Biological	Formed by accumulation of biological material or by biological processes (i.e., calcite = limestone)
Metamorphic Rock	Foliated	Slaty – parallel orientation of platy minerals that are too small to see (i.e., slate) Phyllic – parallel platy minerals slightly larger than those seen in slate texture with a shiny appearance (i.e., phyllite) Schistose – layering in a coarse grained rock due to parallel arrangement of platy minerals (i.e., schist) Gneissic – bands of granular minerals alternating with platy minerals (i.e., gneiss)
	Nonfoliated	Lacks planar characteristics, based on the composition of minerals in the rock (i.e., marble)

MINERALOGY

The mineralogy of common igneous rocks is summarized in the following charts. [3]



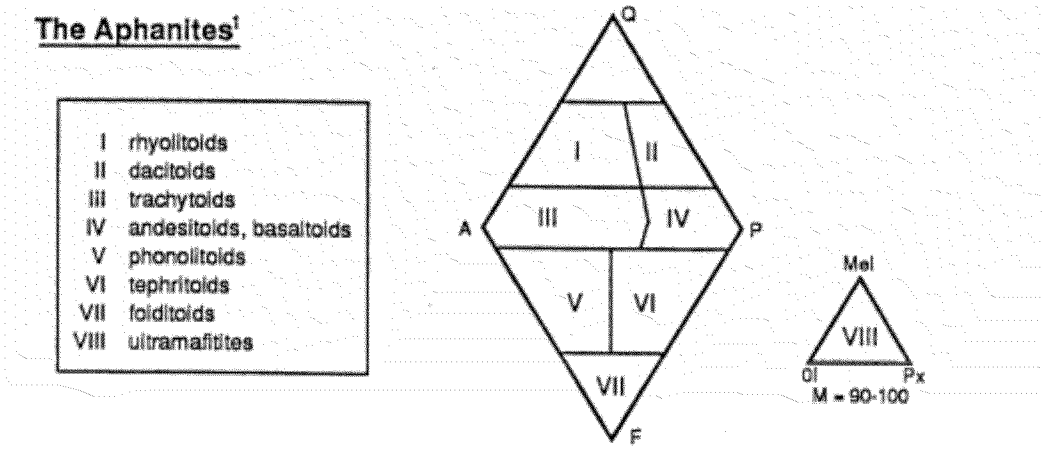
a. General classification; b. Ultramafic and gabbroic rocks, and anorthosites; c. Ultramafic rocks.
I, granitoids; II, syenitoids; III, dioritoids; IV, gabbroids; V, foid syenitoids; VI, foid dioritoids and gabbroids; VII, fo idolites; VIII, anorthosites; IX, peridotites; X, pyroxenites; XI, hornblendites; II-IV, qualifier "foid-bearing" if foids are present; IX-XI, ultramafic rocks.

In order to plot a rocks composition in the appropriate triangle on "a", the three components alkali feldspar (A), plagioclas e feldspar (P), and quartz (Q) or the foid minerals (F) are equated to 100 percent-i.e., the other components are subtracted from the total mode and the remaining QAP or FAP percentages are normalized to 100 percent… etc. (for "b" and "c").

[3] American Geological Institute, 1982, AGI data sheets for geology in the field, laboratory, and office, American Geological Institute, Falls Church, Virginia.

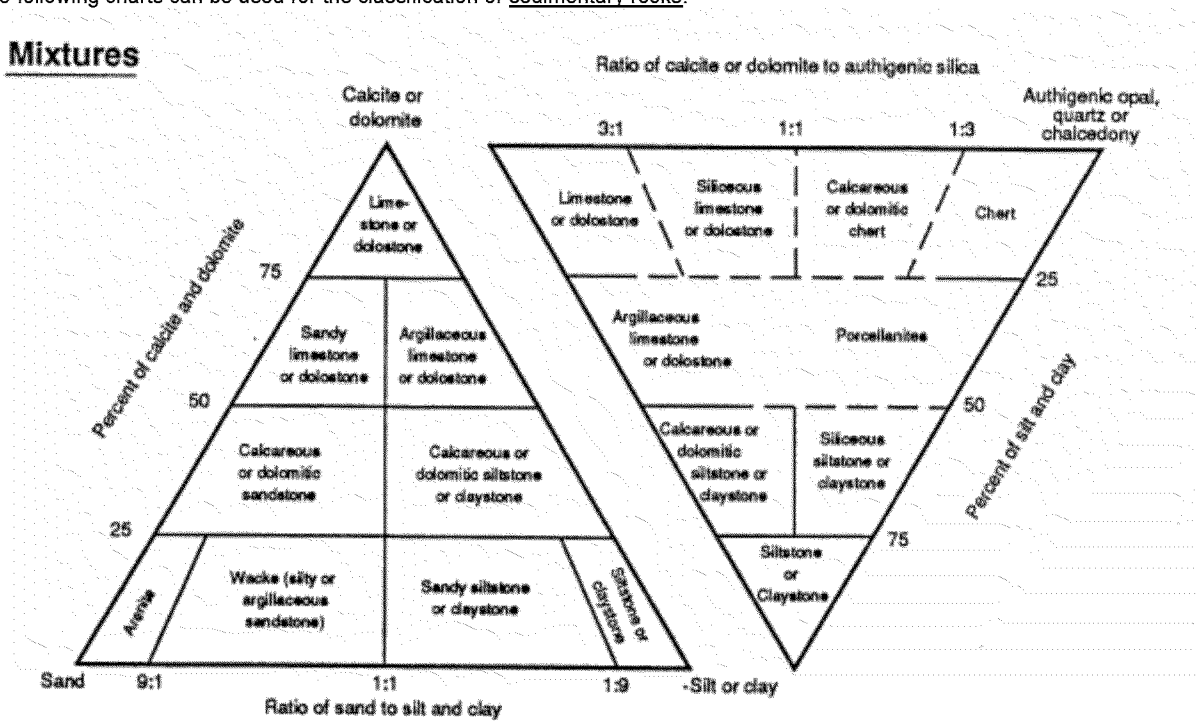
TABLE 11-2 (continued)

TERMS USED TO DESCRIBE THE PHYSICAL CONDITION OF ROCKS



Q-quartz; A-alkali feldspar (including orthoclase, sanidine, perthite, and anorthoclase; P -plagioclase; F-Feldspathoids; Mel-melilite; Ol-olivine; Px-pyroxene; M-mafic minerals.

The following charts can be used for the classification of sedimentary rocks. [4]

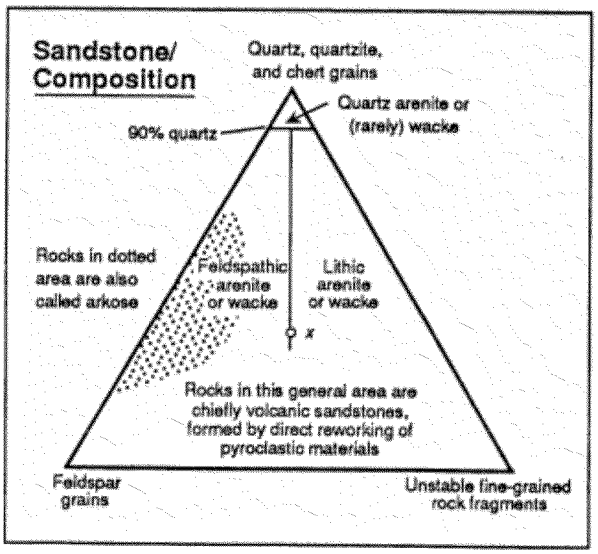


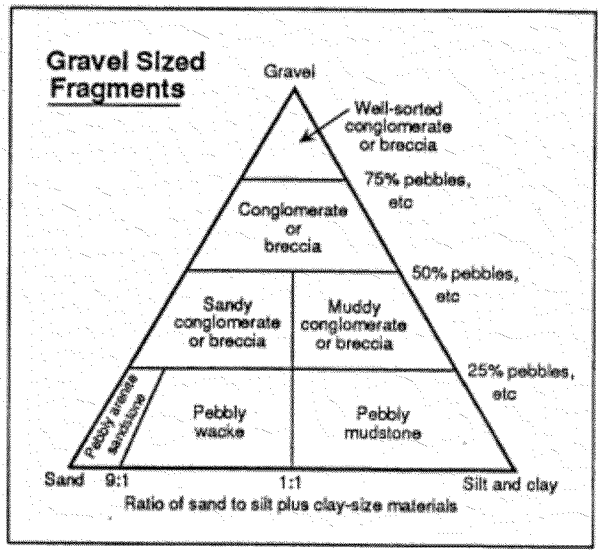
Arenite: relatively well sorted sandstone
Wacke: sandstone so poorly sorted as to include more than 20 percent silt or clay
Graywacke: strongly indurated dark-colored wacke
Shale: siltstone (silty shale) or claystone (clay shale) with prominent bedding cleavage (fissility)
Mudstone: mixture of silt and clay with blocky or spheroidal fracture
Argillite: highly indurated (generally recrystallized) claystones or siltstones that break into hard, angular fragments

[4] Williams, Turner, and Gilbert, 1954, Petrography, San Francisco, W.H. Freeman and Co., p. 270.

TABLE 11-2 (continued)

TERMS USED TO DESCRIBE THE PHYSICAL CONDITION OF ROCKS





To name a rock: (1) determine the amounts of the various mineral and rock grains, (2) sum these amounts into the three groups shown at the corners of the triangle, and (3) using the proportions between the groups, estimate a point in the triang le. A poorly sorted sandstone with equal amounts of quartz, feldspar, and slate grains, for example, would fall at point x (a lithic, feldspathic wacke). Other detrital minerals that form more than 10 percent of the sand may be used as adjectives in the name , as biotitic.

MOHS HARDNESS SCALE OF MINERALS [5]

MINERAL	MOHS HARDNESS	OBSERVATIONS
Talc	1	very easily scratched by the fingernail, has a greasy feel
Gypsum	2	can be scratched by the fingernail
Calcite	3	very easily scratched with a knife and just scratchable by a copper coin
Fluorite	4	easily scratched with a knife but not as easily as calcite
Apatite	5	scratched with a knife, with difficulty
Orthoclase	6	cannot be scratched with a knife, but scratches glass
Quartz	7	scratches glass easily
Topaz	8	scratches glass very easily
Corundum	9	cuts glass
Diamond	10	used as glass cutter

Acid (HCl) will react with minerals containing carbonate. Calcite and dolomite are the two most common minerals that react to HCl.

[5] Klein, C., Dutrow, D., 2007, Mineral Science, 23rd Edition, Table 2.3, p31.

TABLE 11-3

KEY TO TERMS USED TO DESCRIBE DISCONTINUITES IN ROCK [6]

DISCONTINUITY TYPE (and dip angle)

(Be) Bedding plane
(Fo) Foliation
(Me) Mechanical break (dip angle not recorded)
(Jo) Joint
(Sh) Shear or Fault
(Ve) Vein

APERTURE

(Ti) Tight	No visible separation
(Op) Open	Note amount of separation; note staining or coatings on fracture surfaces; note fracture surface moisture conditions
(He) Healed	Note degree of healing, (i.e., partial or complete, thickness and mineralogy/hardness)
(Fi) Filled	Note degree of filling (i.e., partial or complete, thickness and type of filling)

SURFACE SHAPE

(Ir) Irregular
(Pl) Planar
(Wa) Wavy or undulating

ROUGHNESS (note presence of slickensides or striations)

(St) Stepped	Near normal steps and ridges occur on fracture surface
(Ro) Rough	Large, angular asperities (unevenness of surface) can be seen
(Mo) Moderately rough	Asperities are clearly visible and fracture surface feels abrasive
(Sl) Slightly rough	Small asperities on the fracture surface visible and can be felt
(Sm) Smooth	No asperities smooth to touch
(Po) Polished	Extremely smooth and shiny

Where appropriate during field mapping, the following discontinuity characteristics also should be noted:

Discontinuity orientations (strike and dip)
Prominent joint sets, cleavages, foliations, etc.
Fracture continuity
Fracture cross-cutting relationships
Moisture/seepage conditions

[6] Based on US Bureau of Reclamation, 1998, Engineering Geology Field Manual, Second Edition, Vol. 1.

TABLE 11-4

KEY TO USDA TERMS USED TO DESCRIBE SOILS [7]

HORIZON

Common horizons are described below. For a more extensive list of horizons that can be used, refer to the NRCS Soil Manual (USDA, 1993, Soil Survey Manual, Soil Survey Division Staff, October) or Soils and Geomorphology (Birkeland 1999).

Master Horizons		Subordinate Departures		
Old	New	Old	New	Description
O	O	--	a	Highly decomposed organic matter
O1	Oi, Oe	b	b	Buried soil horizon
O2	Oa, Oe	cn	c	Concretions or nodules
A	A	--	e	Intermediately decomposed organic matter
A1	A	f	f	Frozen soil
A2	E	g	g	Strong gleying
A3	AB or EB	h	h	Illuvial accumulation of organic matter
AB	--	--	i	Slightly decomposed organic matter
A&B	E/B	ca	k	Accumulation of carbonates
AC	AC	m	m	Strong cementation
B	B	sa	n	Accumulation of sodium
B1	BA or BE	--	o	Residual accumulation of sesquioxides
B&A	B/E	p	p	Plowing or other disturbance
B2	B or Bw	si	q	Accumulation of silica
B3	BC or CB	r	r	Weathered or soft bedrock
C	C	ir	s	Illuvial accumulation of sesquioxides
R	R	t	t	Accumulation of clay
		--	v	Plinthite
		--	w	Color or structural B
		x	x	Fragipan character
		cs	y	Accumulation of gypsum
		sa	z	Accumulation of salts

COLOR

Record the color of both dry and moist soil in each horizon using the Munsell soil color chart. Record any mottling colors in the Notes section.

STRUCTURE

Type:

(gr)	granular	Spheroidally shaped aggregates with faces that do not accommodate adjoining ped faces.
(pl)	platy	Particles are arranged about a inherited horizontal plane.
(pr)	prismatic	Particles are arranged about a vertical line, and ped is bounded by planar vertical faces that accommodate adjoining faces; ped has flat top.
(cpr)	columnar	Particles are arranged about a vertical line, and ped is bounded by planar vertical faces that accommodate adjoining faces; ped is columnar in shape and has a rounded top.
(abk)	angular blocky	Approximately equidimensional blocks with planar faces that are accommodated to adjoining ped faces; face intersections are sharp with angular blocky appearance.
(sbk)	subangular blocky	Approximately equidimensional blocks with planar faces that are accommodated to adjoining ped faces; face intersections are rounded with subangular blocky appearance.

Grade:

(m)	massive	Enough aggregation to maintain a vertical face but no formation of structure type (structureless).
(sg)	single grain	No aggregation (structureless). Loose grains of a sand dune are a good example.

[7] Based on Birkeland, Peter, 1999, Soils and Geomorphology, Third Edition, Oxford University Press.

TABLE 11-4 (continued)

KEY TO USDA TERMS USED TO DESCRIBE SOILS

(1)	weak	Peds barely observable in place, and, when disturbed, few entire peds are observed; much of the material is unaggregated
(2)	moderate	Peds easily observable in place. When disturbed, there is a mixture of whole peds, broken peds, and some material not organized into peds.
(3)	strong	Peds are distinctly visible in place, and, when disturbed, nearly the entire mass consists of whole peds.

Size:

Size Class	Diameter of Granules (mm)	Thickness of Plates (mm)	Diameter of Blocks (mm)	Diameter of Prisms (mm)
vf – very fine	<1	<1	<5	<10
f – fine	1-2	1-2	5-10	10-20
m – medium	2-5	2-5	10-20	20-50
c – coarse	5-10	5-10	20-50	50-100
vc – very coarse	>10	>10	>50	>100

GRAVEL

Estimate volume percentage occupied by gravel (>2mm).

CONSISTENCE

Dry Consistence (naturally dry in exposure):

(lo)	loose	Noncoherent, such as grains of a sand dune.
(so)	soft	Easily fails to powder or single grain, with very slight force between thumb and forefinger.
(sh)	slightly hard	Easily fails under slight force between thumb and forefinger.
(h)	hard	Fails in the hands without difficulty; requires strong force to fail between thumb and forefinger.
(vh)	very hard	Fails in hands with difficulty, but not between thumb and forefinger.
(eh)	extremely hard	Cannot be failed in hands.

Moist Consistence (usual moisture when one digs back into exposure):

(lo)	loose	Noncoherent.
(vfr)	very friable	Easily fails to powder or single grain, with very slight force between thumb and forefinger.
(fr)	friable	Fails under slight force between thumb and forefinger.
(fi)	firm	Fails under moderate force between thumb and forefinger.
(vfi)	very firm	Fails under strong force between thumb and forefinger.
(efi)	extremely firm	Fails under very strong force between hands but cannot be crushed between thumb and forefinger.

Wet Consistence (usually wetted artificially, but not so much the mass flows):

Stickiness (measured by pressing the wet soil between the thumb and forefinger and noting its adherence)

(so)	nonsticky	Practically no adherence to thumb and forefinger when pressure released.
(ss)	slightly sticky	After release of pressure, soil adheres to both thumb and forefinger but comes off one or the other rather cleanly. Does not appreciably stretch.
(s)	sticky	After release of pressure, soil adheres to both thumb and forefinger and tends to stretch somewh at before pulling apart from either digit.
(vs)	very sticky	After release of pressure, soil adheres strongly to both digits and is markedly stretched when they are separated.

Plasticity (measured by rolling the wet soil between the thumb and forefinger an d observing whether a roll can be formed and maintained)

(po)	nonplastic	No roll can be formed.
(ps)	slightly plastic	A roll 4 cm long and 6 mm thick can be formed and, if held on end, will support its own weight. A 4 -mm-thick roll will not support its own weight. The roll is easily deformed and broken.
(p)	plastic	A roll 4 cm long and 4 mm thick can be formed and support its own weight. A 2 -mm-thick roll will not support its own weight.
(vp)	very plastic	A roll 4 cm long and 2 mm thick can be formed and support its own weight. The roll is readily bent in a half or full circle.

TEXTURE

Use established names from the textural triangle. Scree or pick out gravels and determine the textural class of the <2 -mm fraction by noting the grittiness and wet consiste nce.

TABLE 11-4 (continued)

KEY TO USDA TERMS USED TO DESCRIBE SOILS

(S)	Sand
(LS)	Loamy Sand
(SL)	Sandy Loam
(SCL)	Sandy Clay Loam
(L)	Loam
(CL)	Clay Loam
(SiCL)	Silty Clay Loam
(SiL)	Silty Loam
(Si)	Silt
(SiC)	Silty Clan
(C)	Clay
(SC)	Sandy Clay

CLAY FILMS

Amount

(v1)	very few	Occupies less than 5% of the total area of the kind of surface described.
(1)	few	Occupies 5-25% of the total area of the kind of surface described.
(2)	common	Occupies 20-50% of the total area of the kind of surface descri bed.
(3)	many	Occupies more than 50% of the total area of the kind of surface described.

Distinctness

(f)	faint	Evident only on close examination with 10X magnification and cannot be identified positively in all places without greater magnification. The contrast with the adjacent material in color, texture, and other properties is small.
(d)	distinct	Can be detected without magnification, although magnification or tests may be needed for positive identification. The feature contrasts enough with the adjac ent material that a difference in color, texture, or other properties is evident.
(p)	prominent	Conspicuous without magnification when compared with a surface broken through the soil. Color, texture, or some other property or combination of properties cont rasts sharply with properties of the adjacent material, or the feature is thick enough to be conspicuous.

Location of Clay Films (if films are preferential to some orientation [horizontal vs vertical], this should be noted)

(pf)	ped faces	Clay films occur on ped faces. Where the structure grade is weak or the soil is structureless, ped faces are indistinct or absent. It is probable that only when the structure grade is moderate or strong are the clay films on ped faces discernable.
(po)	pores	Clay films line tubular or interstitial pores.
(br)	bridges	Oriented clay occurs as bridges holding mineral grains together. This is probably an initial step that occurs before clay films coat grains and is best observed in coarse -textured soils.
(co)	coats	Colloid coats mineral grains.
(cobr)	coats & bridges	Coats and bridges are present. This is probably more common than coats or bridges alone.

HORIZON BOUNDARIES

Distinctness

(a)	abrupt	Transition is less than 2 cm.
(c)	clear	Transition is 2-5 cm thick.
(g)	gradual	Transition is 5-15 cm thick.
(d)	diffuse	Transition is more than 15 cm thick.

Topography

(s)	smooth	Boundary is planar or parallel to the geomorphic surface.
(w)	wavy	Undulating surface with pockets wider than they are deep.
(i)	irregular	Pockets are deeper than their width.
(b)	broken	One or both of the horizons separated by the boundary are discontinuous, so that the boundary is interrupted.

Geologic Units Identified by Herbst and Sciacca (1982)
Excerpted from Brown and Caldwell (1983)

QUATERNARY UNITS

LANDSLIDES (Qls) and DEBRIS FLOW (Qdf)--

Landslides and debris flow in pit area are post-mining, on oversteepened slopes cut during the mining process. Landslides in pit appear stabilized; fresh ground cracks visible in slope above ore rock on northeast side of pit and in sandstone on west rim of pit. Debris flow in pit is active. Large landslides immediately north of pit in tailings and downslope are active. Both Qls and Qdf are composed of loose material and are probably permeable.

ALLUVIUM (Qal) and PONDED SEDIMENT (Qps)--

Alluvium composed of native material or reworked mine tailings. Ponded sediment has formed as a result of mining activities. Permeability may be high depending on sediment composition.

ARTIFICIAL FILL (Qaf)--

Generally composed of mine tailings but may include disturbed native materials in roadbeds. On wet day, several inches of standing water noted on Qaf near old Isabel Construction Company site; unit may not have high surface permeability.

TALUS (Qt) and TALUS RESULTING FROM MINING (Qtm)--

Naturally-occurring talus present on slopes outside the pit and artificial fill areas. Talus formed on oversteepened mined slopes mantles slopes within pit. Sand-sized talus on west side of pit may be highly permeable; appears to have high storage capacity.

TERTIARY UNITS

QUARTZ LATITE PORPHYRY (Tqlp)--

Well-indurated dark to white-grey weathering light blue-grey groundmass of very fine-grained plagioclase and quartz (70%) containing 2 to 5 millimeter plagioclase phenocrysts (20-25%) altering to clay ; euhedral biotite (5%) present along with prismatic hornblende phenocrysts with some slight flow alignment (1%); mafics altering. Tqlp may intrude Tlpa, but within study area, Tqlp is always in contact with Tsib/Tsb and never seen in contact with Tlpa, so exact relationship unknown. Unit well-jointed; may have some fracture permeability.

Excerpted pages include pages 14-20.

ED_001709_00000321-00188

SILICIFIED BRECCIA (Tsb) and SILICIFIED IRON-STAINED BRECCIA (Tsib)--

Tsb is grey to white on fresh and weathered surfaces with streaky blue relict breccia texture; jasperoid appearance; locally contains kaolinite bodies; generally lacks sulfur and sulfide mineralization. Tsib is dark rust brown on weathered surfaces, red to blue-black on fresh surfaces; often jasperoid apperance; is more resistant rock, forming cornices; pervasively fractured. Free sulphur and abundant sulfides present in Tsib which is dark blue on fresh surfaces (within pit); locally contains blue-green copper mineral (chrysocolla); appearance varies--some examples:

Tsib on north side of pit: silicified iron-stained breccia and argillically altered silicified breccia (lahar?); argillically altered rock weathers peach. Both rock types show breccia texture, local flow banding on some light-colored sialic clasts. Breccia clasts average 1 to 20 cm, are subangular to rounded; matrix and clasts are of different compositions; clasts appear to be volcanic, range from andesite with relict texture to jasperoid; can be mineralized with sulfur, some sulfides (10-15%) (pyrite, marcasite, arsenopyrite) present, particularly in dark colored clasts.

Tsib west of Leviathan Creek: iron-stained, silicified breccia-type relict texture, clasts weather yellow-white, as compared to matrix, which weathers dark red; clasts angular to subrounded, 3 to 15 cm in size, relict andesitic texture in some clasts. May contain minor arsenopyrite. Also, some non iron-stained, more argillically altered breccia in same location. Calcite deposits present where water moves through fractures. No sulfur.

Age of Tsb/Tsib uncertain; Tsb in contact with altered Tlpa, Tsib or Tsb surrounds Tqlp whenever Tqlp present in study area. Units highly fractured but without persistant joint orientation. Most float rounded. No primary permeability but may have fracture permeability. Relict textures suggest unit origionally lahar, conglomerate, or sedimentary breccia, silicified and locally mineralized.

LEVIATHAN PEAK ANDESITE (Tlpa, Tlpaa)--

Porphyritic hornblende andesite with well-indurated red and light grey weathering red and grey glassy groundmass (40-50%) containing fine-grained and porphyritic plagioclase (45-50%), porphyritic hornblende (5-7%) and possible biotite (1%) phenocrysts. Seen only as angular float in study area; may have some fracture permeability. Locally argillically altered with relict hornblende phenocrysts, copper sulfide stains (bormite?) where in contact with Tsb (noted as Tlpaa on geologic map).

Excerpted pages include pages 14-20.

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BIOTITE PYROXENE HORNBLENDE ANDESITE (Ta)--

Well-indurated red-brown weathering black glassy groundmass (60-65%) containing 20-30% flow-aligned tabular 1 to 3mm plagioclase phenocrysts with some iron-staining, twinning, and zoning, and hornblende (5-8%), pyroxene (5%), and biotite (1%) phenocrysts; groundmass shows some alteration to clay and may contain minor very fine grained dark grey opaque minerals; plagioclase locally altering to clay with extensive calcite replacement; pyroxenes replaced by chlorite. In some areas , calcite crystals present as vug linings with quartz crystals inside vugs. Locally copper sulfate stained (light blue-green). Locally flow banded. Slightly propylitized. Unit only seen in contact with sediments and, locally, underlying Trb. Locally jointed and/or fractured; may have fracture permeability.

UPPER SEDIMENTARY SEQUENCE (Trs)--

Interbedded fine- to coarse grained sandstones, pebbly sandstones, breccias, and lahars. Unit includes leached and bleached sandstone and kaolinite beds visible in pit. Also includes sandstones and breccias permeated with sulfur that comprise principal ore body.

Sandstone (Trss)--

Best exposed on west rim of pit: very fine to fine-grained poorly indurated lithic wacke, matrix poorly to moderately sorted, subangular, propylitically altered to green minerals; pebble conglomerates and granule beds with finer particles, contains 2 m by 7 m sized lenses of fine sandstone; fractures iron-stained with calcite rinds on pebbles, especially near fault. Sandstone at northwest edge of pit even less indurated; many fault scarps and incipient arcuate fractures present which have created or could create catchment basins for precipitation. Poor induration of this unit is a main contributor to landsliding in the pit area as most slides seem to originate in this unit or its altered equivalents. Unit unconformably overlies Trb and Trba on west side of pit with basal scour channel. Basal conglomerate consists of basalt (Trb) chunks (60%, angular to subangular) in iron-cemented matrix of fine to medium sand- sized rock fragments (40%). Possible primary permeability.

Lahar (Trsl)--

Angular to subrounded 5 to 25 cm clasts in tan ashy matrix. Matrix comprises 85-90% of rock (matrix supported). Clasts include Tra. In area east of pit, clasts average 2-15 cm with most 2-3 cm, angular to subangular. Locally slightly silicified, locally graded bedding, locally conglomeratic with more sandy matrix. Laterally discontinuous; only seen nonconformably overlying Tra. Possible matrix permeability.

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Argillically Altered Sandstone (Trsa, Trsab)--
White to peach (iron-stained) argillically altered sandstone and breccia; locally shows conchoidal fracture, locally appears porous and may be permeable. Relict siltstone texture and possible fining-upward sequence immediately west of pit. Above is rock (clast?) with fluidal outline, relict andesitic texture (relict plagioclase phenocrysts) in punky white matrix. Permeability questionable because of high clay content. May have breccia texture (Trsab).

Chloritized Breccia (Trsb)--
Only found underlying Tsib. Matrix brown to green, waxy to greasy luster, soft, some slickensides, massive with no discernable grains. Some black, round, very fine grained opaque minerals. Representative clast altered to chlorite, clays, talc?; some minerals with fresher cores; only visible relict textures are volcanic with relict phenocrysts 1/2 to 2mm long and tabular to prismatic habit. Some minerals altered entirely to epidote with indistinct outlines. Minor iron staining along outside of clasts; clasts up to size in Tsib (1 to 20 cm); may be correlative to Tsib, differing in alteration and lacking flow banding. Permeability probably low because of high clay content.

Ore Rock (Tso)--
Consists of mineralized breccia (Tsob) and sandstone; may include mineralized tuff. Breccia is at least 20-30% sulfur (pervasive replacement); most clasts less than or equal to 6cm; unit contains very fine to fine-grained grey, brassy, and silver sulfides (up to 30%) (oxidized and unoxidized pyrite, disseminated and in very fine grained irregular masses, and arsenopyrite (?) in aggregates). Sandstone contains a maximum of 20% disseminated sulfur; sulfur also as fracture coatings. Sandstone generally contains fewer sulfides than breccia. Possible fracture permeability in both sandstone and breccia. Largest concentrations of sulfides in Tso are east of pit entrance in dark blue brecciated ore rock and west and opposite of pit entrance (fine grained, locally oxidized pyrite in patchesand seams).

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HORNBLENDE PYROXENE ANDESITE (Tra)--

Strong flow banding, flow alignment of plagioclase and hornblende phenocrysts. Red to tan weathering, purplish-grey groundmass (60-70%) containing: 1-2 mm plagioclase phenocrysts (andesine) with weathering rinds and some albite twinning and zoning (25- 35%), orthopyroxene (10%), and minor hornblende (1-3%), and very minor, slightly altered biotite (1%). Most mafics have altered cores. Only scattered outcrops; usually present as angular float. May have fracture permeability. Locally altered to punky buff-colored rock with dark opalescent copper sulfide staining (no native sulfur) east of pit near silicified iron-stained breccia.

BASALT (Trb)--

Fine grained igneous rock, olive green to black on weathered surface, grey black on fresh surface; fine-grained plagioclase (labradorite) (45-50%) and clinopyroxene (5-7%) phenocrysts in glassy groundmass (40-50%). Pyroxenes replaced by chlorite, rimmed by magnetite. Calcite filling fractures; no sulfur mineralization; manganese oxide (dendritic) staining; locally autobrecciated with calcite cement on or in breccia fractures. Contact between autobreccia and basalt appears sheared with foliation subparallel to joints in basalt. Locally minor light turquoise-colored powdery copper minerals (chrysocolla ?), some hornblende altering to blue green mineral. Some pyroxene phenocrysts from 1-7mm long dispersed in rock. Forms cliffs and hills; locally is massive flow with wavy, blocky fracture and pervasive jointing; salt stains on joints indicate water flow through fractures. On west end of pit, unit is poorly indurated and grey-colored with 0.5-1 mm long altered plagioclase phenocrysts.

AUTOBRECCIATED BASALT (Trba)--

As above with autobreccia texture, spheroidal weathering.

LOWER SEDIMENTARY SEQUENCE (Trc)--

Interbedded very fine- to coarse-grained sandstone with pebbly sandstone and laminar siltstone interbeds, and lahars. Propylitically altered.

Sandstone Sequence (Trcs)--

Ridge west-southwest of pit entrance: poorly-sorted sequence of fine to very fine grained-sandstone with pebbly sandstone interbeds and laminar siltstone interbeds. Rock is moderately- to well-indurated, subangular to subrounded, green brown on fresh and weathered surfaces, with calcite underlying siltstone.

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crystal lithic sandstone: medium to coarse grained volcanic lithic fragments with some quartz, plagioclase, hornblende, and pyroxene crystals; silica cemented; contains other fine to very fine grained beds, medium scale low angle crossbeds in sets up to 8 cm, outcrop principally laminar sandstone. Also laminar bedded red-brown to yellow-tan fine to very fine-grained sandstone in 2-5 cm thick beds with good parting, highly fractured.

pebble interbeds: comprise 10 to 20% of rock; interbeds up to 6 cm thick with subangular to subrounded pebbles up to 3 cm (isolated pebbles up to 8 cm), pebble lines and lenses laterally discontinuous.

shale interbeds: purple fresh and weathered surfaces with some iron stains, ripple marks, recumbant folds (soft sediment deformation) up to 7 cm thick.

hydrology: little primary permeability present in rock itself, but water movement possible along fractures and bedding planes. Rock appear similar to sandstone in pit except more indurated; variation could be result of propylitic alteration of stratigraphically different but lithologically similar sandstone.

Waterfall near waste dump: shale, weathering hard and blocky; sandstone, especiallypebblysandstone, weathering spheroidally, friable with hand.

pebbly sandstone: large, sub-rounded (60 cm by 30 cm) volcanic clast. In clast, all mafics altered to light green clay, contains fresh plagioclase phenocrysts (1 to 2 mm), with only minor saussuritization of plagioclase. Near top of the unit, sandstone and pebble conglomerate well indurated, indicating "baked" zone near contact with basalt, matrix green. May be equivalent of Trl. Overall induration of this unit much less than igneous units; tends to form topographic lows, appears to underlie large landslides north of pit. May have some primary permeability.

Lahar (Trcl)--

Near crusher building: Unsilicified breccia, 40% clasts, 60% matrix; clasts 3 to 25 cm; approximatly 95% volcanic; types noted: medium to light grey porphyritic hornblende andesite with phenocrysts up to 2 mm, averaging 1 1/2 to 2 mm; red silicified rock, angular to subrounded; andesite basalt clast, 6 cm, subrounded; two poorly indurated light grey very fine to fine grained sandstone clasts, 10 cm, angular to subangular, and 25 to 30 cm, angular to sub angular; some weathered rinds present on clasts; matrix fine grained light grey to white, may be amorphous and green, with

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hornblende/pyroxene and biotite crystals. Matrix may be reddish on fresh surface, weathers spheroidally. Euhedral biotite alters to brown or brown green (chloritized). Also quartz, sericite, muscovite, with ashey matrix that alter to clay or zeolite. No fresh plagioclase. Rock is matrix supported with matrix and clasts of similar hardness but matrix is more fractured. May have some low matrix permeability.

Basal mudflow unit along waterfall near waste dump: 90% green ashy matrix composed of 60-65% glass with phenocrysts of plagioclase (30%), quartz (3-5%), biotite (1%), green amphibole (1%), and pyroxene (1%). Rock contains 10% volcanic clasts. Alteration includes rhodochrosite? (salmon veinlets), alteration of mafics (hornblende and pyroxene most altered), some alteration of plagioclase to clay, calcite replacement.

Induration of the above units can vary throughout the study area. Lower sedimentary sequence poorly exposed in vicinity of landslide north of pit. Where visible, is friable wacke with few pebble and gravel interbeds.

Excerpted pages include pages 14-20.

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PROJECT: CLIENT:	**Log of Boring No.** **Monitoring Well / Piezometer ID:**	
BORING LOCATION:	ELEVATION (feet)	NORTHING/EASTING
DRILLING CONTRACTOR:	DATE STARTED:	DATE FINISHED:
DRILLING EQUIPMENT:	TOTAL DEPTH (feet):	MEASURING POINT:
DRILLING METHOD:	DEPTH TO WATER (FIRST / COMPLETION):	
SAMPLING METHOD:	SCREEN INTERVAL (feet):	TOC ELEVATION (feet):
BOREHOLE DIAMETER:	LOGGED BY:	REVIEWED BY:

DEPTH (feet)	BLOWS / 6 INCHES	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												

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See explanation sheet for descriptions of codes and symbols.

Project No.

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Amec Foster Wheeler Environment & Infrastructure, Inc.

PROJECT:

CLIENT:

Log of Boring No.

Monitoring Well / Piezometer ID:

DEPTH (feet)	BLOWS / 6 INCHES	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS

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See explanation sheet for descriptions of codes and symbols.

Project No.

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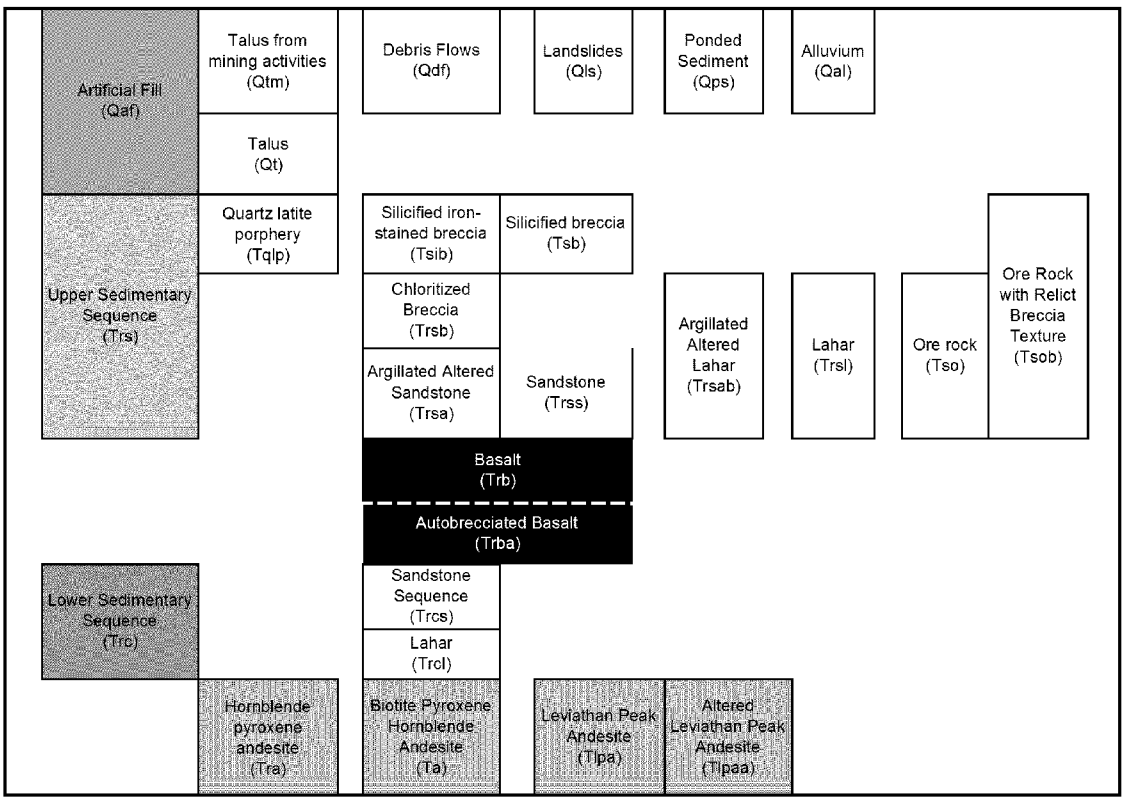
Amec Foster Wheeler Environment & Infrastructure, Inc.

Stratigraphic Column of the Geologic Units Identified by Herbst and Sciacca (1982)
Leviathan Mine Site
Alpine County, California



Herbst and Sciacca, (1982) = *Geology of the Leviathan Sulfur Mine and Vicinity, State Water Resources Control Board, Division of Technical Services. October 1982.*

A detailed description of the geologic units are presented in Appendix A of the *Leviathan Mine Pollution Abatement Project* by Brown and Caldwell dated April 1983.

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SOIL PEDON DESCRIPTION FORM

Location: _____

Site No.: _____ Date: _____ Time: _____ Slope: _____ Aspect: _____

Geomorphic Surface: _____ Parent Material(s): _____

Vegetation: _____

Described by: _____

Depth (in.)	Horizon	Color moist / dry	Structure			Gravel (%)		Consistence Wet		Consistence Moist	Consistence Dry	Texture		Clay Films			Boundaries		Notes
			m	vf	gr					lo	lo	S	SiCL	v1	f	pf			
			sg	f	pl	0	50	so	po	vfr	so	LS	SiL	1		po	a	s	
			1	m	pr	<10	75	ss	ps	fr	sh	SL	Si	2	d	br	c	w	
			2	c	cpr	10	>75	s	p	fi	h	SCL	SiCL	3		co	g	i	
			3	vc	abk	25		vs	vp	vfi	vh	LS	C		p	cobr	d	b	
					sbk					efi	eh	CL	SC						
			m	vf	gr					lo	lo	S	SiCL	v1	f	pf			
			sg	f	pl	0	50	so	po	vfr	so	LS	SiL	1		po	a	s	
			1	m	pr	<10	75	ss	ps	fr	sh	SL	Si	2	d	br	c	w	
			2	c	cpr	10	>75	s	p	fi	h	SCL	SiCL	3		co	g	i	
			3	vc	abk	25		vs	vp	vfi	vh	LS	C		p	cobr	d	b	
					sbk					efi	eh	CL	SC						
			m	vf	gr					lo	lo	S	SiCL	v1	f	pf			
			sg	f	pl	0	50	so	po	vfr	so	LS	SiL	1		po	a	s	
			1	m	pr	<10	75	ss	ps	fr	sh	SL	Si	2	d	br	c	w	
			2	c	cpr	10	>75	s	p	fi	h	SCL	SiCL	3		co	g	i	
			3	vc	abk	25		vs	vp	vfi	vh	LS	C		p	cobr	d	b	
					sbk					efi	eh	CL	SC						
			m	vf	gr					lo	lo	S	SiCL	v1	f	pf			
			sg	f	pl	0	50	so	po	vfr	so	LS	SiL	1		po	a	s	
			1	m	pr	<10	75	ss	ps	fr	sh	SL	Si	2	d	br	c	w	
			2	c	cpr	10	>75	s	p	fi	h	SCL	SiCL	3		co	g	i	
			3	vc	abk	25		vs	vp	vfi	vh	LS	C		p	cobr	d	b	
					sbk					efi	eh	CL	SC						
			m	vf	gr					lo	lo	S	SiCL	v1	f	pf			
			sg	f	pl	0	50	so	po	vfr	so	LS	SiL	1		po	a	s	
			1	m	pr	<10	75	ss	ps	fr	sh	SL	Si	2	d	br	c	w	
			2	c	cpr	10	>75	s	p	fi	h	SCL	SiCL	3		co	g	i	
			3	vc	abk	25		vs	vp	vfi	vh	LS	C		p	cobr	d	b	
					sbk					efi	eh	CL	SC						
			m	vf	gr					lo	lo	S	SiCL	v1	f	pf			
			sg	f	pl	0	50	so	po	vfr	so	LS	SiL	1		po	a	s	
			1	m	pr	<10	75	ss	ps	fr	sh	SL	Si	2	d	br	c	w	
			2	c	cpr	10	>75	s	p	fi	h	SCL	SiCL	3		co	g	i	
			3	vc	abk	25		vs	vp	vfi	vh	LS	C		p	cobr	d	b	
					sbk					efi	eh	CL	SC						
			m	vf	gr					lo	lo	S	SiCL	v1	f	pf			
			sg	f	pl	0	50	so	po	vfr	so	LS	SiL	1		po	a	s	
			1	m	pr	<10	75	ss	ps	fr	sh	SL	Si	2	d	br	c	w	
			2	c	cpr	10	>75	s	p	fi	h	SCL	SiCL	3		co	g	i	
			3	vc	abk	25		vs	vp	vfi	vh	LS	C		p	cobr	d	b	
					sbk					efi	eh	CL	SC						

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Form Checked by (initials and date): _____

14.0 – SOIL AND ROCK SAMPLING

Purpose and Scope: The purpose of this document is to provide procedures for collecting soil and rock samples. It includes a discussion of general procedures, various sample devices, surface soil sampling, bulk soil sampling, soil sample compositing, and rock sample handling.

Equipment:

Cleaning and decontamination equipment (Liquinox and distilled water);
Continuous core samplers (macrocore, sonic coring tool);
Double bagged "wet" ice;
Drive sampler;
Field test kits (if applicable);
Hand auger and stainless steel barrels;
Hand-held global positioning system (GPS) device;
Ice chest;
Laboratory sampling containers (if applicable);
Miscellaneous tools;
Paper towels;
Plastic sheeting;
Plastic sleeve caps;
Power auger/drilling rig;
Putty knife;
Re-sealable plastic storage bags;
Safety equipment;
Sample labels;
Shelby tubes;
Shovel, stainless steel spatulas, stainless steel spades;
Sieves or strainers attached to a pole (for rotary drilling);
Silicone tape;
Split spoon samplers (standard penetration test [SPT], California-modified split spoon);
Stainless steel container;
Stainless steel measuring cup;
Stainless steel sampling sleeves;
Stainless steel spoon or trowel; and,
Teflon sheets.

Documentation:

Chain-of-custody form (COC);
Daily Field Record (DFR);
Digital camera;
Maps/plot plan;
Sample Control Log;
Field Test Pit Log (attached);
Field Test Pit Sampling Form (attached); and,
Soil and Rock Boring Log.

This Standard Operating Procedure (SOP) is to be used in conjunction with the applicable Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. In addition to the SAP, the following SOPs should be consulted:

- SOP 1.0 – General Preparation and Mobilization Requirements
- SOP 2.0 – Basic Health and Safety for Field Operations
- SOP 3.0 – Field Documentation and Sample Handling
- SOP 4.0 – Sample Collection Techniques and Data Collection Strategies
- SOP 7.0 – Equipment Decontamination
- SOP 11.0 – Soil and/or Rock Logging
- SOP 12.0 – Test Trench Excavation
- SOP 13.0 – Drilling
- SOP 18.0 – Cone Penetrometer Test
- SOP 30.0 – Hand-Held Global Positioning System (GPS)
- SOP 31.0 – Incremental Sampling

Also refer to the Leviathan Mine Site Health, Safety, Security and Environmental (HSSE) Program Document. A Field Authorization Form (FAF) and Task Risk Assessment (TRA) will be prepared for the task.

14.1 GENERAL PROCEDURES

All soil sampling activities must be performed by appropriately trained field staff under the direct supervision of a California-licensed Professional Geologist or Professional Engineer in good standing with the appropriate expertise.

The following is a list of general procedures that should be followed during soil sampling:

- Obtain an approved Remediation Management (RM) ground disturbance permit if samples will collected from a depth greater than 12 inches below ground surface;

- Record relevant data on a Daily Field Record prior to sampling (SOP 3.0 – Field Documentation and Sampling Handling);
- Decontaminate all sampling equipment prior to sampling (SOP 7.0 – Equipment Decontamination);
- Clear surface vegetation, rocks, and other material not designated for sampling from the sampling point;
- Reach the desired sampling depth by excavating a trench (SOP 12.0 – Test Trench Excavation), by drilling a boring (SOP 13.0 - Drilling) or other intrusive methods described in this SOP;
- Collect the soil or rock sample and transfer it to the container that is appropriate for the analytical methods to be performed;
- Record the sample lithology if required in the SAP for the investigation being performed (SOP 11.0 – Soil and/or Rock Logging);
- Affix an appropriate label to the sample container, being sure to provide required information. Place the completely labeled sample container in a protective carrying container and maintain the sample at the required temperature. Add information pertaining to the sample to the respective borehole log, COC, DFR, and sample control log. Package and ship samples to the applicable laboratory following the sample handling procedures described in SOP 3.0 – Field Documentation and Sample Handling (Samples may be held overnight as long as they are packaged, labeled, placed in a secure location, and chilled [if chemical analysis is to be performed on the sample]; COC procedures must be followed for samples held overnight prior to shipping.);
- Document the surface location of the sample using a GPS device if required in the SAP for the investigation being performed (SOP 30.0 – Hand-Held Global Positioning System (GPS) Device); and
- Either discard or decontaminate all items which contact the sample such as trowel, split-spoon sampler, or core barrel, and gloves before proceeding to the next sampling location (SOP 7.0 – Equipment Decontamination).

Specific procedures for the various methods that may be used to collect soil or rock samples are described in the following sections.

14.2 SAMPLER DEVICES AND METHODS

Several drilling methods or hand digging methods may be used to reach desired depths for soil and rock sampling. When the desired sampling depth has been reached and the borehole has been prepared, the following devices and methods may be used to collect samples:

- Penetration test and split-barrel sampler (split-spoon);
- Thin wall sampler;
- Continuous sampling system (sonic coring tool, macrocore sampler); and/or
- Collection of cuttings.

Some of these samplers cannot be used to collect a rock sample. For example, it isn't possible to advance a thin walled sampler into rock. Penetration test and split barrel samplers can be used to collect rock samples as long as the rock is weathered or altered. Some continuous sampling systems can be used to collect rock core samples but typically, a drilling fluid (i.e. water or mud) has to be used to advance the sampler and cut the rock.

14.2.1 Penetration Test and Split-Barrel Sampling

Penetration test and split-barrel sampling are methods used to collect relatively undisturbed soil samples. Samples collected by these methods will be used for description and identification, chemical analysis, and in some cases physical analysis. A split-barrel sampler consists of a section of pipe that splits into two pieces along its long axis. A driving shoe and threaded adapter screwed to the ends hold the split section together while it is driven into the subsurface. Aids for sample retention may also be incorporated into the split-barrel sampler. These include sand catchers, spring or gravity traps (in the lower end), and check valves (in the top end). The standard sampler is 18 or 24 inches long, has an outside diameter of 2-inches and an inside diameter of 1-3/8 inches, and is constructed with stainless steel. Sleeves or rings can be used to line the inside of the sampler if laboratory testing is required. Rings are typically 1 inch long and sleeves are typically 6 inches long.

The penetration test samplers have been used to develop an empirical relationship between driving resistance and the relative density of soil. The procedure for determining and interpreting penetration resistance or relative density is the Standard Penetration Test (SPT), which is described as follows:

- After the boring has been advanced to the desired sampling depth and extracted drill cuttings have been suitably removed, a SPT sampler, attached to drill rods or a sand line (cable) is lowered to the bottom of the boring. The sampler should be driven below the bottom of the drill bit being used to advance the boring if the drill casing or augers are left in the hole during sampling activities.
- Once the sampler is on the bottom of the boring, three, 6-inch increments are marked on the drill rods above a convenient fixed datum.

- The sampler is driven by a 140-pound hammer free falling a distance of 30-inches onto a collar or drive head attached to the top of the drill rods. A 140-pound down-hole hammer, lowered to the bottom of the borehole on a sand line, can also be used to collect the sample. The sampler is driven a total of 18-inches into the undisturbed soil, and the number of blows required to advance each 6-inch increment is recorded on the boring log.

- The standard penetration test should be terminated if one of the following occurs:

  - A total of 50 blows has been applied during any one of the three 6-inch increments;

  - A total of 100 blows has been applied;

  - There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

- After the total penetration of the sampler has been achieved, the sampler is retrieved to the surface and opened.

The sample is then logged and removed from the sampler. The sampler is decontaminated and then re-assembled in preparation for the next sampling run. If the samples are to be retained for future testing or reference, they will be placed in sealable plastic bags and labeled with the depth and location according to procedures listed in the project planning documents and/or applicable SOPs. Typically, samples are collected at each lithologic change and at intervals not greater than 5 feet (unless otherwise stipulated by the field geologist).

Where relatively undisturbed samples are to be collected, samples are obtained with a "California-modified" or similar split-barrel (split-spoon) sampler fitted with dry, decontaminated 2.5-inch diameter, 3 or 6-inch long stainless steel sleeves. Procedures for sampling with the "California-modified" sampler are similar to procedures described for the standard penetration test. Soil or rock samples will be collected by driving the split-barrel sampler 18-inches (or until refusal) into undisturbed material at the bottom of the borehole. The drill rig is equipped with a 140-pound hammer to drive the sampler. Hammer blows required to drive the sampler in 6-inch increments will be recorded on the boring log. Upon retrieval from the borehole, the sampler will be dismantled, and the sample sleeves removed and placed on clean plastic or paper towel. These sleeves will be separated and then logged by the field geologist. The geologist should log the soil or rock observed at the ends of the sleeves or a sleeve that is not required for testing. Soil and rock cuttings may also be used for logging. After logging, the exposed ends of the sleeves will be covered with Teflon sheets and plastic end caps. The end caps should be

taped in place using silicone tape to seal-in moisture. Adhesive sample labels will be affixed to the sleeves in accordance with SOP 3.0 – Field Documentation and Sample Handling.

14.2.2 Thin Walled Sampler

A thin walled sampler (i.e. Shelby tube) is a one-piece metal tube, of thin gauge, which is forcefully driven into soil to collect a relatively undisturbed sample. The tube is the sample container and cannot be reused. Thin walled samplers cannot be used in extremely hard soil. Thin wall sampling tube methods are used where relatively undisturbed samples of fine-grained materials are to be obtained for chemical analysis, saturated vertical hydraulic conductivity testing, or other geotechnical analysis. Other larger diameter samples (3- to 6-inches in diameter) are helpful in sampling gravel deposits and retrieving samples of sufficient volume to perform compaction tests. The size of the sampler should be documented on a boring log.

The thin walled sampling method is conducted by attaching a sampling tube to the nose-end of the “California” sampler and pushing the tube, in one continuous motion, into the material to be sampled. Once the tube is retrieved, slough material will be removed from the tube and the actual sample length will be measured. If the sample is to be retained for future reference or analysis, it will be trimmed, logged, capped, sealed, and labeled. The sample should be stored in a vertical orientation during transportation.

14.2.3 Continuous Core Sampling System Methods

Continuous core sampling system methods may be specified where continuous soil cores are to be recovered by hollow-stem auger, direct push, or sonic drilling methods. The continuous sampling system utilizes a core barrel, which recovers a soil or rock core from the interval drilled. The core barrel is recovered after each interval is drilled. Split-barrel samplers are typically used when continuously coring a borehole using hollow-stem auger drilling methods. Split-barrel samplers can also be used to collect samples using direct push and sonic drilling methods. Four or five foot long by two inch diameter macrocore samplers are used to collect continuous core by direct push method. Sonic coring tools range in length and diameter but they are typically 4 inches in diameter and 10 to 20 feet long.

Soil and rock samples may be cut directly from continuous cores or transferred into laboratory supplied containers. In some cases, the entire length of the cores will be placed in core boxes so that the logged conditions can be confirmed by a geologist tasked with the responsibility of review.

14.2.4 Cuttings Collection Methods

Cuttings brought to the surface during drilling activities may be collected as grab samples for laboratory or physical analysis. Cuttings will be collected at a minimum of every five feet and at changes in lithology. The geologist should observe the "up time" or the time it takes for the cuttings to travel from the drill bit to ground surface before assigning a depth to it. For example, the travel time for cuttings to reach the surface when drilling using hollow-stem auger methods is much greater than when drilling with air rotary. The drill rig operator should be able to assist the geologist when determining up time for soil cuttings. Direct push and sonic drilling methods do not generate cuttings. Cuttings samples will be placed in re-sealable plastic bags marked with a unique designation that includes the borehole identification and the sample depth.

14.3 SURFACE SOIL SAMPLING

Methods to be used for collection of surface soil samples include taking a grab sample with either a spoon, scoop or trowel, hand auger, or the hand drive sample method. The spoon, scoop or trowel samplers are used to collect shallow soil samples, up to 6-inches in depth. A hand auger fitted with a stainless steel barrel (typically 3 inches in diameter) can be used to collect soil samples at the surface up to approximately 10 feet below ground surface if the soil is soft enough. The sample barrel is constructed with a cutting shoe, with hard surfacing on it to help with cutting through hard or rocky materials. The sampler will transfer the sample into a laboratory-supplied glass jar or pre-cleaned stainless steel sleeve and seal the end(s). In the case of the hand drive-sampler method, samples will be collected directly into stainless steel sleeves. If collecting a sample in a stainless steel sleeve, the sampler will seal the ends with a sheet of Teflon and a cap on both ends of the tube. The caps will be taped in place using silicone tape to preserve soil moisture. The sampler will document the soil type on a boring log and label the sample container with sample number, depth, date, time, study area, and project number.

14.3.1 Field Test Pits

Intrusive surface soil samples are collected using hand auger techniques. If it is not possible to collect a sample using a hand auger because of rocky conditions (for example), a shovel or a post-hole digger may be used. Use a Field Test Pit Log (attached), if necessary to record detailed borehole lithology or features.

Collect the soil sample and place the soil collected from the target depth interval in a decontaminated stainless steel container. Remove any sticks, leaves, large organic material or

other debris being careful to retain any soil stuck to the item being removed. Document sample collection on the Field Test Pit Sampling Form (attached).

After the appropriate sample containers have been filled, place any remaining material back in the sample borehole and use additional loose material from the surrounding area to completely backfill the borehole. Compact the materials in the borehole.

14.4 BULK SOIL SAMPLING

Bulk soil samples for some physical and mineralogical tests may be collected from test trenches and soil borings. Samples will be collected from a test trench or a test pit less than 5-feet deep from the wall using a stainless steel spoon or trowel. In test trenches deeper than 5-feet, samples will be collected out of the backhoe bucket. Bulk samples from soil borings will be collected from the cuttings produced during drilling or retrieved from a sampler.

Samples of sand, silt, and clay-size material will be collected into gallon-sized re-sealable plastic bags (minimum) or in stainless steel sleeves. Coarse-grained gravels, cobbles, or boulders will be collected into 5-gallon buckets. Samples will be labeled in accordance with SOP 3.0 – Field Documentation and Sample Handling.

14.5 SOIL SAMPLE COMPOSITING

Soil sample compositing is used to combine soil from two or more samples so that the composite that is submitted for analysis is representative of the entire mass of soil sampled. Soil samples can be composited in the laboratory or in the field. Not all target analytes are amenable to compositing (e.g., volatile compounds, highly oxidizing analytes) and should not be collected for chemical testing by compositing samples.

Individual samples to be composited will be identified on their labels. A composite sample, made from two or more individual samples, will have its own sample identification. Samples to be composited also will be identified clearly on the COC and on the sample control log. In general, compositing consists of the following steps:

- Take an approximately equal in weight sub-sample from each sample to be composited;
- Combine and homogenize the sub-samples; and
- Take a sample of homogenized soil for analysis.

Grab samples are disturbed samples obtained by shovel, spoon, hand trowel, hand auger, or similar means. A grab sample can be sub-sampled by taking a smaller grab sample if the material is relatively homogeneous or if the grab sub-sample will contain the various types of materials in approximately the proportions present the larger sample. Otherwise, the material should be homogenized and subdivided as described below.

Split-spoon and similar samples may be more easily subdivided by splitting the sample lengthwise with a spatula into halves or smaller fractions. Another approach is to cut a v-shaped channel from the side of the sample and use the material from the channel for compositing.

Sub-samples should be the same volume. A measuring cup or small container (i.e. glass jar or sleeve) is satisfactory for determining size. The size of each sub-sample should be chosen based on the final sample volume and the amount of material available. Make the size of the sub-sample after quartering or splitting larger than the desired volume, then mix the sub-sample thoroughly in the measuring cup with a spatula and discard the excess. Combine the sub-samples on a hard surface covered with plastic sheeting or similar material that will prevent incidental contamination of the samples. Break up cohesive materials into pieces considerably smaller than the final sample size with a trowel or spatula. Mix the composite sample until it appears homogeneous. If the composite sample is too large, subdivide it as follows: pile the soil in a cone, flatten the cone to a uniform thickness, draw two lines across the pile, dividing it into quarters, discard two opposite quarters re-mix the remaining quarters, repeat the process until the sample is slightly larger than the sample container, fill the container and discard the excess. Label the container and document the sample as described in SOP 3.0 – Field Documentation and Sample Handling. The sampler must identify the sample as a composite and identify the number and locations of samples that were composited.

Some soil samples will be composited using Incremental Sampling Methodology (ISM). ISM is a structured sampling protocol that reduces sampling error associated with compositional and distributional heterogeneity of the analyte of interest in soil or sediments. The ISM protocol consists of defining sampling or decision units, collecting a minimum of 30 individual soil samples from randomly selected locations within each unit, and submitting the samples to the laboratory for processing (drying, compositing, sieving, and sub-sampling) in a specified manner prior to laboratory analysis. Some target analytes are not amenable to drying, compositing or sieving; consult the planning documents to determine appropriateness for any given target analyte. Additional information on ISM is provided in SOP 31.0 – Incremental Sampling.

14.6 ROCK SAMPLE HANDLING

Rock samples are typically collected using continuous core sample systems. For example sonic and mud rotary drilling methods have samplers that allow for the collection of rock core. It may not be possible to place the rock sample collected during coring in a laboratory supplied container for testing or analysis. In this case, the rock sample should be wrapped in plastic and taped closed to maintain the sample shape and retain moisture. The rock sample should also be wrapped in bubble wrap to prevent it from breaking during transportation. As with soil samples, rock samples will be labeled in accordance with SOP 3.0 – Field Documentation and Sample Handling.

14.7 ADDITIONAL SAMPLING METHODS

The selection of sampling methods presented above is not all inclusive of the soil and rock sampling devices that may be used. The use of additional or alternative sampling devices may be required and will be described in the planning documents.

14.8 REVISION LOG

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
1	Britt Jones	Removed references to the HSSE Program Document and RI/FS TSHASP (D14.0). Replaced JSA with WRA or TSEA (D14.0). Added Hand-Held GPS device in the equipment list (D14.0). Added SOP 30.0 and SOP 31.0 to list of other SOPs to consult (D14.0). Specify the proper personnel for overseeing soil sampling (D14.1). Add GPS activities (D14.1). Added information about performing incremental sampling (IS) (D14.5). Added section on “Additional Sampling Methods” (D14.6).		

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
2	Eric Morita/Josh Klein	Changed the title of the SOP 14.0 from "Soil Sampling" to "Soil and Rock Sampling". Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. Changed the purpose of the SOP to include rock sampling (D14.0). Added the following equipment (D14.0): Shovel; Standard Penetration Test (SPT), California, and California Modified drive samplers; Sieves or strainers attached to poles (for rotary drilling); Drive samplers; Silicone tape; Paper towels; Putty knife; Laboratory sampling containers; Field test kits		
2	Jon Browning	Added the sample control log to the required documentation (D14.0) and provided procedures for completing the sample control log (D14.1). Provided a number of additional procedures that apply to the various soil sampling methods listed in section D14.2. Provided additional procedures for collecting surface soil samples with a hand auger (D14.3) and documenting composited soil samples (D14.5). Added procedures for rock sample handling (D14.6). Added revision log (D14.8). Added reviewed and finalized column to revision log. Updated footer to match current location.		2/11/13
3	Kristi Hayward	Formatting and change IS to ISM to be consistent with SOP 31	Kent Parrish	3/13/14 9/30/14

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
4	Lynda Lombardi	Technical review and edits. Clarified trench pit sampling vs. test pit sampling. Included field test pit log and sampling form. Added QA information on compositing and ISM methods.	Kent Parrish	2/27/15 2/27/15

ATTACHMENTS

- 14a - Field Test Pit Log
- 14b - Field Test Pit Sampling Form

FIELD TEST PIT LOG

Leviathan Mine Site
Alpine County, California

Project Number:	Test Pit Number:	Start Date:
Project:	Test Pit Location:	Finish Date:
Client:	Total Depth of Test Pit:	Start Time:
Survey Datum:	Depth to Groundwater:	Finish Time:
Excavator Type:	Ground Elevation:	Backfill Date:

Depth (ft)	Elevation (ft)	Sample ID	Soil Description
0			
0.5			
1			
1.5			
2			
2.5			
3			
3.5			
4			
4.5			
5			
5.5			
6			

Depth (ft)	Elevation (ft)	Sample #	Test Pit Sketch
0			
0.5			
1			
1.5			
2			
2.5			
3			
3.5			
4			
4.5			
5			
5.5			
6			

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Form checked by (initials and date): _____ Page ___ of ___

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FIELD TEST PIT SAMPLE LOG

Levithan Mine Site
Alpine County, California

Project Number:	Client:	Date:
Test Pit Depth:	Test Pit Location:	Contractor:
Depth to Groundwater:	Test Pit Length:	Test Pit Width:
Responsible Geologist or Engineer:	Sampler:	Surface Elevation:
		Sampling Method:

Sample Details						Soil / Materials Description
Time	Depth (ft)	Sample ID	Type (grab or composite)	Moisture Level	Volume and Sample Container	(Color, consistency or density, texture, structure, shape and surface condition or grains, odor, etc.)

Amec Foster Wheeler
Form checked by (initials and date): _____

Page ___ of ___

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30.0 – HAND-HELD GLOBAL POSITIONING SYSTEM (GPS) DEVICE

Purpose and Scope: The purpose of this document is to present the procedures for recording the locations and naming using a hand-held GPS Device. This document provides the basic guidelines to collect, download, and post-process the coordinates for point, line, and area features.

Equipment:
Trimble GeoXH GPS Unit
Trimble TerraSync Software (installed on GPS unit)
Laptop/desktop computer with GPS Pathfinder® Office Software installed
GPS docking station
GPS power cable
GPS/Office computer cable

Documentation:
GeoExplorer 2008 Series Quick Start Guide (attached)
TerraSync Software Guide (available on CD-ROM)
GeoXH 2008 User Manual (attached)
Pathfinder Office Software Getting Started Guide (available on CD-ROM)
GPS Pathfinder Office® Getting Started Guide (available on CD-ROM)
Maps
Existing Site GPS Background Files (Table 1, attached)
GPS Log

This Standard Operating Procedure (SOP) has been developed for use with the Trimble Geo XH GPS unit, which, under the proper conditions using only the internal antenna, has the ability to record locations and features with a horizontal accuracy of less than a foot and a vertical accuracy of 18 inches after the data has been post-processed. A horizontal and vertical accuracy of up to 4 inches can be obtained if the optional Zephyr external antenna is added and other conditions are met). Other GPS units may be used; however, they must meet or exceed the accuracy requirements described in this SOP for the task being performed.

This SOP is also to be used in conjunction with the applicable Sampling and Analysis Plan (SAP) and Focused Remedial Investigation (FRI) work plans. In addition to the SAP, the following SOPs should be consulted:

- SOP 1.0 – General Preparation and Mobilization Requirements
- SOP 2.0 – Basic Health and Safety for Field Operations
- SOP 3.0 – Field Documentation and Sample Handling

Also refer to the Leviathan Mine Site Health, Safety, Security and Environmental (HSSE) Program Document, the Field Authorization Form (FAF), and the Task Risk Assessment (TRA).

30.1 GETTING STARTED

First time operators of the Trimble GeoXH should refer to the GeoExplorer 2008 Series Quick Start Guide for an overview of the features and functions of the GPS system. It briefly describes the accessories, the physical features of the GPS system, how to charge the battery, interaction with the handheld unit using the stylus, connection to the computer, icon descriptions, etc. The remainder of this SOP assumes that the user has reviewed the Quick Start Guide and the GeoXH 2008 User Manual prior to performing the following procedures.

Turn the GPS unit on by pressing the green power button for 3 seconds. Open the TerraSync program by selecting GPS in the bottom right corner of the screen. Only use the stylus which is provided along the right side of the unit to make selections on the screen (e.g., do not use a pen which will damage the screen).

The TerraSync program automatically displays the Skyplot window. The physical layout and major components of the GeoXH GPS Device are shown in GeoExplorer 2008 Series Quick Start Guide. Satellites included in the coordinate calculations are highlighted in black on the left side of the Skyplot window. The center of the screen shows a compass with the currently detected overhead satellites (represented by a number identification). A number of other icons are present on the screen and are described in pages 56 through 61 of the TerraSync Software Manual. Three drop down menus are available in the top left hand corner of the screen. From top to bottom these include: the Start Menu (i.e., Microsoft logo); the Section tab (i.e., Status); and the Subsection tab (i.e., Skyplot). The Section and Subsection tabs are used to maneuver between the various screens within TerraSync and are frequently referenced within this SOP.

30.2 SYSTEM SETTINGS

This section describes the system settings required to be entered in the GPS Device prior to collecting data for the Leviathan Mine Site field programs. Failure to enter these settings may prevent the use of the pre-loaded background files and may require that any field data collected be further processed in the office to convert to the correct coordinate system.

30.2.1 Setup

On the Section tab press "SETUP". This opens up six boxes that contain all of the system settings that will be used during data logging: Logging Settings, GPS Settings, Real-time Settings, Coordinate System, Units, and External Sensors. The following subsections discuss the specific settings required to be entered.

30.2.1.1 Logging Settings (Accuracy Settings)

Press the box labeled "LOGGING SETTINGS" and verify the following settings are selected:

- Accuracy Settings = 3 ft – Horizontal – Post-processed. This value represents the minimum accuracy that shall be recorded by the GPS device. The GPS device will automatically adjust the system settings to only collect coordinates that meet or exceed this criterion. Field staff can change the accuracy settings in order to meet the data quality needs of the task being performed. Keep in mind that selecting greater accuracy may overly constrain the data quality requirements of the GPS device and prevent it from collecting coordinate data.
- Point/Vertex Auto-pause Count = None;
- Antenna Height = _____ (Varies by operator).
  Enter the height at which the GPS Device will be held while recording data points. For example, if the GPS Device will be held at waist level when recording data, enter the height of the operator's waist above ground surface.
- Log Carrier Data = Auto
- Log Velocity Data = No
- Allow Position Update = Confirm;
- Confirm End Feature = No;
- Filename Prefix = _____ (3 alpha characters).
  According to the naming designation requirements stated in SOP 3.0 – Field Documentation and Sample Handling, GPS points collected are to be assigned an 11-digit alphanumeric code. The first three alphanumeric characters will be entered here in the Filename Prefix and the remaining eight digits (consisting of the date and a continuous numbering sequence for each data point collected in each study area during each day) will be entered later within the file creation and comments section during the collection of coordinate data. The three characters in the Filename Prefix are as follows:

  - Job Name – A two-digit acronym can be used to differentiate data collection tasks or investigations. For example, an appropriate acronym for the Mine Features and Underground Utility Investigation Mapping could be MF; and
  - Study Area Designation (as applicable) – Aspen Creek Study Area (A), Leviathan Creek Study Area (L), Pit Study Area (P), Downstream Study Area (D),or Reference (R).

  For example, if coordinate data for the Mine Features and Underground Utility

Investigation within the Leviathan Creek Study Area, the Filename Prefix will be *"MFL"*.

- Waypoint Filename Prefix = _____(---MMDDYYw).
  Similar to the filename prefix except that the date and a lowercase "w" are added at the end (example: MFL020510w).
- Between Feature Logging = Time; and
- Interval = Off.

After settings have been entered, press "OK".

30.2.1.2 GPS Settings (Precision-Productivity)

Press the box labeled "GPS SETTINGS" and verify that GPS Receiver Port = "COM3". Move the Productivity-Precision slider all the way to the Precision-side (right side). This slider automatically adjusts the criteria for Position Dilution of Precision (PDOP), Signal to Noise Ratio (SNR), and satellite elevation angles. After settings have been entered, press "OK".

Generally, the lower the PDOP and the higher the SNR and the higher the elevation angles result in more precise coordinates. Moving the precision-productivity slider all the way to the precision-side (right-side) sets a PDOP requirement of 4.0 or less (lower PDOP provides more precise readings). Satellites that do not meet specified precision requirements will be excluded from the coordinate calculation. A minimum of 4 satellites are needed to triangulate a position.

If no satellites are registered on the GPS Device, the productivity-precision criteria may need to be lowered to be less constraining. In many cases, the required accuracy can be obtained when the precision settings are lowered because lowering the data collection requirements may allow for more satellites to be included in the calculation (better triangulation). The precision-productivity settings can be adjusted in the GPS Settings window (under section tab "SETUP" subsection tab "GPS SETTINGS" or in the Skyplot window (under section tab "STATUS" subsection tab "SKYPLOT"). If it is necessary to move the precision-productivity slider more toward productivity (to the left), be sure to verify that the change in the estimated accuracy meets the minimum requirements (sub meter, or less than 3 feet). The estimated accuracy is shown in the top right corner of the Skyplot window.

30.2.1.3 Real-Time Settings

Press the box labeled "Real-Time" and verify that Choice 1 = "USE UNCORRECTED GPS". Press "OK".

30.2.4 Coordinate System

For the Leviathan Mine Site, all coordinates are to be collected using the California State Plane System, North American Datum 1983 (NAD83), in units of feet. Other system settings can be applied (e.g., Latitude/Longitude, WGS84, meters). However, use of other coordinate systems will result in additional time being spent to convert the coordinate system prior to map development. This may introduce error when uploading the information into various software programs.

Press the box labeled "COORDINATE SYSTEM" and verify the following settings are selected:

- System = US State Plane 1983
- Zone = California Zone 2 0402
- Datum = NAD 1983 (Conus)
- Altitude Reference = Mean Sea Level
- Altitude Units = US Survey Feet
- Geoid = DMA 10 x 10 (Global)
- Coordinate Units = US Survey Feet
- Display USNG = Off

After settings have been verified or entered, press "OK". A window may appear stating: "Changing the coordinate system may cause one or more raster background files to be unloaded. Do you want to continue?" This message appears only if a background file was open before changing the coordinate system. Press "YES," this action only unloads the background file but does not delete it from the system. Background files may be reloaded later.

30.2.5 Units

In the box labeled "UNITS" verify the following settings are selected:

- Distance Units = Feet
- Area Units = Square Feet
- Velocity Units = Feet per second
- Angle Units = Degrees
- Lat/Long Format = DDºMM'SS.ss"
- Offset Format = Horizontal/Vertical
- North Reference = True
- Magnetic Declination = Auto (14.2˚ E)

After settings have been entered, press "OK".

30.2.6 External Sensors

In the box labeled "EXTERNAL SENSORS" verify that all boxes (Laser, Sensor 1, Sensor 2) are unchecked. Press "OK".

30.3 SATELLITE ALMANAC AND PLANNING

The Satellite Almanac is a set of data that every GPS satellite transmits (e.g., time signals, orbit projections, clock corrections, atmospheric delays, etc.) and provides the data quality of the entire GPS constellation that is used to triangulate a location. When a GPS Device has current Satellite Almanac data, it can be used to plan a GPS data collection event when there are the most satellites in the sky.

The Satellite Almanac updates automatically when the GPS system is turned on and allowed to remain exposed to the open sky for a sustained period. To verify the update, on the Section tab select "STATUS" then on the subsection tab select "PLAN". In this window, you will see a circular satellite configuration map on the left side of the screen referred to as the SkyPlot and a PDOP forecast shown on the bottom of the screen. In the "PLAN" Subsection tab, the GPS screen will read "ACQUIRING ALMANAC" blinking on and off to the right of the SkyPlot. Allow the GPS unit to run in this idle state for approximately three minutes while it downloads the Satellite Almanac from the network of satellites. You will know the Satellite Almanac is completely downloaded when you can see the schedule filled in at the bottom of screen for the following 12-hour period.

Checking the PDOP forecast provides information on when to expect the best conditions for using the GPS Device. Earlier while setting up the GPS Settings (Section 30.2.1.2), the productivity-precision slider was moved all the way to the precision side (right side). This precision setting created a PDOP threshold of 4.0 which is shown on the PDOP vs. time plot as a horizontal line on the bottom of the screen. A low PDOP means that more precise coordinates can be collected and the areas shown in aqua blue on bottom of the screen. . In this example, data be scheduled anytime during the next 12-hours except between the hours of 2:30 pm and 3:30 pm when the satellite constellation health is poor (i.e., PDOP exceeds the threshold). If data must be performed between 2:30 and 3:30 pm, the precision settings will need to be lowered. Refer to Section 30.2.1.2 for instructions on how to adjust the productivity-precision and how this can affect the estimated accuracy.

30.4 B ACKGROUND FILE

Background files should be pre-loaded into the GPS Device prior to conducting mapping or positioning. To open a background file, select the Section tab "MAP" and under the "LAYERS" dropdown menu make sure that the "Background" selection has a check to it. Then select "Background Files…" (different than the similarly named "Background" selection). A list of the names and descriptions of Leviathan background files that have been pre-loaded to the GPS Device are include as Table 1.

While under "Background Files…" check the file or multiple files to be loaded. After selecting the desired background file(s), select "OK" and the image should appear.

Other background files can be loaded onto the GPS Device by obtaining a georeferenced image, merging it into the GPS Pathfinder software program to create a coordinate system file, and transferring it to the GPS Device. Georeferenced images can be obtained from the Microsoft® Research Maps website (http://msrmaps.com/) or from Geographic Information System (GIS) software (i.e., ArcMap). Refer to GeoXH 2008 User Manual for details on how to create a coordinate system file and import the file onto the GPS Device.

30.5 D ATA COLLECTION

There are two ways to collect data with the GPS Device: Structured Data Collection or Quick Field Collection.

- Structured Data Collection: This method pertains to the collection of not only position (coordinate) data, but also specific attributes about the feature (e.g., locating a monitoring well and recording attributes of depth-to-water, pH, temperature, etc.). Refer to the GeoXH 2008 User Manual for details on how to implement this method.

- Quick Field Collection: This method is used to collect quick positions with the GPS Device (i.e., identifying just the location of a monitoring well). This is the method is discussed below.

Prior to collecting data using the quick field collection method, a data file must be created. On the GPS Device, maneuver to the data collection screen. Press the Section Tab → "DATA" and Subsection Tab → "NEW". This is the Data File window. All of the information on this screen reflects the information previously entered under Logging Settings (Section 30.2.1.1). The file name prefix previously entered (Section 30.2.1.1) should be pre-entered along with a seven

digit alphanumeric sequence starting with MMDD. This seven digit sequence needs to be changed to a six digit numeric date (MMDDYY). If all new data points need to have a different prefix, return to Logging Settings (Section 30.2.1.1) and make the appropriate changes. The prefix can also be edited at this step.

After creating a data file, you will then be prompted to "CONFIRM ANTENNA HEIGHT". This is the height above ground that you will hold the GPS Device while it is recording. Enter the height by pressing the keyboard icon at the bottom center of the screen, then press 'OK.' The height that is entered will apply to all new features collected while the Leviathan file is open. To change the height after it is first entered, simply close the data file (Section Tab → "DATA", Subsection Tab → "UPDATE", press "CLOSE") and then reopen it.

As stated above, the "CONFIRM ANTENNA HEIGHT" depends on the height that you plan on holding the GPS Device when recording a point, line, or area feature. For example, if a user holds the GPS Device 4 feet above the ground surface, all points will be automatically corrected by the GPS Device to reflect the actual ground surface elevation. If another user then operates the Device and holds it at a different height, the elevation coordinates of the recorded features will be inaccurate. For this reason, be sure to hold the GPS Device at the same "CONFIRM ANTENNA HEIGHT" when recording features.

Prior to collecting data, press the 'Options' menu and select or confirm 'Log Later.' Press the blue "CREATE" button.

In the comments section, enter the two-digit continuous sequence number followed by any comments or clarification about the feature that you are about to create. For example, the GPS identification code for the first mine feature surveyed in Leviathan Creek Study Area on July 12, 2014 would be MFL07121401.

Once the comments for the feature have been entered, hold the GPS Device at the specified "CONFIRM ANTENNA HEIGHT" (described earlier). Press the "LOG" button with a green triangle on the right side and the GPS unit will begin recording data points from the satellites.

For each point feature collect a minimum of 30 data points by holding the GPS Device still in place for enough time that the blinking number seen in the upper right corner of the screen reaches "30". This counts the data points that are being collected for that given feature and has a red bull's eye to the left of the number. For line and area features, the number of required data points will depend on the walking speed of the user, the available satellites, and the

location of interest. The actual number of data points collected will be at the discretion of the user. If possible, the user should try to record a line or area feature twice: recording in one direction and then repeating the process in the reverse direction. This will help check for accuracy and precision. When the data collection is finished, press "OK" and the Data Collect screen will close. More information on how to collect data is presented on pages 90 through 104 of the TerraSync Software Guide.

While data points are being logged, take note of the estimated field accuracy. When it can be safely performed, pause the logging and enter the estimated field accuracy in the COMMENTS field. Due to the limited space available within the COMMENTS field, enter EFA (for Estimated Field Accuracy) and the value. The estimated field accuracy should also be hand written in the sample control log with a description of the feature (explained later). After this information has been entered and completed the logging, press "OK" to close the data file.

To view the feature that you have collected on a map within the GPS Device, press the Section tab → "MAP". It should be noted that the mapped feature is approximate unless the data have been differentially corrected (real-time or post-processed). Post-processing is discussed later in this SOP.

30.6 GPS LOG

A GPS log shall be filled out immediately after collecting the data point with the GPS Device. This hand written log will serve as a backup to the electronic information stored on the GPS Device and will help to associate the GPS identification code (e.g., MWL07031108) to the location identification name (e.g., MW-08) and can be used to provide additional comments such as the estimated field accuracy. GPS logs are provided in SOP 3.0.

30.7 POST-PROCESSING

Data collected in the field must be post-processed to obtain sub-meter accuracy. This activity can be performed by trained personnel that have computers containing the appropriate data management software (i.e., ActiveSync, Windows Mobile) and the appropriate differential correction software (i.e., ESRI, ArcPad or GPS Pathfinder Office). It is highly recommended that all data be submitted to trained personnel to avoid errors or loss of data. Instructions for independently post-processing the data are described below.

Three steps are required in order to post process field data: 1) a data transfer, 2) differential correction of the data, and 3) the data must be exported in the desired format. The following

instructions assume that the user will have access to a computer that has the appropriate software preloaded. If software is not preloaded, ActiveSync and GPS Pathfinder Office must be installed before continuing.

30.7.1 Data Transfer

On the computer, open GPS Pathfinder® Office Software program ('START MENU' →"PROGRAMS" → "TRIMBLE" → "GPS PATHFINDER OFFICE"). Load the GPS unit into the docking station and connect the dock to an AC outlet and to the computer. The Pathfinder Office program will recognize the GPS Device and display a successful connection. When prompted on the computer to choose a project file, select the LEVIATHAN project file, if it exists. Otherwise, create a new project file.

Under the "UTILITIES" dropdown menu at the top of the page, select "DATA TRANSFER". In the Data Transfer window, select "ADD" →"DATAFILE". Select the appropriate data files to be post-processed and select "OPEN". In the Data Transfer window select "TRANSFER ALL". The program will import the field data from the GPS unit and read "SUCCESSFULLY TRANSFERRED" once the data transfer is complete. Close this window and the Data Transfer window.

30.7.2 Differential Correction

Under the "UTILITIES" dropdown menu, select "DIFFERENTIAL CORRECTION". This will open up a separate program appropriately named "DIFFERENTIAL CORRECTION". Then select the files you created in the field (Section 30.4) and click "NEXT". Select "AUTOMATIC CARRIER AND CODE PROCESSING" for "PROCESSING TYPE" and "USE A SINGLE BASE PROVIDER" for "H-STAR PROCESSING" before pressing "NEXT". Verify that on the "CORRECT SETTINGS" are as follows: "OUTPUT CORRECTED POSITIONS ONLY, SMART AUTOMATIC ROVER FILTERING, AND RE-CORRECT REAL-TIME POSITIONS" before pressing "NEXT".

At the Choose Base Station window, select the Base Station in use at Leviathan: **UNAVCO, Wellington, Nevada (p136)**. If UNAVCO, Wellington, Nevada (page 136) is not an available option, select "Update List" to download all available base stations. See Section 30.8 for information regarding the base station.

Note: UNAVCO is a non-profit membership-government consortium, which facilitates geoscience research and education using geodesy (http://www.unavco.org). Another reputable base station source is the Continuously Operating Reference Stations (CORS) managed by the National Geodetic Survey (http://www.ngs.noaa.gov/CORS/cors-data.html).

Click "NEXT" and then "START". Select Confirm and the screen will read "DIFFERENTIAL CORRECTION COMPLETE". Close the Differential Correction window.

30.7.3 Exporting Features

Under the "UTILITIES" dropdown menu, select "EXPORT". Unless otherwise coordinated with the CAD/ArcGIS personnel that will be receiving the data, choose Shape File package. Select "OK" and the files will be exported and saved in the chosen locations. Alternately, if it is desired to get the coordinate information for each point for compilation on a location table, the data can be exported to an .mdb file (Microsoft Access format).

30.8 DATA MANAGEMENT

The coordinates collected in the field with the GPS Device must be post-processed for subsequent data management or use in geospatial software. All data records, including the GPS Logs, the downloaded electronic files, and other field notes will be maintained in the project files and managed accordingly.

30.9 CREATING WAY-POINTS TO LOCATE A PRE-RECORDED FEATURE

The Geo XH GPS has the ability to create way-points to find a location. For example, if Northing and Easting are known for borehole DB-05, they can be entered into the GPS as a way-point and used to navigate to that location. For setting up GPS settings refer to Section 30.2.1 Setup. To create a new way-point file, perform the following steps:

1. Section Tab → "NAV".
2. Select Subsection Tab → "Waypoint".
3. Select "NEW" and the GPS unit will prompt for a file name.

The 9 digit alphanumeric name with "w" at the end that should have been entered when setting up GPS settings will appear along with an additional 7 digit alphanumeric value assigned by the GPS. If the 9 digit alphanumeric name is incorrect it can be edited at this step.

4. Delete the 7 additional digits after "w" and select "OK".
5. Select Options → "New". The GPS unit will prompt to enter a name for the point, Northing, Easting and Elevation. Bearing (T), Horizontal distance and vertical distance should be left with their default values of 0.00.
6. Enter Point name, known Northing, Easting and Elevation and choose "OK". Multiple way-points can be created in the same file by following the same steps starting with selecting Step 5 Options → "New".

Once all the points have been created and saved they can be used to navigate to their coordinates. If the file is still open, this first step for opening a file can be skipped.

7. Select Section Tab → "Nav"
8. Select Subsection Tab → "Waypoint". Highlight the desired file in the list by clicking on it and choose "Open". The list of available way-points will be listed. Highlight the desired way-point by clicking on it.
9. Select Options → "Set Nav Target". Two crossing black flags should appear in the highlighted way-point name.
10. Select Subsection Tab → "Navigate" once a way-point is selected as a Nav target and the GPS will be ready to direct the user to the way-point which is set as the Nav target.

    The screen will show a circle with an arrow pointing in the direction of the way-point, along with four information boxes which can be customized to the user's needs. Some examples are distance, altitude, heading or bearing. The user must begin moving in order for the GPS unit to give an accurate direction to the way-point.

11. Select Subsection Tab → "Waypoint" in order to change the Nav target. Highlight the desired way-point.
12. Select Options → "Set Nav Target".
13. Select Subsection Tab → "Navigate" and follow the GPS directions to the newly selected Nav target.

30.10 OTHER FEATURES AND ASSISTANCE

A number of other features are available on the Geo XH GPS Device which have not been discussed within this SOP. These features consist of:

- Uploading other background files;
- Real-time differential correction to get sub-foot accuracy in the field (no post-processing); or

- Structured data collection and creating data dictionaries with pre-designed drop down menus.

These features are described in detail within the user manuals. Copies of all user manuals must be made available in the project field office at all times. Additional assistance can be obtained from California Surveying and Drafting Supply, Inc. by calling (800) 243-1414.

30.11 REVISION LOG

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
1	Travis Phelps Kristi Jones Jon Browning	Changes made to sections 30.2.1.1, 30.5, 30.6, 30.7.2, 30.7.3, 30.9 and 30.10. Changed AMEC Geomatrix, Inc. to AMEC Environment & Infrastructure, Inc. Added section 30.11 revision log. Updated footer to match current location. Removed Eric Morita from section 30.4 as alternative contact. Edited header. Added GPS log to documentation and attachments.		7/10/12 3/28/12 12/11/13

Revision Number	Author	Description of Change (Section number)	Reviewed and Finalized	Date
2	Joe Gonzales	Updated sections 30.2.1.1, 30.5, 30.6, 30.7.3, 30.10, updated figure numbers, updated Section 30.7.2 with updated differential correction screen shots, added section 30.9.	Kent Parrish	4/25/14 7/24/14
3	Abby Cazier	Technical review and edits. Removed redundancy with operation manual. Removed figures from text. Created Table 1 that includes a summary of existing site GPS background files.	Lynda Lombardi	2/26/15

ATTACHMENTS

- 30a - GeoExplorer 2008 Series Quick Start Guide
- 30b - GeoXH 2008 User Manual
- 30c - Table 1 Existing Site GPS Background File Acronymns

Geoexplorer 2008 series Quick start Guide

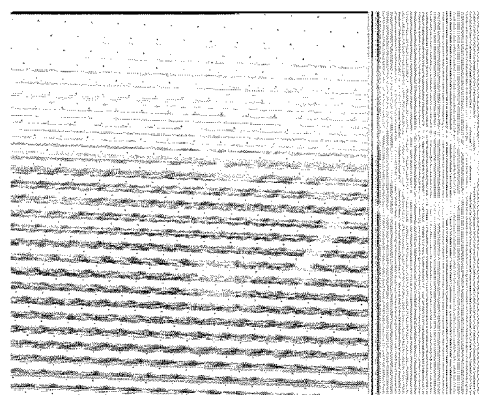
This guide provides an overview of the features and functions of the Trimble® GeoExplorer® 2008 series handheld.

For more information, refer to the *GeoExplorer 2008 Series User Guide*, provided on the *GeoExplorer 2008 Series Getting Started Disc*.

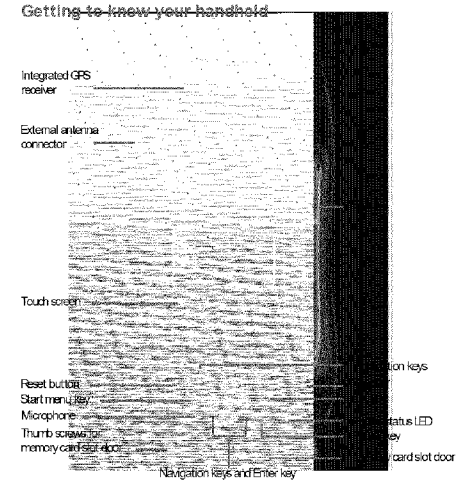
For the latest information, including release notes, go to www.trimble.com/support.shtml. Click the link for your model of handheld (*GeoXH™*, *GeoXM™*, or *GeoXT™*) and then click *GeoExplorer 2008 series*

Trimble

What's in the box?



Getting to know your handheld



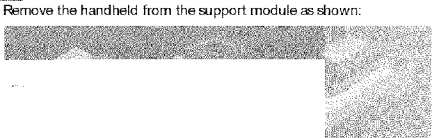
Charge the battery first

C Warning – For safety information, refer to the "Safety" section of the *GeoExplorer 2008 Series User Guide*

Place the handheld in the support module as shown:

Connect the support module to an AC power outlet and leave to charge. This may take up to eight hours. When charging, the Power LED on the handheld is solid orange. When fully charged, the Power LED is green

Remove the handheld from the support module as shown:



TIP – To improve battery performance, turn off the integrated Bluetooth and wireless LAN radios and disconnect from the integrated GPS receiver when not in use.

Turn on the handheld

Press and release the **Power** key to turn on or to turn off the handheld.

The first time you turn on your handheld, you must select the language used by the Windows Mobile® operating system.

C caution – You can only select the language once. To change the language used on the handheld, you must return the device to your Trimble service provider.

To select the language used on the handheld:

1. Press the **Up** or **Down Navigation** key to select the language you want to use and then press the **Enter** key.
2. In the confirmation screen that appears:
   - To select a different language, press the **Enter** key to return to the previous screen.
   - To use the selected language on the handheld:
     a. Use the **Up Navigation** key and the **Enter** key to check the box and confirm your selection.
     b. Use the **Down** and **Right Navigation** keys to select the Next button.
     c. Press the **Enter** key to install the selected language onto the handheld.

   Once the selected language is installed, the handheld restarts.

Follow the on-screen instructions to align the touch screen, using the stylus to tap on the screen.

Interacting with the handheld

Trimble recommends that you use only the stylus provided to tap on the touch screen.

To remove the stylus from its holder on the front of the handheld, press the spring on the stylus downwards and then lift the stylus forward, as shown.

Use the stylus to:

- Tap the screen once to open items and select options.
- Tap and hold the stylus on an item to see a pop-up menu of available actions. Then tap the action you want to perform.

To enter text, use one of the input panels.

To display the current input panel, tap a text box.

To select an input panel, tap the arrow next to the Input Panel button and then tap the input panel you want to use.

The Keyboard input panel is shown to the right. To enter characters, tap on the keyboard.

TIPS –

To enter special characters, tap 123 to display keypads containing numbers and symbols. To switch back to the main keyboard, tap 123 again.

To make the keys larger, tap the Input Selector arrow and then tap **Options**. In the *Input method* list, select Keyboard and then select *Large Keys*

Set the date and time zone

In the *Today* screen, tap the clock icon. The *Clock Settings* screen appears. Tap the *Time* tab, select the *Home* option and then select the correct time zone for your location.

Inserting a memory card

To use an SD or SDHC memory card:

1. Use the thumb screws on the base of the handheld to remove the memory card slot door.
2. Insert the memory card into the memory card slot with the swipes facing down. Gently press the card until you hear a click, and the card is locked into place.
3. Reattach the memory card slot door and use the thumb screws to tighten.
4. When you select the *Save As* option in an application, the memory card appears in the list of available storage locations.

***Note** – Do not store required data or applications to a memory card if the card will be removed. Data saved to a memory card is available only when the card is inserted in the handheld.*

To remove the memory card, gently press the card in. The card pops out.

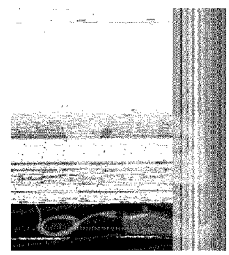
Connecting to a computer

To transfer files to the handheld, or to install software onto the handheld, you must connect the handheld to a computer. If the computer is running the:

- Windows Vista® operating system, use the Windows Mobile Device Center (WMDC) to manage the connection.
- Windows® XP or 2000 operating system, use Microsoft® ActiveSync® technology to manage the connection

***Note** – You must install the Windows Mobile Device Center or ActiveSync technology onto the computer **before** you connect the handheld.*

To download the Windows Mobile Device Center or ActiveSync technology from the Microsoft website, go to www.microsoft.com/windowsmobile.



Status indicators

Status indicators are displayed in the title bar at the top of the screen.

Icon	Description	Tap icon to...
	Battery level	check battery level
	Low battery (20% or less remaining)	
	Battery charging/using external power	
	Speaker is on	change volume
	Speaker is off	
	Connected to ActiveSync or the Windows Mobile Device Center (WMDC) on a computer	configure the connection or access the Wireless Manager
	Connected to a Bluetooth-enabled phone	
	Disconnected from ActiveSync or WMDC	
	Disconnected from a Bluetooth-enabled phone	
	Wireless LAN radio is on	
	A wireless LAN is detected	
	Sending or receiving wireless signals	

The Wi-Fi and Bluetooth icons on the *Today* screen show the status of each radio. Tap the icon to access the Wireless Manager and turn on or turn off the radio.

The Power LED on the handheld flashes re when the battery is low (less than 15%).

Connecting to GPS

To collect GPS data, install GPS field software onto the handheld and, if required, configure the software to connect to the integrated GPS receiver.

Icon	Description
TerraSync™ software	No configuration required. The software automatically activates the GPS receiver on COM3.
GPS Controller software	
ArcPad with the GPScorrect™ extension	During installation, the Trimble GPScorrect extension automatically configures the ArcPad software to use the GPS receiver on COM3. To connect to GPS, tap the **GPS** button and then tap **Yes**
ArcPad 7 without the GPScorrect extension	In ArcPad, tap the **GPS** button drop-down menu and select GPS Preferences. Then tap the GPS tab. In the Protocol field, select NMEA 0183 and then select COM2 from the Port field. Tap **OK**. To connect to GPS, tap the **GPS** button and then tap **Yes**
NMEA application	Configure the software to connect to GPS on COM2 and then use the Connect or Activate GPS command.

TIP – To configure GPS receiver or real-time correction settings when using NMEA applications, use the GPS Controller software provided on the handheld.

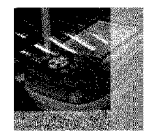
Troubleshooting

If the screen on the handheld is blank, do one of the following:

- Tap the screen with the stylus or press one of the **Navigation** keys to turn on the backlight.
- Press the **Power** button to turn on the handheld.

If the handheld stops responding to the stylus, or if it does not respond when you press any keypad button, you may need to reset it. First, try a soft reset.
If the handheld does not respond, perform a hard reset.

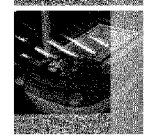
Performing a soft reset



A soft reset retains all data and settings.

To perform a soft reset, use the tip of the stylus to lightly press the **Reset** button on the keypad.

Performing a hard reset

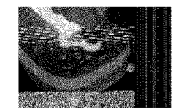


***Note** – Any unsaved data may be lost after a hard reset.*

Perform a hard reset only if performing a soft reset does not resolve the issue.

To perform a hard reset, press and hold the **Power** button as you use the tip of the stylus to lightly press the **Reset** button on the keypad.

Fitting the handstrap



1. Align the straight bracket with the slots below the Microsoft Windows Mobile logo. Insert the bracket by pressing down and into the slots.
2. Insert the first screw and then use a coin or screwdriver to tighten the screw.
3. Align the curved bracket with the slots above the communication swipes at the base of the handheld.
4. Insert the second screw and then use a coin or screwdriver to tighten the screw.

Applying the screen protector

To protect the screen from pressure and abrasive objects, Trimble recommends that you apply one of the screen protectors provided with your GeoExplorer 2008 series handheld to the touch screen.

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Trimble Navigation Limited
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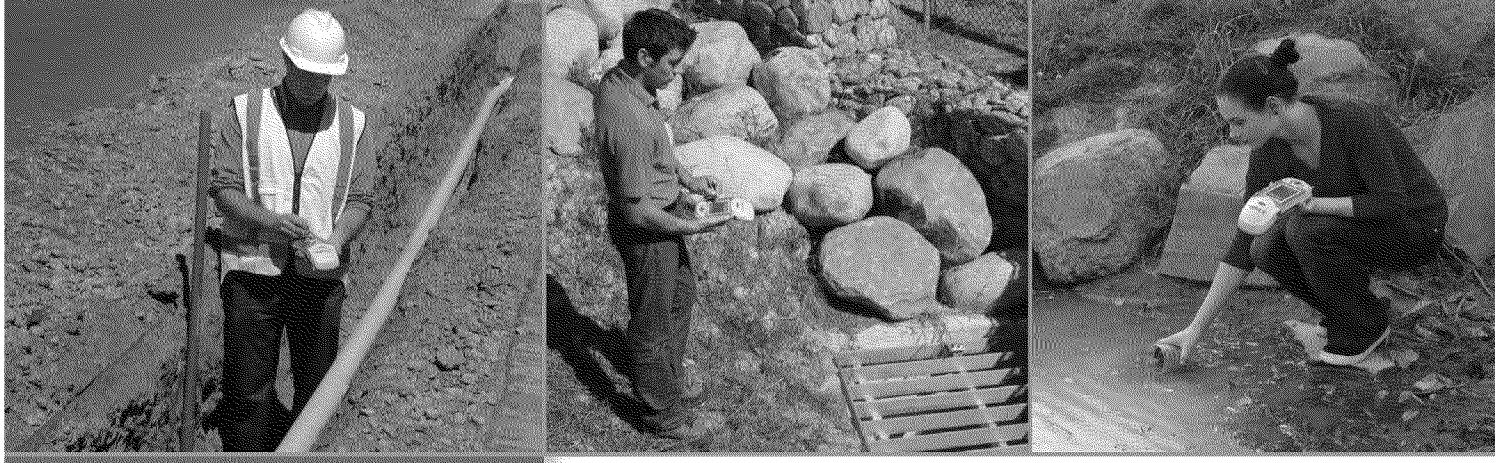
Suite #100
Westminster, CO 80021
USA

www.trimble.com

Trimble



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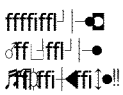

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- $/’;=(8’/GG’;%&’<,=&;//;%’789’>)(&,&66’?@A’(79)/6’/8,EK

’/(7B$72&’%)&&R)7(&,&66’?&8’XI)E’):/8’
6:(&&8’789’;%&8’;72’[\]^_^‘’abYcYd^]B’

+B$72’ eff ’;/’;=(8’/GG’+/;%’(79)/6B’$%&’6;7;=6’G)&,96’+&,/>’;%&’R)gH)’789’
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k┬¶┤ m¶╢ ←n├o┬├ ←┬n ¶╢┬!├ ¶ #

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;=(8’);’/8’T6&&’=(8)8J’/8’789’;=(8)8J’/GG’;%&’)8;&J(7;&9’(79)/6’/8’

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}YcX}^_Xa\iaz}^a{Wxcz]Za\ca~}\{}aZWxaY]^a~W]Ñ\cdaXW^‘acWzaYÖÜ]W|^az}^ax‘^aWia~\]^_^‘’
YcXÇW]aÉ_x^zWWz}a~\]^_^‘’az^{}cW_WdZjaÜaZWxaY]^axc‘x]^aYáWxza~}^z}^]az}^aà^WâäÖ_W
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789ì/(’<,=&;//;%’(79)/D’/(’;/’(&7:;)I7;&’;%&’(79)/6’)G’;%&E’%7I&’+&&8’9&7:;)I7;&9B’$%&’
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_<B'O@EBA<A:aTTb:9<A8<9:7?K;7<E;^9:D?CC<ALV:J9<:C7<:7?K;7<E;V:@QX<adN

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>86D6:15?121345@2<2E6F
GH3?4;28E65?121345676418343195I8=<59=A85J=@95J6I=8659=A51=A4;52:95=I51;65676418=:34
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55A:>23:16@5<61275?A8I246B

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a_]OWPcR_]\b\R_[PR‘PVRePNag\]\bhPOTbWOgOVhPN\^NPfRVbi^O V^OPOfO_b[P
iWOPUR[[\jVOkPl[OW[PiWOPi]f\[O]PbNibPbNOPW\[mPR‘Pcia[_^P]\[PbRP
[O_[\b\fOPOVOcbWR_\c[Pci_PjOPg_\g\[O]PjhPifR\]_^P‘_^OWPcR_bicbPbRPbNOP
WOcO[[O]PcR__OcbRW[PibPbNOPjicmPR‘PbNOPa_\bk

nNRaV]P[acNPi_POfO_bPRccaWoPbNOP[cWOO_PgihPjOPbOgURWiW\VhPi‘‘OcbO]Pi_]PjO
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WO[bRWOPbNOPa_\bPbRPbNOPRW\^_iVP]\[UVihoPi_]PbNOWOPe\VVPjOP_RPiccRgUi_h\
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Ç31;3A<É3=:5J211689B5Ñ28E652:@5A?651;65J2116895=:7953:5?183415244=8@2:465Å31;51;65
3:?18A413=:?5>8=D3@6@B5
C=5>86D6:153ÖA895=85@2<2E6F
GÜ6D6852116<>151=586<=D6K586>7246K5=8586>23851;65J21168959=A8?67IB5
GH=5:=15@2<2E651;65J211689B
GH=5:=15?1=865=85762D651;65;2:@;67@5:628525;6215?=A8465?A4;52?525I386>72465=85=1;685
555;621ÉE6:68213:E52>>732:46K5=85=1;68Ä3?656}>=?653151=516<>6821A86?53:56}46??5=I5á 5aÑ5
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GH=5:=15A?651;65;2:@;67@53I51;65J21168952>>628?51=5J65762è3:EB5
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XRP^PTKOYKLKMNOZLVL_P‘
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OO[TXLMTKPZOVPKLQOY[RcLNP\

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KUPOYKWRL_PONLRZOYQWK‘O
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OOOKUPOULTZUPQZOW[KZWWRY\O
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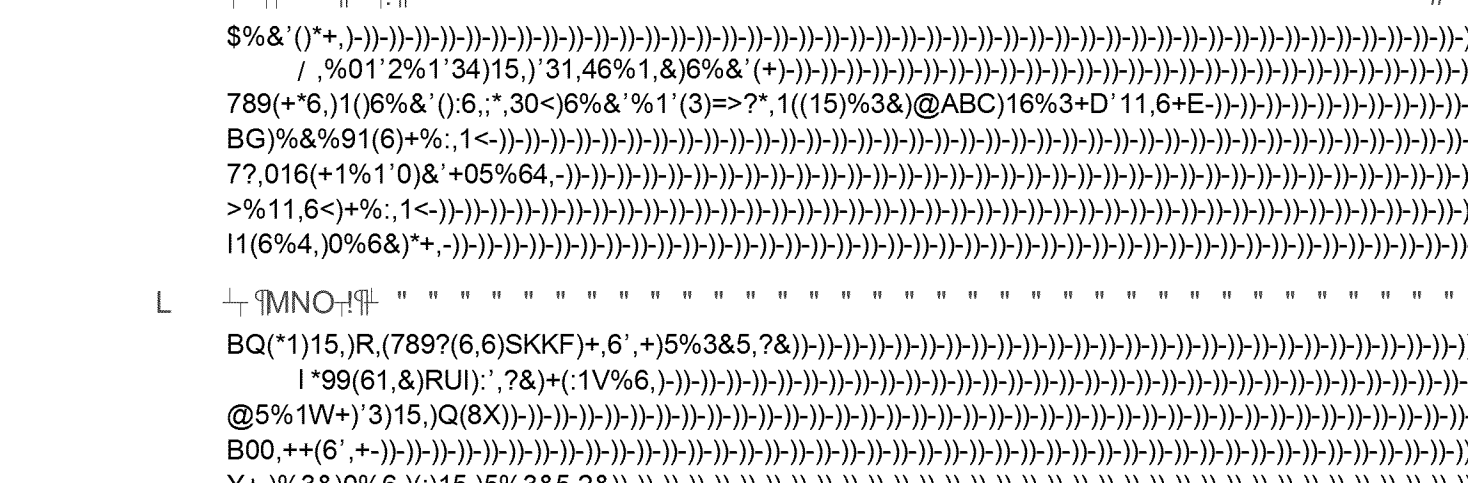

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.07F>921/@@7D3A04?0/G2:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

H2>9?3167321I@C23:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

K7G4L>9?3/9D307A@/8>9?3167321I@C2:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

M9170/81>9?3N>16316736/9D67@D:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

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Q9170>9?3>9540G/1>49:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

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Y7L>873@48U:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

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BI986049>W>9?37FG/>@3G722/?72:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

[499781>9?3D>0781@I3143/937FG/>@3270L70:33:33:33:33:33:33:33:33:33:33:33:33:33:33

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[499781>9?316736/9D67@D3143/384GAC1703:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

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P700/BI9832451N/07:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

QBKM3=08./D32451N/073/9D31673P0>Gb@73i.B840078137j1792>49:33:33:33:33:33:33:33:33:3

i.B3[49104@@7032451N/0733:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

k16703i.B35>7@D3/AA@>8/1>492:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

P0>G.>j3178694@4?I33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

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i.B3[kT3A4012:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

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B1/01>9?31673i.B35>7@D32451N/0733:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33:33

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?,#=,##┴↑├ !-0‹#←#.→┬7#┬)↑← →@,┴=5┬↑#$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$

A BCDDEFGHIJFFCKDCLMHHMHHMHHMHHMHHMHHMHHMHHMHHMHHMHHMHHMHHMH

┬↑┬)← →┤┴)┬ ┬""→*.↑↑┬*#┴.↑┤┴↑/.)5‹#┴.↑$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
<┬←*#┴ ‹#┴↑├#(┬→┴↑#┬|)‹#┬0→)-0┴."→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
O,)↑┴↑├.↑←↑0-#,)↑┴↑├.//-#(┬→┴↑#┬|)‹#┬0→)-0┴."$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
?=#┴.↑"→/.)→*.↑↑┬*#┴↑├┤┴)┬ ┬"" -#.→.#(┬)-0┬ ┴*┬"←↑0→↑┬#|.)P"→$→$→$→$→$→$→$→$→$→$→$→$→$
4.↑↑┬*#┴↑├#.←→┤┴)┬ ┬""-9QR←**┬""←=.┴↑#→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
4.↑↑┬*#┴↑├#.←S ,┬#..#(2┬↑← ┬0-0┬ ┴*┬→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
4.↑↑┬*#┴↑├#.←S ,┬#..#(2┬↑← ┬0←=(.↑┬/.)-T↑#┬)↑┬#←**┬""→.)→)┬← 2#┴5┬*.))┬*#┴.↑"→
U┴↑* ,0┴↑├¶!→┬#|.)P"V→→→→→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
4.↑↑┬*#┴↑├#.←S ,┬#..#(2┬↑← ┬0→"┬)┴← -0┬ ┴*┬$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
4.↑↑┬*#┴↑├#.←↑→.//┴*┬*.5=,#┬)-#.→,"┬Q*#┴ ┬!-↑*-#┬*(↑. .├→→$→$→$→$→$→$→$→$→$→$→$→$→$W3
?,#=,##┴↑├ !-0‹#←#.→.#(┬)-0┬ ┴*┬"→,"┴↑├S ,┬#..#(→┤┴)┬ ┬""-#┬*(↑. .├$→$→$→$→$→$→$8XX
+↑← ┴↑├.#(┬)-0┬ ┴*┬"-#.-#)←↑"/┬)→/┴ ┬"→,"┴↑├S ,┬#..#(→┤┴)┬ ┬""-#┬*(↑. .├→$→$→$→$→$→$8X8
S┬5┴↑├/┴ ┬"-#.→.)→/).5←↑.#(┬)-0┬ ┴*┬→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
Q**┬""┴↑├←*.)=.)‹#┬→↑#|.)P-#()., |(←.,)-T↑#┬)↑┬#-*.↑↑┬*#┴.↑$→$→$→$→$→$→$→$→$→$→$→$8X;
S ,┬#..#(→┤┴)┬ ┬""→*.↑↑┬*#┴.↑"→┬7= ←┴↑┬0→$
4.↑↑┬*#┴↑├#.←S ,┬#..#(-0┬ ┴*┬←"←* ┴┬↑#→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
). ┴0┴↑├S ,┬#..#(→"┬) ┴*┬"←"←(."#→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
4.↑↑┬*#┴↑├#.→.#(┬)-0┬ ┴*┬"→,"┴↑├#(┬→"┬)┴← →* ┴=→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
Q##←*(┴↑├#(┬→"┬)┴← →* ┴=$→$
4.↑↑┬*#┴↑├#.→┬7#┬)↑← -0┬ ┴*┬"→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$→$
4.↑↑┬*#┴↑├#.←↑→┬7#┬)↑← ←=.┤┬)→".,)*┬→┤#(-#(┬→"┬)┴← →* ┴=$→$→$→$→$→$→$→$→$→$→$→$→$

N YZJ[\]C^_JJDEFGHHMHHMHHMHHMHHMHHMHHMHHMHHMHHMHHMHHMHHMHHM

.┤┬)→┴"",┬"→$
S←*P ┴|(#→┴"",┬"→$
O.,*(→"*)┬┬↑→┴"",┬"→$
b┬-=‹0→┴"",┬"→$
!#.)←├┬*←)0→┴"",┬"→→→$
4.↑↑┬*#┴.↑→┴"",┬"$→$
Q*#┴ ┬!-↑*-#┬*(↑. .├→→→→$

¶┴┤↑├ ↑ ┴ ← !┴" ‹# ┬$ %←←←←&←

) $├↑%*‹"↑┬┬ "$┴↑┬←←←←&←

+ , $↑↑$-←┴% →$ "-┬↑ ↑./←&←

¶┴% →12)‹"↑┬┬ "$┴↑┬←←←←←&

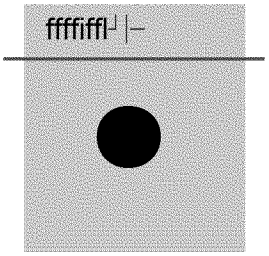
4 %┴5 ‹" ┴6←┴→, ←←←&←

9:4‹% " ┴! %←┴→, ←←←←&←

; 5 <$┴= ←9:4←┴→, ←←←←←&←

; "↑== ┬┤ ┤‹9:4↔ $$┴┬.←?↑%‹=5@┴=,=‹6% "┴┴↑┬←&←&←&←&←&←&←&←&←&←&←&←&←&←&←&←&

BCDEFGHHGHHGHHGHHGHHGHHGHHGHHGHHGHHGHHGHHGHHGHHGHHGHHG



!"# $

%&'()*+',)-.(/01

- 2456789:8;:5<=>?5@:@8ABBC8 D:@E:D89FGH9:?H
- 2 I9F7JD8EG879:845=K
- 2 3LL:DD5@E:D
- 2 MD:8FGH8LF@:85N879:89FGH9:?H
- 2 O:L9GELF?8FDDED7FGL:
- 2 P56@8L5QQ:G7D

RSTUVWXYZ[\X]W]^_''a^bW]cWd^edW]^VfcgWUhTijklmTiU
SnoUpnUiTpUqrUsthUqiTUpSTUURklumvT
xTnyzrvnkTkU{||}UiTklTiUSsthSTvh~URSTU
lt nkusplntUltUpSliUÄqlhTUiqrrvTuTtpiUpSTU
lt nkusplntUltUpSTUVWXYZ[\X]W]^_''a^bW]cWd^ÅfcÇÉ^
bÑÖÜÑ^VfcgWÜUoSljSUánqUkTjTlàThUolpSUpSTU
SsthSTvh~U

RSliUÄqlhTUhTijklmTiUSnoUpnâ

- ä qiTUpSTUãljknin/ÅÄthnoiUãnmlvT wU àTkilntUçUnrTksplÄUiáipTu~
- ä qiTUpSTUSsthSTvhéiUltpTÄkspThUxèêUkTjTlàTk~
- ä iátjSkntlëTUlt nkusplntUmTpoTTtUsU j nurqpTkUsthUpSTUSsthSTvh~
- ä TzjSstÄTUlt nkusplntUmTpoTTtUpSTU SsthSTvhUsthUnpSTkUhTàljTi~
- ä jnttTjpUpnUpSTUítpTktTpUnkUpnUsUjnurqpTkU t Tponkì~

yàTtUl UánqUSsàTUqiThUnpSTkUxvnmsvUènilplntlÄU
êáipTuUîxèêïUrknhqjpiUmTl nkTÜURklumvTU
kTjnuuTthiUpSspUánqUirTthUinuTUpluTUkTshltÄU
pSliUÄqlhTUpnUvTsktUsmnqpUpSTUirTjlsvUl TspqkTiUnl U
pSTUrknhqjp~Ul UánqUskTUtnpUl sulvlskUolpSUxèêÜUÄnU
pnUpSTURklumvTUoTmnlpTkUîmvT~jnìUl nkUstU
lt pTksjplàTUvnnìUspURklumvTUsthUxèê~

↑├-×- -!"#$-% % &''( ) %*) +,- $-

./012034567380819::;1<08=0<1=>?7@A0<1B/01
203CDE F11203CEGH>A1203CE.1
/H>A/07A<I1./0<01/H>A/07A<1?3JK=>01H
.8=JK7012LM180?0=N081O=B/1H1P=07A
63O080A1KQ1G=?83<3PB1R=>A3O<G3I
N08<=3>1S13608HB=>T1<Q<B0JI1

./012034567380819::;1<08=0<1/H>A/07A1
K@=7BU=>1V7W@0B=3B7/0<<1B0?/>373TC
?HK70UP8001?3>>0?B=3>1B313B/081A0I
O=8070<<1XYZ1[X3?H71Y80H1Z0BO38\]
?3>>0?B=N=BQ1P381?3>>0?B=3><1B31

./01203CG1/H>A/07A1683N=A0<1807=HK
H??@8H?Q1O=B/=>1^1B31_1J0B08<I1./(
/H>A/07A1@<0<14'4a4M1J@7B=6HB/1
80b0?B=3>1B0?/>373TQ1B31683N=A01<@KJ0B081
H??@8H?QI1./01203CD1/H>A/07A1@<0<1K3B/14'4a4MF1HB0?/>373T=081B31
683N=A01<@KP33B1[_:1?J]1H??@8H?QF10=B/081=>180H71B=J01381HPB08163<B683?0<
=>P38JHB=3>F1H608eF1f<=>T1B/012LM1aD?0=N08

g-##-% - hg i* $-)-i j+%

.31?3770?B12LM1AHBH1O=B/1B/012034567380819::;1<08=0<1/H>A/07AF1Q3@1J@<B1=>
P=07A1<3PBOH8013>B31B/01/H>A/07AI1k3@1?H>1@<01B/012034567380819::;1<08=0<1/H
O=B/1B/01P3773O=>T12LM1P=07A1<3PBOH80I

- .8=JK701.088HM=<3PBOH80F1P381?3>P=T@8=>T180H7UB=J01A=PP080>B=H71?3
36B=3><1H>A1P381683A@?B=N012nM1AHBH1?3770?B=3>1H>A1JH=>B0>H>?0I
- ./01.8=JK7012LM?3880?B=3>1B0><=3>1P3814Man1Y8?LHA1<3PBOH80F1P381?3>P=T@8
80H7UB=J01A=PP080>B=H71?3880?B=3>136B=3><1H>A1P381683A@?B=N012nM1A
H>A1JH=>B0>H>?0I
- ./01.8=JK7012LM1LHB/P=>A083<1M3PBOH801o0N0736J0>B1p=B1[Mop]F1P381
=>B0T8HB=>T12LM1AHBH1H>A1HAA=>T1NH7@01B31H>105=<B=>T1JH66=>T1H>A
<3PBOH801H667=?HB=3>I
- .8=JK7012LM1d3>B8377081<3PBOH80F1P381?3>P=T@8=>T180H7UB=J01A=PP080>
?3880?B=3>136B=3><1H>A1ZG4Y13@B6@B1<0BB=>T<I
- qB/0812LM1P=07A1<3PBOH801B/HB1H??06B<1ZG4Y1J0<<HT0<I

r stuvwvxyz{|}~ yÄÅÇÉÑÖÜÄ ázÉ~{~}àÄ~ÄÄÇâ{äÄzäz~{zÉ{yÄ~ÑäÇÖÄzãyÄÇÅ~åÅÄçyÄéyãäzèêÄÜÄ
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/ 66*2’(*0,@.,)()2;>*/;*;’,A)*B(6,AC*

DEFGHIJKLKEQRSGTITJUENVJNVIJWIXYZ[SXHIHJ\]]^JP I HEIPJV_QTVIST

‘);.(02*/66*0,)2()2;*a,7*?<;<B6(*=/@/b(*c;07/20’(;>*=()2;d*/)=*<a*/)+*0,@.,)()2;*
/ ..(/7*=/@/b(=>*),2<a+*2’(*;’<..<)b*0/77<(7C*e((.*2’(*;’<..<)b*/)=*./01/b<)b*@/2(7</6*
a,7*2’(*0/77<(7f;*<);.(02<,)C*******

!"#$%%$&'()"$*+'$(,%",--!..$/'!.",/!",0,'%,1%!2

- M$&!/7.!/',%"-%'*
- ZH%%"4$G!4"-,1%! T
- [! '-%!"*$&!/",G,*+$/ T
- C8+!/(,%"*$&!/"O'+
- \,/G"-,//L"-,.!
-],()!"*$%!
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- \H//'-,(!",(+!((,"O'+ D
- ^!* L/ _ ",(+!((,"O'+ S
- C8+!/(,%"*,+- ",(+!((,.
- M$%!'4$H(+,1%!")/$H(G"*%,(!
- a,.!1,%%"-,*"&'+ ",(+!((,".%!!0!
- a,-O*,-O"O'+
- R-/!!("*/$+!-+$/."QD"*,-OU
- R+L%H."O'+
- B!$a!,-$(_ "/!-!'0!/"Q/!-!'0!." G##!/!(+',%"-$//!-+'$(."#/$4","1!,-$(" (!+&$/OU

T]!bH'/!."*$&!/"7".!/',%"-%'*"Q.$%G".!*,/,+!%LU"

D c$4*,+'1%!"&'+ "B!$d\7de7d " ,(G !%G."#$/"'4*/$0!G"L'!%G6"f%.$"'4*/$0!.",--H/,-L"#$/"+ !"B!$de",(G" B!$d " ,(G !%G."$(%L6

S c$4*,+'1%!"&'+ "+ !"B!$d\" ,(G !%G"#$/"'4*/$0!G",--H/,-L6

3$/"4$/!"'(#$/4,+'$(5")$"+$"&&&6+/'41%!6-$47)!$8 6. +4%5 5% &&&6+/'41%!6-$47)!$846. +4%5 5"$/&&&6+/'41%!6-$47)!$8+6. +4%6

9↔:;<=:├; →: >:?@→:@;<=@→A=

$"*/$+!-+"+ !"B!$C8*%$/!/"DEEF".!/'!." ,(G !%G"& !("($+"'("H.!5" /'41%!" /!-$44!(G.".+$/'()"+ !" ,(G !%G"'("+ !"*$H- "*/$0'G!G6

I !("H.'()"+ !" ,(G !%G2

- $"*/$+!-+"+ !"+$H- ".-/!!("#/$4"*/!..H/!",(G",1/,.'0!"$1K!-+.5" /'41%!" /!-$44!(G."+ ,+"L$H",**%L"$(!"$#"+ !".-/!!("*/$+!-+$/."*/$0'G!G"&'+ "+ !" B!$C8*%$/!/"DEEF".!/'!." ,(G !%G6
- M/$+!-+"+ !"+$H- ".-/!!("1L"H.'()"+ !".+L%H."*/$0'G!G5",(G",0$'G"H.'()"!8-!..'0!" */!..H/!",(G". ,/*"$/",1/,.'0!"$1K!-+.6
- N!!*"+ !"$H+!/".H/#,-!"#/!!"$#"G'/+",(G"GH.+6
- C(.H/!"+ ,+"*/$+!-+'0!"-$0!/.",(G"G$$/.",/!",**/$*/',+!%L"#'++!G"+$"+ !"!8+!/(,%" , (+!((,"*$/+",(G".+$/,)!"-,/G",/!,.5".$"+ ,+"+ !L",/!"O!*+"#/!!"#/$4"G'/+5"GH.+5" #%H'G"'()/!.."P"!%!-+/$.+,+'-"G'.- ,/)!"QR!"$/,)!"-,/G.5"*,)!ST U6
- M/$+!-+"+ !" ,(G !%G"#/$4"!8+/!4!"+!4*!/,+H/!.6"3$/"!8,4*%!5"G$"($+"%!,0!"+ !" ,(G !%G"$("+ !"G,. 1$,/G"$#","0! '-%!6

$"-%!,("+ !" ,(G !%G5"&'*!"'+"&'+ ","-%!,("G/L"-%$+ 6"V$"WXY"'44!/.!"+ !" ,(G !%G"'(" &,+!/6

↑├→ ├! " # !$#

%&'()*'+,-'.)/'0)1.0'/)'*2-'/3-'3+.43-54'&),'/3,--'6)./32'),'6),-7'8,1695-'
,-:)66-.42'/3+/'()*'4)'.)/'5-+;-'/3-'3+.43-54'1.'<*2=-.4'6)4-'>2--' =+0-?@AB'
%2/-+47'=+,/1+55(':3+,0-'/3-'9+//-,('+.4'/3-.'/*,.')&&'/3-'3+.43-54B

8)'=,-=+,-'/3-'C-)DE=5),-,'?FF@'2-,1-2'3+.43-54'&),'2/),+0-G

HB3,+.2&-,'+.('4+/+'/3+/'()*'.--4'/)'+.')&&1:-':)6=*/-,B

?B3+,0-'/3-'9+//-,('/)'+==,)E16+/-5('JFK'+.4'/3-.',-6);-'/3-'3+.43-54'&,)6'
/3-'2*==),/'6)4*5-B

JBL,-22'/3-' MNOPQR-('&),').-'2-:).4'*./15'/3-'STUVW'6-.*'+==-+,2'+.4'/3-.'/+='
/3-'XYZ[\NO] '9*//).B

^B </),-'/3-'3+.43-54'+/',))6'/-6=-,+/*,-B

8)'*2-'/3-'C-)DE=5),-,'?FF@'2-,1-2'3+.43-54'+&/-,'2/),+0-G

HBL,-22'/3-' MNOPQR-('/)'/*,.').'/3-'3+.43-54B

?B '-:3+,0-'/3-'1./-,.+5'9+//-,('*21.0'/3-'2*==),/'6)4*5-'>2-- I3+,01.0'/3-'
9+//-,(7'=+0-?aAB

b!c c"$ "dd d├" c!

b!c c"$ deff→├

C)'/)'/3-'C-)DE=5),-,'?FF@'2-,1-2'3+.43-54'/-:3.1:+5'2*==),/'=+0-'
>g ggB/,1695-B:)6h0-)E3i/2B+27=gggB/,1695-B:)6h0-)E6i/2B+27'),''
gggB/,1695-B:)6h0-)E/i/2B+2A=').'/3-'8,1695-'g-921/-'&),'/3-'5+/-2/'2*==),/'
1 &),6+/1).'+9)*/'/3-'2)&/g+,-7'1.:5*41.0G

j klm2

j 2*==),/'.)/-2'4-/+151.0'2*==),/'122*-2

j 4):*6-./+/1).

j /3-'5+/-2/'&15-2'+;+15+95-'&),'4)g.5)+4

n## ├→"$!$f

%&'()*'2/155':+..)/'&1.4'/3-'1.&),6+/1).'/3+/'()*'.--47'opqrsortupvwtxwyz{|}tw}~}||}wB'

!"" " "!# "$ %

&’(’)*(+,-(*.+/),(+(012*)/)’3(41,5)6/(7**)*(8.9)*31,:(51+;):(+99.+*/<(1,512+31,:(3=+3(
3=.(=+,5=.;5()*(>*1?@;.(ABC(’1.;5(/)’36+*.(=+/(.,2)D,3.*.5(+(9*)@;.?(+,5(,..5/(3)(
2;)/.<(-)D(+*.(9*)?93.5(3)(/.,5(+,(.**)*(*.9)*3(3)(012*)/)’3E

>*1?@;.(*.2)??.,5/(3=+3(-)D(2;12F(+,-(/D@/.LD.,3(;1,F/(3=+3(+*.(
D/.5(3)()@3+1,(+55131),+;(1,’)*?+31),E(

>*1?@;.(2+,(+22.//(3=.(*.9)*3(3=+3(1/(/.,3(3)(012*)/)’3(+,5(D/.(13(3)(1?9*)M.(3=.(
A.)7N9;)*.*(OPPQ(/.*1./(=+,5=.;5E

R S" T UU!$

V)D*(’..5@+2F(+@)D3(3=.(/D99)*31,:(5)2D?.,3+31),(=.;9/(D/(3)(1?9*)M.(13(613=(.+2=(
.M1/1),E(7W?+1;(-)D(2)??.,3/(3)(+5.*X..5@+2FY3*1?@;.E2)?E

ffffiffl┘|–

!"# $% &

’()*+,-).+/0*123

TUVWXYUZ[\]^X_]WY^V‘]WX\U]XaZVbXc]Z\d^]WXecX\U]X
f]egh[ie^]^XjkklXW]^V]WXUZb_U]i_mXZb_X[^enV_]WX
\U]XVbce^aZ\VebXoedXb]]_X\eXp]\Xd[XZb_X^dbbVbpX
qV\UX\U]XUZb_U]i_r

4789:;<:8=>:?>;@ABC;7>7:DEEF:
9>7G>9:=6HI=>CI

4 J>KB6I:LM88;H9

4 5;N>7GHO:8=>:=6HI=>CI

4 PM7HGHO:;H:6HI:8M7HGHO:;<<:8=>:
=6HI=>CI

4 Q>9>88GHO:8=>:=6HI=>CI

4 R8;7GHO:I686

4 SG88GHO:8=>:=6HI9876B

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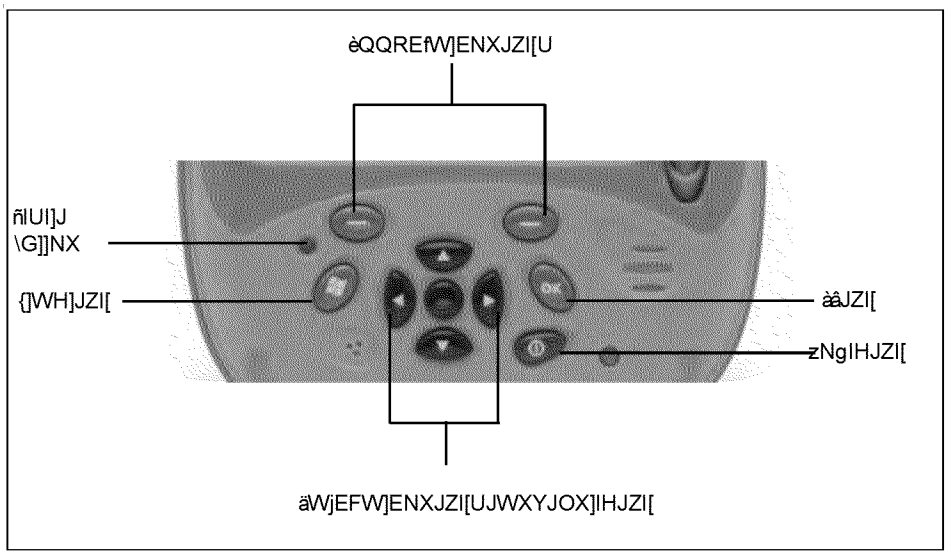

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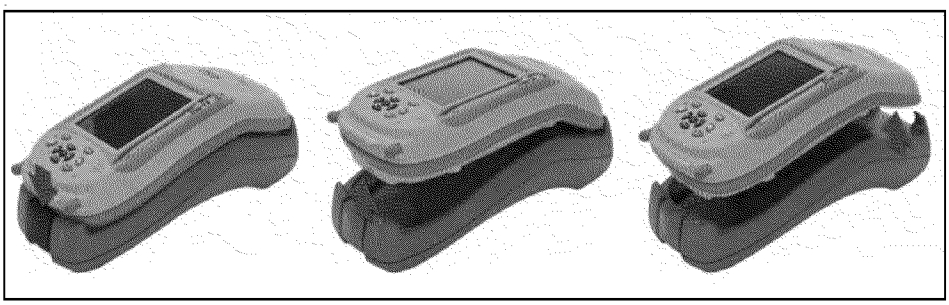

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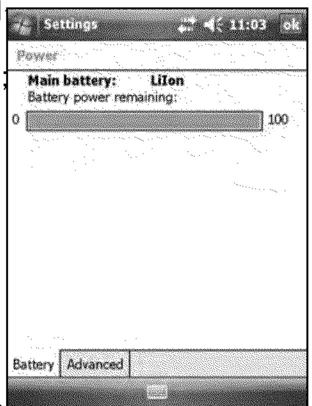

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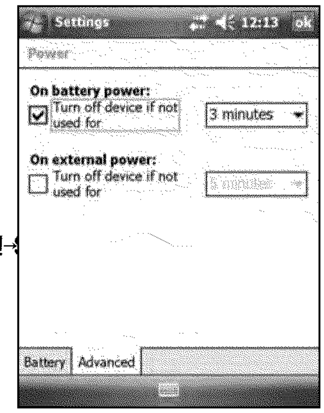

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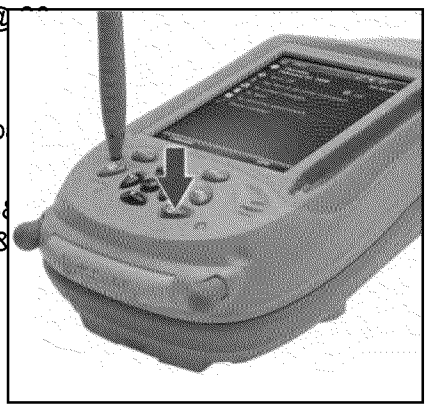

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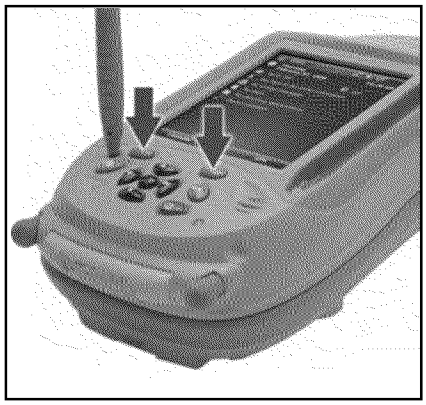

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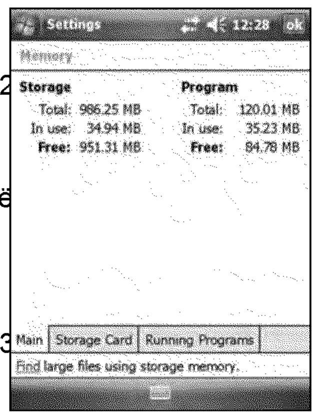

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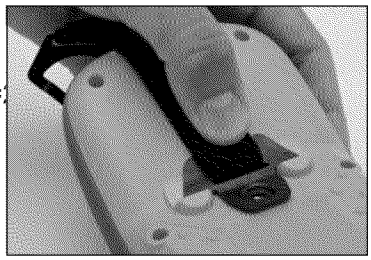

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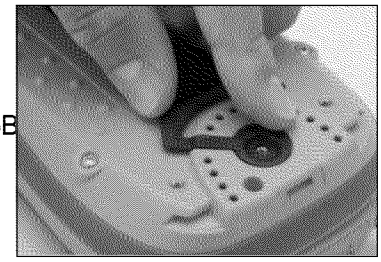

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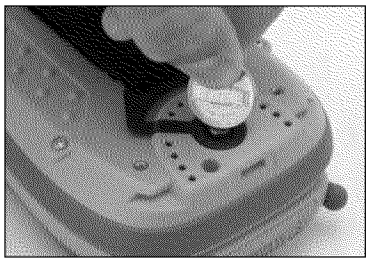

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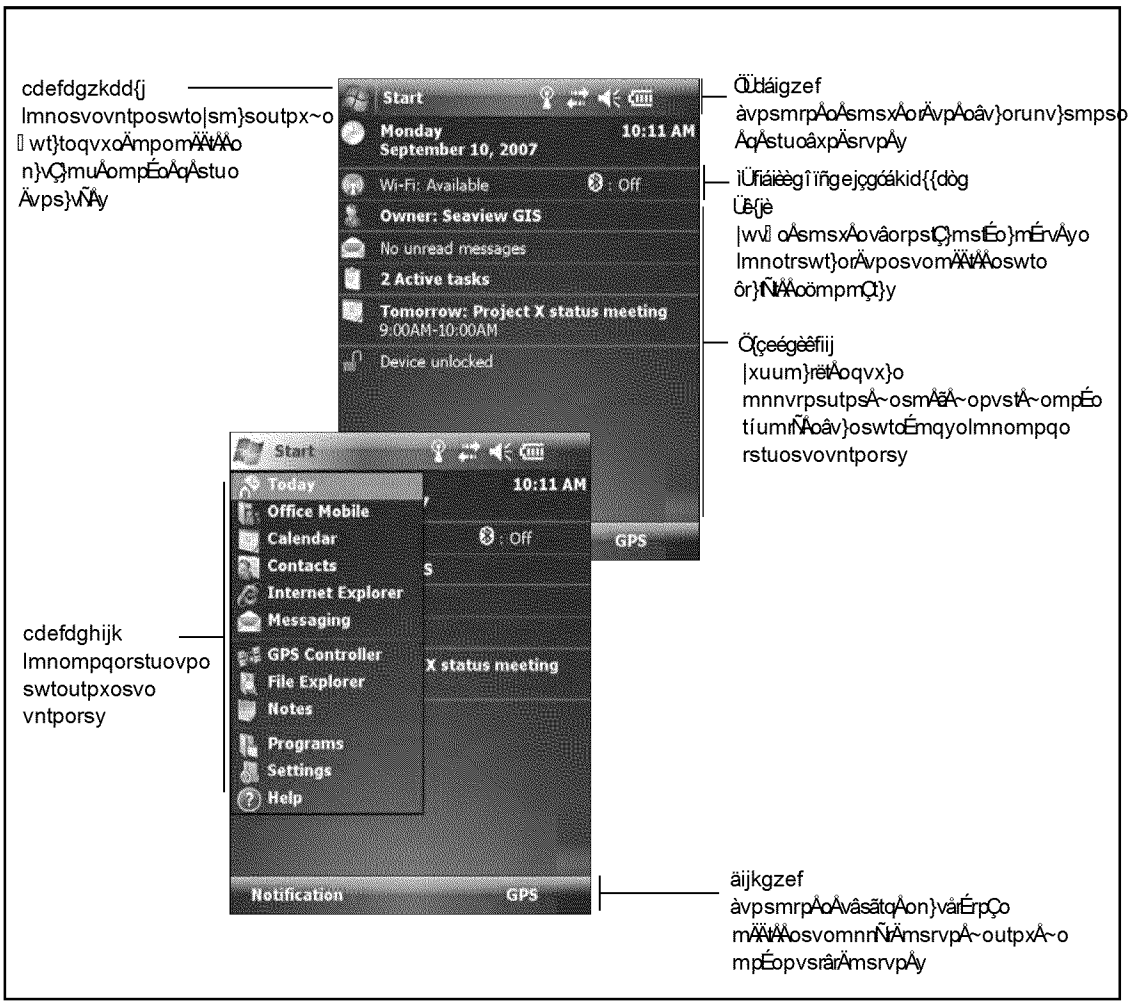

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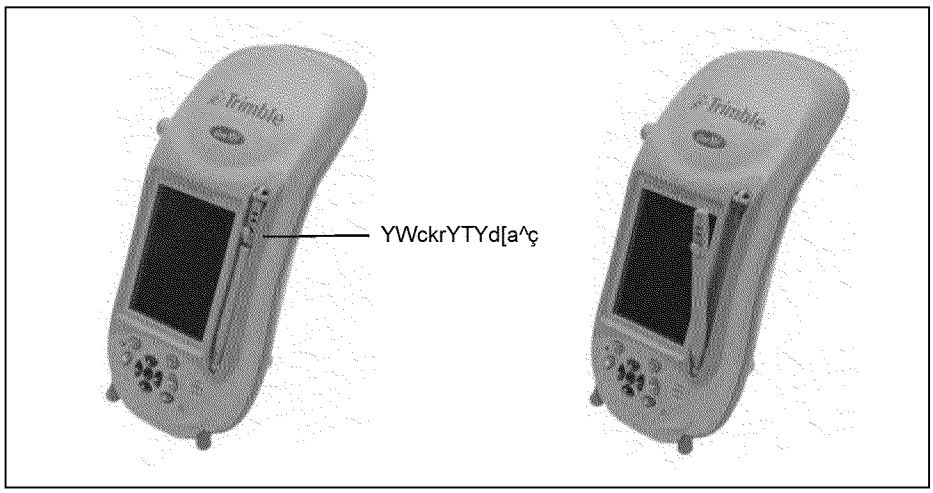

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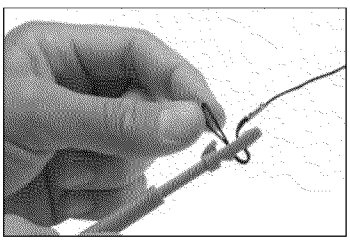
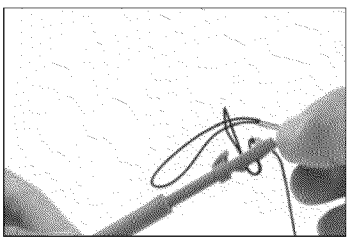
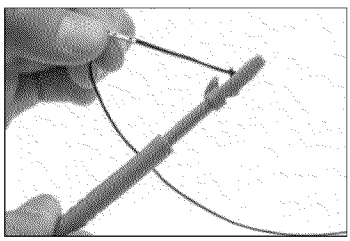

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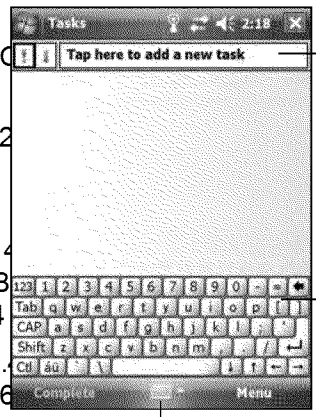

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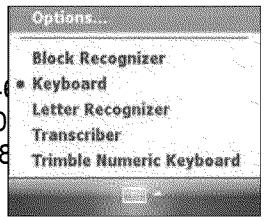

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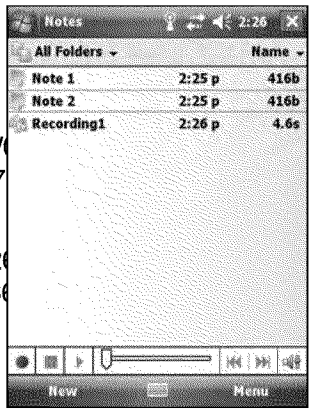

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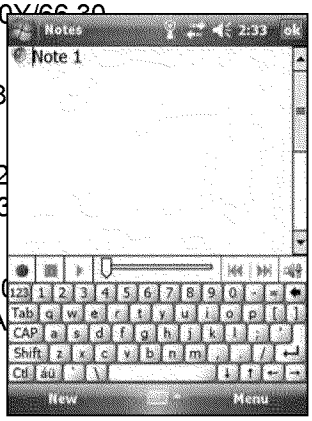

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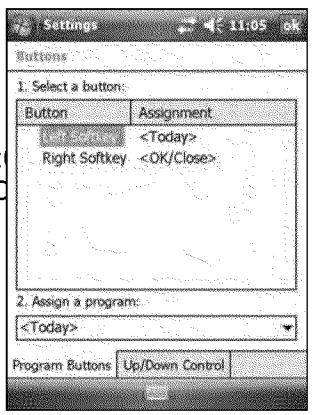

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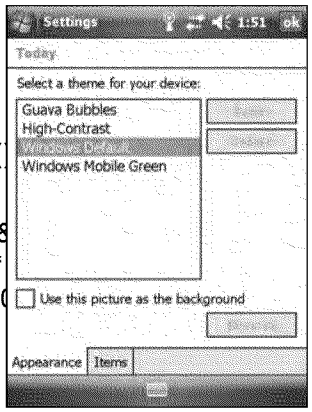

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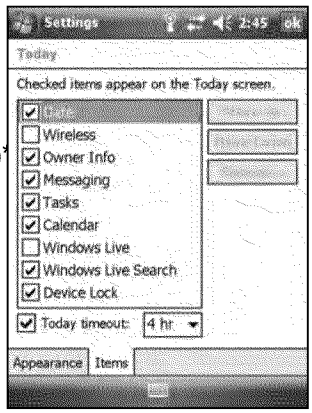

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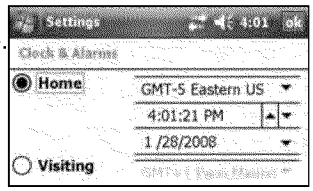

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A=-<=7>-./0-Q0'?709-.:;-ZH[JDHFaKC2DEH3F?,-./0-12345-67800,@-A/0-12345-67800,-6/=^6-ZH[JDHFC2DEH39-:,Q-bKC2DE-:;;0:86-?,-./0-<0c.-7=8,08-=c-./0-R0,_-O:8@

d,70-./0-/:,Q/0<Q-?6-<=7>0Q9-./0-67800,-:,Q-R=6.-=c-./0->0]6-Q=-,=.-806;=,Q-_,.?<-./0-/:,Q/0<Q-?6-_,<=7>0Q@-A/0-0e70;.?=,6-:80ij./0–>0]-:,Q-./0-kilim -O_..=,9-^/?7/-: <^:]6-806;=,Q-^/0,-;80660Q@

n=RR_,?7:.?=,-^?./-0e.08,:<-Q0'?706-6_7/-:6-:-opq-8070?'089-=8-0e.08,:<-60,6=86-_60Q-O]-opq-c?0<Q-6=c.^:809-?6-,=.-?,.088_;.0Q-O]-<=7>?,r-./0-/:,Q/0<Q@-A/?6-R0:,6-./:.-]=_-7:,->00;-_6?,r-./0-opq-c?0<Q-6=c.^:80-^/0,-./0-/:,Q/0<Q-?6-<=7>0Q@-s=8-0e:R;<09-]=_-7=_<Q-<=7>-./0-Q0'?70-6=-./:.-]=_-7:,-6:c0<]-.8:,6;=8.-?.-O0.^00,-c0:._8069-^/?<0->00;?,r-./0-6=c.^:80-7=,,07.0Q-.=-./0-opq-8070?'08-6=-./:.-]=_-7:,-7=,.?,_0-807=8Q?,r-opq-;=6?.?=,6@

A=-_,<=7>-./0-Q0'?709-.:;-./0-bKC2DE-,=.?c?7:.?=,-?,-./0-<0c.-7=8,08-=c-./0-12345-67800,-R0,_-O:8-:,Q-./0,-.:;- tuvgwx @-

y=_-7:,-/0<;-.=->00;-]=_8-Q:.:-607_80-O]-80z_?8?,r-:-;:66^=8Q-0:7/-.?R0-./0-/:,Q/0<Q-{GHIJKLM{-|2ÅH}@1 4C{-\2DEF.=-60.-:-;:66^=8Q-=8-.=-7/:,r0-;:66^=8Q-60..?,r6@

~}] "Ä

A=-=;0,-./0-|2ÅH}-7=,.8=<9-Q=-=,0-=c-./0-c=<<=^?,rÇ

É -?A:/0-./0-<0-08}-7c=-./ 2345-67800,@

É A:;{ IIJKLM{G5MIHN{-|2ÅH}@

A:;-./0-Ñ4IIH}5-.:O-.=-7/07>-./0-O:..08]-<0'0<-Ö600-7>?,r-./0-<0'0<-=c-O:..08]-;=^089-;: r0Ü á à@

A: ;-./0-â3[4KDH3-.:O-.=-60.-./0-.?R0-O0c=80-./0-/:,Q/0<Q-._8,6-=cc-^/0,-?Q<0-Ö600-q_6;0,Q-R=Q09-;:r0Ü à@

ffffffffffffiffl ff ff ffl ff ff ffl ffl ff ffl

!"#$%&'($%'$")*+*,()*"$&

-./012/03456789:9;4<=>=?@<=4680ABC1DBE01B0./10FD/G/D/CA/.0GBD012/0.F/HI/D0JBEKL
.N.1/L0.BKCM.O0PB0BF/C012/03456789:9;4<=>=?@<=4680ABC1DBEQ

R PHS T<<=6U8SVTW846@XS3456789:9;4<=>=?@<=468O

PB01KDC0BC0BD01KDC0BGG0.BKCM.Q

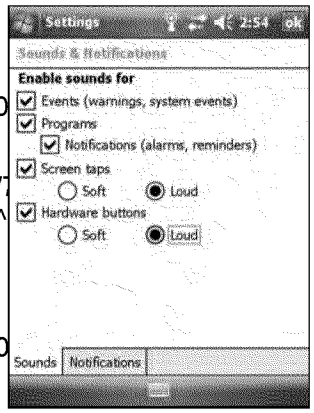
YOPHF012/034567801HZO

[O\/E/A10BD0AE/HD012/0A2/AI0ZB]/.01B0/CHZE/0
AH1/_BD^/.0BG0.BKCM.O

'OaG0NBK0./E/A1012/03?WTT69<@b80BD0c@W
A2/AI0ZB]/.f0./E/A1012/034><0BD0g4570BF1^
ABC1DBE012/0JBEKL/0BG012/0.BKCM.O

iOPHF0 jkl 0

mBK0AHC0K./0FD/M/G^C/M0.A2/L/.01B0AK.1BL^n/0
NBK0AHC0AD/H1/0NBKD0BoC0.BKCM0.A2/L/.O



PB0.F/A^GN0H0.BKCM0.A2/L/Q0

YOPHF012/0;4<=>=?@<=46801HZO

[OpDBL012/0qrT6<0MDBFsMBoC0E^.1f0./E/A10H

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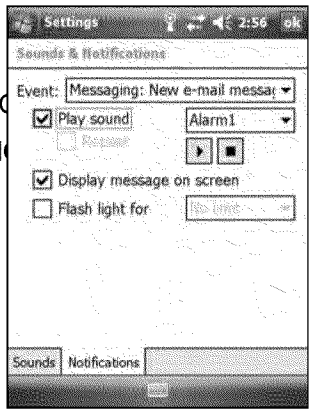
GBD012H10/J/C1O

iOPHF0 jkl



ffffffffff ff ff ffl ffl ffl ff

!"#$$%

&’()*+(),-.//0)123*425)*2)65783)*+()*291+)’14((3)24)*2)1+638()*+()6::(64631()2;)*(<*)23)
+()’14((3=)>2)2:(3)+(),-.//0)123*425?)

@ >6:A BC0DEA,FEB/GA),-.//0=

>2)1+638()*+()’14((3)’(**738’?

H=>6:)*+()I/0/.JK)*6L=

M=>2)1+638()*+()247(3*6*723)2;)*+()’14((3N)’(5(1*)6
2:*723)73)*+()O.C/0BJBCP0)8429:=

Q=>2)’*64*)*+()65783R(3*)’(S9(31();24)*+()*291+)
’14((3N)*6T)UVWXYZ[\]]X=)

^= >6:) _‘a

bcdefgfhPiJKCD0iBj/iE-.//0iJBiJ0FiBCG/kiI./EEiJ0mijP
nopqr istBBP0iuP.iviE/-P0mit0BCKiBj/iwPx/.iG/0tiJII/J.
J0miBj/0iBJ|/iz{|}~Ärqq} Å

&’738)Ç5(64>É:();23*)’R22*+738)163)R6Ñ()*(<*)(6’7(4)*2)
4(6Ö)23)*+()’14((3=

>2)(36L5()Ç5(64>É:(?

H=>6:)*+()ÜK/J.hFI/)*6L)63Ö)*+(3)’(5(1*)*+()á0JsK/ÜK/J.hFI/)1+(1Ñ)L2<=)

M=>6:) _‘a

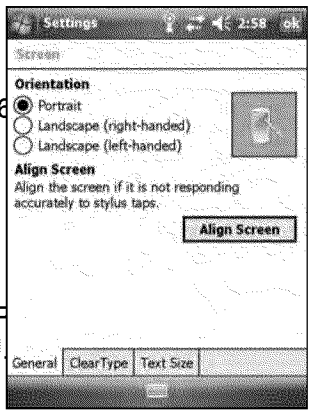
>2)1+638()*+()’7à()2;)*(<*)23)’14((3?

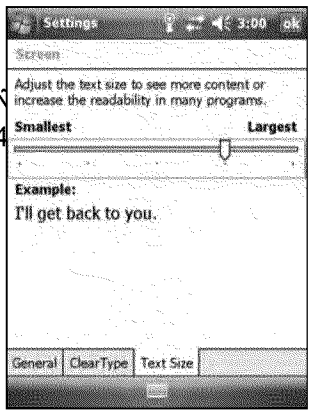
H= >6:)*+()h/âBi,Cä/)*6L=)

M=>6:)63Ö)Ö468)*+()’57Ö(4)123*425)*2)*+()5(;*)*2)R6Ñ
(<)’R655(4N)24)*2)*+()478+*)*2)R6Ñ()*(<*)564

>+()(<6R:5()*(<*)L(52ã)*+()’57Ö(4)’+2ã’)+2ã)*+()
(<)ã755)6::(64)23)’14((3=

Q=>6:) _‘a





ffffffffffffiffl ff ff ffl ff ff ffl ff ffl

!"#$%&'()

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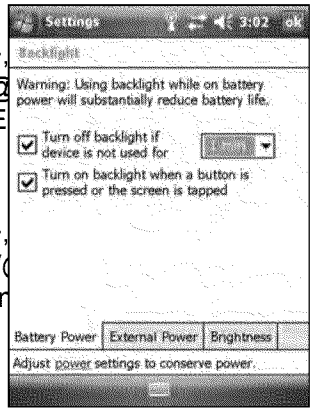
P */@ SKKHTIUQRVUKSWQ-CDEFGHIJKA-

*:-7,5-5+,-./01234+5-5:-/>5:6/530/22X-5>89-:LLO-

YA*:-/>5:6/530/22X-5>89-:LL-5+,-./01234+5-<+,9-5+,
+/9;+,2;-37-3;2,-/9;-37->7394-Z[\\]^_'abc]^=-5/@
CDKKSdVefghSd-5/.A-i,2,05-5+,-jkdTegllemDE
0+,01-.:?-/9;-5+,9-7,2,05-/-536,-L8:6-5+,-
;8:@M;:<9-2375A

nA*:-/>5:6/530/22X-5>89-:LL-5+,-./01234+5-<+,9-5+,
+/9;+,2;-37-3;2,-/9;-37->7394-]o\]^p[q'abc]^=-5/(
5+,-rsKSdTDGefghSd-5/.A-i,2,05-5+,-jkdTegller
0+,01-.:?-/9;-5+,9-7,2,05-/-536,-L8:6-5+,-
;8:@M;:<9-2375A

tA*/@- uv A

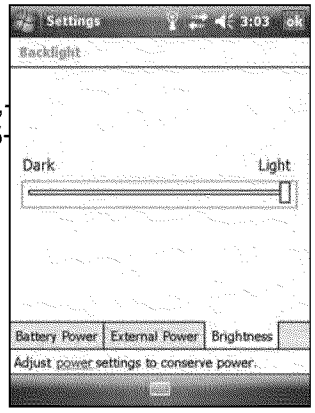


*:-0+/94,-5+,-.834+59,77O

YA*/@-5+,-CdHIJKTSUU-5/.A

nA*/@-/9;-;8/4-5+,-723;,8-0:958:2-5:-5+,-2,L5-5:-6/1,-
5+,-./01234+5-;/81,8=-:8-5:-5+,-834+5-5:-6/1,-5-
./01234+5-.834+5,8A-

tA*/@- uv A



!"##$%&’%

()*+,*))-./0.+12+)*03+-03+4*5*/6*+4*5*/6*+*78-/9+8*))-.*)+:)/0.+1;*+<*2=>?924*4+
@AAB+)*4/*)+;-03;*93C+,*))-./0.+/)+1;*+*D:/6-9*01+2E+F2:4+*78-/9+G0H2>C+

I2+:)*+*78-/9J+F2:+5-0+32+20*+2E+1;*+E2992K/0.L

- NF05;420/O*+*78-/9+8*))-.*)+K/1;+,/542)2E1+=>5;-0.*+24+,/542)2E1+P:1922Q
  20+-0+2EE/5*+528?:1*4C
- N*03+-03+4*5*/6*+*78-/9+8*))-.*)+HF+5200*51/0.+3/4*519F+12+-0+*78-/9+)*46*4+
  1;42:.;+-0+GNS+24+-+0*1K24QC

TU’VWXY’&Z&’%["\]$&^[]"##$%"#

_2:+5-0+)F05;420/O*+*78-/9+8*))-.*)+20+1;*+;-03;*93+-03+1;*+528?:1*4C+

‘abcdefghgijklmnopmqkrkskmtmukvvtwkmolmsjkmjtlqjkrqxmysmyvmqkrkskqmz{oumsjkmozzy|km
|ou}psk{msjkmlk~smsyukmnopmvnl|j{oly kmsjkmqkÄy|kvÅ

I2+)F05;420/O*+*78-/9J+F2:+8:)1+*0-H9*+G0H2>+)F05;420/O-1/20+/0+1;*+Ç51/6*NF05+
)2E1K-4*C+É24+824*+/0E248-1/20J+4*E*4+12+1;*+[illegible]+20+1;*+2EE/5*+528?:1*4C

ë:4/0.+)F05;420/O-1/20L

- ,*))-.*)+-4*+52?/*3+E428+1;*+8-/9+E293*4)+2E+=>5;-0.*+24+P:1922Q+20+1;*+2EE/5*+
  528?:1*4+12+1;*+,*))-./0.+E293*4+20+1;*+;-03;*93C+íF+3*E-:91J+F2:+K/99+4*5*/6*+
  8*))-.*)+E428+1;*+?-)1+ì+3-F)+209FJ+1;*+E/4)1+îAA+9/0*)+2E+*-5;+8*))-.*J+-03+E/9*+
  -11-5;8*01)+2E+9*))+1;-0+îAA+ïí+/0+)/O*C
- =78-/9+8*))-.*)+/0+1;*+P:1H2>+E293*4+20+1;*+;-03;*93+-4*+14-0)E*44*3+12+
  =>5;-0.*+24+P:1922QJ+-03+1;*0+)*01+E428+1;2)*+?42.4-8)C
- =78-/9+8*))-.*)+/0+):HE293*4)+/0+21;*4+*78-/9+E293*4)+/0+P:1922Q+-4*+
)F05;420/O*3+209F+/E+1;*F+K*4*+)*9*51*3+E24+)F05;420/O-1/20+/0+1;*+Ç51/6*NF05+
)2E1K-4*C+

I2+)*03+-03+4*5*/6*+*78-/9+E24+-+)F05;420/O*3+=>5;-0.*+24+P:1922Q+-552:01J+5200*51+
1;*+;-03;*93+12+1;*+2EE/5*+528?:1*4C+NF05;420/O-1/20+-:128-1/5-99F+H*./0)J+-03+1;*+
;-03;*93+)*03)+-03+4*5*/6*)+*78-/9C

!"##$%&'#()*'+$%&,-)&").#)$/0.',)1$+2$+

345677898:459:5;<4=>?:48@84A5BCD68E5DB;;6AB;5F89>5645:GG8=B5=:DHI9B?J5<:I5=64
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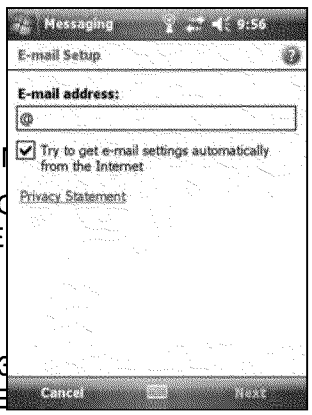
NBG:?B5<:I5=645;B4756475?B=B8KB5BCD68EJ5<:I5DI;95=?B69B56455BCD68E56==:I4958
OB;;6A84A5;:G9F6?BM

PQRSTUTVWXYZX[\Y[]\YX^Y_'Ya'\]b']\YcW'']c\dW'YW'Y\e]Ye_'fe]gfYh]iWb]YjWXYc_'Y[]\Y
X[]YjWXbY]kZ_dgY_ccWX'\IYmWbYZWb]Yd'\WbZ_\dW'YW'Y[]\Y qdb]g][[YrstY_cc][[Y
^Wd'\nY^_p]uWbY''']c\d'pY\WY_YwgX]\WW\ek]'_hg]fY^eW']YjWb]Y[[aW]bY]bY_gk\dZ]Y
cWbb]c\dW'[Yxd'cgXfd'pYyz{Y']\qWb|[]YY^_p]uu

5G5<:I54BB759:5=:44B=959:578GGB?B495D68EL:~B;J5;B95IH5647546DB56578GGB?B495;
B6=>5=:44B=98:4M5

PQRSTUT e]YÄ][[_pd'pY[Wi\q_b]Y[X^^Wb\[YW'gjY\e]YÄÇÉY_'fYaÄsÑY^bW\WcWg[YiWbYd'cW
Z_dgnY_'fY{ÄÅYiWbYWX\pWd'pYZ_dgI

Ö5;B95IH565D68E5;B?K8=BÜ



áMÖ6I9Ä5[[[d'pM

âMÖ6H5t]qYäkZ_dgYsccWX'\M

ãMä49B?59>B5BCD68E5677?B;;5G:?5<:I?56==:I49I

çMÖ56I9:D698=6EE<5AB95=:44B=98:45;B9984A;5C
BCD68E56==:I495G?:D59>B5349B?4B9J5;BE
L:~M

èMÖ6H5 ëëíì M

îM ï:EE:F59>B5;9BH;58459>B5ñB9IH5F8@6?7M53
=:44B=98:45;B9984A;56?B54:956I9:D698=6EE
7:F4E:67B75G?:D59>B5349B?4B9J5<:I5DI;95B49B?59>BD5I;84A59>B5=:44B=98:45
7B968E;5;IHHE8B75L<5<:I?53ñ5:?54B9F:?é567D848;9?69:?M

PQRSTUTVWXYc_''W\Yce_'p]Y\e]Y_ccWX'\Y'_Z]Yg_\]bIY

òMÖ6H5 ôôôúù M

ûMÖ6H5ü† 59:57:F4E:675D68E58DDB7869BE<M

¡ö¢£/£¥§¤'"«¶¥¤»fifl‹§– ›†§¤« · '§¶¶f§ • ,»« · ,§ – «§¶"§'†‡«%§¶f§¶"§ • ,»« · § ""ƒ‹§¶ƒ§
"›‹§'§¶%æ¶§ – §¶"«µ§¶%§ëõ§‹– §¶"‹§' · '"§ ´¯˘ ¸æ§‹§¶"§ ˚ ˚˘ ˚ ˚ ˚ §›¶§¶%§¶"§
'• ,»« · § ""ƒ‹§¶ƒ§Ã‹›fl§µ§¶§¶'"«¶¥¤»fifl‹§¤« · '§æ¶"§ ¸ ¯ "'¸ ¸§Ã«'›¤ – §
%‰›¤æ¶%§ëí§‹¤« · §¶ƒ§¶'›'"§¶"§ · ›µ§¶»§¶§¶"§Ã«'›¤ – æ§¤ƒ§¶"§›' ˙ ¸ – ÿ'"
Ÿ/˘ ¯ Ÿ" ¯ ˜"§ – ¤‰ – ƒÃ§ · «µ§¶' · '"§¤›fifl¼Æ¸+ª ª%Âæ§

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9:59>B5OB;;6A84A5G:E7B?J5DB;;6AB;58459>B5ÁI9L:~5G:E7B?56?B5;B49J56475DB;;6AB;59
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!"#$%&’$(")*$"’+,’-$")$"..+,’-/$01-’$(")*,’2$"’+,’-3$4"#$)-&5$&’5$)-67"’5$8"$
9 -66&2-6$(1,+-$%"’’-%8-5$8"$81-$-:9&,+$6-);-)/$<-66&2-6$&)-$6-’8$&6$6""’$&6$4"#$8&7$
=>?@3$(1,%1$6&;-6$67&%-$"’$81-$1&’51-+5/$

0 1-’$(")*,’2$"..+,’-3$4"#$%&’$5,6%"’’-%8$.)"9$81-$-:9&,+$6-);-)$&.8-)$4"#$5"(’+"&5$
’-($9-66&2-$1-&5-)6$")$7&)8,&+$9-66&2-6$&’5$81-’$5-%,5-$(1,%1$9-66&2-6$8"$
5"(’+"&5$%"97+-8-+4/$A1-$’-B8$8,9-$4"#$%"’’-%83$<-66&2,’2$5"(’+"&56$81-$%"97+-8-$
9-66&2-6$4"#$1&;-$9&)*-5$.")$)-8),-;&+$&’5$6-’56$&’4$9-66&2-6$81&8$4"#$1&;-$(),88-’/

↑│ffffffffff→ ☞ ↕┼□‼ ‼ff ff┴ ‼┘ ffllffffiffl ‼ff→┘♂

ffffiffl┘|–

!" #$! $% $&’’" $ ()*! +

,-./012.3045/678

9 <<=>?@;<ABC<CD=B=<?A
E;F?GCH=

9 :;<<=>?@<DA?I=AIC<JI=KJA?;ACA
>; BLM?=H

9 NC<CD@<DA?I=A>;<<=>?@;<AME@<DA
?I =AO@<J;GEAN;P@K=AQ=R@>=A
:=<?=H

9 NC<CD@<DA?I=A>;<<=>?@;<AME@<DA
S>?@R=TU<>A?=>I<;K;DU

9 V<E?CKK@<DAE;F?GCH=A;<?;A?I=A
IC <JI=KJ

WXYYZ[\]\^Z]_ZX‘abcXdZd]effg]hZdiZh]^jYk^Zck]
\X]jY]XIli[Z][Xmbn\Zd]\X]\djYhlZd]iYlXdmj\iXYo]
hZ\\iYpho]jYk]licZh]ldXm]XYZ]kZqi[Z]\X]\^Z]X\^Zdo]Xd]
\X]iYh\jcc]hXl\rjdZ]XY\X]\^Z]^jYk^Zcks

tXn][jY][XYYZ[\]\^Z]^jYk^Zck]\X]jj][Xmbn\Zd]
nhiYp]\^Z]uvw][jxcZ]Xd]jj]wcnZ\XX\^]ridZcZhh]ciYys

zX]bdX\Z[\]{Xnd]kj\jo]zdimxcZ]dZ[XmmZYkh]\^j\]
{Xn]dZpncjdc{][Xb{]imbXd\jY\]kj\j]\X]jY]XIli[Z]
[Xmbn\Zds

!"# $%& &’ % "$( )"*&+

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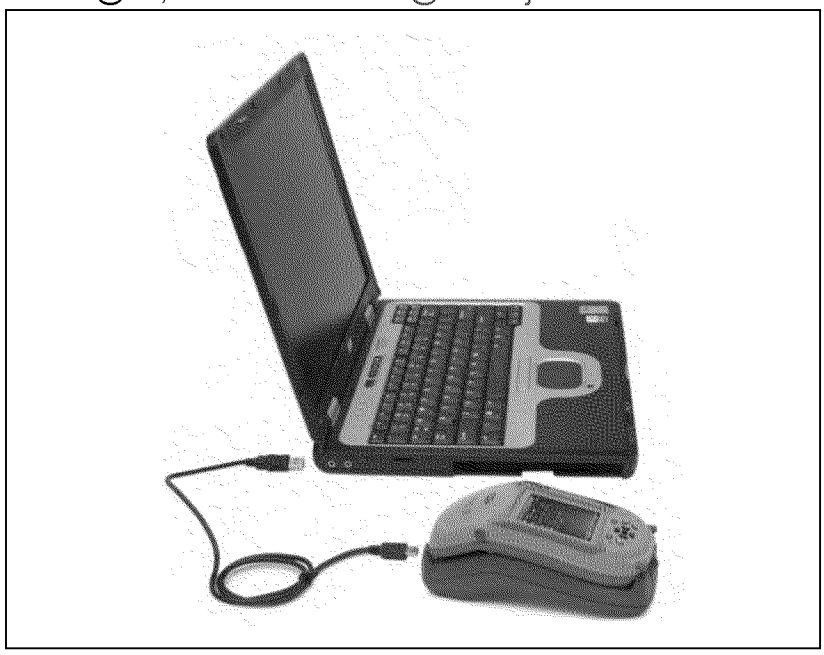

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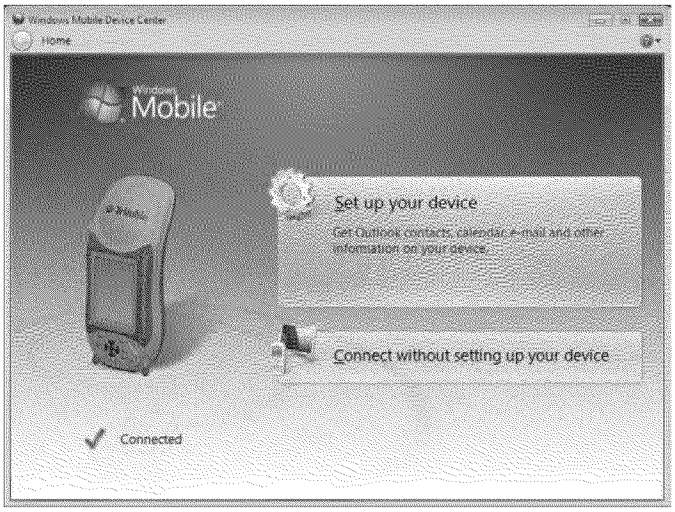

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unguvSw]a[xSyUVSWXXYZ[\]^[_‘a]bac\dSefTgehSkffVkljx

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LMNOPOQRSTUVSÖÜäSÜkTURghiVlSàRRguVSjeRToklVSgjSghjTknnViSehSTUVSeRRguVSueâfäTVltSãeäSukhS
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käTeâkTguknnãSiVTVuTSoUVhSãeäSuehhVuTSkSÖVeèêfnelVlSëííìSjVlgVjSUkhiUVniSTeSTUVS
ueâfäTVlxSyUgjSVhkmnVjSãeäSTeSkäTeâkTguknnãSTlkhjRVlSikTkSRleâSTUVSyVllkáãhuSjeRToklVtS
igRRVlVhTgknnãSuellVuTSTUVSikTktSkhiSTUVhSVêfelTSgTSTeSkSÖQáxSîelSâelVSghRelâkTgehtSlVRVlSTeS
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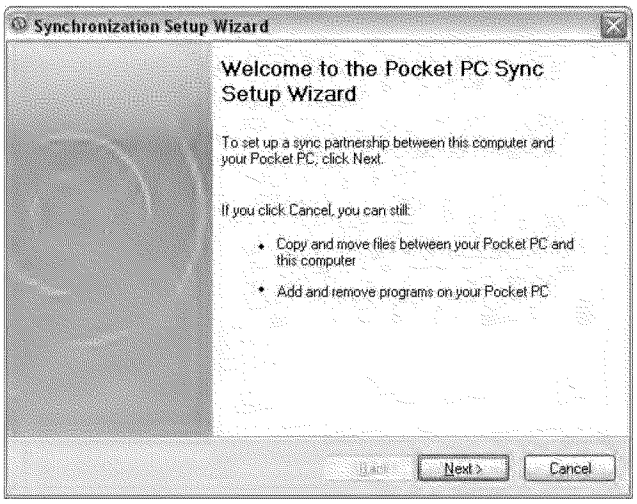

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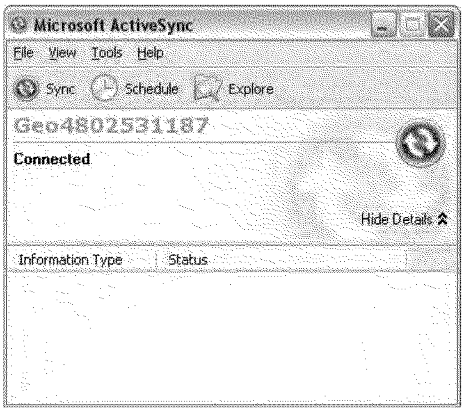

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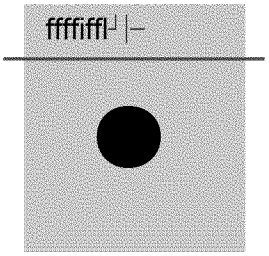

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9 RLH;>FLMB?N@BJOO;>JOSB=EBS=;>BCD:BAJ?J

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C/20S64737B/4H1

P/1G613G=617/1CBFF6>647B3==E12/>>6271{>2U3C19UQ1C3[illegible]>5B/41?H|
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‘a_ëY^ãZp_à‘abcZYX_\‘q_ZYX_qàn]oí_ì‘Y_ç‘YX_n]a‘YçZbn‘]î_o‘_b‘_
cccíbYnçèêXí^‘çïoéà^‘YYX^bñbàíZàên^á_[qéé‘Yb_ó‘bXà_Z]p_bäX]_àXZY^ä_a‘Y_bäX_ÜZéén]
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ö[ôò_ëY^ãZp_[‘abcZYX_de1B417861fghijk1C>BM61/F1312/S<076>134C105617861S64051
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<>/MBC6C1B417861WYnçèêX_mã[^‘YYX^b_öåbX]àn‘]_mXbbn]o_[bZYbXp_mqnpXH

&’ %ú K"! **#!%+ (",-!#

P8619UQ1f/47>/==6>15/F7D3>61B51<>6hB4573==6C1/41786196/:;<=/>6>1?@@A156>B651
R56178615/F7D3>617/12/4FBI0>6134C1S/4B7/>178615737051/F17861B476>43=19UQ1>626

!"#$%"&' ()"*++(',* '-./

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[illegible]	[illegible]
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+,>,8</892382-5,2?@A24/,0<2134-6.;,2=3:25.Z,2/81-.00,<Y2-5,2<,4.:0-2?@A24/,0<2134-6.;,26/002W,2?@A2B38-;300,;Y2P,;;.A=87Y23;2-5,2P;/\W0,2?@A73;;,7-2,S-,81/38243;2RA]^2_;7@.<2134-6.;,[2

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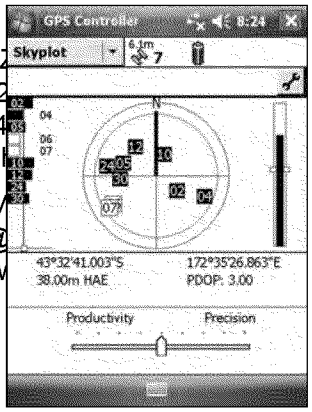

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45210GHH682W04/0WG4G0E/662E42W081045203826W028452=0810=2G6048>20/=0WN=8
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[S^_bU'YiTS'TUTV\[_SjTUtthXVU_XSfTgYZYhStYgT\[XfkT_WYTcnmTnU_W^XfgY'TRSSh[Tn
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5%" ' &#%#&#É $$ 6 '$ 5 &')- !#6 #% !$! %6 5%" -''!)5 ((#
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ÖB }$ 8'7 5! 7)#%F 5 * '; 5%" ("J 6'%$#F7! "5 5 6'((6 #'%)'$ >5! ' ('F
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- à aD4CQ13<2=1C07378C<34H2ã3G8F378C<2åG1453H2?14G8E12@a=ãå?B2037155871
  743EN1:28<2aD4CQ1J2
- à ä'?Y'2?371558716I301:2YDF91<7378C<2?H07192@ä?Y?B2037155871023412743EN1:
  ç3Q3<J

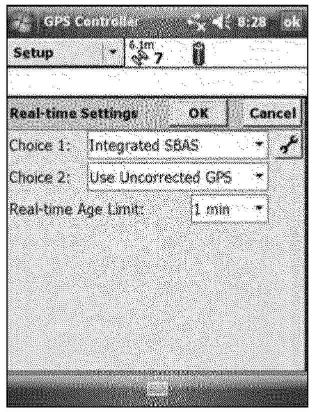
éCD2E3<2EC<;8FD4127L1241E18G1427C2D012Q3478ED5342?[Y?2037155871028<27L12èp
wvmmtp~z2;C492C;27L12'489I512=>?2;815:20C;7M341J2?151E727L12ZD07C92CQ78C<28
jo{|}tp~êkÅv2;815:23<:27L1<21<3I512C42:803I512743EN8<F2;C423<H20Q1E8;8E2037155871

defghihèqÑknÇ{ëvlkmÇvoljotrísvlìîwlqtvsÅlzkqmÖ{ovltpzm{ssvÅ l|kpqt~novlov{sïmtrvl
|koov|mtkplzvmmtp~zltplmÇ{ml{uust|{mtkpltpzmv{ÅlkqlmÇvlìîwlÄkpmokssvolzkqmÖ{ovÜ

↵ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ │├ ff□┤ fflffffffl ├ff

!" #$%# & ’’"&() *!+

,- .* (/" 01# 2)"34 ! 2(56’"7 8"* (/" 9"63:();" !"&() * 6*4 (68 (/" <=>?@B-((*



G- .* (/" DEFGHIJK 2)"347 !"3"&(.*("L’6("4 #$%#-

M- !"3"&(86’()& 36’ !6("33)("!7 (68 (/" <=>?@A B (("N((/" DEFGHIJK 2)"34- #"3"&(O !(; (’6&P)*L ; 4" 6*4 (/"* "*6B3" ’ 4)!6B3" (’6&P)*L 2 86’()& 36’ !6("33)("!-QR68(’"(’* ((/" SITUVWGXIJYIWWGZ[\ !&’""*-

]- .* (/" DEFGHIJ^ 2)"347 !8"&)2_ 5/"(/"’ (!" *& ’’"&("4 8 !)() *!7 ’ (!(8 !)*L 01# 8 !)() *!7)2 & ’’"&() *! 6’" * (6‘6)36B3"-

a- 68 QRb

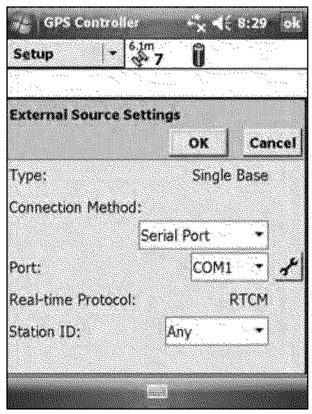
c defghijklmneojhpqiijpneqfdhriqohkfhjsnjifklhpqiijpne qfhdqtipj

u &6*);8’ ‘" (/" 6&& ’6&_ 2 _ ’ 46(6 B_ !)*L ’63:();" & ’’"&() *! 2’ ; 6* "N("’*63 & ’’"&() * ! ’&"7 ! &/ 6! 6 0" $"6& * ’"&")‘"’ ’ 6 v01# ’64) - O **"&((/" "N("’*63 & ’’"&() * ! ’&" (6 $3 "((/ 8 ’(w!"" 86L"xyz ’ ((/" 8() *63 !"’)63 &)B3 w!"" 86L",{| z- }!" (/" 01# 2)"34 ! 2(56’" (!"(8 6*4 ; *)(’ (/" ’"63:();")*8 (! ’&" (/6(_ 56*((!"-

/")*("L’6("4 01# ’"&")‘"’ & ;; *)&6("! *3_ (/’ L/)(! 01# O 8 ’(! wO C7 O M7 6*4 O]z- ’);B3" 01# 2)"34 ! 2(56’"7 ! &/ 6! "’’6#_*& 6*4 01# O *(’ 33"’7 6 (;6()&633_ ’"4)’"&(!)*8 (2’ ; 6* "N("’*63 & ’’"&() * ! ’&" & **"&("4 (O , ’ (6 $3 "((/ 8 ’(((/" ’"63:();" 01# O 8 ’(wO]z-

!"(8 6* "N("’*63 & ’’"&() * ! ’&")* (/" ’);B3" 01# 2)"34 ! 2(56’"+

,- .* (/" 01# 2)"34 ! 2(56’"7 8"* (/" 9"63:();" !"&() * 6*4 (/"* (68 (/" <=>?@B-((*



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M- 68 (/" <=>?@B (("N((/" DEFGHIJK 2)"34-

]- .* (/" DFZZIHWGFZJÅIWEFÇ 2)"347 !"3"&(#"’)63

a- .* (/" ÉFÑW 2)"347 !"3"&((/" O 8 ’((!"- .2 _ 6’" !)*L+

- ö (/" !"’)63 &3)87 !"3"&(O ,-
- ö 6 $3 "((/ 5)’"3"!! & **"&() *7 !"3"&((/" O 8 ’(_ & *2)L ’"4 2 ’ (/" $3 "((/ & **"&() *)* (/" DÜÅJÉFÑW\ (6B 2 (/" $3 "((/ ;6*6L"’-

y- 68 QRb

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!" #$ %& !’"!(&%) * ((!*"+ & #(*! , (# ! -+". & &/ (+01)! 234 ,+!)5 ,"-%(!6

78 9& ".! (+01)! 234 : &"( ))!(,"-%(!; * &,+<#(! ".! 234 (!*!+=!(" # ! (!%)/"+0! * ((!*"+ & & :>?@8 A (0 (! +&, (0%"+ &; !! ".! "!$ %1 =!8

B89& ".! 234 : &&!*" (,"-%(!; 0%&#%))C (!5+(!*" ".! (!%)/"+0! * ((!*"+ & #(*! " :>?@ 1C "%$$+&< 4!"#$ ".!& !)!*" ".! (!%)/"+0! #(*! ,(0 ".! 5($ 5 -&)+ "8

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FGHIJKJLMNOPQPRSPNOPTUVWRXPNQMOOPQWRMYZ[NW\PN]^_N‘MYYPQWMONZMa MYNW\PN\TYe\PUef

ghijklmnkilopqrostuukils

FGHIJKJL\RZNZPQWRMYNePZQORvPZNWRPNW\PN]_PW\WRYdZMaUOXNZMaWbTOPNTYe LORXvUPN]^_QMOOPQWNPwWPYZRMYf

x ! ".!]^_N_PWWRYdZ , (0 +& ".! (+01)! 234 ,+!)5 ,"-%(! " * &,+<#(! ".! 234 E#%)+"C !""+&< C # (!E#+(!8 .!) -!(".! 234 E#%)+"C !""+&< ; ".! 0 (! $(5#*"+=! C # %(!)+y!)C " 1!; % ".! 234 (!*!+=!(-+)) "(%*y 0 (! %"!))+"! %&5 1! 1!""!(%1)! " *%)*#)%"! % 234 $ +"+ &8 .! "(+*"!(".! 234 E#%)+"C !""+&< ; ".! 0 (! $(!*+ ! ".! 234 $ +"+ & ".%" %(! *%)*#)%"!58

FGHIJKJzaN{McNTOPNcZRYdNW\PNLPOOT_{YQNZMaWbTOPNSPOZRMYN|f}~NMONUTV W\TWN{McNcZPNTQQcOTQ{VvTZPeNTÁNdWRYdNZPWMONMUNW\PNÑcTURW{NMaNW\PN]^_ ÄMZRWRMYZNUMddPefNÖZPNW\PNePaTcUWN]^_NÑcTURW{NZPWWRYdZNTYeNUPWNW\ XTYTdPNW\PNUMddRYdNMaNÄMZRWRMYZNvTZPeNMYN{McONOPÑcROPeNTQQcOTQ{fl

ÜC 5!,%#)"; ".! .%&5.!)5 + * &,+<#(!5 " (!*!+=! %"!))+"! +<&%) +& 0 " * &5+"+ & 8

$!& ".!]^_N_PWWRYdZ , (0; 5 &! , ".! ,)) -+&<6

- % $àâãäåçéèêë +& ".! 4!"#$!*"+ &8
- % $ ".! 4yC$) "; 4%"!))+"! 9&, ; (3)%& !*"+ &8

!"#$%&’ ( )"# (%* !!"#$*%+*"#$%!, %-. %* "(’

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01339@E0F2

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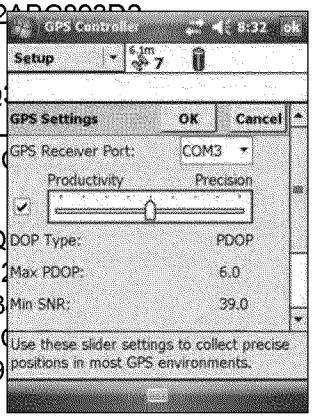

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L<;129@?<;LC39<@2CH<B321C=42?918:K2011:2567201339@E02?<;2LCI9LBL2
>;1=909<@K2>CE1efg

ha## !"#$%!a%i#% j! ’#i %i#! ##i

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=C@<>DK2D<B2=C@2B012C2qB;;9=C@12C@31@@CK2<;2C2>C3=42C@31@@C2Y9342

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9L>;<N1:2C==B;C=D2Y41@2D<B2=<881=32:C3C2?<;2><03>;<=1009@E2B09@E2qM73C;2

s<@?9EB;12C@31@@C201339@E029@234125672?918:20<?3YC;1K2<@=12D<B24CN12
1I31;@C82C@31@@C23<234124C@:418:F

J<2=<@?9EB;12C@31@@C201339@E029@23412J1;;C7D@=20<?3YC;1t

eFn@23412713B>201=39<@2<?23412J1;;C7D@=20<?3YC;1K23C2412
AAÇÉÑÜáàÇÉâ2?<;L2C>>1C;0F

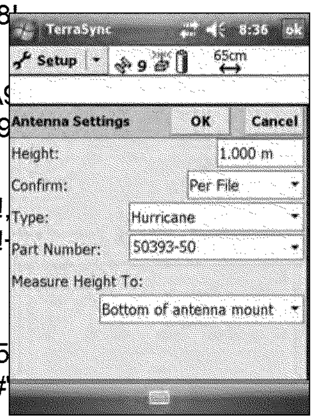
fFJC>23412 HB@3H 3<23412ÄáÄÉÑÜÇÉâ2?918:F2J412ÄáÄÉÑÜáàÇÉâ2
?<;L2C>>1C;0F

!"#$!%&'()*!+,$-./!01$2,+3!"#$!#$,4#"!5+!"#$!678!
9 "$ 9!"#9"!,0!25 $2"$.!"5!"#$!678!150,",5 !!

: !"#$!;<=>'?@!+,$-./!0$-$2"!#5A!5+"$!"#$!05+"A9
A,--!90C!35D!"5!25 +,BE!"#$!25 +,4DB$.!9 "$ 9
#$,4#"!.DB, 4!.9"9!25--$2",5

F !"#$!GHI&!+,$-./!0$-$2"!"#$!"31$!5+!9 "$ 9!"#9"!,
25 $2"$. !J#$! DEK$B!, !"#$!LM?*NOP@Q&?!-
9D"5E9",29--3!D1.9"$.!A#$!35D!0$-$2"!"#$!
9 "$ 9!"31$

R !"#$!S&MTP?&N%&'()*NG<!+,$-./!0$-$2"!"#$!15
"#$!9 "$ 9!"#9"!35D!#9U$!E$90DB$.!"#$!#$,4#



V J91! wx!"5!B$"DB !"5!"#$!Y<(('=(NZ&**'=(T!+5BE

[\]]^_]'abcc^dc'ebfb

g#$!35D!-54!29BB,$B!.9"9/!"#$!678!B2,U$B!-540!9..,",5 9-!.9"9!90!A$--!90!678!
150,",5 !B$25B.0 !J#$!9..,",5 9-!.9"9!,0!D0$.!.DB, 4!150"1B52$00, 4!"5!,E1B5U$!"#$!
922DB923!5+!"#$!678!150,",5 0

+!35D!9B$!D0, 4!9!6$5hi!#9 .#$-./!ij8"9B!29BB,$B!.9"9!,0!-544$.!K3!.$+9D-" ! +!35D!9B$!
D0, 4!9!6$5hJ!#9 .#$-./!29BB,$B!.9"9!,0! 5"!-544$.!K3!.$+9D-" ! +!35D!A9 "!#,4#$B!-U-0!
5+!922DB923!9 .!9B$!A,--, 4!"5!-54!.9"9!+5B!kl!E, D"$0!5B!E5B$!A#,-$!E9, "9, , 4!
25 ", D5D0!-52C!5 !9"!-$90"!+5DB!09"$--,"$0/!35D!29 !25 +,4DB$!"#$!678!+,$-.!05+"A9B$!"5!
-54!29BB,$B!.9"9

J5!25 +,4DB$!29BB,$B!.9"9!-544, 4!, !"#$!J$BB983 2!
05+"A9B$m!!

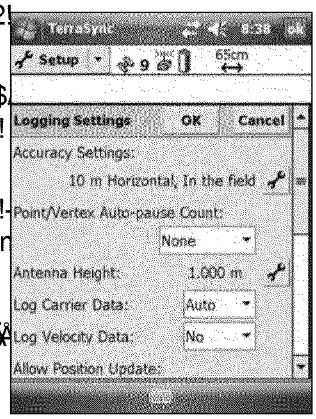
k !"#$!8$"D1!0$2",5 !5+!"#$!J$BB983 2!05+"A9B$
noppqrpstuvvqrpw !J#$!Y<(('=(NZ&**'=(T!+5BE!
911$9B0

x !"#$!Y<(N;M??'&?NyM*M!+,$-./!0$-$2"!"#$!.9"9!-
51",5 !+5B!"#$!"31$!5+!#9 .#$-.!35D!9B$!D0, 4r

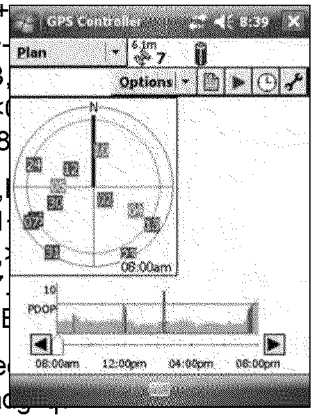
z +!35D!9B$!D0, 4!9!6$5hJ/!0$-$2"!{|}

z +!35D!9B$!D0, 4!9!6$5hi/!E9C$!0DB$!~ÄÅ
0$-$2"$.

J91! wx !



! "# #$ % #&' (&%!' #)())!'



*+,-./0-012,34+56780908:;,3<.=,>?@,5.8.,7+<<2780+
. 4+6=5,8A2,80-2B,+C,8A2,5.:,DA2=,B.82<<082,E2+-
F2B8G,*A2,>?@,H+=84+<<24,B+C8D.42,0=7<652B,
B2780+=,D08A,.=,.=0-.825,BI:3<+8,.=5,JK?,LB.82<<
E2+-284:M,E4.3A,C+4,:+64,3+B080+=,C+4,8A2,=2/8

P=,8A2,?<.=,B2780+=;,:+6,7.=,7A27I,8A2,3<.==0=E,
.B,:+6,3<.:,.,B2BB0+=;,8A2=,6B2,8A2,80-2<0=2,8+,1
+=,80-2B,DA2=,E2+-284:,0B,3++4G,QB,:+6,.5R6B8,
B2880=EB;,8A2,?<.=,B2780+=,0B,635.825;,B+,:+6,7.
2CC278,+C,50CC242=8,S6.<08:,7+=84+<,B2880=EB

TUVWXYXZ[\]^_\'abc\^d'ce\feghijc\klm\[gcjn\o^[dpae
gqodajjcnr_oc\d'c\sjaqqgqt\[cad_ec\gq\d'ad\assjguad
gqodcan\^[\d'c\klm\v^qde^jjce\o^[dpaecw

x!yy(z(%! #{ |#(}~ ! ($

 B2,50CC242=80.<,>?@,8+,7+44278,244+4B,0=,:+64,7+<<27825,5.8.G,J0CC242=80.<,>?@,L
4S6042B,+=2,+4,-+42,.55080+=.<,42720924B;,7.<<25ÄÅÇWXÇVÅVÉÜÑÇX+4,42C242=72,B8.80+=
DA07A,.42,<+7.825,.8,I=+D=,3+0=8BG,J.8.,7+<<27825,.8,8A2,F.B2,B8.80+=B,0B,6B25,8+,
52824-0=2,>?@,-2.B642-2=8,244+4B,.=5,7+-3682,7+442780+=B,8+,8A2B2,244+4BG,Q=,
6=<0-0825,=6-F24,+C,-+F0<2,>?@,42720924B;,7.<<25ÖÜÜWÖÇ,7+<<278,>?@,5.8.,.8,6=I=+D=
<+7.80+=B,D08A0=,8A2,9070=08:,+C,8A2,F.B2,B8.80+=GáA44+4B,7+--+=,.8,F+8A,8A2,F.B2,
B8.80+=,.=5,8A2,4+924,42720924,.42,7+4427825,D08A,J>?@,208A24,0=,42.<,80-2,+4,5640=
3+B834+72BB0=EG

à(â%!ä(#x{ |

P=,42.<ã80-2,J>?@;,8A2,F.B2,B8.80+=,7.<76<.82B,.=5,F4+.57.B8B,8A2,244+4,C+4,2.7A,
B82<<082,.B,2.7A,-2.B642-2=8,0B,42720925;,2=.F<0=E,:+6,8+,.33<:,7+442780+=B,DA0<2,0=,
8A2,C02<5,.=5,7+<<278,.7764.82,>?@,5.8.G,J>?@,7+442780+=B,.42,.9.0<.F<2,C4+-,.,9.4028
+C,36F<07,.=5,7+--2470.<,B+6472BG,*A2:,7.=,F2,E2=24.825,.=5,F4+.57.B8,0=,42.<ã80-2,
F:,3409.82<:,+4,B2<Cã+D=25,>?@,F.B2,B8.80+=B;,+4,F:,.,D052,4.=E2,+C,E+924=-2=8,
.E2=702BG,

å2.<ã80-2,J>?@,B+6472B,0=7<652,2/824=.<,F2.7+=,.=5,4.50+,B+6472B;,.B,D2<<,.B,@.82<<0
ç.B25,Q6E-2=8.80+=,@:B82-B,L@çQ@M,B67A,.B,éQQ@,0=,8A2 @,.=5,á>èK@,0=,á64+32;,
.=5,êå@,=28D+4IBG,@çQ@,.=5,êå@,=28D+4IB,6B2,-6<803<2,F.B2,B8.80+=B,8+,7.<76<.82,8A
J>?@,7+442780+=B,8A.8,.42,8A2=,52<092425,8+,8A2,6B24,C4+-,.,>2+B8.80+=.4:,B.82<<082
L@çQ@M,+4,C4+-,.,4.50+,+4,72<<6<.4,3A+=2,Lêå@,=28D+4IBMG

ë.78+4B,8A.8,.CC278,42.<ã80-2,J>?@,.7764.7:,0=7<652,A+D,+C82=,8A2,7+442780+=B,.42,
635.825;,A+D,C.4,:+6,.42,C4+-,8A2,F.B2,B8.80+=;,.=5,DA28A24,8A2,7++450=.82,B:B82-,
6B25,F:,8A2,7+442780+=,B+6472,-.87A2B,8A2,7++450=.82,B:B82-,6B25,F:,8A2,>?@,427209

!" #$ $%&'( )

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- H 0:3,678,7<0:>=+431,I>>=23,/.>0B<13,J31/=.+,KCLM,,NB=0:,0:3,;<03/0,@-4<03/O,.1, ;<031C
- H 0:3,E1=?A;3,678,P+<;Q/0,3R03+/=.+,>.1,S8T*,P126*8,/.>0B<13,J31/=.+,UCLM,NB=0:, 0:3,;<03/0,@-4<03/O,.1,;<031C

EQ-=2<;Q9,-./0-1.23//34,5678,@/3/,.+;Q,.+3,A</3,/0<0=.+C,V.B3J319,B:3+, 4=>>313+0=<;Q,2.11320=+F,4<0<,2.:;32034,B=0:,63.WV,1323=J31/,@/=+F,VX80<1,032:+.;.F Q.@,2<+,/3;320,?@;0=-;3,A</3,/0<0=.+/,0.,2.11320,0:3,>=;3,<F<=+/0,>.1,=?-1.J34,<22@1<2Q

Y<20.1/,0:<0,<>>320,0:3,<22@1<2Q,.>,-./0-1.23//34,5678,=+2;@43,0:3,0Q-3,.>,1323=J31, <+4,<+03++<,@/34,<0,0:3,A</3,/0<0=.+9,0:3,4=/0<+23,A30B33+,0:3,A</3,/0<0=.+,<+4,0:3, ;.2<0=.+,B:313,0:3,1.J31,4<0<,B</,2.:;320349,0:3,<22@1<2Q,.>,0:3,A</3,/0<0=.+,-./=0=.+9, <+4,0:3,;.FF=+F,=+031J<;,<0,0:3,A</3,/0<0=.+C

Y.1,?.13,=+>.1?<0=.+9,13>31,0.,0:3,4.2@?3+0<0=.+,-1.J=434,B=0:,0:3,-./0-1.23//=+F, /.>0B<13C

!" #$ $%&"$Z[\ ]^$&'( )

*>,Q.@,2.:;32034,4<0<,B=0:,/@A>..0,<22@1<2Q,=+,13<;,0=?39,Q.@,4.,+.0,+334,0., -./0-1.23//,0:3,4<0<C

V.B3J319,=>,Q.@1,4<0<,>=;3/,2.+0<=+,<@0.+.?.@/,N@+2.1132034O,-./=0=.+/,</,B3;;,</ 13<;X0=?3,2.1132034,-./=0=.+/9,E1=?A;3,132.??3+4/,0:<0,Q.@,-./0-1.23//,0:3,4<0<C, 5@1=+F,-./0-1.23//=+F9,Q.@,2<+,2:../3,B:30:31,0.,2.11320,.+;Q,<@0.+.?.@/,-./=0=.+/9, .1,<;;,-./=0=.+/C,

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Y.1,?.13,=+>.1?<0=.+,<A.@0,678,<+4,56789,BBBC01=?A;3C2.?_F<+4,13J=3B, 0:3,P;;,PA.@0,678,0@0.1=<;C

!"#$%&#'((#)#*+ *,!(-#*. /*!

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4 28FGBD8<2<3HIIJ3=2<A2=31@9E12DEK3L=23;1
=B2:A>M318?3;123A9;2N<@;2E34563<2:2AO2<3:8
?A;132RQABP29;3;1@;3A=3:8992:;2E3;8389238>3;
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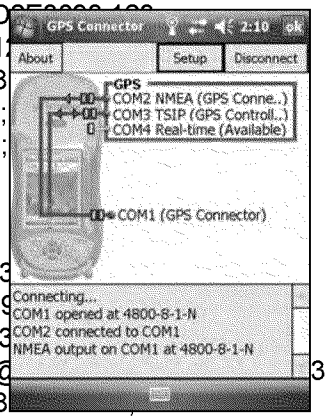

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B8<;3=2;;A9N=3=Q:13@=3;123h@QE3<@;2K34563
=8>;?@<231@=3@3N<@B1A:@D3EA=BD@M3;1@ 3
:8992:;A89=T3@9E3@3;2G;3EA=BD@M3;1@;3=18
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A9;2N<@;2E34563<2:2AO2<3;83@98;12<3E2OA:2T3=Q:13@=3@932G;2<9@D3E@;@3:8D

lmnopqprsbt^ubvcWbu\YZ[bvbwxuWX^^Xybz^cX{bW
wxuWX^^Xybcv|Y^bY\b^ZbvZ|bXyWbyvZ|yWx|bY\b}Y
|W}Y_W bbÄ\WbXyWb'aVb]^ZZW_X^cb\^sXÅvcWbX
ÇÉÑb^cbÜVrab^uXzuXbX^bwxuWX^^Xybáb]ÉÂ{bÅyY_yb
zcWá|WsYZW|bwxuWX^^Xybä^\XbVWcYvxba^cX bã^
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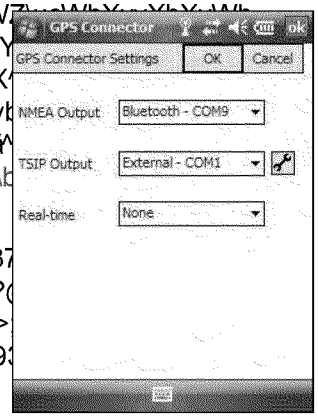

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D@h2D2E3456378992:;8<3A93;123=;@;Q=3=:<229
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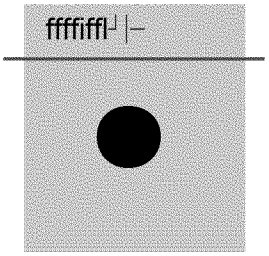

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3 K9L5@??@G:;<7595==:>?665>@<?6=:5MD98<65H

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OP^]RbP_WdQYRaQ]bY^nQ]RPTfRdTRQ‘_nXQRdPQRY_a_‘aRdPQRm_^‘RbT‘‘Qbd^l^drRTWd^T‘]R_l_^X_nXQq

s]QRdPQRd_nXQRT‘RdTR^aQ‘d^orRdPQRf^YQXQ]]RbT‘‘Qbd^T‘RdrWQRrTcRf_‘dRdTRm_pQR_‘aRdPQ‘RoTXXTfRdPQR]dQW]RWYTl^aQaRdTRbT‘‘QbdRdTRdP_dRaQl^bQq

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hXdQY‘_d^lQXrkRrTcRb_‘Rc]QRjXcQdTTdPRf^YQXQ]]RdQbP‘TXTerRdTRbT‘‘QbdRdTRdPQRw‘dQY‘QdRc]^‘eR_RbQXXcX_YRWPT‘QR_‘aRdPQ‘RYQbQ^lQRYQ_Xzd^mQRbTYYQbd^T‘]RoYTmR_R{|}R‘QdfTYpRTYRaTf‘XT_aRn_bpeYTc‘aRm_WRa_d_qRuTcRb_‘R_X]TRbT‘‘QbdRa^YQbdXrRdTRTdPQYRjXcQdTTdPzQ‘_nXQaRaQl^bQ]R]cl_]R_RSQTjQ_bT‘RYQbQ^lQYkR_RX_]QYRY_‘eQo^‘aQYkRn_YbTaQR]b_‘‘QYq

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QRSTUVUWXYZ[\]Z^__'ZaXZ'_\bacd\a_Zae_Zfcg_h_iiZjklZ\^'mXgZnhY_aXXaeZg\'cXZc^Zae_ e\^'e_h'Zoi__Zp_hXfqZcrZae_ZbXY^ag]Zc^ZfecbeZ]XYZ\g_ZfXgsc^tZ'X_iZ^XaZ\uugXd_Zae_ fcg_h_iiZjklZ\^'mXgZnhY_aXXaeZfcg_h_iiZa_be^XhXt]v

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QRSTUVU|rZ]XYZ\g_ZY^iYg_Z\pXYaZfe_ae_gZae_Z}_X~ uhXg_gZÄÅÇZi_gc_iZe\^'e_hÉZg\'c \ uugXd_'ZrXgZYi_Zc^Z]XYgZbXY^ag]ÑZbe_bsZfcaeZ]XYgZÖgc[ph_Zg_i_hh_gv

Ü7+,<*+,á9;8.,@B<8L9<8.:,à9:9=+3,7.O<>93+,<.,;+9B<8L9<+,<*+,8:<+=39<+;,>83+2+77,?@A, 9:;H.3,I2J+<..<*,39;8.M,.3,<.,3+9B<8L9<+,<*+,39;8.7,8O,<*+K,*9L+,G++:,;+9B<8L9<+;E,)*+, á9;8.,@B<8L9<8.:,à9:9=+3,7.O<>93+,3J:7,.:,9:,.OO8B+,B.C1J<+3E,

)*+,29<+7<,B.1K,.O,<*+,7.O<>93+,87,9L9829G2+,O.3,;.>:2.9;,O3.C,<*+,)38CG2+,>+G78<+E,-. <.,>>>E<38CG2+EB.CH7J11.3<M7B28Bâ,<*+,28:â,O.3,K.J3,3+B+8L+3,<K1+,N}_XããM, }_XääM,.3,}_XäÖPM,B28Bâ,çXf^hX\'iM,B28Bâ,}_X~ uhXg_gZÄÅÇZé_gc_i,9:;,<*+:,B28Bâ,è\'cXZ kbacd\acX^Zå\^\t_gE

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í.J,B9:,J7+,<*+,ì83+2+77,à9:9=+3,91128B9<8.:,<.,<J3:,.:,9:;,<J3:,.OO,<*+,-+./012.3+3, 4556,7+38+7,*9:;*+2;î7,>83+2+77,?@A,39;8.,9:;H.3,I2J+<..<*,39;8.,N7+8, ì83+2+77,à9:9=+3M,19=+PEñ

í. J,B9:,927.,<J3:,.:,.3,<J3:,.OO,<*+,I2J+<..<*,39;8.,O3.C,>8<*8:,<*+,I2J+<..<*, 91128B9<8.:,N7+8:=,.:,9:;,<J3:8:=,.OO,<*+,I2J+<..<*,39;8.,O3.C,>8<*8:,<*+, I2J+<..<*,91128B9<8.:M,19=+PE65

). ,C9â+,<*+,-+./012.3+3,4556,7+38+7,*9:;*+2;,L878G2+,<.,.<*+3,I2J+<..<*ó+:9G2+;, ;+L8B+7,9:;,+:9G2+,<*+C,<.,B.::+B<M978+,<*+,*9:;*+2;,L878G2+,N;87B.L+39G2+P,<., .<*+3,I2J+<..<*,;+L8B+7M,19=+65

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-.:+1*5.+);;+J)12+5-:4)/+-1+120+/-K0+14K0L+)5+,).15)6+0-,2+5-:4)+4.:4M4:*-66NI

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O*5.+);;+120+C45060//+DEF+5-:4)+-.:G)5+H6*01))12+5-:4)+1)+950M0.1+120+2-.:206:+;5)K+
/0.:4.8+)5+50,04M4.8+C45060//+/48.-6/I+

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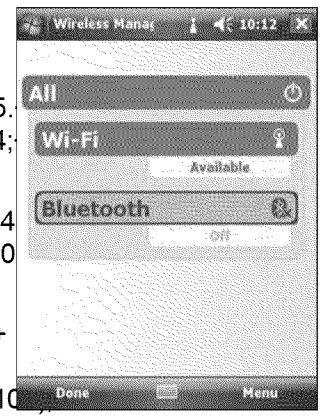

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J)12+5-:4)/L+)5+1)+1*5.+);;+J)12+5-:4)/+4;
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C45060//+DEF+.01C)5g+4/+:010,10:L+-.:+-+F)14;4,-14).+;)5+120+:010,10:+.01C)5g+K-N+
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V1XYS/

]/ 0123 ^_ /

‘ abcdedfgD7B6D8976:Qh76JD?@A67==7BDQhJ8=)
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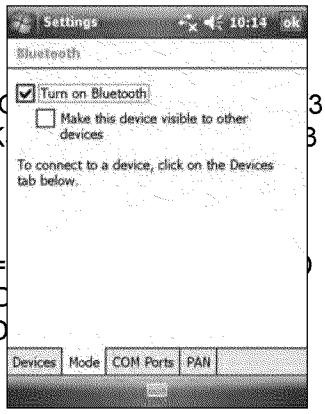

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L/ MHNHOF3FGH3PAQ9D=9D?@A67==7BDOGHOR3KSTZ3Y\3YF3Y[3WSF31NVH1Xé3[HN
FGH3YWFHêV1FHX3áNUHFSSFG3V1XYS/

]/ MHNHOF3FGH3Ihõ6D7B8;DJ6i8>6Di8;8ú@6D7=D=7B6QDJ6i8>6;DOGHOR3KST/3

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K4@@1KB2B4V

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[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

fghijkjlmnopqrmnstupmqomqovmqqwvupqxoumowyuwnqtzo{w|pvw}o~}pqxou womÄupmqtzo}wr
Çmqqwvupqxoumomu wno{w|pvw}o~}pqxou [illegible]ptzovzpÄÅoÄ

→ !" ←"#"$ % & ' '"()*"# ' '"+←

,-./-001/2.2-.3.45617188.9:;.3//188.<-502=.>-?.@?82A

BC D12.?<.2E1.45617188.9:;./-001/25-0

FCG-001/2.2-.2E1.45617188.9:;.0124-6H.-6.3//188.<-502C

IJKLMNMOPQRSTQUVWXQYZ[\V]]X^QVQ_X'[SZV]QaX'\YPYaV\XQSZQ\UXQUVZ^UX]^bQF
T_Q\UXQcY'X]X[[QaSZZXa\YSZQdVZTV]]RQV[Q^X[a'YeX^QYZQf\X_QghQiSQaSZZXa\Q\SC
VaaX[[Q_SYZ\QkSQ\SQnSZZXa\YZkQ\SQ\UXQZX\cS'jQhS'QVaaX[[Q_SYZ\

o +"pq"o !"r+" s "$ % & ' '"()*" ← ←

BC3H1.8?61.2E32.2E1.u1-vw<7-616.Fxxy.816518.E3z4E3C17188.9:;.63z5-.58.
103|71z.}81¢3~1 yÄC.

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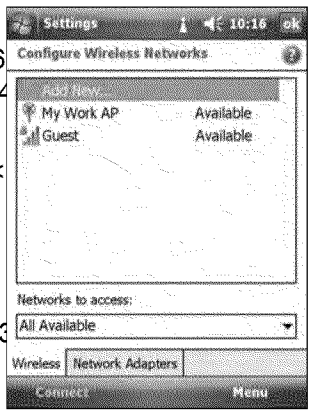
ÉCD171/2.2E1ÑY'X]X[[23|C...

:0>.0124-6H8.2E32.>-?.E3Ö1.37613z>./-0Ü5~?6
361.z58<73>1z.50.2E1.7582.Ü.<61Ü1661z.0124



áC,-.3zz.3.014.0124-6H=.23<.à^^QÇXch.,-./E30~1.
2E1.812250~8.Ü-6.30.1w58250~.0124-6H=.23<
0124-6HC

âCv0216.2E1.03@1.-Ü.2E1.0124-6H.30z.-2E16.
/-001/25-0.z123578.30z.2E10ãäâ3<C

éC ,-.?81.3?2E1025/325-0=.8171/2.2E1.3?2E1025/3
@12E-z.Ü6-@.2E1.àT\UXZ\YaV\YSZ.7582C

C,-.?81.z323.10/6><25-0=.8171/2.30.10/6><25-0.
@12E-z.Ü6-@.2E1.èV\VQXZa'R_\YSZ.7582C

yC,-.3?2-@325/377>.?81.3.0124-6H.H1>=.8171/2.2E1./E1/H.|-w.Ü-6.iUXQjXRQY[Q
VT\SdV\YaV]]RQ_'SWY^X^C.ê2E164581=.10216.2E1.0124-6H.H1>C

ëC,3<. äãâç C

BxCí-6.50/61381z.81/?652>=.8171/2.2E1.ì[XQOîîîQïñlhgóQZX\cS'jQVaaX[[QaSZ\'S]Q/E1/H.
|-w.30z.2E10./-0Ü5~?61.3zz525-037.3?2E1025/325-0.50Ü-6@325-0C.

BBC,3<ôöõõú C.

o +"ùq"→ !" ←" s " $←%ù"←%"# ' '"+←

BC01@-Ö1.2E1.E30zE17z.Ü6-@.2E1.8?<<-62.@-z?71=.E30zE17z.<65-6525†18.3.
¡D¢./-001/25-0.-Ö16.3.45617188.9:;./-001/25-0C

FC¢650~.2E1.E30zE17z.452E50.630~1.-Ü.2E1.0124-6H.-6.3//188.<-502C

£E10.3.45617188.9:;.58.z121/21z=.2E1.3//188.<-50 5/0.2E1.25271.|36.58.
305@321z=.30z.3.0-25Ü5/325-0.@1883~1.3<<1368.-0.2E1.71Ü2.8-Ü2H1>C

→ !! "" #$%& %!$& $' &$ %←%! %$& ($ " &$ ## ') *" +%' , "" - & . ' $ *'& $← &(& *'& / !0 $& 1%' , "" 234 ' (%$5 + & 1%' , "" 234 ' (%$ %" *'& ($&) &6 & 1$'0" $' !! "" #$%& " 1% %& ' &. ' (! (&(%!$& &(&$ %←%! %$& ## '5

758 # !! "" #$%& %!$& $& % , / ' $' #:;<=<>?;<:@ $& , ← "$← 0 65

3 #$#*# A "" . " $1" B %, /, & 1$'0"5

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G5 D , ! HIJKLMNJOMJNKPQOKRQOSKTUVKVKWXYZ [\]^_`abcdefgh&(&← # "$← 0 65

^5→ YJNRQOSK_Q'KaM "!' & ## '") & ' 6$*' *" ' & A) # ""1$'() &(($A %& %&←$'A %$& &(&EF# $& , ← "$← 0 65

+ & &(,(%" !$&& ! ($ & 1$'0 $' !! "" #$%&) 1%' , "" 23## !$'&%& (%!%& '5

b5D ' *"%&. #'$.' A 6$* 1 & $ *") ←$' c A#, +%&($1" dc#,$' ' -$/%, $' →& '& dc#,$' '5

efghijiHQKkUlmQMMJmNKnOQoKNIJKMJNRQOSKQOKVMKVmmJIlKpQUMNKVNKVMqKNL
KUMKNIJKNUNtJKVMkIJtkulKRUOJtJIlKOVkUQvKHQKkQKNIUlrKNVpKNIJKRUOJ[illegible]lK_wYKmQMMJmNJkK%!$
xVOrKIJtJmNKyz{h|h}}i~[illegible]Ah{KVMkKNIJ[illegible]QMv

Ö<Ûàáâãäåæçèéêëìíîïðñòóôõöøùúûüýþÿ
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→ !" ←"#"$%& ← '(#)% *"* + ""

,-./01.23-4516.78/14--459132:81;.;1<=>1.?=45.451.@1-ABC8-616.DEEF.016=10.523;518;G.
H/.I/04.J-6I.2.78/14--45.>-331>4=-3.:14?113.451.4?-.;1<=>10G.;/6=3K.?5=>5.H-/..
0181>4.451.4HC1.-J.016<=>1.4-./01.J-6.451.>-331>4=-3L..,5=0.;1J=310.5-?.451.;1<=>10.?=88
>-II/3=>241.?=45.12>5.-4516L

MJ416.J-6I=3K.451.78/14--45.>-331>4=-3.:14?113.451.;1<=>10.H-/.I2H.311;.4-.
>-3J=K/61.0144=3K0.J-6.451.>-331>4=-3.0/>5.20.451.NOP.C-64.J-6.451.J=18;.0-J4?261.4-.
/01G.-6.451.3/I:16.J-6.451.C5-31.4-.;=28L.Q-/.I/04.4513.>-331>4.4-.451.-4516.;1<=>1.
/0=3K.451.2CC6-C6=241.0-J4?261.2CC8=>24=-3L

,-.>-331>4.451.@1-ABC8-616.DEEF.016=10.523;518;.4-.23-4516.78/14--459132:81;.
;1<=>1G.H-/.>23./01.1=4516.2.C2=61;.>-331>4=-3.-6.2.3-39C2=61;.>-331>4=-3L

RSTUVWVXYZ[\]Z^_'Za\bb'acdbeZc\Z^Zfg\b'hZijdfZcgdiZ[\acd\bb\b^kZeZZc\Z
m]'c\\cgo'b^pn'kZfg\b'ZY_ZXbc'_b'cZ^aa'iiZ_Z_'^nocdq'Za__'acd\biZrdban]kdbeZstuZ
b'cv_jiwZ\bZe'xx hZvg'_'Zcg'Zf^d_dbeZic'fZdiZk'ia_dp'kZ^iZf^acZ\YZog'_Z
a\bb'acdbeZc\Z^Zfg\b'y

,6=I:81.61>-II13;0./0=3K.2.C2=61;.>-331>4=-3G.=J.C2=6=3K.=0.0/CC-641;.:H.451.-4516.
;1<=>1G.20.2.C2=61;.>-331>4=-3.>612410.2.I-61.01>/61.>-331>4=-3.23;.I2z10.
61>-331>4=3K.4-.451.;1<=>1.120=16L.{-6.I-61.=3J-6I24=-3G.=J.C2=6=3K.=0.0/CC-641;.:H.451.-4516.
132:81;.;1<=>1.118-?L

}-I1.;1<=>10G.0/>5.20.2.,6=I:81.@1-712>-3.61>1=<16G.;-.3-4.0/CC-64.C2=61;.
>-331>4=-30L.~01.2.3-39C2=61;.>-331>4=-3.=J.451.;1<=>1.;-10.3-4.52<1.2.z1H:-26;G.23;.
=J.H-/.z3-?.4524.451.;1<=>1.;-10.3-4.2/4-I24=>288H.1B>523K1.2.C619C6-K62II1;.
C200z1H.;/6=3K.C2=6=3KL.{-6.I-61.=3J-6I24=-3G.=J.C2=6=3K.=0.0/CC-64.C2=61;.
C2=61;.;1<=>1G.C2K1F

,- .>-331>4.451.@1-ABC8-616.DEEF.523;518;.4-.451.-4516.;1<=>1G.;-.-31.-J.451.J-88-?=3KÄ

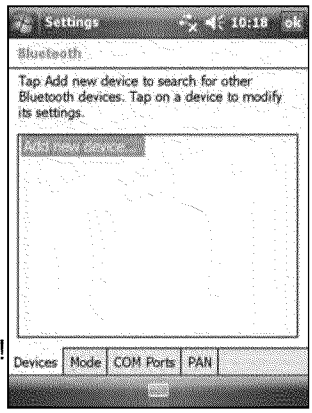
- |2=6.?=45.2.78/14--459132:81;.;1<=>1.011.:18-?É
- }14./C.2.>-331>4=-3.4-.2.3-39C2=61;.;1<=>1.011.:18-?É

Ñ#Ö !"Ü '"#"$%& ← '(#)% *"* +

|2=6=3K.451.523;518;.?=45.23-4516.78/14--459132:81;.;1.>612410.2.C16I23134.
01>/6=4H.:-3;.:14?113.451.;1<=>10G.?5=>5.518C0.4-.1B>523K1.=3J-6I24=-3.01>/618H.
:14?113.451.;1<=>10L.,51.C2=61;.61824=-305=C.=0.1042:8=051;.?513.4?-.;1<=>10.>61241.
23;.1B>523K1.2.8=3z.z1HL.O3>1.451.61824=-305=C.=0.1042:8=051;G.451.523;518;.23;.451.
-4516.78/14--45.;1<=>1.-38H.311;.4-.52<1.451=6.78/14--45.62;=-0.4/631;.-3.4-.1B>523K1.
=3J-6I24=-3á.451H.;-.3-4.311;.4-.:1.<=0=:81.4-.-4516.;1<=>10L

,-.C2=6.?=45.2.78/14--45.;1<=>1Ä

- àLP2z1.0/61.4524.451.523;518;.23;.451.78/14--45.;1<=>1.H-/.?234.4-.C2=6.?=45.261.
  ?=45=3.J=<1.I14160.-J.12>5.-4516G.23;.4524.451.78/14--45.62;=-.=3.12>5.;1<=>1.=0.
  4/631;.-3L
- DLO3.451.@1-ABC8-616.DEEF.016=10.523;51[illegible]a.42Ccdbeiâ.I\bb'acd\biâ.
  m]'c\\cgL



→← ! "#$%&#' ()* (+ ,--./#0.-#$%&#← 1 !
(2 !32 4!(56 !4 785 8 !5 93:! 88 2!;<6!4
(2 2<4+3(=4 !> < ! 3<4 ←

7 ! 2!;<6! =8: (5! 5=< ? 8 68 !6 <4 8
2<4+3(=!2 < ! 3<4 * ! 4:5! (! 2!;<6! <4 8
(2 @< < 5(?! (2 ! (+ ABCDBEF 8 4!(56
785 2!;<6!4 (?(< ←

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L← ! MN''&O-# 7<!32* ! !5 (+(44682! 87)! @!
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s (2!;<6! @< (K!=+(2* ! !5 (+(44682! 87
=8:5 6 8<6!←

s (2!;<6! @< 8: (K!=+(2*): =8: K 8@ (! 2!;<6! (4 (
+5!T+58?5(>>!2 +(44682! (@<33)! !U6 (?!2* ! !5 (+(44682! 8
! V!8WU+385!5 (2 !32←

XYZ[\]\^_%'ab#._#&O''#/-'.cdNc.eOf.#/c#_.O/be./f'a#_'g.N'.'O'#.-#$%&#'.-O./Oc.'fhhO_c.
hN''&O-#'.cdNc.%/&bf-#.b#cc#_'i

Q←1(+ HBIJj 8 ! 5<? 487 K!=←

k← l ! +58>+ !2* ! !5 ! 4(>! +(44682! 8 ! 8 !5 2!;<6!←

m ! (2 !32* ! MN_c/#_'d%h.n#cc%/o' 465!! (++!(54←

p← 7 5!q:<5!2* 6 (?! ! (>! 87 ! 2!;<6! < ! "%'hbNe.rN'# 7<!32←

s←t!3!6 ! 4!5;<6!u4v =8: @(8 :4! @< <4 2!;<6!← w85 !U(>+3!* <7 =8: (5!
68 !6 < ? 8R

s (93:! 88 T! ()3!2 + 8 ! 8 68 !6 8 ! !5 ! (2 5!6!<;! 5!(3T <>!
6855!6 <8 4 85 28@ 38(2)(6K?58: 2 >(+4* 4!3!6 xyz{|}\X[Z~Y ÄyÅÇ\
ÉxÑXÖ←

s (4!5<(3 2!;<6!* 4:6 (4 (V!89!(68 5!6!<;!5 85 (3(4!5 5(?!7< 2!5* 4!3!6
Ü[yz{\áY Z←

s (68>+: !5 8 (66!44 à6 <;!t= 6 !6 838?=* 4!3!6 âäZyã[ÜåÅä←

XYZ[\]\çO_.'O_#.%/éO_'Nc%O/.O/.cd#.ceh#'.Oé.-#$%&#'.cdNc.cd#.è#OêëhbO_#_.íìì î.'#_%#'.
dN/-d#b-.&N/.&O//#&c.cOg.N/-.cd#.'fhhO_c#-.ïbf#cOOcd.'#_$%&#'g.'d#O.N.
ï bf#cOOcd.-#$%&#.N'.N.&b%#/cig.hNo#óìò

Pô←1(+ öõúõEFj 8 ! 5<? 487 K!=←

PP←1(+ ùû < ! 8+ 5<? 685 !5 87 ! 465!! 8 6384! ! 93:! 88 (++3<6(<8 ←

Pü←1(+< 8+ 5<? 685 !5 8 6384! ! n#cc%/o' 465!! ←

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#→!! #%)→!9 4→ 5←(% #→5'. % % #→!:)8←$ %)→! (% '(:→$ % % %4' →: #→!! #%)→! !&
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bP\RX]VRcdefgRX[hViR

jkllmnopqrpsptunnktlmunplupspnunvrsmwkxpxkymtk

C%%)!8 ↵ #→!! #%)→! %→ !→!3')$ & &)# ! *. (4→ %→#→!! #% %→ &)# % %
&→(!→% ..→" 4→ %→ !% $ ' ((#→& →! % &)# 9 →$ % % &→(!→% ←%→5 %)# ..4
→# !8 '$ 3'$→8$ 55 & ' ((D 4 &←$)!8 ')$)!86

7→(% ↵ !→!3')$ & #→!! #%)→! %→ 2.←%→% 3 ! *. & &)# <

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GECKGAQK?MEC?M=CCAMF?F=U?ECK?FGA?JVII=>FA[illegible]LBMAJU?JA
WQAF==FG?KALBMA?EJ?E?MQBACFU?IEYAZS[

]7 ^← _'a'bcd + "e# $'fe" % g"h#*7

i j7^← kl '+ "e# " $'fe" $+#$ g "e# % $##+ " - %# "e# m-!#" "e ← -' ←"' +7

i i7^←'+ '[illegible] " $'fe" $+#$ " - %# "e# nAFFBCYJ % $##+7

o ! e←(# + p $#←"#q ← ←$"+#$%e' r#"p##+ "e# s# tu - $#$ vjjw e←+qe#-q ←+q "e#
"e#$ m-!#" "ex#+←r-#q q#(' # % "e←" "e#* ←+ !+' ←"#7 ^ %"←$" !%'+f "e#
++# "' +, * ! !%" -#"# "e# +g'f!$←"' + %"# % g $ "e←" "* # g ++# "' + ←+q
"e#+ ++# " " "e# q#(' #7 y $ $# '+g $ ←"' +, %##z

{ | ++# "'+f " ←m-!#" "ex#+←r-#q e +# g $ }+"#$+#" ← #%% $ $#←x"' #
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, "$' / ! →,, →.!0 ← $%) ←!123!← 4→,5.6!!!!!!!

789:;<9:=9>?@AB>C9C:89CD98:<EFG<9BGH8:IBJ9;>>;<:CEGD>:;>:K>FF9K;:;>:E:
I BJ9;>>;<L9FEMB9G:K9BBJBEC:A<>F9:EFG:;<9F:K>FF9K;:;>:;<9:NF;9CF9;O:789:;<D8:;PA9
K>FF9K;D>F:;>:EKK988:E:RST:F9;U>CV:>C:>;<9C:K>CC9K;D>F:8>JCK9:QC>W:;<9:NF;9CF
MEKVYC>JFG:WEA:89CZ9CX:>C:Q>C:NF;9CF9;:EFG:9WEDB:EKK988O

[\]^_'_abcdefdgghgijeklbmdnenhkkbjoeoldepghdobboleqrsetqdjnbmigerjdiesdoubjvwmxye
ndjzwfdeineudggeineoldepghdobbole{|set{wighkesdoubjvwmxyendjzwfd}epdfihnde{|se
fbmmdfowbmneijdecbjdefbccbm~eolwnendfowbmeinnhcdne bheijdecivwmxeieÄwighkemdoubjv
fbmmdfowbmeuwoleoldepghdobbolÅdmÇgdÄeklbmd}

É>:K>FF9K;:;>:E:IBJ9;>>;<L9FEMB9G:A<>F9:J8DFY:E:IBJ9;>>;<ÑÖÜÑDEBJAÖ9;U>CVDFYá:
K>FF9K;D>FX:P>J:WJ8;à

- âCä>FF9K;:;<9:=9>?@AB>C9C:ãåäç:89CD98:<EFG<9BG:;>:E:IBJ9;>>;<L9FEMB9G:A<>F9:
  EFG:;<9F:K>FQDYJC9:;<9:K>FF9K;D>F:;>:;<9:GDEBJA:F9;U>CVO
- ãCä>FF9K;:;>:;<9:NF;9CF9;:J8DFY:;<9:GDEBJA:F9;U>CVO
- éCä>FQDYJC9:;<9:8>Q;UEC9:;>:J89:;<9:K>FF9K;D>FO:è>C:9@EWAB9X:P>J:WJ8;:K>FQD\
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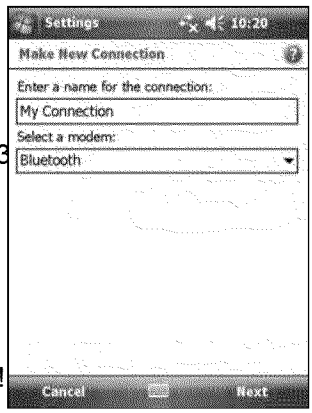

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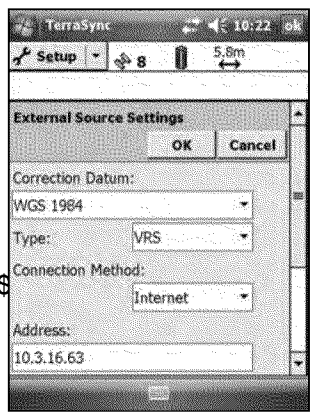

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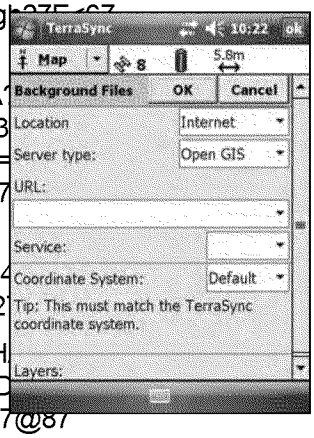

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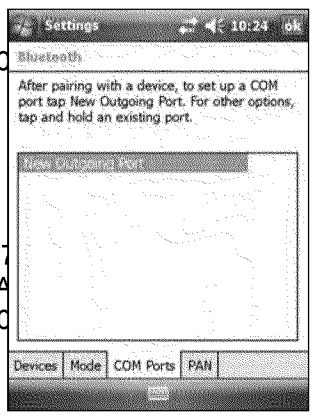

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E6IH
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åHIAP1 êëèéíìà 6<15701:9=751/6B5â0>H

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I T UMG8 defghijkelmeiijnop T8UA78q'rstauv'w_'aauxyz8<:?S8MGG7M?LT

{T |?:S8@A78}~ uÄ'wÅ8<=7HNR8L7H76@8[illegible]

èTUMG8@A78W7@;G8[illegible]78@A78}~ uÄ'wÅ[illegible]
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6:??76@=:5LT8

U?=SBH78?76:SS75NL8@AM@89:;8L7H76@[illegible]
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D;M?N8B7M6:58L7?Q=67R8:?8úDWKè8<:?8M[illegible]
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£T|?:S8@A78} xx'Äau xw/'a~ ¥8<=7HNR8L7H76@8[illegible]
ƒâÜÑT

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@A78õ7MHP@=S78L;BL76@=:58M5N8@A758L7H76@8êëa'íxrsw_[illegible]85T

├→ ! "#$% &'!&# (→$)#*& ← !+& ,&## -. * → $"!/ #&

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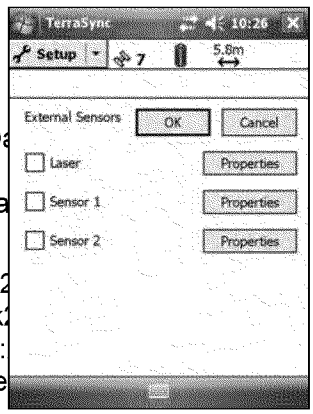

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!" ←"# "←$$ " ←%&' (" ←"') "* + ,- " . ←/←!-"""""

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Ö\lbk\l'7\gb[oY_gb7Ñ7ÜdgbYkf[áYtd]'[à'cde'[r'gZ'lQ

xE47rYgg'eZdYg[o'ZZdgif76;5A8<75DD45@2y7

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OèMëQ

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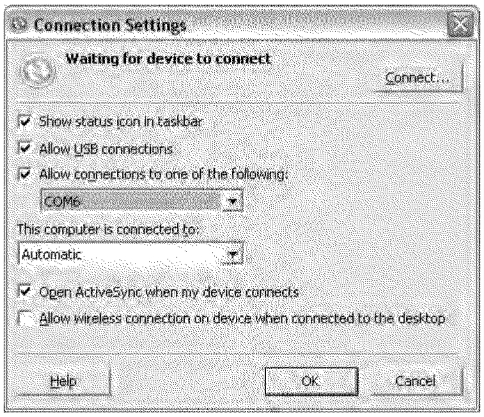

1← → 0 :##';+)'(($)*"'(.+*'+'($+'<+*=$+<'##';"(- 0 -> ?4@←

←A74B 0 28 C 8 → 0 DEF 647 03 G4H 8 → 1 2I3 3I1 0 I → 2->
JK ←

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c←EI 0 03I10 1C 36 %$**"(-.% &'(($)*"'(.%R#U$*''*=←

d← eI 0 f$a")$. 3?C 36 :__+($;+_$a")$←/0 03I10 1 8 37 0 8 g47 4 0 7
h H 44 0 1 i2→8 3I1 1286 3G8 0 B 2I 0 28 ←

j←/36 0 I3B 4g 0 4B6H 7 G4H k3I 4 4II → 4 3I1 0 I 36 lmnop4I 0
7250 84g > G←

q←r0 I 674B6 1C I 7 3 6388 41 4g G4H7 042→ 03 G4H k2 382 G 7 B B? 7
4I 0 03I10 1←

s←tI 7 0 83B 6388 41 4I 0 4gg2→ 4B6H 7←

u←EI 0 03I10 1C 8 → 0 vwNxyOz{|w 0 -> ?4@ 2I 0 28 4g 8 7i2→8 674i21 1
?G 0 4B6H 7 3I1 0 I 36 ÄÅ 4I 0 7250 84g > G←

Ç4H 03i I4k 7 3 1 3 637 I 78026 ? k I 0 É4t@6 47 7ÑÖÜu 8 72 8
03I10 1 3I1 0 4gg2→ 4B6H 7 84 03 0 G 3I 4BBHI2 3 ←

Ü←/36 JK 2I 0 46 7250 47I 7 4→48 0 h H 44 0 366 2 3 24I←

áÖ/36 2 46 7250 47I 7 4→48 0 ,$**"(-. 8 7 I←

/4 4II → 4 à→2i GI C 8 6Ñ4I 0 g4 4k2I5 635 ←

|→ !"" #→$"% →! &#→$'←|("#)*$"% +,)←!!→ .$/←,←** →#→"!,!%(

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→ ← !"#$!%& &! '!' ()*!%)+ ,)-!← !./←) '' (! 0 *)/)--!
),('/' 1!

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STU3@@:K?4?C:43?C:649:78K:4?34?C:4;:3DE5F36:64GHHI4>:68:>4CJ@9C:F9T

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VTU3@A8ML6:4?C:43?C:649:78K:4?346:K:87:49J?J4A63B4?C:4CJ@9C:F9T

$) !WX!Y'), ! ()!' ()*!%)+ ,)! '! ()!")'Z[/'*) *!-)*)-!(& %()/%

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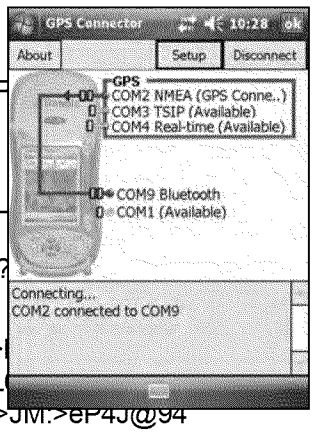
CJ@9C:F9T

rTf@4?C:4CJ@9C:F9P4?L54?43@4?C:468MC?4>3A?]:QT

$) !xX!Y' y ←* ! ()!(& %()/%! '!'← ←!%& &!
' ! ()!' ()*!%)+ ,)! 4



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GTg>:4?C:4;<=4U3@@:K?364>3A?OJ6:4?343L?5L
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;:3DE5F36:64GHHI4>:68:>4CJ@9C:F9ê>4ë3>?
NFL:?33?C4>:68JF4536?T

VTg>:4?C:4268BjF:4;<=4A8:F94>3A?OJ6:4?34:@>
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→ !"#$%&'(%#& ←) "←) (* +%, ←" (, %+ *-← $(". ←))-#*) /*

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N#-O/%#& "←) (* +%, P ←" ←(-#P$ ($%/ P 'P%#& Q/' ←""←) R%(/ PP
← ,)#"/"&S

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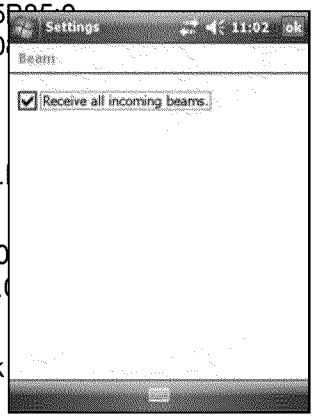

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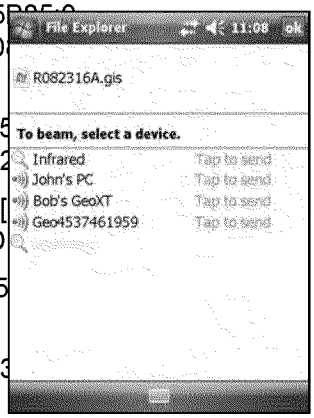

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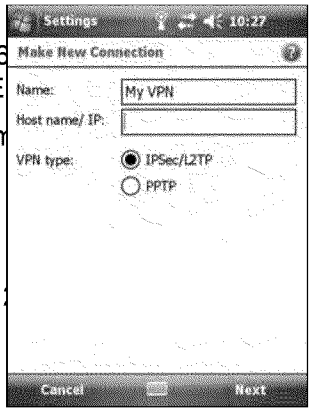

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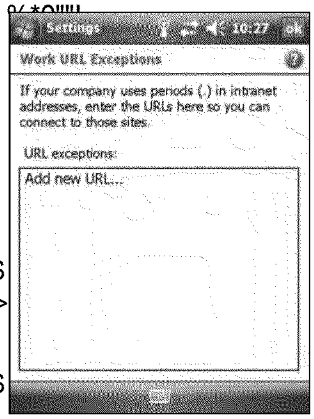

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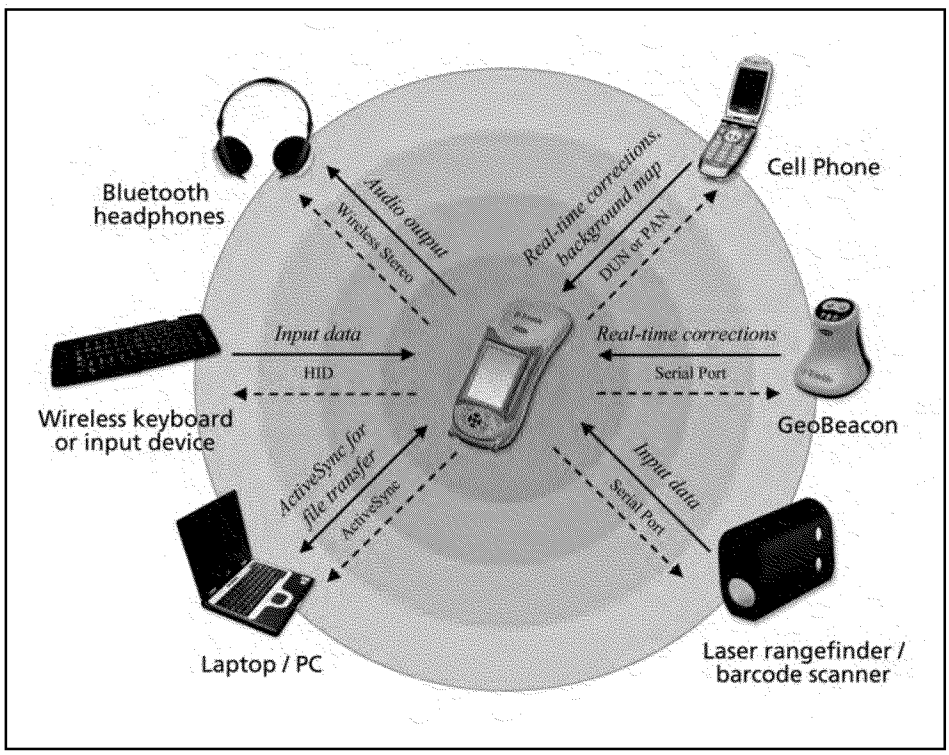

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- E→JEPBGP→IGZP;B=<→G<→GVV9I=→IGZP;B=<A→BC=→D=K9I=F→;F=→BC=→nIB9K=ro7I→F=<I
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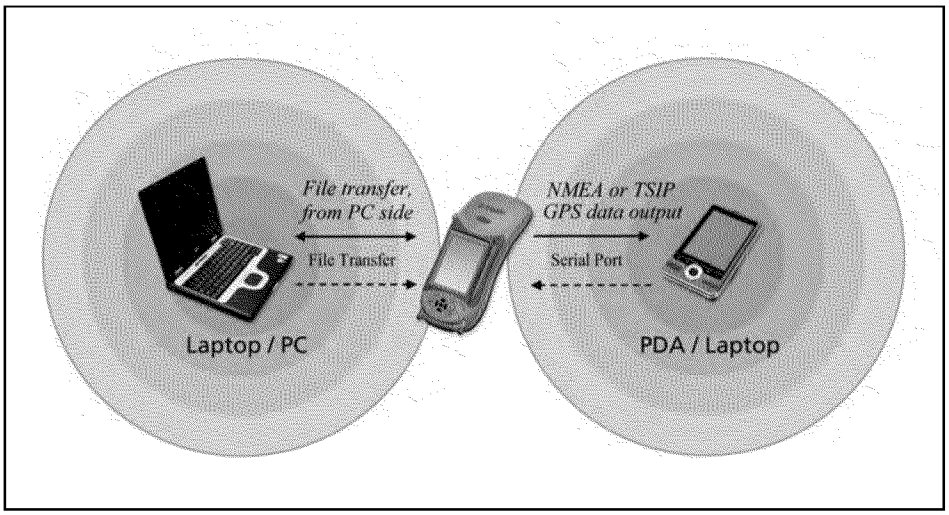

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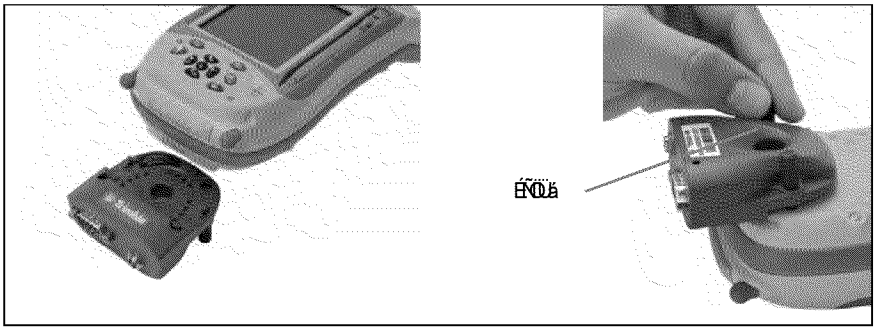

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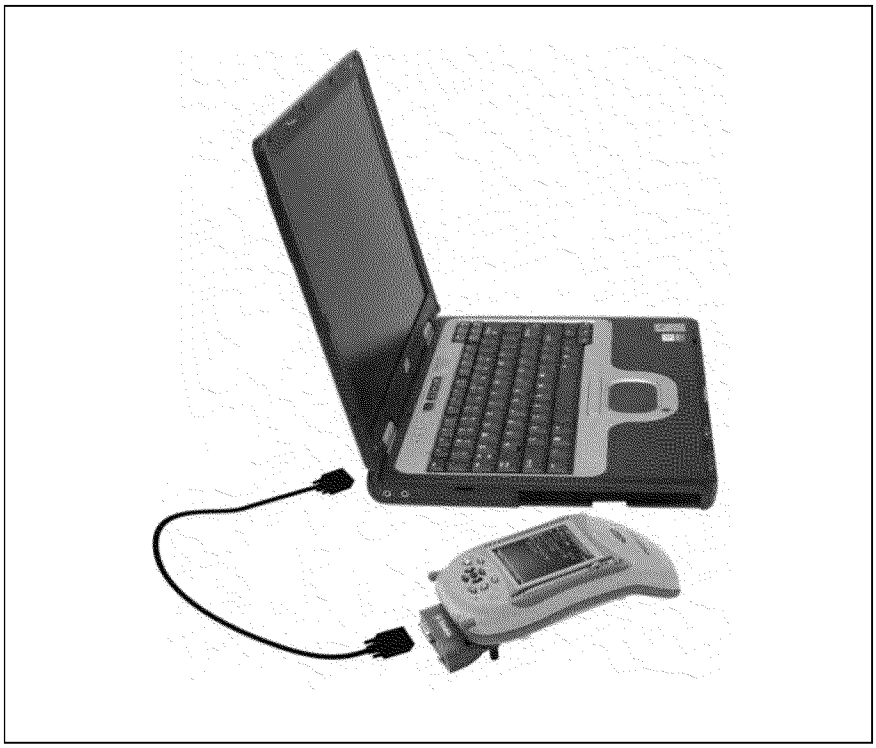
@-.+002.3-3+-/0-2<3250/7-92=6.2-34/3-4/1-/-1256/7-8+53i

j? k33/.4-342-1256/7-.768-3+-342-4/094279?-

l? m7,n-342-0,77-;+92;-./o72-603+-342-1256/7-pqrst-8+53-+0-342-1256/7-.768?

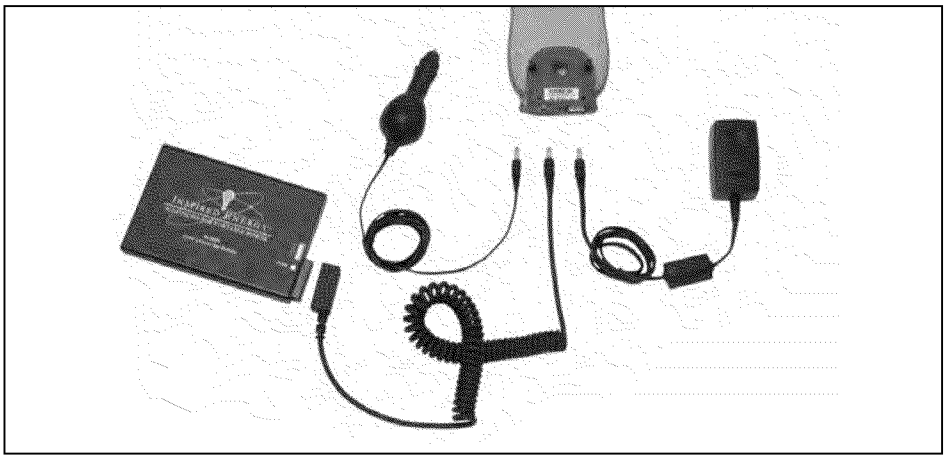
u?q+002.3-342-+3425-209-+:-342-./o72-3+-342-1256/7-8+53-+0-342-2<3250/7-92=6.2?



@+-.+002.3-3+-/-1256/7-92=6.2-34/3-9+21-0+3-4/=2-/-13/09/59-vw860-1256/7-8+53>-,12-/-./o7
34/3-4/1-/-xyv-.+002.3+5-+0-+02-209>-/09-342-/885+856/32-.+002.3+5-:+5-342-+3425-92=6.2-+0-342-+3425-209?-k-1,63/o72-./o72-;/z-o2-1,887629-{634-342-2<3250/7-92=6.2?

[illegible] ←! →!"←! # $←"%!&→' $!(→)$!' *! * !($ " %! % &

+,-./0-.12/31456.,-7356.8632./1.8144-8/./0-.9-1:;2617-7.<==>.,-73-,.054?0-6?./1.54.
-;/-7456.21@-7.,1A78-B.C-2-4?34D.14./0-.12/31456.588-,,173-,./05/.E1A.05F-.
2A7805,-?G.E1A.854.A,-.H534,.21@-7G./0-.-;/-7456.21@-7.I3/G.17.5.F-0386-.J5//-7E./1.
,A226E.21@-7./1./0-.054?0-6?B



K1.8144-8/./1.54.-;/-7456.21@-7.,1A78-L

MB//580./0-.,-7356.8632./1./0-.054?0-6?B

<BO6AD./0-.522712735/-.85J6-.34/1./0-.21@-7.217/.14./0-.,-7356.8632B

PBQ144-8/./0-.1/0-7.-4?.1R./0-.85J6-./1./0-.-;/-7456.21@-7.,1A78-B.C-/536,.5J1A/.
-580./E2-.1R.-;/-7456.21@-7.,1A78-.57-.5,.R1661@,L.

z{|}~ |ÄÅÇÉÑÖ	Ü{áàâäãåçéèêëíìî	à{ãåï
ïñóòôöõúùûüª°¢£§•¶ß®©™´¨≠ÆØ	∞±≤≥¥µ∂∑∏π∫ªºΩæø¿¡¬√ƒ≈∆«»…ÀÃÕŒœ–—“”‘’÷◊ÿŸ⁄€‹›ﬁﬂ‡·‚„‰ÂÊÁËÈÍÎÏÌÓÔ	∞±≤≥¥µ∂∑∏π∫ªºΩæø¿¡¬√ƒ≈∆
ÒÚÛÙıˆ˜¯˘˙˚¸˝˛ˇ!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_	∞±≤≥¥µ∂∑∏π∫ªºΩæø¿¡¬√ƒ≈∆«»…ÀÃÕŒœ–—“”‘’÷◊ÿŸ⁄€‹›ﬁﬂ‡·‚„‰ÂÊÁËÈÍÎÏÌÓÔ	†ˆ‰ˇ¯˘˙˚¸˝˛ˆ˜¯˘˙˚¸˝˛ˇ!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
ÒÚÛÙıˆ˜¯˘˙˚¸˝˛ˇ!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_	∞±≤≥¥µ∂∑∏π∫ªºΩæø¿¡¬√ƒ≈∆«»…ÀÃÕŒœ–—“”‘’÷◊ÿŸ⁄€‹›ﬁﬂ‡·‚„‰ÂÊÁËÈÍÎÏÌÓÔ	†ˆ‰ˇ¯˘˙˚¸˝˛ˆ˜¯˘˙˚¸˝˛ˇ!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
«ÊÒÌÙÈÂÊÁÒÚÛÙıˆ˜¯˘˙˚¸˝˛ˇ!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_	∞±≤≥¥µ∂∑∏π∫ªºΩæø¿¡¬√ƒ≈∆«»…ÀÃÕŒœ–—“”‘’÷◊ÿŸ⁄€‹›ﬁﬂ‡·‚„‰ÂÊÁËÈÍÎÏÌÓÔ	Îˆ¯˘˙˚¸˝˛ˇ!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
	ÒÚÛÙıˆ˜¯˘˙˚¸˝˛ˇ!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_	ÊÒÌÙÈÂ

S *"$ ←!T$→U!"←! # $←"%!&→' $!(→)$

VE.?-R5A6/G./0-.9-1:;2617-7.<==>.,-73-,.054?0-6?B.3/,.34/-7456.J5//-7E.R71H.
54E.-;/-7456.21@-7.,1A78-./05/.3,.8144-8/-?B.W-8057D34D./0-.J5//-7E.?75@,.H17-.
21@-7.R71H./0-.-;/-7456.,1A78-./054.3,.A,-?./1.21@-7./0-.054?0-6?B

XYZ[\]\^_'abcd'aedaf_'aghff'ijakhlag'amcnlcdckhlfbjam_eif'l'oacdapeq'iacmakelmfhlfbjamrppb
feaf_'a_hlo_'bosa^eahtecoaf_cmacmmr'uakell'kfaf_'a_hlo_'boafeahla'vf'ilhbapeq'iamerik'a
elbjaq_'laf_'aghff'ijai'wric'mak_hinclnsaxlk'adrbbjak_hin'ouaocmkell'kfaf_'a'vf'ilhbapeq'ia
merik'ahloahbbeqaf_'aghff'ijafeaocmk_hin'af_iern_aleiyhbarm's

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6 9:7<=>>?:>

6 @ABCD=EFG<=>>?:>

6 H8?BF<>B;:I<=>>?:>

6 J:KLAM<=>>?:>

6 NG8;AE:<BA;M<=>>?:>

6 O8II:BG=8I<=>>?:>

6 P7N<;:B:=Q:;<=>>?:>

6 R:ADSG=T:<UP7N<=>>?:>

6 R:B8TT:IM:M<P7N<>:GG=IE><V8;<
TAW=T?T<L;:B=>=8I

XYZ[\]^Y[YZ_\^‘a[\‘[^bZa\^cd[eab[Y‘fgZ[_‘hh‘a[
i j‘kfZhY[\]e\[hed[‘__lj[m]Za[lY^an[\]Z[
oZ‘pqif‘jZj[rsst[YZj^ZY[]eab]Zfbu[vfZeYZ[jZeb[
\]^Y[YZ_\^‘a[kZc‘jZ[d‘l[_‘a\e_\[\Z_]a^_ef[Ylii‘j\u

← !""# "

,-./012	34561	7.0589.:
;<=><?@A<=BA>AC=D>@CE> EFG@>C@H	;<=>I?EE=GJ>KD>LB?EH	?EE=GJ>PD==> Q?O=RSTH
;< =>DNG==@?@A<=BA>KD>	EFG@=A> CLLH	VG=DD>E<W1-X IFEEC@>EC>EFG@>C@>E<=><?@A<=BAH
	; <=><?@A<=BA><?D>BCNU FQH	MAD=E>E<=><?@A<=BA>PD==EK@O>E<=><?@A<=BAY> Q?O=RZTH
;< =><?@A<=BA>KD>@CE> N<?GOK@OH	;<=>K@E=G@?B>E=[Q=G?EFG=<?D>GKD=@>?IC\=>E<=> ?BBC]=A>[?^K[F[>PS_>‘a> CG>b_S>‘cT>LCG>N<?GOK@O>E<=> I?EE=GJH	fG=G@=>CG>?BB>CL>E<=>LCBBC]K@Oe f ;FG@>CLL>E<=>K@E=OG?E=A>G?AKCD>I=LCG=>N<?GOK@O>E<=> <?@A<=BAH f gFDQ=@A>E<=><?@A<=BA>I=LCG=>N<?GOK@OH f M=[C\=>E<=><?@A<=BA>LGC[>?@J>=^E=G@?B<=?E> DCFGN=D>PLCG>=^?[QB=Y>DF@BKO<ETH>;<=><?@A<=BA>]KBB> ?FEC[?EKN?BBJ>DE?GE>N<?GOK@O>?O?K@>]<=@>E<=> K@E=G@?B>E=[Q=G?EFG=><?D>AGCQQ=A>I=BC]>E<=>G?@O=> LCG>N<?GOK@O>E<=>I?EE=GJH
;<=>I?EE=GJ>QC]=G> Q=GN=@E?O=>I?G>AC=D>@CE> ?QQ=?G>K@>E<=>VC]=G> NC@EGCBH	;<=>I?EE=GJ><?D>_h> @CE=GH	M=N<?GO=>E<=>I?EE=GJ>PD==>RSTH>i@N=>E<=>I?EE=GJ> B=B>KD>?IC\=>_hY>E<=>I?EE=GJ>QC]=G>Q=GN=@E?O=>I?G> G=?KQmnnopqj>krqmlsj>tuvlw>j>xymmlwr> EC>\K=]>E<=>B=\=B>CL>QC]=G>G=[?K@K@O>K@>E<=>I?EE=GJH
;<=>N<?GO=>B=\=B>CL>E<=> I?EE=GJ>AGCQD>]<=@>E<=> <?@A<=BA>KD>EFG@=A>CLLH	;<=><?@A<=BA>]?D>B=LE>K@> gFDQ=@A>[CA=>CG>]?D>B=LE> ?BBJ>N<?GO=A>LCG>?>BC@O> AFG?EKC@H	z@>CG=>DECGK@O>E<=><?@A<=BAY>NC[QB=E=BJ>D<FE>AC]@>E<=> <?@A<=BA>PD==>K@O>C@>?@A>EFG@K@O>CLL>E<=> <?@A<=BAY>Q?O=TH>;<=@>DECG=>E<=><?@A<=BA>?D> G=NC[[=@A=A>PD==>gECGK@O>E<=><?@A<=BAY>Q?O=bZTH

$%&'(!)*+ !""# "

,-./012	34561	7.0589.:
;<=>I?NUBKO<E>AC=D>@CE> NC[=>C@>]<=@>JCF>E?Q> E<=>DNG==@>CG>QG=DD>VC]=G> IFEEC@H	;<=>I?NUBKO<E>KD>@CE> EFG@=C@>K@>E<=>z?NUBKO<E> NC@EGCBH	P?OD=>mmnopqj>krqmlsj>xy|}~np mEC>\K=]>E<=> z?NUBKO<E>NC@EGCBY>?@A>[?U=>DFG=>E<?Ee f E<=>ÄwoÇuoÇÉy|}~np mÇ loÇyÇÉmmuoÇnqÇÑwlqqÖuwÇ mÇ lÇq|wlloÇnqÇmyÑÖ>N<=NU>IC^>KD>D=B=NE=AH f E<=>IGKO<E@=DD>KD>@CE>D=E>EC>Üyw}>K@>E<=>xwnp molqq> E?IH
;<=>DNG==@>KD>IB?@U>CG> <?GA>EC>D==H	;<=>I?NUBKO<E>KD>E@=CGDECG>QG=DD>?>IFEEC@H	;<=>I?NUBKO<E>KD>E@=CG>QG=DD>?>IFEEC@H
	;<=>I?NUBKO<E>B=\=B>@==AD> EC>I=>?AáFDE=AH	?O=>mmnopqj>krqmlsj>xy|}~np mEC>\K=]>E<=> z?NUBKO<E>NC@EGCB>?@A>E<=@>?AáFDE>E<=>DBKA=G>K@>E<=> xwnp molqq>E?IH

← ! "##$ %!! #!

+,-./01	23450	6-/478-9
:;<=>?@A;=BAC<<D=E?<B=D?>=C<BF?DE=>?=B>GH@B=>IFBJ	:;<=>?@A;=BAC<<D=KB=H?DA?CC<A>HG=IHKLD<EJ	M<IHKLD=>;<=BAC<<D=NB<<=FIL<_d QJ
	: ; <=>?@A;=BAC<<D=KB=H?AR<EJ:?=@DH?AR=>;<=>?@A;=BAC<<D=KB=H?AR<EJ:?=@DH?AR=>;<=>?@A;=BAC<<D=KB=H?AR<EJ:?=@DH?AR=>;<=W<D@=XIC=?Y=>;<=Z[\]^=BAC<<DJ	
	:;<=;IDE;<HE=;IB=H?AR<E=@FJ	M<B<>=>;<=;IDE;<HE=NB<<=FIL<_d QJ
: ; <=BAC<<D=KB=XIHDC<E=?YYJ	aC<BB=>;<=b0,c X@>>?D=>?=>@CD=?D=>;<=;IDE;<HEJ	
	: ;<=XI>>MCG;KB<=YH<=XI>><CG=NB<<= FIL<_d QJ	
	: ; <=;IDE;<HE=;IB=H?AR<E=@FJ	M<B<>=>;<=;IDE;<HE=NB<<=FIL<_d QJ
:; <=BAC<<D=KB=;ICE=>?=B<<J	:;<=XIARHKL;>=H<e<H=D<<EBF<E?=X<=IEf@B><EJ	gF<D=>;<=hIARHKL;>=A?D>C?H=IDE=>;<D=IEf@B>=>;<=XIARHKL;>=H<e<H=NB<<=FIL<_d QJ
	: ; <=XIARHKL;>=BAC<<D=KB=?YYJ	H<e<H=NB<<=FIL<_d QJ
	j?@=IC<=@DIXH<=>?=B<<=FIC?Y=ID=IFFHKAI>K?D=kKDE?kS=A;IDL<=>;<=k;<D=>;<=BAC<<D=KB=KD=HIDEBAIF<=?CK<D>I>K?DJ	IC<=E<BKLD<E=Y?C=F?C>CIK>=?CK<D>I>K?D=kKDE?kS=A;IDL<=>;<=BAC<<D=EKBFHIG=>?=F?C>CIK>J
	:;<=B<H<A><E=EKBFHIG=>;<=B<H<A><E=EKBFHIG=>;<=mKL;no?D>CIB>=EKBFHIG=>;<W<=:IF=E?<B=D?>=;Ie<=<D?@L;=A?D>CIB>J	xryw[u]zp=Z[\]^S=B<H<A>=>;<=mKL;no?D>CIB>=>;<W<=IDE=>;<D=>IF={[J
}WIL<B=?D=>;<=BAC<<D=E?=D?>=EKBFHIG=A?CC<A>HGJ	D=<H<A>C?B>I>KA=EKBA;<D=;IB=?AA@CC<E=>?=?D<=?Y=?C<C<A<BB<E=A?DD<A>?C=><CWKDIHB=I>=>;<=C<IC=?Y=>;<=;IDE;<HEJ	aC<BB=>;<=b0,c X@>>?D=>?=>@CD=?YY=>;<=;IDE;<HE=IDE=>;<D=F<C<BB=>;<=b0,c X@>>?D=ILIKD=>?=>@CD=?D=>;<=;IDE;<HEJ : ;KB=A?CC<A>B=>;<=BAC<<D=EKBFHIG=kK>;?@>=H?BKDL=IDG=EI>IJ

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+,-./01	23450	6-/478-9
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/012345	67894	:138;<1=
>?@A?BCD?@EDADF@GACFHA I@JFKCLM@ABAGHFIBK@AGOPPF	>?@A?BCD?@EDADF@GACFHA GOPPFIHAQRSTAUQRA LCPOHVFOHPOHWAJBIDGN	XA@ABCAQRAFIAQRYZAJBIDN
[LE@GAFCAH?@AGHFIBK@AEBIGA BI@ACFHA\LGL]E@AFIABI@AGOPPF B]E@AHFA]@AFP@C@DN	?B\@A]@@CA@CJI^PHLFCA H?@IAD@\LJ@ABCDA BAN_@CJA‘LE@A@aH@CGLFCN	A@A@CJI^PHLFCA‘IF_AH?@A‘LE@GAFCAH?@A AFIBK@AJBIDGdAPBWN@ef

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/012345	67894	:138;<1=
gJHL\@Q^CJA H@J?CFEFK^AhLEEA JFCC@JHAHFAH?@A ?BCD?@EDN	>?@AJFCC@JHLFCALGACFHA LFCAHLBH@DABOHF_BHLJ	F\@AH?@A?BCD?@EDA‘IF_AH?@AGOPPFIHA_FDOE@ABCDAH?@CA ALHALCAH?@AGOPPFIHA_FDOE@ABKBLCNAgEH@ICBHL\@E^dALCAH?@ gJHL\@Q^CJAGF‘HhBI@AFCAH?@AF‘‘LJ@AJF_POH@IdAG@E@JHA ijklVmnoolpqjnorslqqjotuBCDAH?@CAHBFA==4v; N
	g JHL\@Q^CJADF@GACFHA I@JFKCLM@AH?@A w@FcaPEFI@IAfxxyAG@IL@GA ?BCD?@EDN	A@GHBIHAH?@AF‘‘LJ@AJF_POH@INAb@_F\@AH?@A?BCD?@EDA‘IF_AH?@A GOPPFIHA_FDOE@dAI@G@ @CAH?@CAI@PEBJ@ALHALCAH?@AGOPPFIHA_FDOE@N
	gCALCJF_PBHL]E@A\@IGLFCA F‘AgJHL\@Q^CJAGF‘HhBI@A LGALCGHBEE@DN	gJHL\@Q^CJA\@IGLFCA{N|ABCDAEBH@IALGAJF_PBHL]E@AhLH?AH?@A FcaPEFI@IAfxxyAG@IL@GA?BCD?@EDNAS‘A\@IGLFCA{N|AFIAEBH@IAF‘AH?@ gJHL\@Q^CJAGF‘HhBI@ALGACFHALCGHBEE@DAFCAH?@AF‘‘LJ@AJF_POH@IdA ^FOAJBCALCGHBEEALHA‘IF_AH?@A}ln~ÏÄknÅÄÇÉÑslÅjlur}lqqjotr sqÄqÜrájupNàFOAJBCABEGFADFhCEFBDAH?@AEBH@GHA\@IGLFCA‘IF_AH?@A âLJIFGF‘HAh@]GLH@ABH h h hN_LJIFGF‘HNJF_VhLCDFhG_F]LE@VBJHL\@G^CJVD@‘HNDEHN_GPa
	>?@AJFCC@JHLFCALGACFHA @CB]E@DALCAgJHL\@Q^CJA FCAH?@AJF_POH@IN	H?@AgJHL\@Q^CJAGF‘HhBI@AFCAH?@AF‘‘LJ@AJF_POH@IdAJELJäA jklVmnoolpqjnorslqqjotuNAS‘A^FOABI@AOGLCKã å H?@AGOPPFIHA_FDOE@dA_Bä@AGOI@AH?BHAH?@Açkknéèsêr pnoolpqjnouAJ?@JäA]FaALGAG@E@JH@DA‘IF_AH?@ADIFPéDFhCAELGHN å BAíEO@HFFH?AJFCC@JHLFCdA_Bä@AGOI@AH?BHAH?@AJFII@JHAPFIHA‘FIA íEO@HFFH?ALGAG@E@JH@DNA>?@CAFP@CAH?@AíEO@HFFH?AJFCHIFEA H?@A?BCD?@EDNASCAH?@AáIijpluAHB]dAHBPAH?@APBIHC@IG?LPABCDA LCAH?@AG@I\LJ@GAELGHA_Bä@AGOI@AH?BHAH?@AçpqjilsîopAJ?@JäA]FaA LGAG@E@JH@DN
	>?@AJFCC@JHLFCALGACFHA @CB]E@DALCAgJHL\@Q^CJA FCAH?@A?BCD?@EDN	[illegible]VA dAolpqjnouNAâBä@AGOI@AH?BHAH?@AsîopôÅnojölrÖkkrïmurùujotrqôjur pnoolpqjnoAJ?@JäA]FaALGAG@E@JH@DdABCDAH?BHAH?@AJFII@JHAFPHLFCAL G@E@JH@DN
	>?@A?BCD?@EDA JFCC@JHLFCAG@HHLCKGA JFC‘ELJHAhLH?AC@HhFA G@HHLCKGAFIAõüAJEL@GhA GF‘HhBI@N	S‘A^FOABI@AOGLCKAH?@AGOPPFIHA_FDOE@dAOG@AH?@AXQíAHFAúZAOHLE AJ?BCK@AH?@AJFCC@JHLFCA_@H?FDAH?@A?BCD?@EDAOG@GAHFA gJHL\@Q^CJAFCAH?@AJF_F[illegible]@INA>BPA olpqjnouVAèsêrqnrïmrèqjkjqîNAZE@BIAH?@A~oÜkIÖÜÖpLÜr olqénÅürùopqjnoÖkjqîAJ?@JäA]FaN >?@A?BCD?@EDAGHFPGAOGLCKAH?@AD@‘BOEHAbùRSQA_@H?FDAHFA JFCC@JHAHFAH?@AgJHL\@Q^CJAGF‘HhBI@N

→ !" #←$%!&%'←(%!)% *%+!!!

./01234	56783	9027:;0<
=>?@ABCDEAF>GHDIHJ>KHDLH?MHNDB>GGD?AMDKA??HKMD MADMOHDOP?@OHG@Q	ROHDKA??HKM>A?D>CD?AMD ?HKMD@DPSMATPM>KPGGUQD	AMDTAJHDMOHDOP?@OHG@DWNATDMOHDCSXXANMDTA@SGHDP?@DMOH? [illegible]MD>?DMOHDCSXXANMDTA@SGHDPYP>?QDZGMHN?PM>JHGU[D>?[=>?@ABCDEAF>GHDIHJ>KHDLH?MHNDCAWMBPNHDA?DMOHDAWW>KHD KATXSMHN[DCHGHKMD\]^_'abcad_eabfagg_hijkl]hhaeg_]hb fagg_hijQ
	ROHD=>?@ABCDEAF>GHD IHJ>KHDLH?MHNDCAWMBPNHD @AHCD?AMDNHKAY?>m nHAopXGANHNDqrrsDCHN>HCD OP?@OHG@Q	DHCMPNMDMOHDAWW>KHDKATXSMHNQDVHTAJHDMOHDOP?@OHG@DWNA MDCSXXANMDTA@SGH[DNHCHHDMMDCHHD HDMOHDOP?@OHG@[D DP?@DMOH?DNHXGPKHD>MD>?DMOHDCSXXANMDTA@SGHQ
	ROHDKA??HKM>A?D>CD?AMD H?PFGH@D>?D=>?@ABCD EAF>GHDIHJ>KHDLH?MHNDCAWMBPNHDA?DMOHDKATXSMHNQ	AMDMOHD=>?@ABCDEAF>GHDIHJ>KHDLH?MHNDCAWMBPNHDA?DMOHD AWW>KHDKATXSMHN[DKG>KxD\]^_'abcad_eabfagg_hijkDl]hhaeg_]hb fagg_hijQDwWDUASDPNHDSC>?Yy z MOHDCSXXANMDTA@SGH[DTPxHDCSNHDMOPMDMOHD{''|b}f~b e]hhaeg_]hDKOHKxDFApD>CDCHGHKMH@DWNATDMOHD@NAX @AB?D G>CMQ z PDÄGSHMAAMODKA??HKM>A?[DTPxHDCSNHDMOPMDMOHDKANNHKMD XANMDWANDÄGSHMAAMOD>CDCHGHKMH@QDROH?DAXH?DMOHDÄGSHM KA?MNAGDA?DMOHDOP?@OHG@QDw?DMOHDcad_eajDMPF[DMPXDMOHD XPNM?HNCO>XDP?@D>?DMOHDCHNJ>KHCDG>CMDTPxHDCSNHDMOPMD {eg_daÅheDKOHKxDFApD>CDCHGHKMH@Q
	ROHDKA??HKM>A?D>CD?AMD H?PFGH@DA?DMOHD OP?@OHG@Q	[illegible] l]hhaeg_]hjQDEPxHDCSNHDMOPMDMOHDÅheaÑh_âabÖ'bÉjbäj_hib gà_jbe]hhaeg_]hDKOHKxDFApD>CDCHGHKMH@[DP?@DMOPMDMOHDKANNHKM AXM>A?D>CDCHGHKMH@Q
	ROHDOP?@OHG@D KA??HKM>A?DCHMM>?YCD KA?WG>KMDB>MOD?HMB CHMM>?YCDANDäaDKG> CAWMBPNHQ	wWDUASDPNHDSC>?YDMOHDCSXXANMDTA@SGH[DSCHDMOHDçÄDMADäLD SDM>G>MUDMADKOP?YHDMOHDKA??HKM>A?DTHMOA@DMOHDOP?@OHG@D KA??HKMDMADMOHD=>?@ABCDEAF>GHDIHJ>KHDLH?MHNDA?DMOHD [illegible] }g_'_gÅQDLGHPNDMOHDèÖ'abÇèdÇheaêbhag]Ñèbíáheg_]hÖ'_gÅD KOHKxDFApQ ROHDOP?@OHG@DCMAXCDSC>?YDMOHD@HWPSGMDVälwéDTHMOA@DMAD KA??HKMDMADMOHD=>?@ABCDEAF>GHDIHJ>KHDLH?MHNQ

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	: ; <=@<GEB<=EF=CLD=CQ=H>?N<M	WCG<=D;<=@<GEB<F=BACF<H=DC=<>B;=CD;<H=>?@=D;<?=FB>?= >N>E?M
	KAL<DCCD;=REH<A<FF= D<B;?CACNJ=EF=?CD= <?>IA<@=C?=C?<=CH=ICD= @<GEB<FM	W>S<=FLH<=D;>D=D;<=KAL<DCCD;=H>@EC=EF=DLH?<@=C?T=C?=ICD;= D;<=;>?@;<A@=YF[<^_]=>?@=D;<=CD;<H=KAL<DCCD;= @<GEB<M
	:;<=@<GEB<=;>F=?CD=I<<?= '>@<=ZEFBCG<H>IA<M	W>S<=FLH<=D;>D=D;<=KAL<DCCD;=@<GEB<=;>F=I<<?='>@<= ZEFBCG<H>IA<M=
:;<=abW=[CHD=D;>D=JCL= >FFEN?<@=DC=>=F<HE>A=[CHD= F<HGEB<=EF=?CD=>G>EA>IA<=E?@<@=>QD<H=D;<= JCLH=>[[AEB>DEC?M	:;<=>[[AEB>DEC?=B>??CD= A=[CHD=?Ec<=[CHDF=EQ=D;<= F<HGEB<=EF=?CD=>G>EA>IA<=E?@<@=>QD<H=D;<= >[[AEB>DEC?=C[<?FM	deED=QHC'=D;<=>[[AEB>DEC?T=>@@=D;<=[CHD=>?@=D;<?=HL?=D;<= [[AEB>DEC?=>N>E?M
:;<=KAL<DCCD;= BC??<BDEC?=Q>EAF=R;EA<=E?@ LF<M	:;<=KAL<DCCD;=@<GEB<=WCG =CLD=CQ=H>?N<M	WCG<=D;<=@<GEB<F=BACF<H=DC=<>B;=CD;<HM=:;<=@<GEB<F=F;CLA@= H<BC??<BD=>LDC'>DEB>AAJM=PQ=D;<J=@C=?CDT=F<A<BD=D;<= KAL<DCCD;=@<GEB<=E?=D;<=fghijgk=D>IM=:>[=>?@=;CA@=D;<= @<GEB<=?>'<=>?@=D;<?=F<A<BD=fglgmgM=:>[=ngo=DC=@EFBCG<H= D;<=@<GEB<=>N>E?M
	:;<=KAL<DCCD;=H>@EC=>EH ACFD=D;<=BC??<BDEC?M	=?=CQQ=D;<=KAL<DCCD;=H>@EC=C?=D;<=;>?@;<A@=>?@=D;<?= DLH?=C?=D;<=KAL<DCCD;=H>@EC=YF_<]M
	KAL<DCCD;=QEA<=DH>?FQ<H= E?D<HHL[DF=D;<= BC??<BDEC?M	=JCL=DH>?FQ<H=A>HN<=E'>N<=CH=@>D>=QEA<FT=CD;<H= KAL<DCCD;=BC??<BDEC?F='>J=FDC[=H<F[C?@E?NM=:C=>GCE@= [HCIA<'FT=BACF<=CD;<H=KAL<DCCD;=BC??<BDEC?F=I<QCH= DH>?FQ<HHE?N=A>HN<=QEA<FM
V?=<HHCH='<FF>N<=H<[CHDF= qrHCIA<'=RED;= KAL<DCCD;=s>H@R>H<tM;	=D;<=?D<NH>D<@= KAL<DCCD;=H>@EC='>J= >BDEG>D<@M	uF<=D;<=U>@EC=VBDEG>DEC?=W>?>N<H=DC=H<>BDEG>D<=D;<= KAL<DCCD;=H>@EC=YFBDEG>DE?N=D;<=E?D<NH>D<@=H>@ECFT= >N<\ ]M

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	89:;9JGE9:OE;HK;@M?;@I; AJGT:;@I;?9:;G:?>@ABQ	V@W;?@;>H?9HG;AJGT:;@I;?9:;G:?>@ABX;?9:G[illegible]L; Z[\\]^_'Yab^^[c\]b^'Yd[\ebfghaifj';;JGE;?9:G;K:?ML;?9:; D@GG:D?H@GQ
89:;9JGE9:OE;DJGG@?; D@GG:D?;?@;J;K:DMA:;KH?JG	89:;EJ?:;@G;?9:; 9JGE9:OE;HK;HGD@AA:D?O	k9:DB;?9J?;?9:;9JGE9:OE;9JK;?9:;EJ?:;K:?;D@AA:D?OP;@G;?9:; lbjim;KDA::GQ;nI;?9:;EJ?:;HK;HGD@AA:D?X;?JL;?9:;DO@DB;HD@G;@G; ?9:;lbjim;KDA::G;JGE;?9:G;JEoMK?;?9:;EJ?:;JGE;?HN:Q
p@M;DJGG@?;D@GIHTMA:;JG; nG?:AG:?;D@GG:D?H@GQ		
UH?9HG;AJGT:;@I;N@A:; ?9JG;@G:;G:?>@ABX;P@M; JA:;G@?;D@GG:D?HGT;?@; ?9:;G:?>@AB;P@M;>@MOE; LA:I:A;?@;MK:Q	89:;AJEH@;HK;D@GG:D?HGT; ?@;?9:;IHAK?;G:?>@AB; KHTGJO;H?;9JK;A:D:HW:EQ	8JL;[illegible]\\]^_'Yab^^[c\]b^'Yd[\ebfghaifj'Q;8JL;JGE; 9@OE;?9:;G:?>@AB;P@M;>@MOE;LA:I:A;?@;MK:;JGE;?9:G;K:O:D?; ab^^[c\Q;
89:;<=:>;=:?>@AB; C:?:D?:EF;G@?HIHDJ?H@G; JLL:JAK;qM?;?9:;N:GM; qJA;JGE;K@I?;B:P;@L?H@GK; JA:;G@?;EHKLOJP:EQ	r@N:;JLLOHDJ?H@GK;JA:; G@?;IMOOP;D@NLJ?HqO:; >H?9;JOO;I:J?MA:K;@I;?9:; UHGE@>K;V@qHO:;s; @L:AJ?HGT;KPK?:NQ	tK:;?9:;JLLOHDJ?H@G;qM??@GK;@G;?9:;B:PLJEX;JK;?9:P;NJL;?@; ?9:;K@I?;B:PK;HG;?9:;N:GM;qJAu v 8@;EHKNHKK;?9:;G@?HIHDJ?H@GX;LA:KK;?9:;AHT9?;JLLOHDJ?H@G; qM??@G;@G;?9:;B:PLJEQ; v 8@;D@GG:D?;?@;?9:;G:?>@ABX;LA:KK;?9:;O:I?;JLLOHDJ?H@G; qM??@GQ; SO?:AGJ?HW:OPX;K:O:D?;J;UHGE@>K;V@qHO:;JLLOHDJ?H@G;IA@N; ?9:;Z\if\;N:GMX;KMD9;JK;?9:;lbjim;KDA::G;@A;wHO:;xyLO@A:AX; JGE;?9:;N:GM;qJA;JGE;K@I?;B:PK;>HOO;q:;EHKLOJP:E;D@AA:D?OPQ
UHA:O:KK;RS=;HK; MGJWJHOJqO:;HG;?9:; UHA:O:KK;VJGJT:AQ	89:;HG?:TAJ?:E;>HA:O:KK; RS=;AJEH@;9JK;q::G; E:JD?HWJ?:EQ	tK:;?9:;zJEH@;SD?HWJ?H@G;VJGJT:A;?@;A:JD?HWJ?:;?9:; >HA:O:KK;RS=;AJEH@;{K:;JD?HWJ?HGT;?9:;HG?:TAJ?:E; AJEH@KX;LJT}Q

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X87I<;=@>=A;B;DY;= D8K>AL7@D>8=KA>L=Z[\]G	H:;=D8B>AA;B@=?;AD7<=FA;?;@@D8C?=:7Y;=I;;8= ?;<;B@;9=>8=@:;=:789:;<9= >A=>8=@:;=>@:;A=9;YDB;G	Z;A@=@:7@=@:;=?;AD7<=F>A@=?;@@D8C?=7A;=@:;=?7L;=>8=I>@:= 9;YDB;?=789=@:;8=@A_=B>88;B@D8C=@>=Z[\]=7C7D8G
	H:;=D8B>AA;B@=97@7= FA>@>B><=D?=?;<;B@;9=>8=@:;= 7FF<DB7@D>8=>8=@:;= :789:;<9G	';<;B@=@:;=97@7=FA>@>B><=?OFF>A@;9=I_=@:;=9;YDB;=789=@:;8= @A@=B>88;B@D8C=7C7D8G
	H:;=?;AD7<=B7I<;=O?;9=D?A 8>@=@:;=B>AA;B@=@_F;G== '>L;=?;AD7<=B7I<;?M=B7<<;9= 8O<<aL>9;L=B7I<;?M= ?bD@B:=@:;=97@7=@A78?LD@= 789=97@7=A;B;DY;=<D8;?M= b:;A;7?=>@:;A=B7I<;?=7A;= c?@A7DC:@=@:A>OC:c=789=9>= 8>@=?bD@B:=@:;=FD8>O@?G	X?;=@:;=?;AD7<=B7I<;=FA>YD9;9=bD@:=@:;=9;YDB;G
d=ef;b=\>9;L= g;@;B@;9h=8>@DKDB7@D>8=789= 7FF;7A?G	i>O=:7Y;=A;?;@=@:;= 789:;<9=789=@:;8= B>88;B@;9=@:;=?;AD7<=B<DFG	H7Fj=41-411 =@>=B<>?;=@:;=8>@DKDB7@D>8G=
6 789:;<9=A;?OL;?=b:;8= ?;AD7<=B<DF=D?=A;L>Y;9G	H:;=:789:;<9=b7?=D8= CO?F;89=L>9;G	H>=A;@OA8=@:;=:789:;<9=@>='O?F;89=L>9;M=FA;??=@:;= ')P,(=IO@@>8G
eX8D9;8@DKD;9=X'k=9;YDB;H; 8>@DKDB7@D>8=7FF;7A?G	H:;=?;AD7<=B<DF=D?=O8;M=B= B>88;B@;9=@>=@:;=9;YDB;?G	B=B>8@D8O;M=B78B;<=@:;=8>@DKDB7@D>8=789=@:;8=A;7@@7B:=@:;= ;AD7<=B<DF=B>AA;B@<_G

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	WB?AA7B@8B?:N=DXA9@=?:?8 >7A=9<8KPQ8H?A@I	567869:;67<;8=>8:?@8XHH<Z=:D8EFG8;9@98@?89:87[@7A:9<8;7C=B78X>=:D8 @678KPQV8>7A=9<8B<=HS8>7@8@678\9X;8A9@78@?8@6786=D6] >H77;85GWF8>7@@=:D^8_'abbS8'S8VS8P;;I
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	t?@87:?XD68>9@7<<=@7>8 C=>=\<7I	9A78@?898<?B9@=?:8O67A78@678A7B7=C7A869>898B<79A8C=7O8 ?N8@678>fZ89:;87:>XA78@6789:@7::98=>8:?@8?\>@AXB@7;I L<@7A:9@=C7<ZS89;vX>@8@678EFG8>7@@=:D>8@?8=:BA79>78 HA?;XB@=C=@ZI8R?A8M?A78=:N?AM9@=?:S8A7N7A8@?8@678w7<H8 HA?C=;7;8O=@68@678EFG8N=7<;8>?N@O9A7I
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	z{kj\}qr|ri{~ jkpi8=>8 >7<7B@7;8=:8@678EFG8N=7<;8 >?N@O9A789:;8@678 =:@7DA9@7;8A7B7=C7A8=>8 O9=@=:D8@?8A7B7=C78 A79<]@=M78B?AA7B@=?:>I	WN8Z?X89A78B?<<7B@=:D8;9@98N?A8H?>@HA?B7>>=:DS8B<79A8@678 >?N@O9A789:;8@678N=7<;8>?N@O9A79<]@=M78>7<7B@=?:I K67Bf8@69@8@678A79<]@=M78B?AA7B@=?:8>?XAB78=>8>7@XH8 B?AA7B@<Z8k>7<7B@=:D8@?898A79<]@=M78;=NN7A7:@=9<8 B?AA7B@=?:8>?XAB7S8H9D7U'
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tQeL8;9@98=:B<X;7>8 9X@?:?M?X>8H?>=@=?:>I	5678=:@7DA9@7;8EFG8 A7B7=C7A8?X@HX@>8 9X@?:?M?X>8H?>=@=?:>8 O67:8A79<]@=M78 B?AA7B@=?:>89A78 X:9C9=<9\<7I	K?:N=DXA78@678tQeL89HH<=B9@=?:8@?8N=<@7A8?X@8:?:]cEFG8 H?>=@=?:>I

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$5+#B.". +-8>-5"5! (H
$5!"0, !". NR ,"+"$4",%&
#-+@$50 5. B5#-+@$5063
> ,!))
," "!!$50)1
!-,$50(1
!=#B *1
!B,5$50 -5 5. !B,5$50 -??)H
B $50 B>>-,! 8-.B#")3
→"-PQ 9::S→"-├A>#-,",)22& ",$" / 5./"#.
→"-P; 9::S→"-├A>#-,",)22& ",$" / 5./"#.
→"-PE 9::S→"-├A>#-,",)22& ",$" / 5./"#.
0"!!$50 /"#>*%
→T
<-B!%(
?$"#. -?!G ,"%)' %6
!"##$!" $05 # %(' %3
!,-B<#" /--!$50()(
4$"G$50 ! !B %6
→T O ; >-,! %1
→T O-55"+!-, -?!G ,"*H' H3
B $50(2&
→T O-5!,-##", -?!G ,"*H
+-55"+!$50 !- →T %6
?" !B," %6
8$ $-5 ># 55$50H*
→T . !
-B!>B!!$50H3
→T ?$"#. -?!G ,"
+-5?$0B,$50%*
B>>-,!".(%' %)
→T T !/?$5.", ??$+" -?!G ,"3H' 3&
→T T !/?$5.", T,- ",$" ,"+"$4",(21
→T T !/?$5.", ",$" ,"+"$4",(21
→T T !/?$5.", E--# LU(%' %*
→T VB #$!= "!!$50 H2' H(' ()6
→T ,"+"$4",
+/ 50$50 "!!$50 %6
," "!!$50%3
0,""5 K├L)3')%
0,-B5. ># 5"(&' H(

W

/ 5. !, >**
/ 5.G,$!$50 ,"+-05$!$-562
/ ,. ," "!)1
QL T()6
Q"#>*%' *H
QXL ",4$+"(23
/$.$50 !/" @"=<- ,.6(

├→← !" #$%
├→← ←& !" ←#$%
├→←'→ ())*+"" ←← '→!,
-./ +& + + 0→11!,1223 %4
-./ +& "├,→0→15#23 223 %6
-7&&!"+, +, ,,+#83 %#

9

! 0 !: 48
;< =>6 :+!0 ←& !" ?$
;,@→A ())*< ←←+1!,16B
;,'7 C !" ←& !" #$?
!,'7 '+, 0←6$
!,←+00!,1
  =" ! /5,"??
  D>/ E! 0 ←→E F+& 24
  ←→E F+& ?%3 ?83 ?B
  G!, →F←<→@!0 C !" H , &?6
!, 1&+ D>/ & " ! &2#
!, &,+ !→,+0 + +' →& I! #%
;, &, JA'0→& & ←→E F+& K%
;, &+, 3 "→,, " !,1 →#$K

L

I 5@→+& M→,.←"& ,N6$
I 5'+ 443 4K
I 5←3 0+&1 & →, ├ ←"& ,6#

O

0+←& &+,1 E!, &B23 #$2
PJC !, !"+ →&42
P & Q "→1,!R &6$3 6#
0→"I ├ ←"& ,4K
0→"I!,1 ├ ├+, ├0 6?
0→11!,1
  "+&&! & + +22
  -./ +& + +22
0→F @+ &5 !, !"+ →&←42
0→F.'→F & :→ ())*/7←' , :→ 48

S

:+!0 ←& !" 3 ← !,1 7'?$
<+!, @+ &5 0→F : ←←+1 ←42
:+!,←'→F &3 7←!,1###
:+!, ,+," #8

<+I T F H→,, " !→, F!R+& #$K
:+,+1!,1 E!0 ←K%
: !,1←3 +&&+,1!,1K%
: :→&5
  '&→1&+: : :→&5K$
  ←→&+1 : :→&5K$
: ,7 @+&K2
: ←←+1 ←
  <+!, @+ &5 0→F42
  <+!, @+ &5 &5 0→F42
  >&→@0 : F! ├U07 →→├ ├+& F+& 8$
< ←←+1!,1 ←→E F+& K%3 ?$
< ←←,1 & ←→E F+& K%
:!"&→'├→, 443 64
<!"&→←→E JA"├+,1 ←→E F+& 6B
<!"&→←→E V7 0→I ←→E F+& 6B
<!"&→←→E W&+,←"&!@ & ←→E F+& 6#
:!←←!→, '0+,,!,1%K
:→ ←
  X0!1├%
  /├7 →F,48
  /7←' , 48
<>K E!0 ←K8
</=/ ←+ 00! ←283 #4K
:70 !'+ ├#46

Y

T+ !1+ !→, I 5←443 4K
, +!1+ !→, 7←!,1 D>/ + +2%
, F→&I3 "→,, " !,1 →+#$K
T F Z +0+, 3 ,→!" ← →7←&←?
T<J=
  "→:'+ !@0 D>/ E! 0 ←→E F+& 2K
  "→,, " !,1 +''0!"+ !→,← →D>/26
  D>/ HV< '→& E→&2K
  →7 '7 → A &,+0 !" %?
  ←7''→& : ←←+1 ←2K
T→ ←←→E F+& K8
,→!" ← →7←&←
  =7←&+0!+ +, T F Z +0+, ?
  J7&→' ?
,→!E!"+ !→,←3 "7←→:!R!,162
,700 :→ : "+@0 #8

[

→""7'+ !→, !: #46
VEE!" <→@!0 ←→E F+& K8
V\ I 5443 4K

↑├×┤ → !"" ##←|$%&
↑ '←↑|!→!"" ##↑(← #)*
↑(!|$ +,-./ .&
↑(← |'!'←↑| ↑0 #"(|12

3

!←(←|$ 4←' ! 5 6←" *17*&
89: # (6←");/);&
!##4↑(5 # ''←|$#1/
8< "↑|| "'←|$ '↑/%
8-=8).1
8 (#↑|!→9(! : '4↑(>←|$ # (6←");/
8←"'?(# !|5 @←5 ↑# #↑0'4!(%*
→!||←|$ A8B 5!'! "↑→"'←↑|&& 2%
→!C←|$! ("↑(5←|$1.
8=8% D!→# (6←" /;
↑#' (↑" ##←|$&/ &2 2. 21
↑?")2
↑4 (
!?'↑D!'←" ↑4 (↑00.*
" !($←|$ E!'' (C.1 ./)))
"↑|# (6←|$1*
F' (|!→)))
→↑4G ↑4 (D↑5 HIIJB?# |5 D↑5 .*
#'!'?# +,-..
'(↑?E→# ↑↑'←|$).)).%
8↑4 (> C.. .%
8↑4 (#'!'?# +,-..
8↑4 (8↑←|' K↑E→ #↑0'4!(%*
("←#←↑|&& 2)).1
(0 (|" #%/
(G←|#'!→5 #↑0'4!(%2
8(↑E→D 4←' L→? '↑↑' !(54!(D ##!$ *;
8%$(!D
(↑$(!D# (G←|#'!→5%2

M

N?←"> B'!(' A?←5)2

O

P!5←↑ 9"'←6!'←↑| K!|!$ (#↑0'4!(2 2*
(! 5←↑ ?# #!0 'C2
(!|$ ↑→)*
(!|$ ↑→ E(!"> ')*
(!"'←6!'←|$ ' L→? '↑↑' (!5←↑2 2*
(!→G'←D
5←00 (|'←!→"↑(("'←↑|&/ && &*72; 2%
F' (|!→"↑(("'←↑| #↑?(" &Q Q1
A8B <=K ↑(' R<=K1S&Q
BL9B "↑(("'←↑|#&*
'(↑?E→# ↑↑'←|$).)
@PB "↑(("'←↑|#&* Q)
(" ←6←|$
E !D 5 0→#);.
GD!→D ##!$ #%2 1Q
(" !($←|$ E!'' (C 0(↑D F' (|!→ ↑4 (#↑?(")))
("↑(5←|$ |↑' #1.
("C"→ E←|%)
(5 +,-.&
(0 (|" #'!'←↑|#&/
(→!# E?''↑| ↑| #? ↑(' D↑5?→ ./
(D↑6←|$ |"(C '←↑| 0(↑D 0→#%.
(T?←(5 !""?(!"C&2
P # ' E?''↑|.. .%
(# ''←|$
A8B (" ←6 (&/
' !|5 →5.Q
(#'↑(←|$ →↑#' 5!'!%;

U

#!0 'C
9< ↑4 (!5! '↑(*
E!'' (CQ .1
(!5←↑ ?# 2
#'↑(!$ "!(5 ?#);
#!' →←' $ ↑D '(C2%
BL9B #!' →←' #
'(!">←|$ D↑5 &*
'(↑?E→# ↑↑'←|$).%
?#←|$&*
#"(| (↑' "'↑(#)*
#"(| HII '↑?" #"(|
B- "!(5#%)
B-V< "!(5#%)
B-W= "!(5#%)
B !(" #↑0'4!(%*
!(" ←|$
0↑(0→# ↑| ' !|5 →5%*
' W|' (| '%*
|5←|$
E !D 5 0→#);.
GD!→D ##!$ #%2 1Q
((↑((↑('.;
←|#'!|' D ##!$ #%2
(←!→"→)*
!''!" ←|$ '↑ !|5 →5);Q
"↑|| "'←|$ '↑ F' (|!→5 6←"));

```
      ├×← ├ ← → ! "←#$ %→& "'''
      " ├(#" ← )# "* & ('''
+ " #$ ,→"
      - ". ├ '//0 '/'0 '/1
+ " #$ ,→" - ". ├ 230 '/40 '/5
-    ← # %#--&→"631
-    ← (    7 31
-    ← 8%
      9,: ├×← ├ →'/;
+(8 6→&←7→6 <=
+>*%$→ 41
->*%$→ 5;
+?@, 7# $ - ". ├ 1/
-→A " -  <2
-→A &#"
      B├ . +*←├;5
      C#$├8$# →";5
      C#$ ←6#";5
      C→← #├ -;5
      D!├ $ ?→) $ ;5
      E $  D!%$→" ";5
      F,+ C→← ├→";50 510 '/=
      F,+ C→← "→$$ ";50 43
      G $%;5
       ←- #$$ ← 12
      H← "←  D!%$→" ";5
      ? --#  ← ;5
      ? -- ← ";5
      :→  -;=
      IAA ├ ?→) $ ;=
      , ├ 8" - #←6 9 6 →-;=
      ,→& ",→← ?→) $ ;=
      %" J ←- #$$ 6;5
      K#6 →B├ .#  →← ?#←#  "50 5=
      + #"├(;=
      @#->-;=
      8← ←- #$$ ← 150 1=
      L ←6→&- M . ;=
      L ←6→&- ? 6 #;=
      L→"6 ?→) $ ;=
-→8←6-0 ├8- →7 N ← 34
-% #> "<<
-% ├ #$ ├(#"#├ "-0 ← " ← 3'
-%" #6-(   -0 &→"> ← & (;5
+ #"  )8  →←;4
+ #"  > *<;
+ #"  7 ←8;4
+ #"  7 ←8 > *<<
- #  ├F,+ %→-   →←-44
- # 8-  ←6 ├# →"-;5
+ →"#  ;/
- →"#
      )#├> ← 8% 6# #;'0 1;
      -%#├ ;/
- →"#   ├#"6
       $ ├ "→- #  ├6 -├(#"  '/
       ←├"*%  6 A $ -;<
       ←- "  ← ;'
       ←- #$$ ← -→A &#"  →12
      " 7→. ← ;'
      -$→ 6→"<<
       (87)-├" &-<<
       "→8)$ -(→→ ← ''4
      &#"← ← -'/0 ;'
- →"#   -%#├ ;/
- →" ←  (  (#←6( $6'2
- " #7 ← F,+ %→-   →←-45
- *$8-<<0 ;2
- *$8- >  '=
-8)A→→ #├├8"#├*44
-8%%→" '2
-8%%→"  7→68$
      ├×← ├ ← →6 -> →% ├→7%8  "11
       ←├$86 6 ├→7%→← ← '5
      %$#├ ← (#←6( $6 ←<1
    <"1 7→. ← (#←6( $6 A"→7
-8%%→"  6 F,+ A  $6 -→A &#" 4<
+8-% ←6 7→6 '20 <=
-&  ├( ← > *)→#"6-3'
-*←├("→← N ←
       J7# $ 7 --#  -32
       ←A→"7#  →←140 15
```

O

```
@#->- -→A &#" ;=
  ├(← ├#$ -8%%→" '2
@ ""#+*←├6# # A $ -0 " ├  . ← )*  J7# $1/
@ ""#+*←├-→A &#"
      #8 →7#  ├#$$*  "#←-A "" ← 6# #150 1=
      ├×← ├ ← →F,+43
       ←- #$$ ← 4<
      -8%%→"  6 . "- →←-4<
  ( " ←  (  - *$8-;2
 !  6  →";=
 !  ← "*3/
 !  - N  →← -├"  ←35
 (87) -├" &-<<
  7  N→← 0 -    ← 31
   $  )#";4
@→6#* -├"  ←;4
→8├( -├"  ←
      #$  ← ← <=0 35
```

```
      ├⇤     !
      "#$%&→' #$$( $)*   +
       & ├,← $,→,#├ "#$├-⇤. )*   +
       ←# /,→,# /01
      , 2, $#3 01
      ,← (4& $-  ,#/.  +
,↔├5#/.
      →%% #/,6 /,$71
      ├ /,→├,$71
      ,→$5$7!
8↔/$├←#4 ← $  ,9⇤ 0
,↔/$  ←#/.  #& $ ,  → ├ 6%(, ←+:* +!
8←#64&  ;<=├ ←← ├,  2, /$# /
      ├ // ├,#/. ,  ;<= ← ├ #> ←:0
      #/$,→&&#/.:?
      $(%% ←, " > ←$# /$:?
8←#6<#2 , ├-/ & .':7
,← (4& $-  ,#/.
      @├,#> ='/├ :*   1
      4→├5&#.-,  0
      4→,, ←' ? *  ?7
      A&( ,  ,- 9#← & $$ , ├-/ & .'  !
      ;<= ?
      % 9 ← ? *  ?7
      ← →&B,#6  ?
      $, ↔.  ├⇤"  :
      , (├- $├←  /  +
      9#← & $$ C@D  1*   )
8=E<
      ;<= FGH % ←,   ←:7
       (,%(, ,   2, ←/→& " >#├ 1+
8(←/     " >#├  #  / , ($ "   ← ├- ├54 2?!
,(←/#/.  / →/"
      -→/"- &" )* ?1
```

I

```
(/& ├5#/. ,-  -→/"- &"0+
J =A ├ // ├,# / ,  → ├ 6%(, ←++*   :*   1
```

K

```
> -#├&
      →/ , //→1
      % 9 ← →"→%, ← !
      ($#/. % 9 ←  ← 6
> & ├#,'  #&, ←#/. ?0
># 9#/.  #& $71
L#←,(→& <←#>→,  D ,9 ←5 ML<DN O7
LP= / ,9 ←5
      →""← $$   ←6→,)?
      ├ // ├,#/. , !!Q)?
      ← →&B,#6  ├ ←← ├,# / $ (←├ :!
```

R

```
S@@= $→, &&#, $:!*  ?7
9→←/#/.$
      @F →"→%, ←!* ?0
      4→,, ←')* ?0
      $,→,#├  & ├,←#├#,' O* 7
      $, ↔.  ├⇤" $& , O* 7
9#B # TUUV9#← & $$ C@D
S#/" 9$ W←← ← P % ←,#/.?O
S#/" 9$ C#>  H $$ /. ←71
S#/" 9$ C#>  $  ,9⇤ 7!
S#/" 9$ H "#→ $  ,9⇤ 7!
S#/" 9$ H 4#&
      - &%7:
      %⇤,$    ,-  $├←  /7:
      ,- 6 $00
S#/" 9$ H 4#&  X >#├  F /, ←
      ├ // ├,#/. ,  ,-  -→/"- &"+:
      #/$,→&&#/.+0
      $'/├-← /#3#/.+:
9#← & $$?1
9#← & $$ C@D
      ,← (4& $-  ,#/.  1*   )
9#← & $$ C@D ←→"#
      ├ /$ ←>#/. % 9 ←?1
      $→  ,'1
S#← & $$ H→/→. ←1)
S#← & $$ =, ←   $ ←>#├  O+*  O:
S ←" H 4#&  $  ,9⇤ 7!
S ←&" S#"  S 471
9←#,  6 $$→. $71
9←#,#/.  / ,-  $├←  /0O
```

Y

```
'# &"* #6%← > "1
```

Z

```
[ %-'← →/, //→!* 1
```

TABLE 1

EXISTING SITE GPS BACKGROUND FILES
Leviathan Mine
Alpine County, California

Background File Name	Description
Onproperty	Includes the entire On-Property Study Area
Pit	Includes The Pit Study Area
P1	Includes Pond 1
P2P3	Includes Ponds 2N, 2S, and 3
LCSA1	Includes the northern part of the LCSA
ACSA1	Includes the southern part of the ACSA and includes the upper part of the Leviathan Creek Basin Landslide
ACSA2	Includes the central part of the ACSA and the Leviathan Creek Basin Landslide
ACSA3	Includes the northern part of the ACSA and the toe of the Leviathan Creek Basin Landslide
ASB	Includes the area surrounding the Aspen Seep Bioreactor
BSA1	Includes the Background Study Area

Acronyms:
ACSA = Aspen Creek Study Area
LCSA = Leviathan Creek Study Area