Atlantic Richfield Company

Anthony R. Brown
Project Manager Mining

4 Centerpointe Drive
La Palma, CA 90623-1066
Office: (714) 228-6770
Fax: (714) 228-6749
E-mail: Anthony.Brown@bp.com

January 25, 2010

Mr. Kevin Mayer
SFD-7-2
US EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

RE: Mapping Focused Remedial Investigation Report
Leviathan Mine Site, Alpine County, California
Administrative Order for Remedial Investigation and Feasibility Study
CERCLA Docket No. 2008-18

Dear Mr. Mayer:

Enclosed is the Mapping Focused Remedial Investigation Report. This document is being submitted in accordance with Paragraph 51 and Attachment 2 of the above-referenced Administrative Order.

Please contact me with any questions regarding this document.

Sincerely,

Anthony Brown
Environmental Business Manager

Enclosure

cc: Gary Riley, EPA Region 9
Chuck Curtis, Lahontan Regional Water Quality Control Board – via electronic
Nathan Block, Esq., BP America Inc. – via electronic
Dave McCarthy, Copper Environmental – via electronic
Adam Cohen, Esq. Davis Graham & Stubbs LLP – via electronic
Joe Niland, AMEC Geomatrix Inc. – via electronic
Sandy Riese, EnSci, Inc. – via electronic

MAPPING

FOCUSED REMEDIAL INVESTIGATION REPORT

Leviathan Mine Site

Alpine County, California

Submitted to:

Atlantic Richfield Company
La Palma, California

Submitted by:

AMEC Geomatrix, Inc.
Rancho Cordova, California

January 25, 2011

Project No. 13091

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Appendix B LiDAR-Based Sediment Maps – Index and Example
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LIST OF ABBREVIATIONS AND ACRONYMS

AMEC	AMEC Geomatrix, Inc.
Atlantic Richfield	Atlantic Richfield Company
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DEM	digital elevation model
EFCR	East Fork of the Carson River
ENVI	Environment for Visualizing Images
EPIC	Environmental Photographic Interpretation Center
ESSI	Earth Search Sciences, Inc.
FRI	focused remedial investigation
GIS	geographic information system
GPS	global positioning system
HSSE	Health, Safety, Security, and Environment
IR	infrared
JPL	Jet Propulsion Laboratory
LiDAR	light detection and ranging
MF	matched filter
NHD	National Hydrography Dataset
NIR	near infrared
RI/FS	remedial investigation/feasibility study
SAM	spectral angle mapper
Summit Engineering	Summit Engineering Corporation
SWIR	short-wave infrared
U.S. EPA	U.S. Environmental Protection Agency

MAPPING FOCUSED REMEDIAL INVESTIGATION REPORT
Leviathan Mine Site
Alpine County, California

1.0 INTRODUCTION

This Mapping Focused Remedial Investigation (FRI) Report was prepared by AMEC Geomatrix, Inc., (AMEC) on behalf of Atlantic Richfield Company (Atlantic Richfield) for the Leviathan Mine Site (site) in Alpine County, California (Figure 1). The mapping activities were described in the FRI Mapping Work Plan (Atlantic Richfield, 2009a), which was approved by the U.S. Environmental Protection Agency (U.S. EPA) on October 1, 2009 (U.S. EPA, 2009). The mapping activities partially fulfill the requirements of the U.S. EPA Region IX Statement of Work attached to the Administrative Order for Remedial Investigation and Feasibility Study (Unilateral Administrative Order), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Docket No. 2008-18 issued on June 23, 2008, (U.S. EPA, 2008) for the site.

The scope of work consisted of developing new aerial photographs, topographic maps, and sediment maps for the on-property and downstream areas; updating the geologic map; and evaluating existing remote sensing data and preparing preliminary maps to show how it can be used for remedial investigation/feasibility study (RI/FS) purposes. The maps developed provide an additional understanding of site conditions and they will be used for base maps and to conduct additional site analysis as the RI/FS proceeds.

2.0 AERIAL PHOTOGRAPHY AND TOPOGRAPHIC MAPS

New aerial photographs and topographic maps were developed for the areas outlined in blue and orange, respectively, as shown on Figure 2. Aerial photography, data processing, and topographic map generation were subcontracted to Summit Engineering Corporation of Reno, Nevada (Summit Engineering). The aerial photography was obtained by American Aerial Surveys of Ione, California, as a subcontractor to Summit Engineering. The aerial photographs were taken on October 22, 2009, and are orthorectified at a 0.4-foot pixel resolution.

Aerial photographs were developed for the on-property area, the off-property area downstream to the East Fork of the Carson River (EFCR), for the River Ranch area, the Poison Creek watershed, and a portion of the Mountaineer Creek watershed. Based on the aerial photography, photogrammetric methods were used to generate the topography. For this

investigation, topography was generated at a 2-foot contour interval for the on-property area and at a 4-foot contour interval for the off-property area downstream to the EFCR. Topography can be developed at 4-foot contour intervals for the remainder of the aerial photography coverage if needed.

The aerial photographs were developed into a new base map for the site and were used as the base map for the sediment mapping performed on-property and downstream (Section 4.0). The topography was used to support sediment mapping. The aerial photographs and topographic maps will be used during implementation of the On-Property FRI Work Plan (Atlantic Richfield, 2010a) and during future reference and off-property FRI activities.

3.0 GEOLOGIC MAPPING

An updated geologic map (Plate 1) was prepared for the on-property area based on original work conducted by John Sciacca and Charlene Herbst in 1982 (Herbst and Sciacca, 1982). As an initial step, the geologic map was overlaid on the new topographic map and geologic contacts were rectified as necessary. Also, the light detection and ranging (LiDAR) imagery with the vegetation removed was evaluated for the presence of large scale features not already mapped and to evaluate the limits of the Leviathan Creek Basin Landslide. In addition, a preliminary classification of material was performed using the hyperspectral imagery to evaluate the extent of the mine waste (Section 5.2).

On August 19 and 20, 2010, AMEC conducted a field visit with Mr. Sciacca to review the on-property geology. The field visit consisted of viewing most of the Tertiary-age units mapped by Herbst and Sciacca, confirming several primary geologic contacts, and viewing several of the faults interpreted to be present at the site. The major landslide features were also reviewed. After the field data were compiled from the August 2010 mapping, additional field verification was performed by AMEC at select locations on November 2 and 3, 2010.

During the August 2010 mapping, samples were collected of most of the Tertiary-age rock units identified by Herbst and Sciacca and strike and dip measurements were made where possible. In general, at each location where a sample of geologic material or a measurement was collected, a photograph was taken, the location was marked by hand on the field map, and the location was recorded using a hand-held global positioning system (GPS) device. Locations where geologic material was collected and where measurements were made are shown on Plate 1. Photographs and descriptions of the geologic material collected are presented in Appendix A.

For each of the rock units sampled, sample boxes were prepared. Each sample box contains one or more representative samples of the rock and a geologic description. These representative samples will be used to aid in the correlation of geologic materials collected during future RI/FS activities, such as mapping mine waste and logging core samples.

Based on the site visit with Mr. Sciacca and the additional field verification, the existing geologic map of the site (Herbst and Sciacca, 1982) was updated (Plate 1). Principal revisions to the map consisted of:

- adjusting the interpreted boundary between the sandstone (labeled as Trcs) and basalt (labeled as Trb) west of Ponds 2N and 2S,
- adjusting the interpreted boundary between the lahar (labeled as Trcl) and the basalt (labeled as Trb) immediately north of the Leviathan Creek Basin Landslide and south of the access road in the vicinity of a mapped fault,
- updating the geology on the bottom portion of the Delta Landslide to reflect grading and other activities performed in that area in 2005 (Kleinfelder, 2006), and
- updating the geology in the pit to reflect the placement and grading of mine waste performed between 1983 and 1985 (California Regional Water Quality Control Board – Lahontan Region, 1995).

The revised geologic map will be used during implementation of the On-Property FRI Work Plan. It is anticipated that additional enhancements and revisions to the geologic map will be made as new information is obtained during future RI/FS activities; therefore, the geologic map presented in this report is considered preliminary. As described in Section 5.1, additional evaluation of the LiDAR imagery will be performed to evaluate geologic features. Additional field mapping of the extent of mine waste is planned as part of the On-Property FRI Work Plan.

4.0 SEDIMENT MAPPING

Sediment mapping was performed from September 14 through September 22, 2010, to delineate sediment storage units along:

- Aspen Creek from Station 22 to the confluence with Leviathan Creek,
- Leviathan Creek from the Channel Underdrain to the confluence with Mountaineer Creek, and
- Bryant Creek from the confluence of Leviathan and Mountaineer creeks to the EFCR.

These locations are shown on Figure 2. The River Ranch diversion ditch was also mapped from its start on Bryant Creek to the River Ranch property (Figure 2) and the water distribution system on the River Ranch property was defined for future evaluation of sediment deposition.

Delineation of sediment along Aspen, Leviathan and Bryant creeks was based on field data collection and interpretation of aerial photography and LiDAR- and National Elevation Dataset-based digital elevation models (DEMs). LiDAR coverage is only available for the on-property area and a portion of Leviathan Creek above Mountaineer Creek (Figure 2). In the field, a hand-held GPS was used to gather points and delineate obvious pockets of sediment. Detailed video notes were also recorded to provide a qualitative assessment of local conditions and sediment transport or deposition. An example screen capture from one of the videos is shown on Figure 3; the photo shows recent flood deposits covered in pine needles in the left foreground.

The GPS data points were imported into ArcGIS (a geographical information system [GIS] program) and overlaid with the high-resolution DEMs and aerial photography. Different factors were used to assess the boundaries, age-categories, and possible presence of fluvially transported sediment. An example of this assessment is shown on Figure 4. Because the vegetation canopy is removed from the LiDAR data, delineation and classification of storage units based on the different elevation levels of sediment terraces was possible in and around the on-property area of the site where LiDAR coverage exists. The aerial photography was interpreted to identify vegetation coverage, exposed flood deposits, and other obvious landmarks to validate the terrace boundaries identified in the LiDAR. Where LiDAR coverage does not exist, the analysis was performed using the aerial photographs, topographic mapping, and field notes.

Without more in-depth investigation of individual sediment storage units, including coring, sieving, and dating, it is not appropriate to provide date ranges for the age of delineated areas. However, there were often obvious relative differences in depositional sequence and composition between local storage units (observed by probing, rapid coring, and in eroded bank cuts) along the mapped channels; therefore, delineations were divided into relative age categories 1, 2, and 3 as presented below:

- Category 1 – Youngest deposits. Exposed flood deposits or minimal/seasonal vegetation coverage. Often low channel adjacent terraces or mid-channel islands. Generally, these storage units are in flux and may have been deposited more recently by processes such as single high-flow events or beaver damming.

- Category 2 - Middle-aged deposits. Recent flood deposits may be on the surface although the body of the unit may also be well consolidated. Vegetation covers a

wide range of ages although regular inundation has been sufficiently strong to prevent trees from becoming established before growing larger than 6 to 8 inches in diameter. Depositional timescales vary from a single large event to slow accumulation.

- Category 3 – Older deposits. Generally high terraces with well-established vegetation (trees greater than 2 feet in diameter) that may be the extent of the largest floodplain the reach has seen. May have been overtopped with more recent flood deposits. Well-consolidated material with developed soil profiles. Generally a mix of mature graded fluvial deposits with considerable colluvial material contributing to the overall volume.

In order to delineate sediment storage area boundaries properly, it is necessary to improve the stream thalweg line because the National Hydrography Dataset (NHD) flow line is not accurate enough for the purposes of this mapping work. To improve the flow line, the thalweg location was marked using the GPS unit at a maximum interval of 100 meters. The recorded line was then further improved through interpretation of the LiDAR DEM (where available) and aerial photography coverage. Figure 5 shows an example of the difference between the NHD thalweg line and the improved stream line developed by the mapping team. Channel reaches are further enhanced by classifying them as storage or transport based on field assessments of channel armoring, incision, sediment deposition, and vegetation.

Mapbooks showing the results of the sediment mapping activities along Aspen, Leviathan and Bryant creeks were prepared using two different bases: LiDAR in the areas where coverage is available and the orthorectified aerial photographs for all areas. One mapbook was produced for the LiDAR coverage and two mapbooks were produced for the aerial photograph coverage. For the LiDAR-based mapbook, the panel index map showing the mapping coverage and one example panel (individual map sheet) are presented in Appendix B. For the aerial photograph-based mapbooks, the panel index map for both mapbooks and three example panels are presented in Appendix C.

In addition to the sediment mapping on Aspen, Leviathan and Bryant creeks, the River Ranch diversion ditch from its start on Bryant Creek to the first head gate on River Ranch was delineated using the aerial photographs. Because there is no definitive information on the water distribution and discharge system on River Ranch, the decision was made to map the distribution system instead of speculating on the origin and distribution of sediments on the property. Field mapping consisted of using a hand-held GPS to locate the remaining visible features of the associated distribution system, including major and minor irrigation canals, culverts, head gates, and other release structures. The condition of these structures was also noted. Two mapbooks for the River Ranch were prepared using the aerial photographs as a base. One of the panel index maps for the River Ranch mapbooks and two example panels

are presented in Appendix C. This information will be used in the future to perform sediment mapping or to develop hydrologic, hydraulic, and sediment transport reconstructions and modeling during future downstream RI/FS activities.

During implementation of the On-Property FRI Work Plan (Atlantic Richfield, 2010a), the sediment maps will be used as the basis for stream sediment, stream sediment pore water, bioassay, and floodplain soil sampling. In addition, the sediment maps will serve as the basis for habitat mapping and plant and soil sampling to be conducted for stream and riparian habitat. During future downstream FRI work, the sediment mapping may provide the basis for further analysis and modeling of potential channel migration and sediment transport or to provide proxy estimates of bedload transport. It is anticipated that additional enhancements and revisions to the sediment maps will be made as new information is obtained during future RI/FS activities; therefore, these maps are considered preliminary.

5.0 REMOTE SENSING IMAGERY

Remote sensing imagery consisting of LiDAR, hyperspectral, and false-color infrared (IR) were previously collected at the site. The remote sensing imagery was evaluated to determine how it could be used for RI/FS purposes; the results of the evaluation for each imagery type are presented in this section. The remote sensing imagery will be used to conduct additional site analysis as the RI/FS work proceeds.

5.1 LIDAR

LiDAR imagery was collected on September 16, 2005, for the U.S. EPA Environmental Photographic Interpretation Center (EPIC). The area of LiDAR coverage is shown on Figure 2 and the imagery is shown on Figure 6. The LiDAR imagery has been used as a base map for figures presented in the RI/FS Program Work Plan (Atlantic Richfield, 2009b) and the On-Property FRI Work Plan. The LiDAR data was also used during geologic mapping (Section 3.0) and sediment mapping (Section 4.0).

In the future, edge detection and other algorithms will be applied to the LiDAR imagery in combination with the aerial photographs to extract geologic features such as lineaments, faults, and fractures. This may be useful to help locate Fault C and other structures as part of the hydrogeologic characterization being conducted under the On-Property FRI Work Plan.

5.2 HYPERSPECTRAL

Two sets of hyperspectral imagery of the site are available. Hyperspectral imagery collected in 2005 was evaluated for its potential use and is discussed in this section. Hyperspectral imagery collected in July and August 2007 has been evaluated by Jeffrey Schoffner and

Wendy Calvin (Shoffner and Calvin, 2008). Ms. Calvin (University of Nevada, Reno) has indicated that the possibility for data sharing exists and that she would like to ground truth some of the preliminary mineral identifications to complete their evaluation (Wendy Calvin, personal communication with Joe Niland, October 16, 2010).

Hyperspectral imagery was collected on August 18, 2005 by Earth Search Sciences, Inc., (ESSI) for the U.S. EPA EPIC. The area of coverage is shown on Figure 2. The sensor used has 128 channels that measure reflected energy (as opposed to thermal or microwave energy). There are no thermal bands on this sensor. The sensor measures wavelengths from 0.430 micrometers (blue wavelengths) to 2.500 micrometers (short-wave infrared [SWIR]) of the electromagnetic spectrum, covering the visible, near infrared (NIR), and the SWIR regions. The average band width is 0.02 micrometers. Incident radiation is dispersed onto four 32-channel linear detector arrays. The resulting data sets contain an effectively contiguously sampled spectrum for each image pixel. The image resolution (pixel size) is approximately 1 meter. The data consists of radiance and reflectance imagery; reflectance imagery is produced by performing atmospheric correction on the radiance imagery. Review of the data indicates that spectral signatures plot as expected along the electromagnetic spectrum as compared to published spectra for vegetation and impervious features. Furthermore, all imagery datasets are cloud-free and appear to have no scan line problems.

Neither the radiance nor reflectance imagery datasets are georeferenced; however, ESSI noted that a GPS log was collected while flight lines were captured. The GPS log would allow for georeferencing of the datasets in order to develop a mosaic dataset for additional processing or for applying registration information to final classification results. AMEC has contacted ESSI to obtain the GPS log.

As mentioned, the wavelengths measured range from visible to SWIR. Visible wavelengths (blue, green, and red) are useful for visual interpretation and analysis. The NIR bands are useful for vegetative analysis, particularly when viewed in combination with the red and green bands (produces a color IR composite view). The SWIR bands are useful for geologic mineral mapping and for general material identification. The narrow band spacing allows for detailed representation of spectral signatures for a variety of features within an image.

As examples of how the hyperspectral data may be used, two simple manipulations were performed using the Environment for Visualizing Images (ENVI) software package. In the first example (Figures 7A and 7B), the imagery was manipulated to perform a preliminary classification of material that may correspond to mine waste. The original image is shown on the left side of Figure 7A. The classification was performed for the material represented by the bright white areas. First, polygons were digitized around the target features to obtain a

representative spectral signature for potential mine waste pixels. Second, the matched filter (MF) algorithm was applied; the results are shown on the right side of Figure 7A. The MF algorithm screens the input image for good matches to the shape of the target spectral signature by maximizing the response of the target spectral signature and suppressing the response of non-target signatures. Third, the spectral angle mapper (SAM) algorithm was applied; the results are shown on the left side of Figure 7B. The SAM algorithm treats the spectra as mathematical vectors and compares the angle between the target spectrum vector and each pixel vector in a space with dimensionality equal to the number of bands. Smaller angles represent closer matches to the target spectrum. Pixels further away than the specified maximum angle threshold are screened out. Finally, the MF/SAM ratio was used to reduce the false positives that exist in one classification output but not the other (i.e., to reduce error in MF spikes and in SAM slope magnifications). The preliminary material classification is shown on the right side of Figure 7B. This simple manipulation was performed only to show how the data might be used and does not represent a complete analysis of the presence of mine waste. For a complete analysis of the hyperspectral data using ENVI, additional and more thorough processing steps would be required.

In the second example (Figure 8), the data were manipulated into a simple three-class image showing the distribution of sulfur, pyrite, and arsenopyrite based on the spectral library (developed by the Jet Propulsion Laboratory [JPL]) that is provided with the ENVI software. Although not performed, advanced processing steps would reduce overlap between the three classes. The spectra in the JPL spectral library are not ideal for specific material classification. These spectra were likely derived in a laboratory environment (no atmospheric interaction), in a different study area (could lead to differing atmospheric interaction), or during a different time of year (change in sun position, differing climate); therefore, they may not be as representative of site conditions as site derived spectra would be.

5.3 FALSE-COLOR IR

Two sets of false-color IR imagery of the site are available. IR imagery was collected in 2004 by Kucera International, Inc., for the U.S. Geological Survey. This data set consists of 36 scanned images (tiff format) of the original photographs. The second set of imagery was collected on July 27, 2004, for the U.S. EPA EPIC. This data set consists of 14 scanned images (jpeg format) of the original photographs. No additional evaluation of the IR imagery was performed; however, in the future the information may be useful in identifying healthy or distressed vegetation or to confirm the presence of mapped vegetation.

6.0 HEALTH AND SAFETY PERFORMANCE

Field activities associated with implementation of the Mapping FRI Work Plan were performed in accordance with the policies and procedures outlined in the Leviathan Mine Site Health, Safety, Security, and Environment (HSSE) Program Document (HSSE Program Document, Atlantic Richfield, 2010b) and the AMEC RI/FS Task Specific Health and Safety Plan (AMEC, 2010). During the mapping, morning safety meetings were conducted so that each person was aware of the day-to-day health, safety, and security concerns for the current site conditions, which included weather, deliveries, and other work being performed. The morning safety meetings were also used to discuss learning opportunities from the previous day's work. In accordance with the HSSE Program Document, incidents, near misses, and stop-work scenarios at the site were reported to the on-site health and safety officer**.** There were no first-aid cases or Occupational Safety and Health Administration recordable injuries, no near misses, and no stop work scenarios occurred.

7.0 REFERENCES

AMEC, 2010, Remedial Investigation/Feasibility Study Task Specific Health and Safety Plan. June.

Atlantic Richfield, 2009a, Focused Remedial Investigation Mapping Work Plan, Leviathan Mine Site, Alpine County, California. Prepared by AMEC Geomatrix, Inc. June 19.

Atlantic Richfield, 2009b, Remedial Investigation/Feasibility Study Program Work Plan, Leviathan Mine Site, Alpine County, California. Prepared by AMEC Geomatrix, Inc. July 10.

Atlantic Richfield, 2010a, On-Property Focused Remedial Investigation Work Plan, Leviathan Mine Site, Alpine County, California. Prepared by AMEC Geomatrix, Inc. August.

Atlantic Richfield, 2010b, Leviathan Mine Site Health, Safety, Security, and Environmental Program Document. Version 2.0. Prepared by AMEC Geomatrix, Inc. May.

California Regional Water Quality Control Board – Lahontan Region, 1995, Leviathan Mine 5-Year Workplan. July.

Herbst, C.M., and Sciacca, J.E., 1982, Geology of the Leviathan Sulfur Mine and Vicinity.

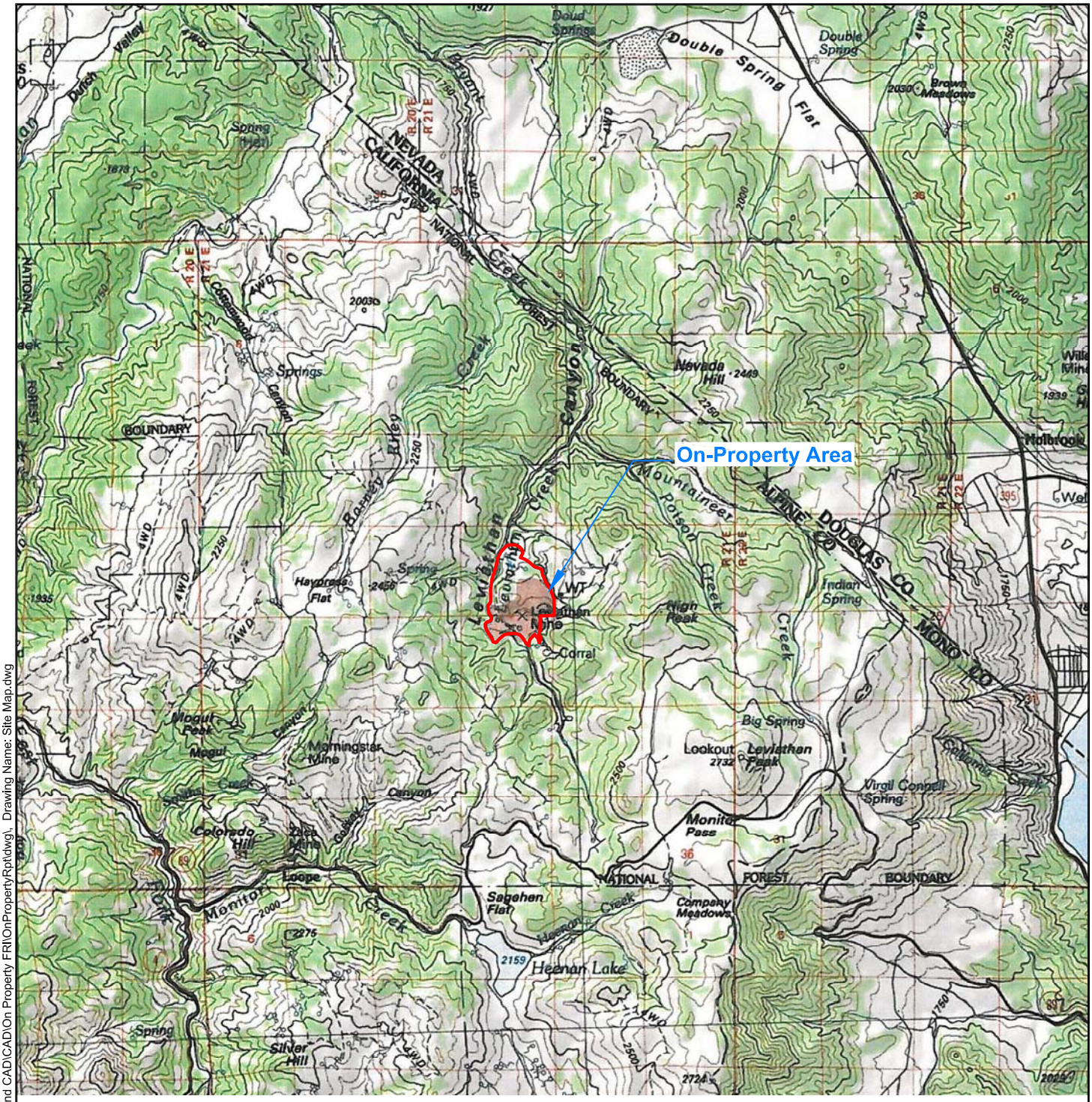
Kleinfelder, 2006, Summary of Material Testing and Observation Services, Geotechnical Slope Stability, Leviathan Mine Delta Area Waste Pile, Alpine County, California. February 9.

Shoffner, J.D. and Calvin, W.M., 2008, Mapping Mineralization in the Monitor Pass Mining District: Society of Exploration Geophysicists Expanded Abstracts 27, 1323 (2008), DOI:10.1190/1.3059159.

U.S. EPA, 2008, Administrative Order For Remedial Investigation and Feasibility Study, Leviathan Mine, Alpine County, California. U.S. EPA Region IX, CERCLA Docket No. 2008-18. June 23.

U.S. EPA, 2009, Comments, Approval, and Direction to Implement 2009 Work Plan for Focused Remedial Investigation Mapping at Leviathan Mine Site, Alpine County, California. October 1.

FIGURES



APPROXIMATE SCALE IN FEET

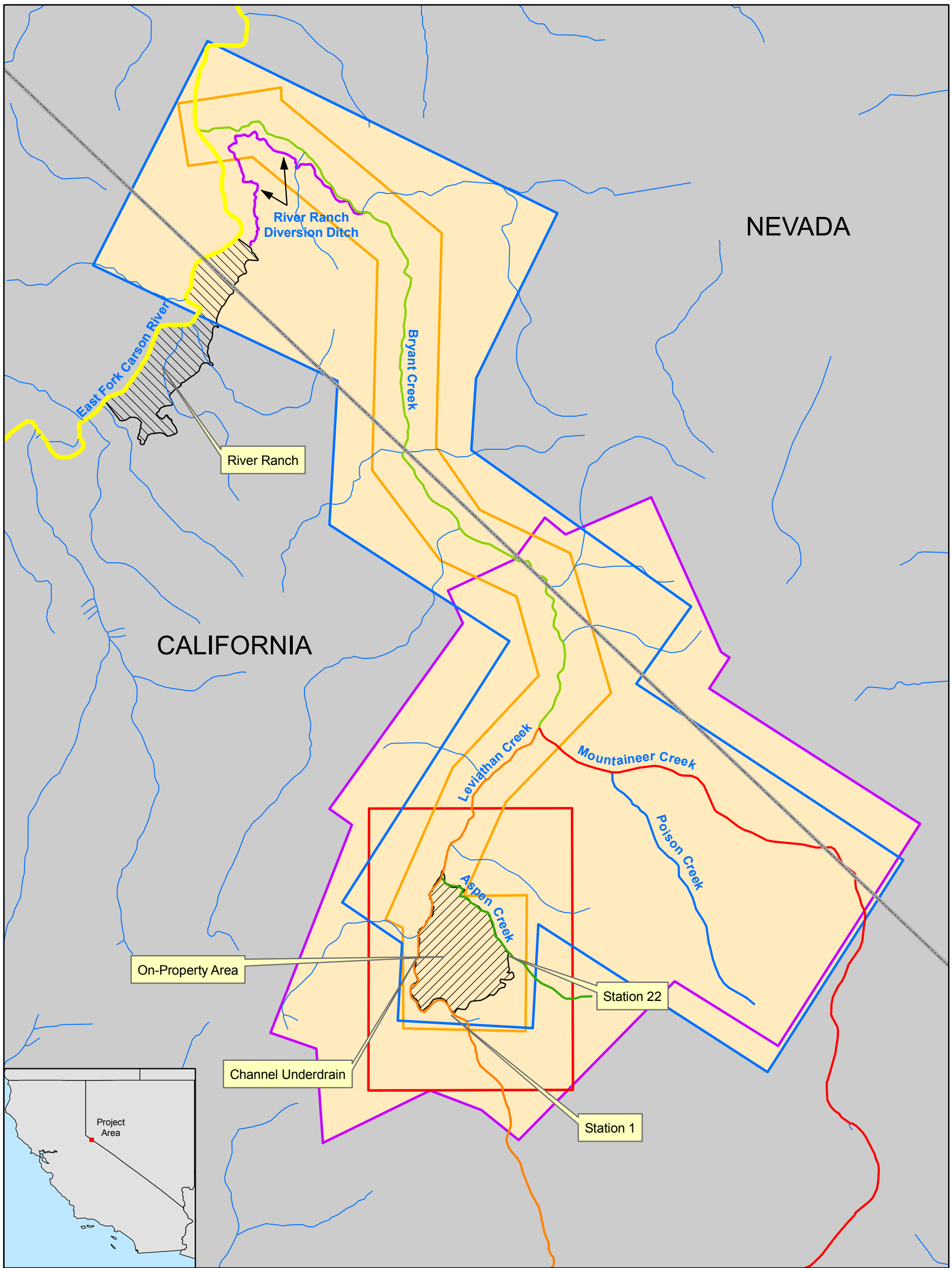
0 8,000

Base Map: National Geographic USGS Topographic Maps

LOCATION MAP
Leviathan Mine Site
Alpine County, California

By: dpv	Date: 2/25/10	Project No. 13091B.110
AMEC Geomatrix		Figure 1

Plot Date: 07/30/10 - 10:01am, Plotted by: donna.valasek
Drawing Path: P:\Project\13000s\13091 Leviathan\14000 Database and CAD\CAD\On Property FR\OnPropertyRpt\dwg\, Drawing Name: Site Map.dwg



Explanation

Extents

- Topography
- LiDAR
- Aerial Photography
- Hyperspectral
- On-Property Area
- Mapping Coverage
- State Boundary

National Hydrography Dataset

- Other Flowlines
- Aspen Creek
- Bryant Creek
- East Fork Carson River
- Leviathan Creek
- Mountaineer Creek
- Poison Creek
- River Ranch Diversion Ditch

N

0 2,500 5,000
Feet

Notes:
1. National Hydrography Dataset Flowlines are stream thalweg delinations provided by the USGS.
2. Dataset extent boundaries are approximate and not to be used for analysis.

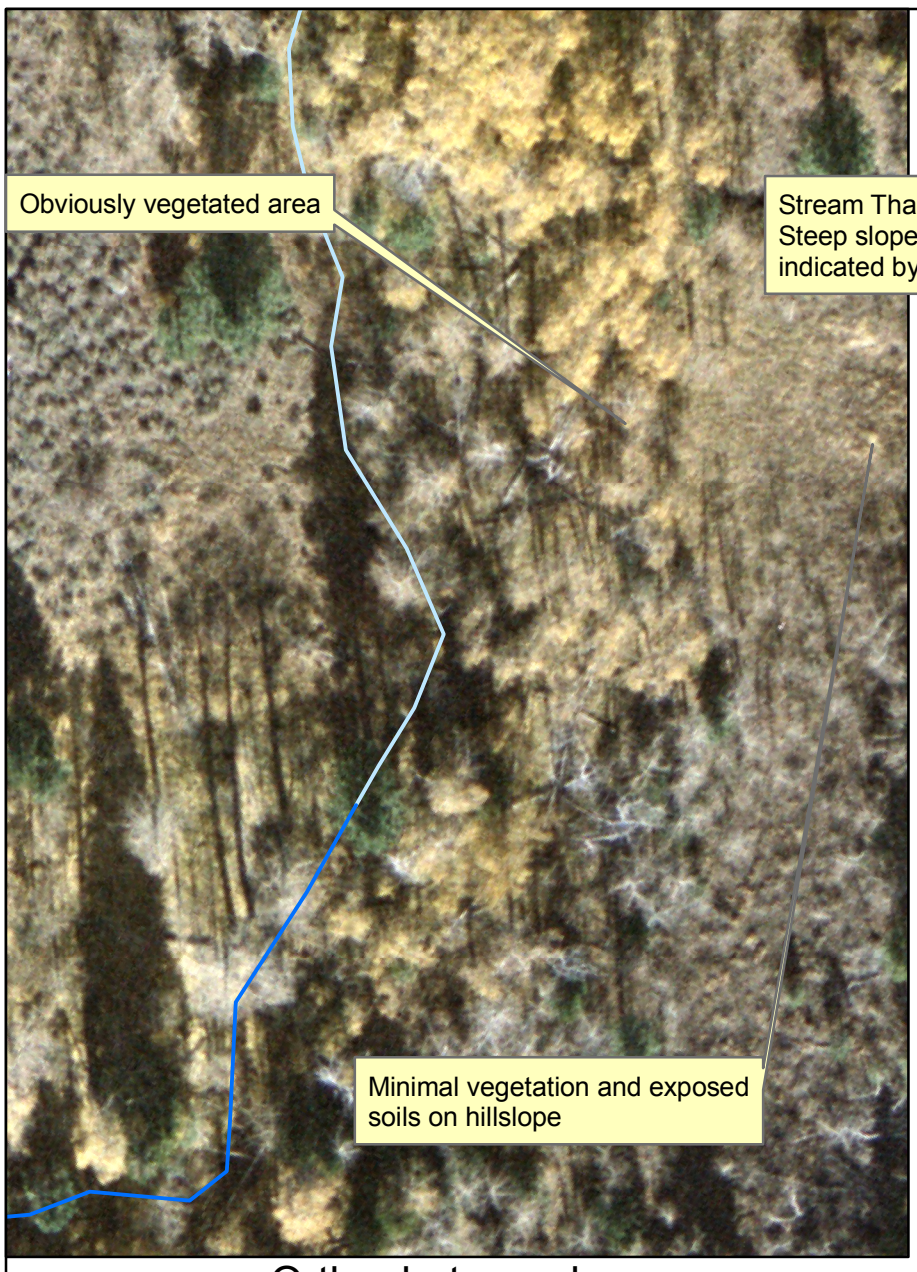
MAPPING COVERAGE

Leviathan Mine Site
Alpine County, California

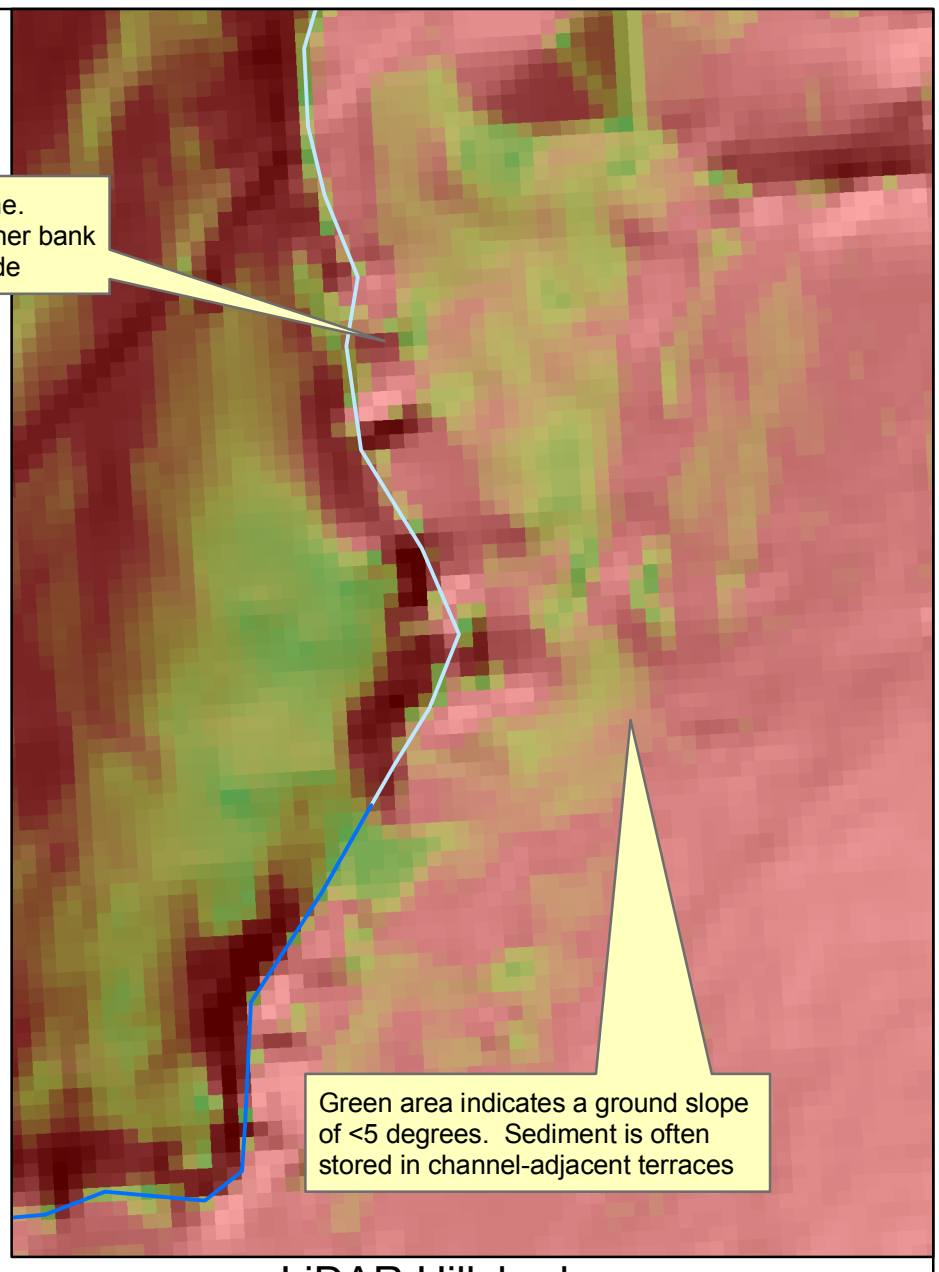
By: PJW	Date: 1/12/2011	Project No.13091C.812A
AMEC Geomatrix		Figure 2

Video screen capture showing recent flood deposits covered in pine needles in left foreground

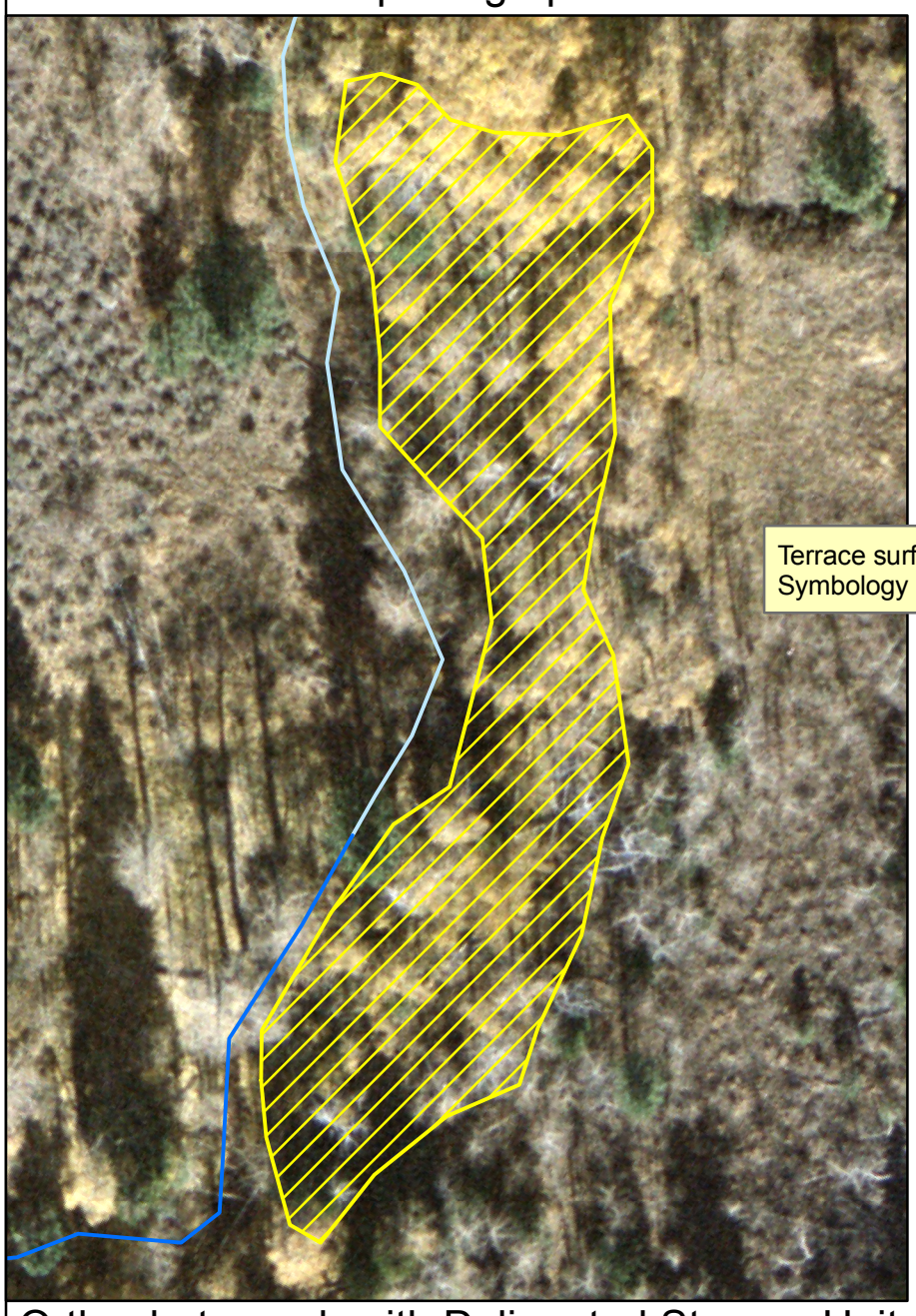
SEDIMENT MAPPING VIDEO SCREEN CAPTURE Leviathan Mine Site Alpine County, California		
By: PJW	Date: 12/16/2010	Proj. No.13091C.812A
AMEC Geomatrix		Figure 3



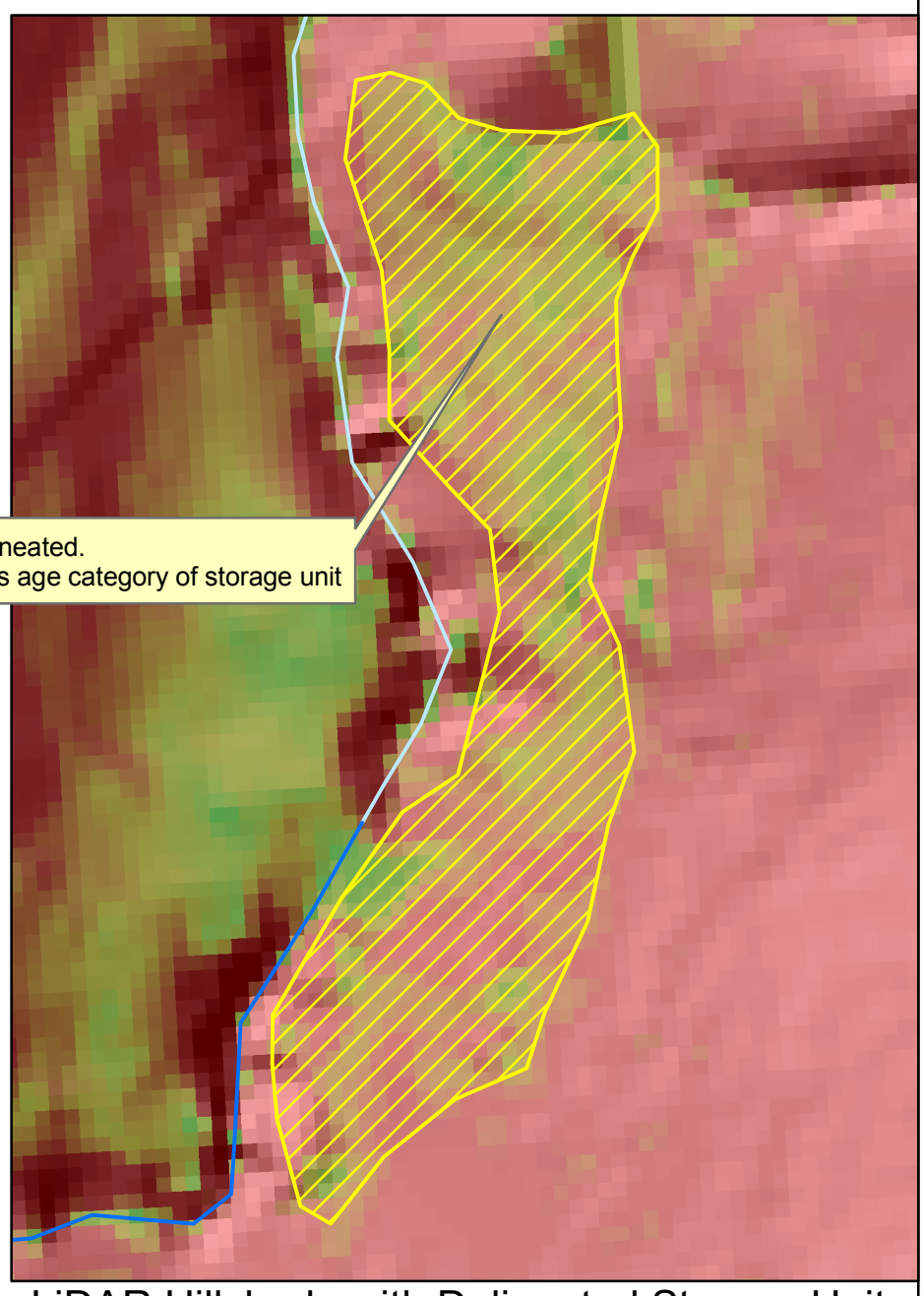
Orthophotograph



LiDAR Hillshade



Orthophotograph with Delineated Storage Unit



LiDAR Hillshade with Delineated Storage Unit

Explanation

Stream Thalweg

Reach Type
- Storage
- Transport

Storage Unit Areas

Age Category
- 1
- 2
- 3

- Project Grids
- NHD Streams
- State Boundary

Notes:
1. Background data is either orthophotography (left) or surfaces generated from LiDAR coverage (right).
2. Maps not to scale.

SEDIMENT DELINEATION

Leviathan Mine Site
Alpine County, California

By: PJW	Date: 1/12/2011	Project No.13091C.812A
AMEC Geomatrix		Figure 4

Explanation

NHD Flowline

Improved Thalweg

Reach Type

Storage

Transport

N

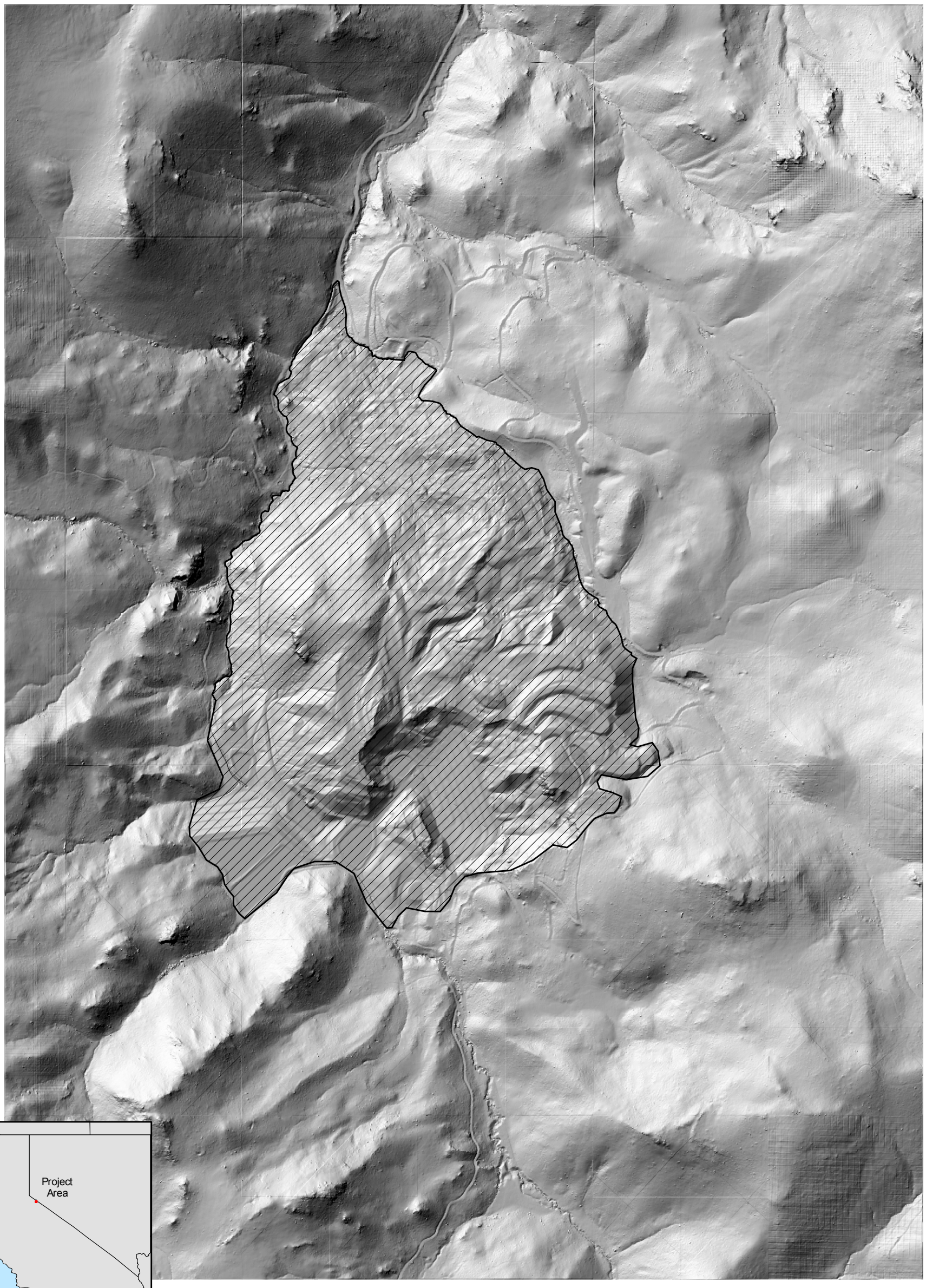
0 100 200 Feet

Notes:
1. National Hydrography Dataset Flowlines are stream thalweg delinations provided by the USGS.
2. Background is orthophotography.

THALWEG DELINEATION

Leviathan Mine Site
Alpine County, California

By: PJW	Date: 12/21/2010	Project No.13091C.812A
AMEC Geomatrix		Figure 5



Notes:
1. Background data is a hillshade surface generated from the September 16, 2006 LiDAR coverage

Explanation

On-Property Area

LiDAR Hillshade

Value

High : 254

Low : 0

N

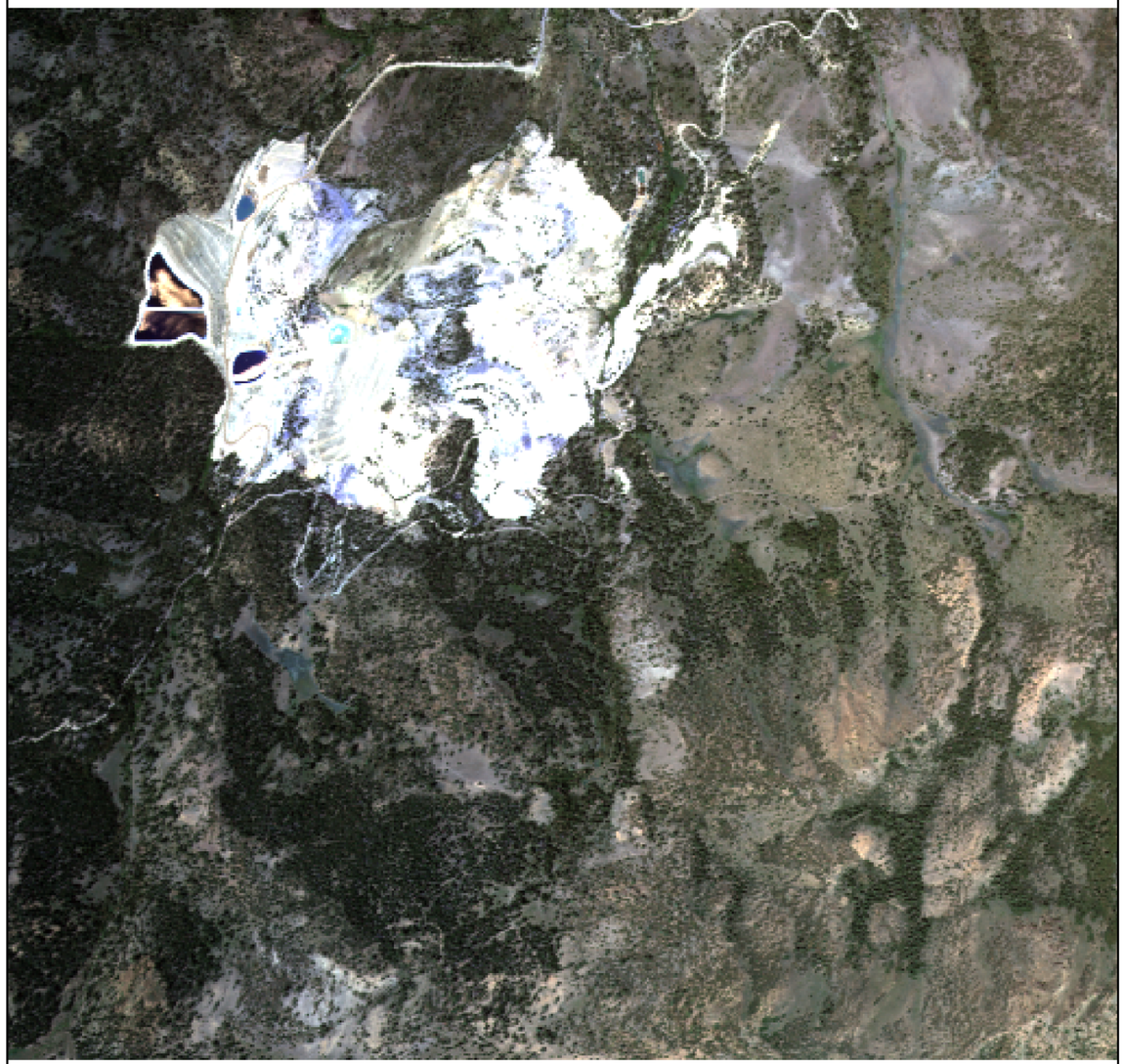
0 487.5 975

Feet

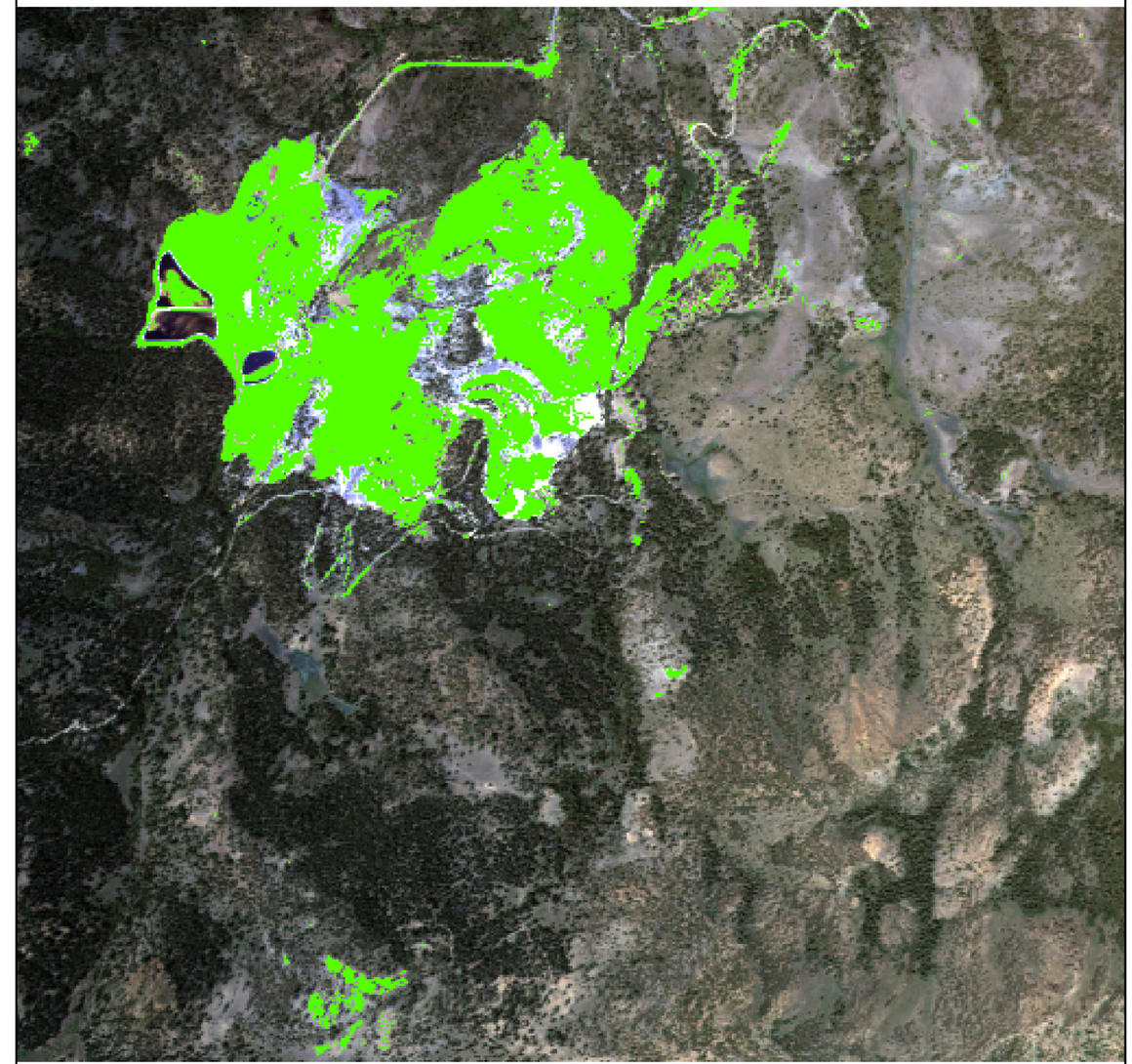
LiDAR COVERAGE

Leviathan Mine Site
Alpine County, California

By: PJW	Date: 1/13/2011	Project No.13091C.812A
AMEC Geomatrix		Figure 6



1. Original Image



2. Image Showing Matched Filter Results

Notes:
1. Hyperspectral imagery was not accompanied with georeferencing information. Orientation of imagery relative to North is unknown.
2. Evaluation performed only to show example of imagery use and is not to be used for analysis.
3. Imagery not to scale.

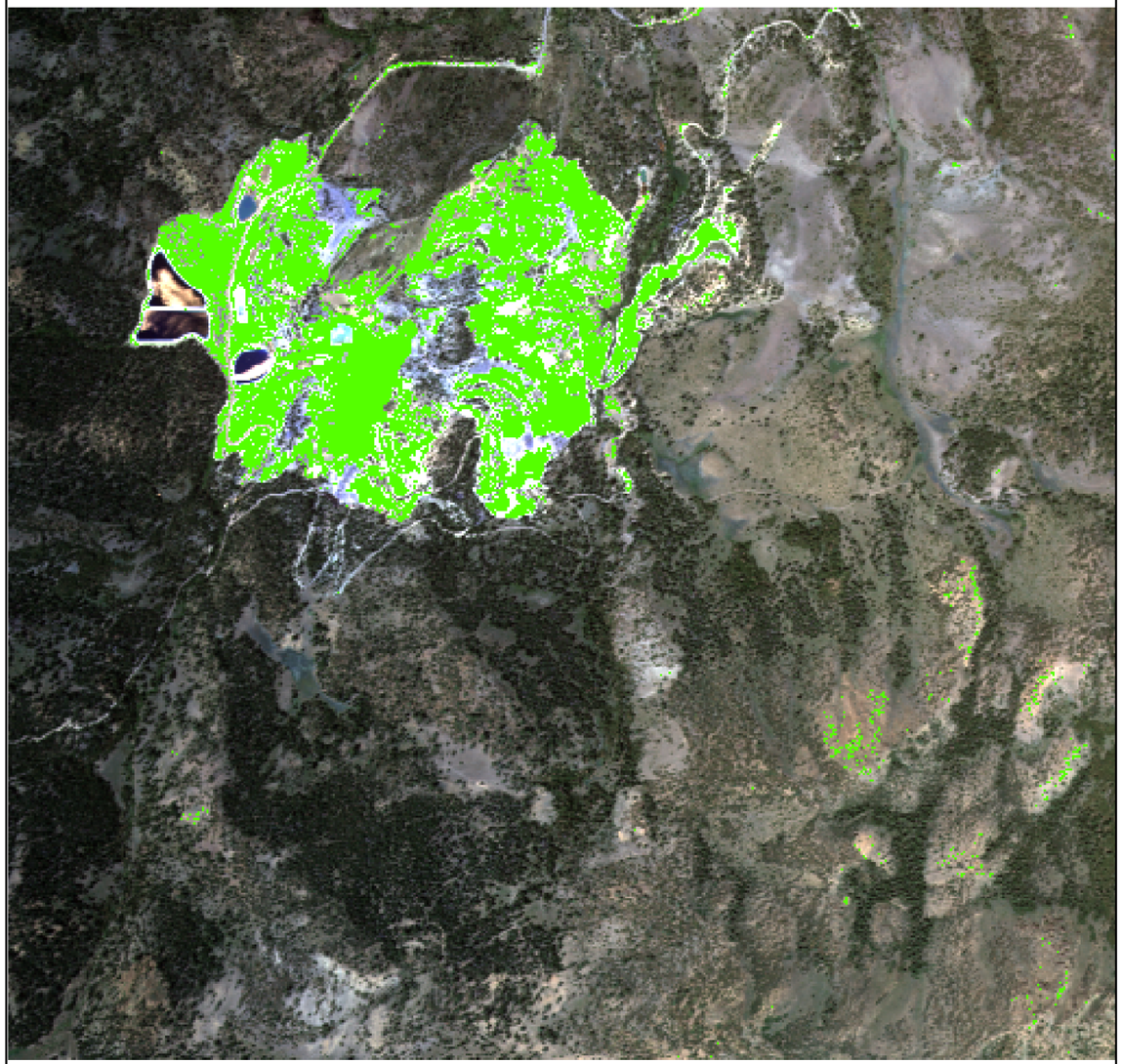
N

North (Estimated)

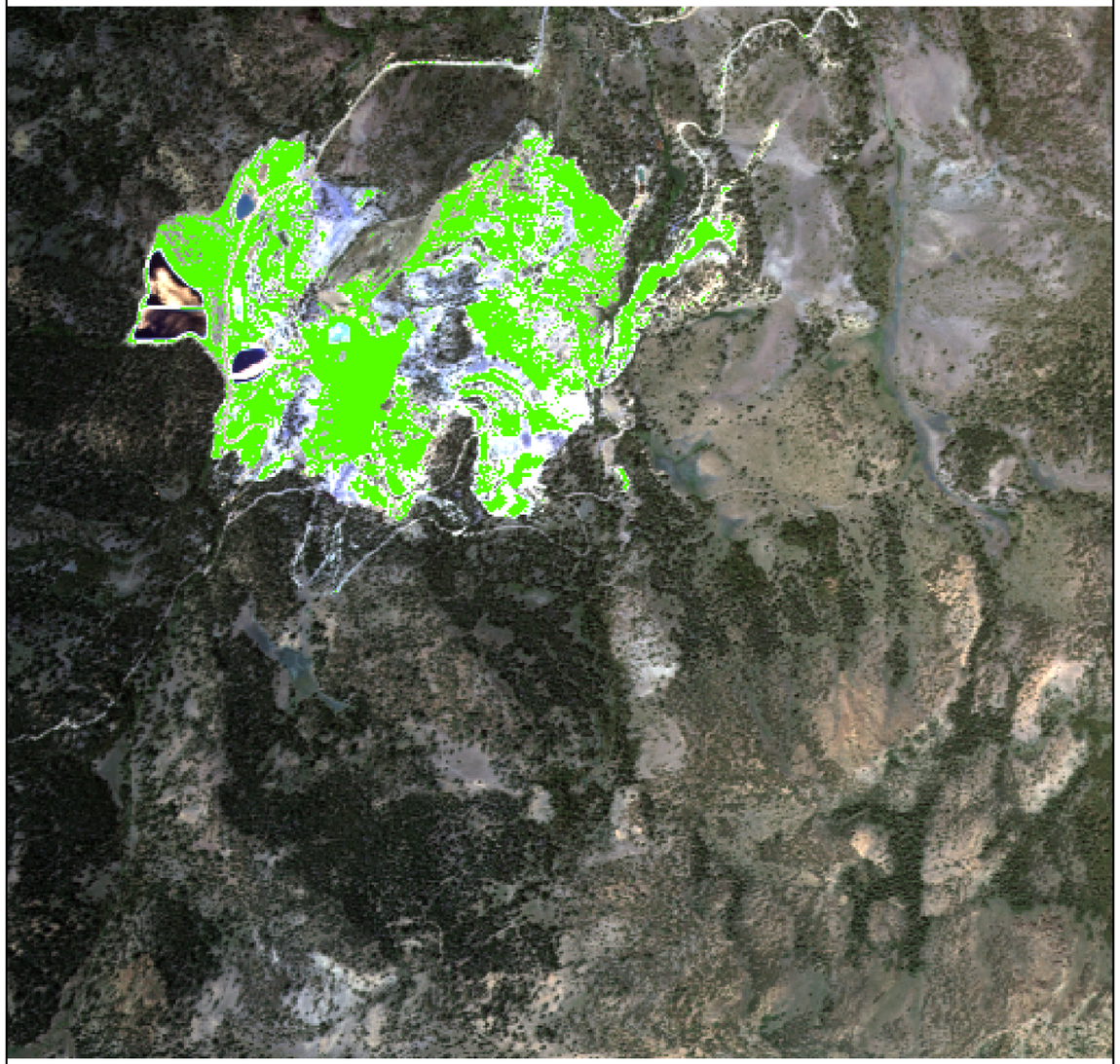
MATERIAL CLASSIFICATION - PART 1

Leviathan Mine Site
Alpine County, California

By: PJW	Date: 1/14/2010	Project No.13091C.812A
AMEC Geomatrix		Figure 7A



3. Image Showing Spectral Angle Mapper Results



4. Preliminary Material Classification

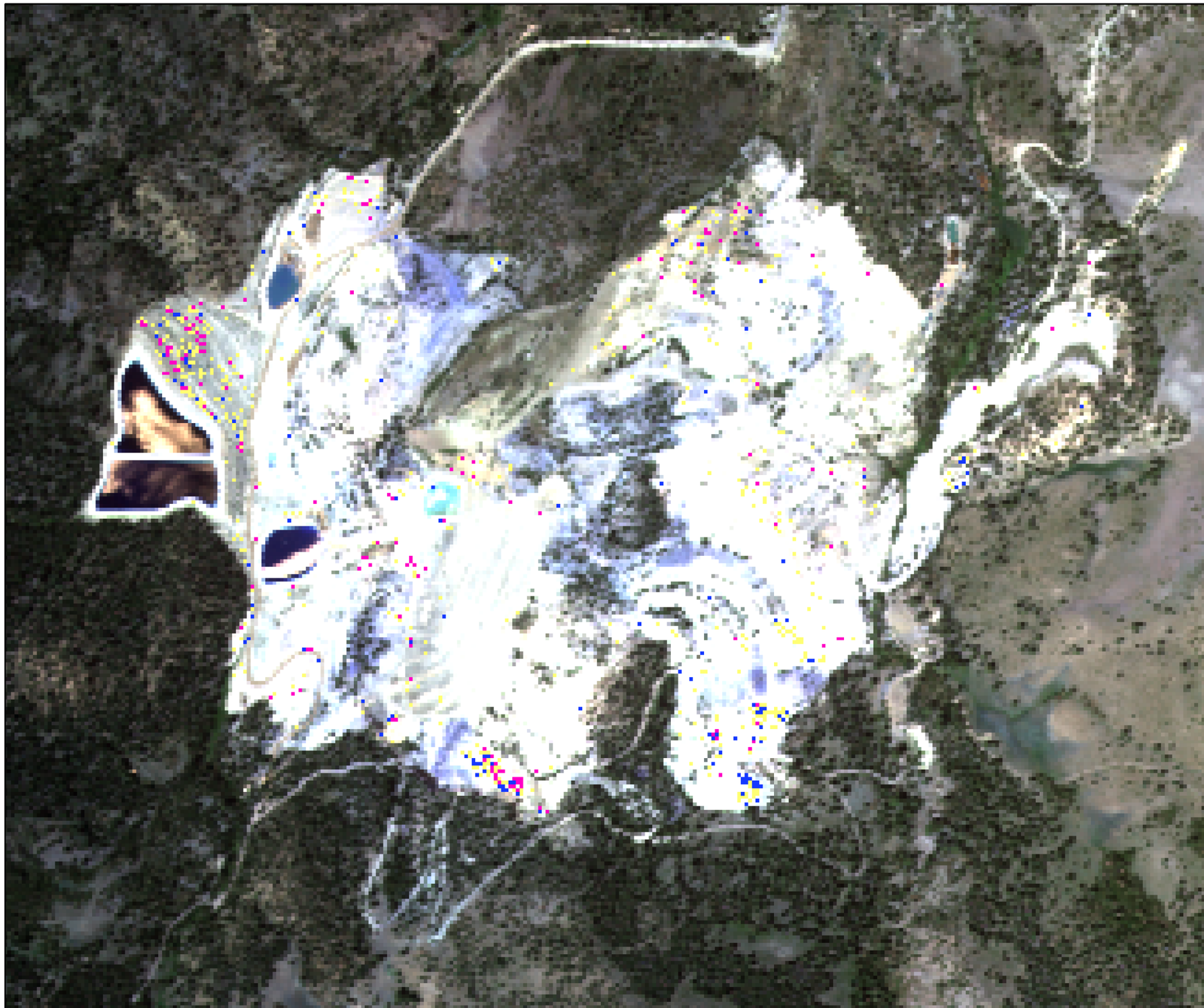
Notes:
1. Hyperspectral imagery was not accompanied with georeferencing information. Orientation of imagery relative to North is unknown.
2. Evaluation performed only to show example of imagery use and is not to be used for analysis.
3. Imagery not to scale..

North (Estimated)

MATERIAL CLASSIFICATION - PART 2

Leviathan Mine Site
Alpine County, California

By: PJW	Date: 1/14/2010	Project No.13091C.812A
AMEC Geomatrix		Figure 7B



Leviathan Mine

Explanation

- Sulfur
- Arsenopyrite
- Pyrite

North (Estimated)

Notes:
1. Hyperspectral imagery was not accompanied with georeferencing information. Orientation of imagery relative to North is unknown.
2. Evaluation performed only to show example of imagery use and is not to be used for analysis.
3. Imagery not to scale..

THREE-CLASS IMAGE

Leviathan Mine Site
Alpine County, California

By: PJW	Date: 12/21/2010	Project No.13091C.812A
AMEC Geomatrix		Figure 8

Geologic Map (For electronic copies, please see separate PDF document)

APPENDIX A

Photographs and Geologic Descriptions

APPENDIX A

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 1 — Silicified Iron-Stained Breccia at Location Tsib - 1[1]

Silicified Iron-Stained Breccia (Tsib)[2]: Dark rust brown on weathered surfaces, red to blue-black on fresh surfaces, often jasperoid in appearance, pervasively fractured. More resistant, forming cornices. Highly fractured but without persistent joint orientation. Relict textures suggest unit originally lahar, conglomerate, or sedimentary breccia subsequently silicified and mineralized.

Pit – Crops out as rounded hematite- and limonite-stained boulders. Iron-stained portion, which is dark blue on a fresh surface, contains elemental sulfur and fine-grained sulfides including pyrite, marcasite, and arsenopyrite. Locally, contains blue-green copper mineral (chrysocolla); appearance varies.

North of Pit – Silicified iron-stained breccia and argillically altered silicified breccias (lahar?); argillically altered rock weathers peach. Both rock types show breccias texture; local flow banding on some light colored sialic clasts. Breccia clasts average 1 to 20 centimeters (cm) and are subangular to rounded; matrix and clasts are of different compositions; clasts appear to be volcanic, ranging from andestie with relict texture to jasperoid; can be mineralized with sulfur; some sulfides present (pyrite, marcasite, aresenpyrite)(10 to 15 percent [%]), particularly in dark colored-clasts.

West of Leviathan Creek (Location Tsib – 1): 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. Some non iron-stained, more argillically altered breccia. Calcite deposits present where water moves through fractures. No sulfur present.

Notes:
1. Location shown on Plate 1. Southwest of Pond 2S.
2. Description from Herbst and Sciacca (1982).

APPENDIX A

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 2 — Silicified Iron-Stained Breccia at Location Tsib - 3[1]

Silicified Iron-Stained Breccia (Tsib)[2]: Dark rust brown on weathered surfaces, red to blue-black on fresh surfaces, often jasperoid in appearance, pervasively fractured. More resistant, forming cornices. Highly fractured but without persistent joint orientation. Relict textures suggest unit originally lahar, conglomerate, or sedimentary breccia subsequently silicified and mineralized.

Pit – Crops out as rounded hematite- and limonite-stained boulders. Iron-stained portion, which is dark blue on a fresh surface, contains elemental sulfur and fine-grained sulfides including pyrite, marcasite, and arsenopyrite. Locally, contains blue-green copper mineral (chrysocolla); appearance varies.

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

West of Leviathan Creek (Location Tsib – 1): 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. Some non iron-stained, more argillically altered breccia. Calcite deposits present where water moves through fractures. No sulfur present.

Notes:
1. Location shown on Plate 1. Upper highwall on west side of pit south of pit entrance.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 3 — Silicified Breccia at Location Tsb - 1[1]

Silcified Breccia (Tsb)[2]: 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. Highly fractured but without persistent joint orientation. Relict textures suggest unit originally lahar, conglomerate, or sedimentary breccia subsequently silicified and mineralized.

Notes:
1. Location shown on Plate 1. Quarried area near road southeast of Aspen Seep gate.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 4 — Sandstone at Location Trss - 1[1]

Sandstone (Trss): 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 meter by 7 meter sized lenses of fine sandstone; fractures iron-stained with calcite rinds on pebbles, especially near fault. Best exposed on west rim of pit. Sandstone on northwest edge of pit even less indurated. Basal conglomerate consists of basalt (Trb) chunks (60%, angular to subangular) in iron-cemented matrix of fine to medium sand-sized rock fragments (40%).

Notes:
1. Location shown on Plate 1. Northwest of pit.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 5 — Lahar at Location Trsl - 1[1]

Lahar (Trsl): Angular to subrounded 5 to 25 cm clasts in tan ashy matrix. Matrix composes 85 to 90% of rock (matrix supported). Clasts included Tra (hornblende pyroxene andesite). In area east of pit, clasts average 2 to15 centimeters (cm) with most 2 to 3 cm, angular to subangular. Locally slightly silicified; locally graded bedding; locally conglomeratic with more sandy matrix. Laterally discontinuous, only seen nonconformably overlying Tra.

Notes:
1. Location shown on Plate 1. Along entrance road north of California access gate.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 6 — Argillically Altered Sandstone at Location Trsa - 1[1]

Argillically Altered Sandstone (Trsa, $Trsa_b$)[2]: White to peach (iron-stained) argillically altered sandstone and breccia; locally shows conchoidal fracture. Relict siltstone texture and possible fining-upward sequence immediately west of pit. At top of sequence is rock (clast?) with fluidal outline, relict andesitic texture (relict plagioclase phenocrysts) in punky white matrix. May have breccia texture ($Trsa_b$).

Notes:
1. Location shown on Plate 1. Highwall east side of pit.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 7 — Argillically Altered Sandstone at Location $Trsa_b$ - 1[1]

Argillically Altered Sandstone (Trsa, $Trsa_b$)[2]: White to peach (iron-stained) argillically altered sandstone and breccia; locally shows conchoidal fracture. Relict siltstone texture and possible fining-upward sequence immediately west of pit. At top of sequence is rock (clast?) with fluidal outline, relict andesitic texture (relict plagioclase phenocrysts) in punky white matrix. May have breccia texture ($Trsa_b$).

Notes:
1. Location shown on Plate 1. Highwall east side of pit.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 8 — Ore Rock at Location Tso - 1[1]

Ore Rock (Tso)[2]: Mineralized breccia (Tso_b) and sandstone; may include mineralized tuff. Breccia is at least 20 to 30% sulfur (pervasive replacement); most clasts less than or equal to 6 cm; 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). Sand stone contains a maximum of 20 percent disseminated sulfur; sulfur also as fracture coating. 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 patches and seams).

Notes:
1. Location shown on Plate 1. Lower slope on west side of pit south of pit entrance.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

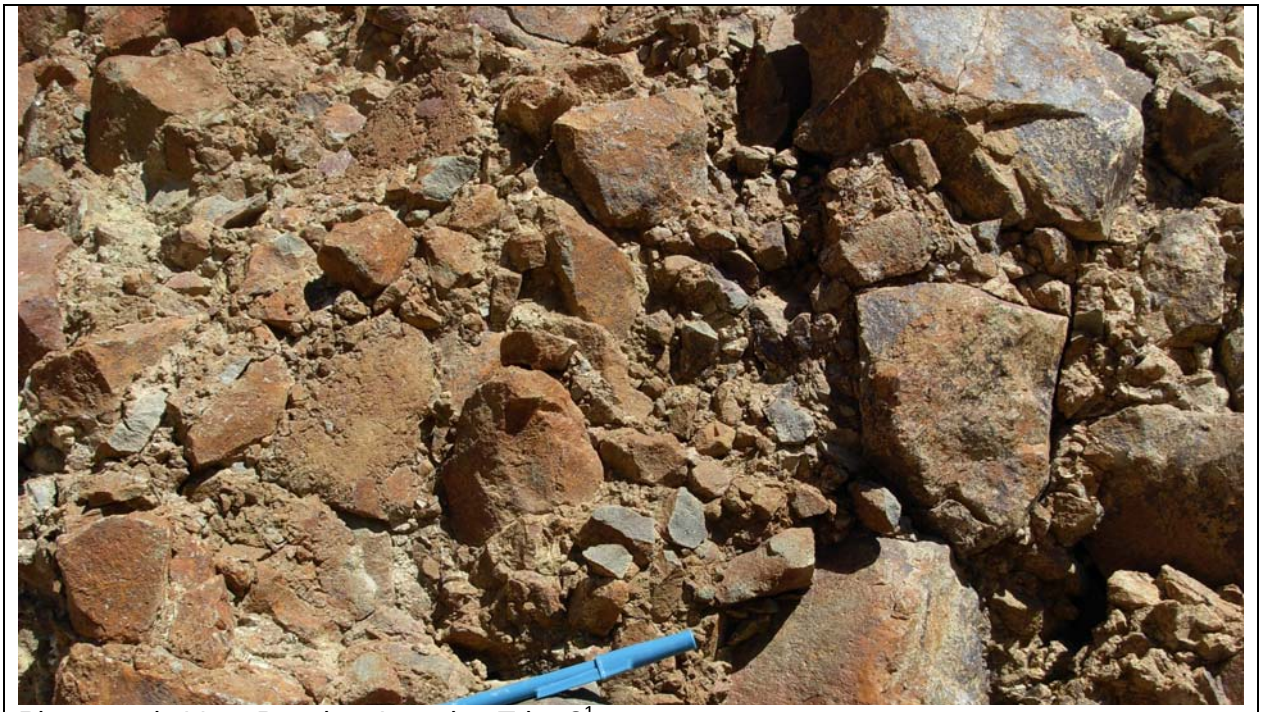
Leviathan Mine Site
Alpine County, California

Photograph 9 — Basalt at Location Trb - 1[1]

Photograph 10 — Basalt at Location Trb - 2[1]

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California



Photograph 11 — Basalt at Location Trb - 3[1]

Photograph 12 — Basalt at Location Trb - 4[1]

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 13 — Basalt at Location Trb - 5[1]

Photographs 8 through 13

Trb: Basalt (Trs)[2]: Fine grained; olive green to black on weathered surface; grey black on fresh surface. Fine-grained plagioclase (labradorite) (45 to 50%) and clinopyroxene (5 to 7%) phenocrysts in glassy groundmass (40 to 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 to 7 mm 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 to 1 mm long altered plagioclase phenocrysts.

Notes:
1. Location shown on Plate 1. Trb-1 – west of Pond 2N. Trb-2 – west of Pond 2N. Trb-3 – south wall of pit entrance near gate. Trb-4 – top of highwall at northwest corner of pit. Trb-5 – northwest of pit.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 14 — Sandstone Sequence at Location Trcs - 1[1]

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.

Crystal lithic sandstone – Medium to coarse grained volcanic lithic framents 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 thick; outcrop principally laminar sandstone. Also laminar bedded red-brown to yellow-tan fine to very fine-grained sandstone in 2 to 5 cm thick beds with good parting, highly fractured.

Pebble interbeds – Make up 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.

(Description continued on the following page.)

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 15 — Sandstone Sequence at Location Trcs - 2[1]

Sandstone Sequence (Trcs) (continued):

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

Waterfall near waste dump – shale, weathering hard and blocky; sandstone, especially pebbly sandstone, weathering spheroidally, friable with hand pressure.

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 2mm), 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.

Notes:
1. Location shown on Plate 1. Trcs-1 – southwest of Pond 4. Trcs-2 – west of Pond 4.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 16 — Sandstone Trcs - 3[1]

Sandstone (Trcs): See description on pages A-12 and A-13.

Notes:
1. Location shown on Plate 1. Trcs-3 – west of Pond 4.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 17 — Lahar at Location Trcl – 1[1]

Lahar (Trcl):
Near crusher building - Unsilicified breccias, 40% clasts, 60% matrix; clasts 3 to 25 cm; approximately 95% volcanic; types noted: medium to light grey porphyritic hornblende andesite with phenocrysts up to 2 mm, averaging 1 ½ 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 subangular; some weathered rinds present on clasts; matrix fine grained light grey to white, may be amorphous and green, with hornblende/pyroxene and biotite crystals. Matrix may be reddish on fresh surface, weathers spheroidally. Euedral biotite alters to brown or brown green (chloritized). Also quartz, sericite, muscovite, with ashy 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.

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

Induration of the above units can vary. Trc poorly exposed in vicinity of landslide north of pit. Where visible, is friable wacke with few pebble and gravel interbeds.

Notes:
1. Location shown on Plate 1. Immediately north of the Leviathan Creek Basin Landslide and southeast of the access road in the vicinity of mapped fault.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 18 — Quartz Latite Porphyry at Location Tqlp - 1[1]

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 mm plagioclase phenocrysts (20 to 25%) altering to clay; euhedral biotite (5%) present along with prismatic hornblende phenocrysts with some slight flow alignment (1%); mafics altering. Unit well-jointed.

Notes:
1. Location shown on Plate 1. Near east corner of Pond 2S.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 19 — Leviathan Peak Andesite at Location Tlpa - 1[1]

Leviathan Peak Andesite (Tlpa)[2]: Porphyritic hornblende andesite with well-indurated red and light grey weathering; red and grey glassy groundmass (40 to 50%) containing fine-grained and porphyritic plagioclase (45 to 50%), porphyritic hornblende (5 to 7%), and possible biotite (1%) phenocrysts. Seen only as angular float in study area. Locally argillically altered (Tlpaa) with relict hornblende phenocrysts, copper sulfide stains (bornite?) where in contact with Tsb.

Notes:
1. Location shown on Plate 1. Outcrop along road southeast of Aspen Seep gate.
2. Description from Herbst and Sciacca (1982).

PHOTOGRAPHS AND GEOLOGIC DESCRIPTIONS

Leviathan Mine Site
Alpine County, California

Photograph 20 — Biotite Pyroxene Hornblende Andesite at Location Ta - 1[1]

Biotite Pyroxene Hornblende Andesite (Ta)[2]: Well-indurated; red-brown weathering; black glassy groundmass (60-65%) containing 20-30% flow-aligned tabular 1 to 3 mm plagioclase phenocrysts with some iron-staining, twinning, and zoning; hornblende (5 to 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. Locally jointed and/or fractured.

Notes:
1. Location shown on Plate 1. East side of Nevada access road near confluence of Aspen and Leviathan creeks.
2. Description from Herbst and Sciacca (1982).

APPENDIX B

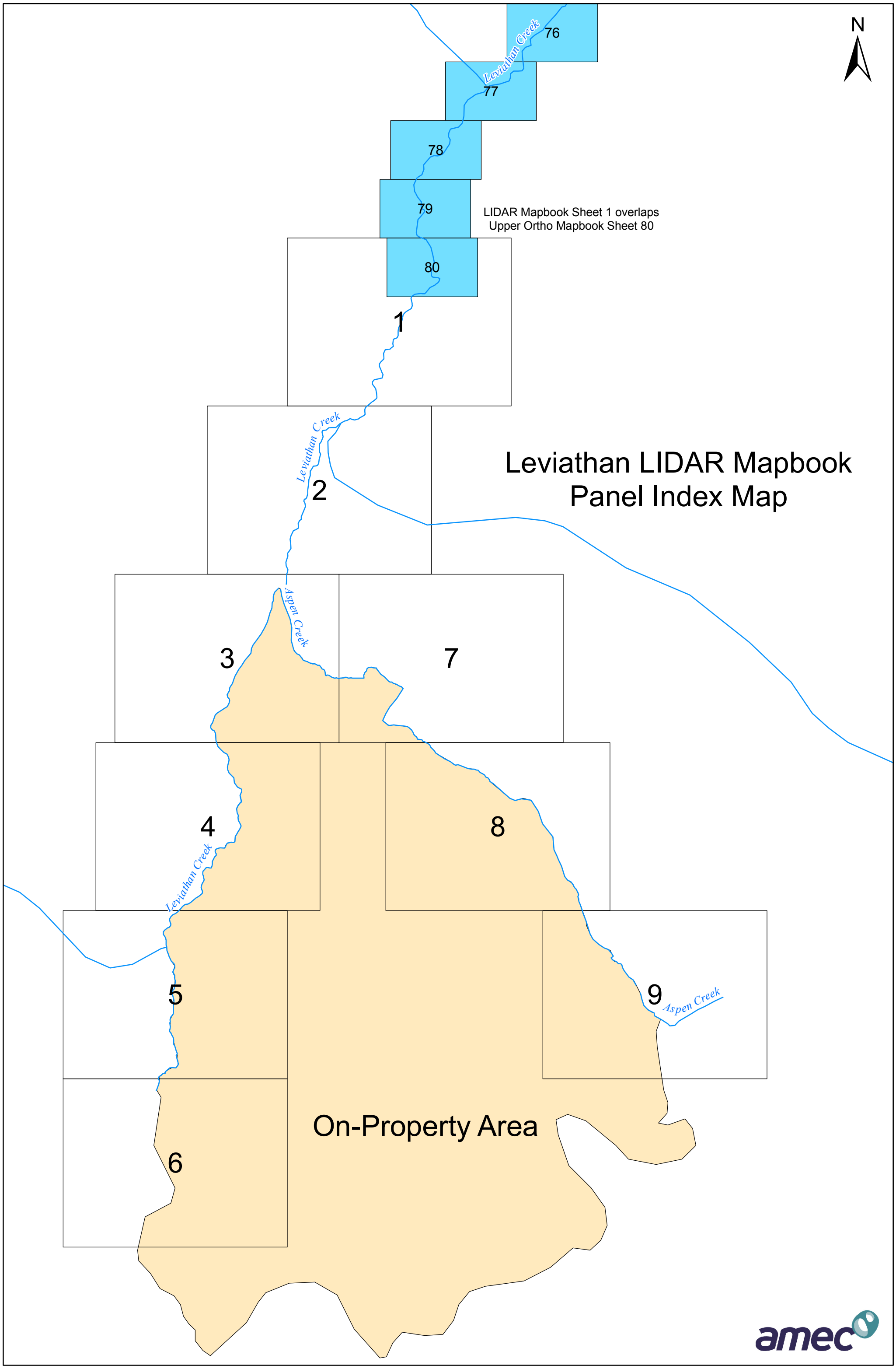
LiDAR-Based Sediment Maps – Index and Example

LiDAR Index:

- Leviathan LiDAR Mapbook Panel Index Map

Panel Example:

- Page 1


N
76
77
78
79
80
1
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3
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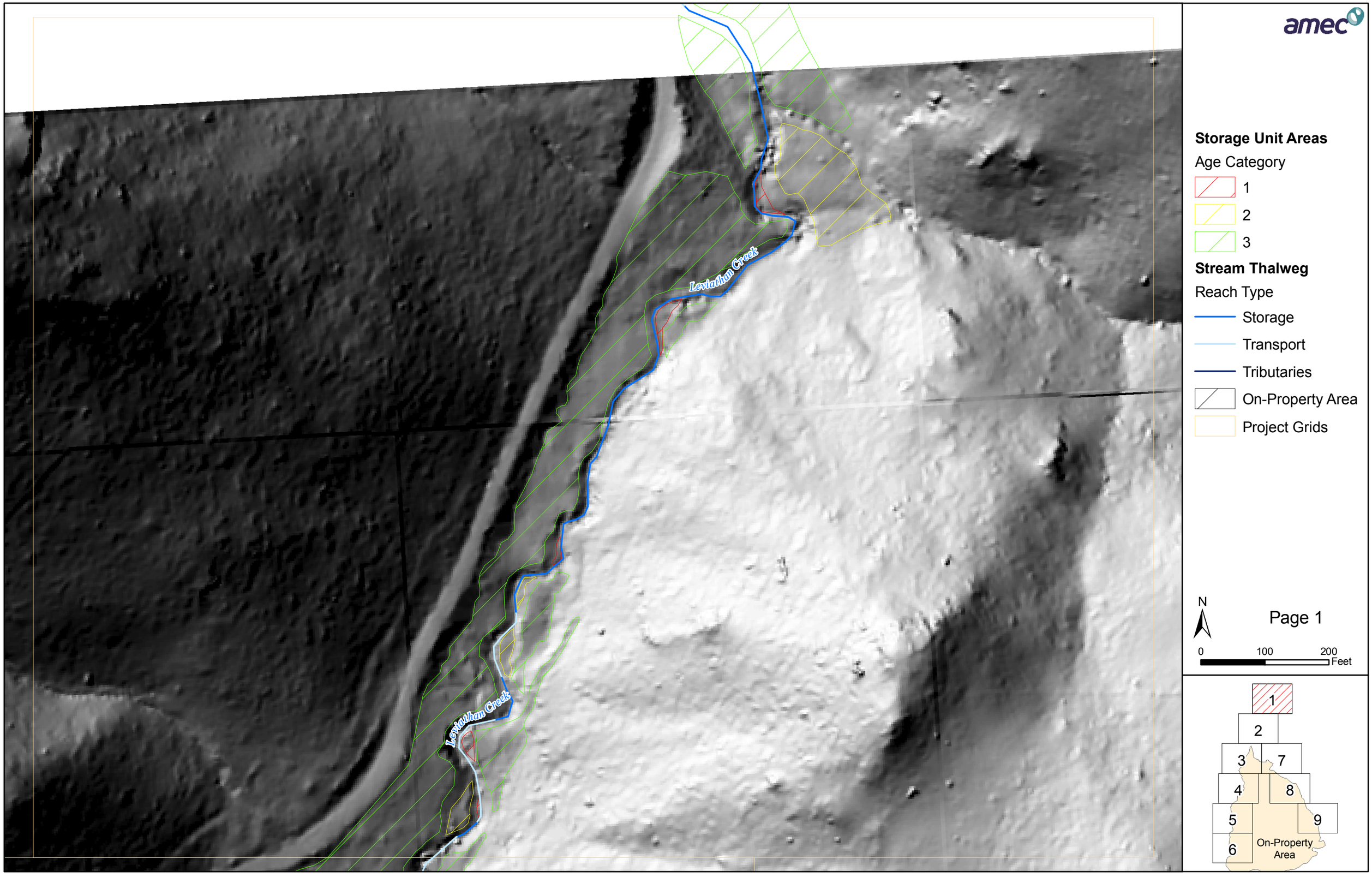
5
6
7
8
9
Leviathan Creek
Aspen Creek
LIDAR Mapbook Sheet 1 overlaps
Upper Ortho Mapbook Sheet 80
Leviathan LIDAR Mapbook
Panel Index Map
On-Property Area
amec


amec
Leviathan Creek
Leviathan Creek
Storage Unit Areas
Age Category
1
2
3
Stream Thalweg
Reach Type
Storage
Transport
Tributaries
On-Property Area
Project Grids
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Page 1
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100
200
Feet
1
2
3
7
4
8
5
9
6
On-Property Area

APPENDIX C

Orthophoto-Based Sediment Maps – Indexes and Examples

Leviathan Panel Indexes:

- Leviathan Ortho Lower Mapbook Panel Index Map
- Leviathan Ortho Upper Mapbook Panel Index Map

Leviathan Panel Examples:

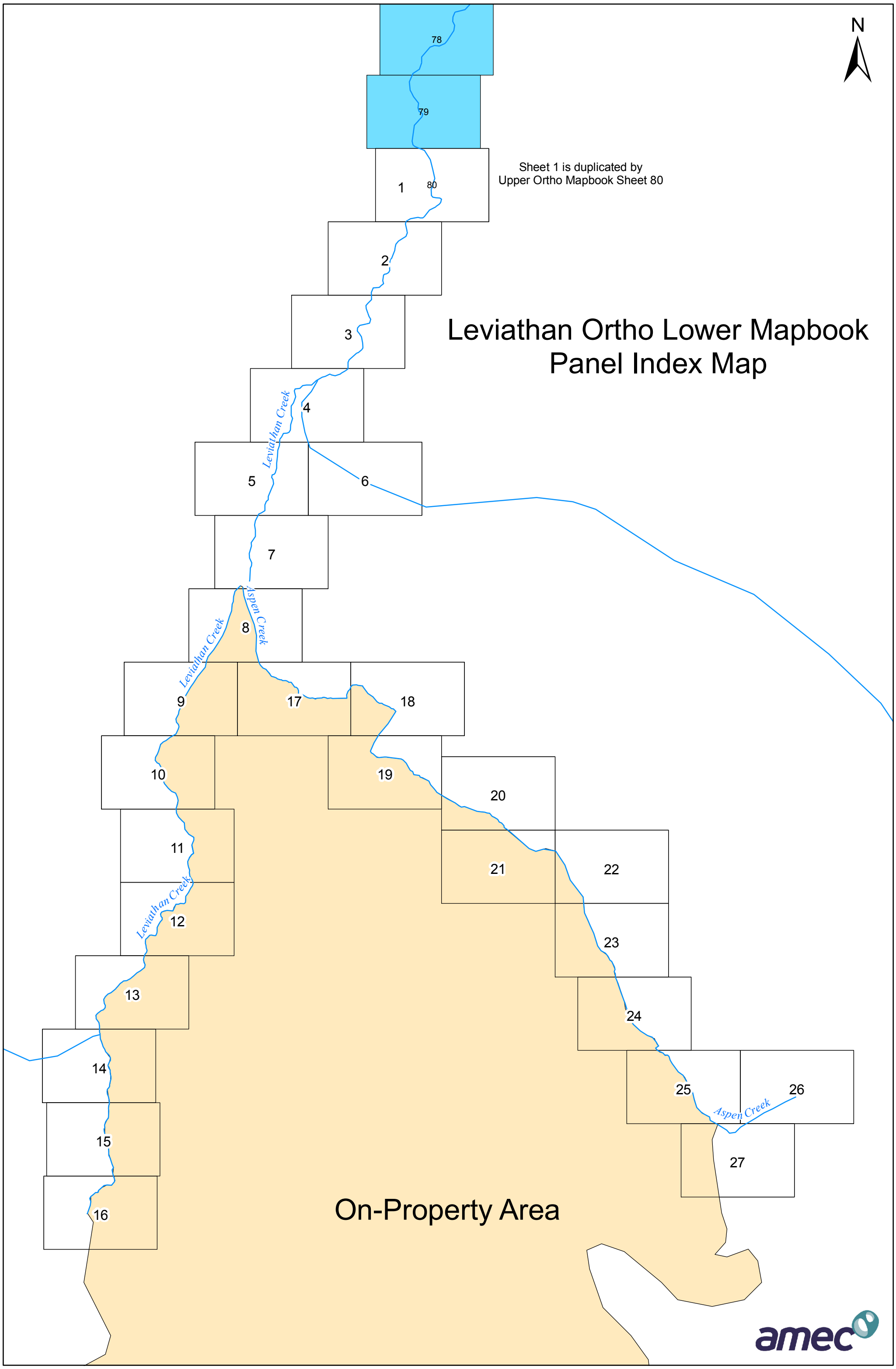
- Page 51
- Page 64
- Page 71

River Ranch Panel Index:

- Lower River Ranch Mapbook Panel Index Map

River Ranch Panel Examples:

- Page 11
- Page 25


N
Leviathan Ortho Lower Mapbook
Panel Index Map
Sheet 1 is duplicated by
Upper Ortho Mapbook Sheet 80
78
79
80
1
2
3
4
5
6
7
8
9
10
11
12
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22
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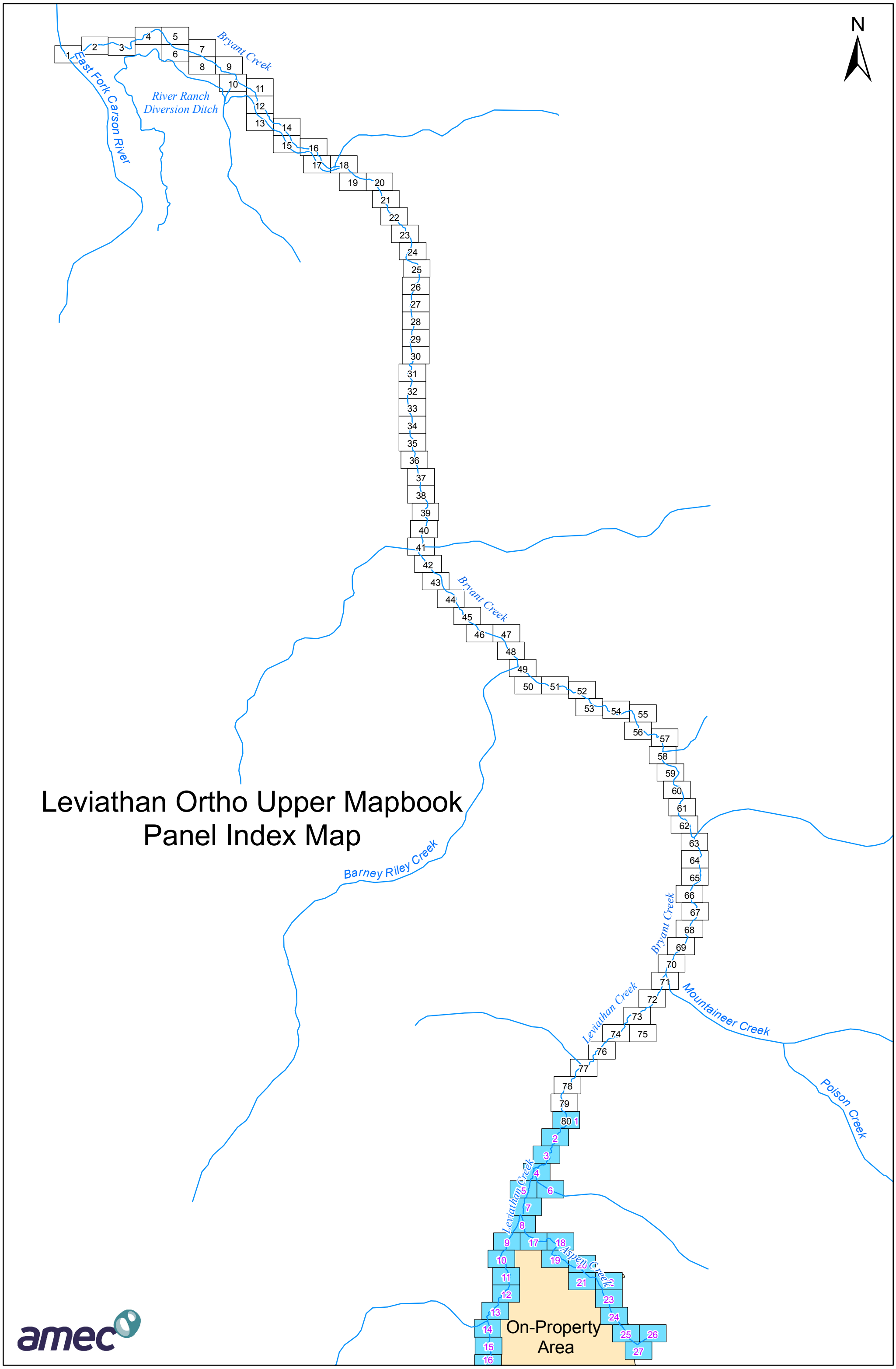
24
25
26
27
Leviathan Creek
Aspen Creek
On-Property Area
amec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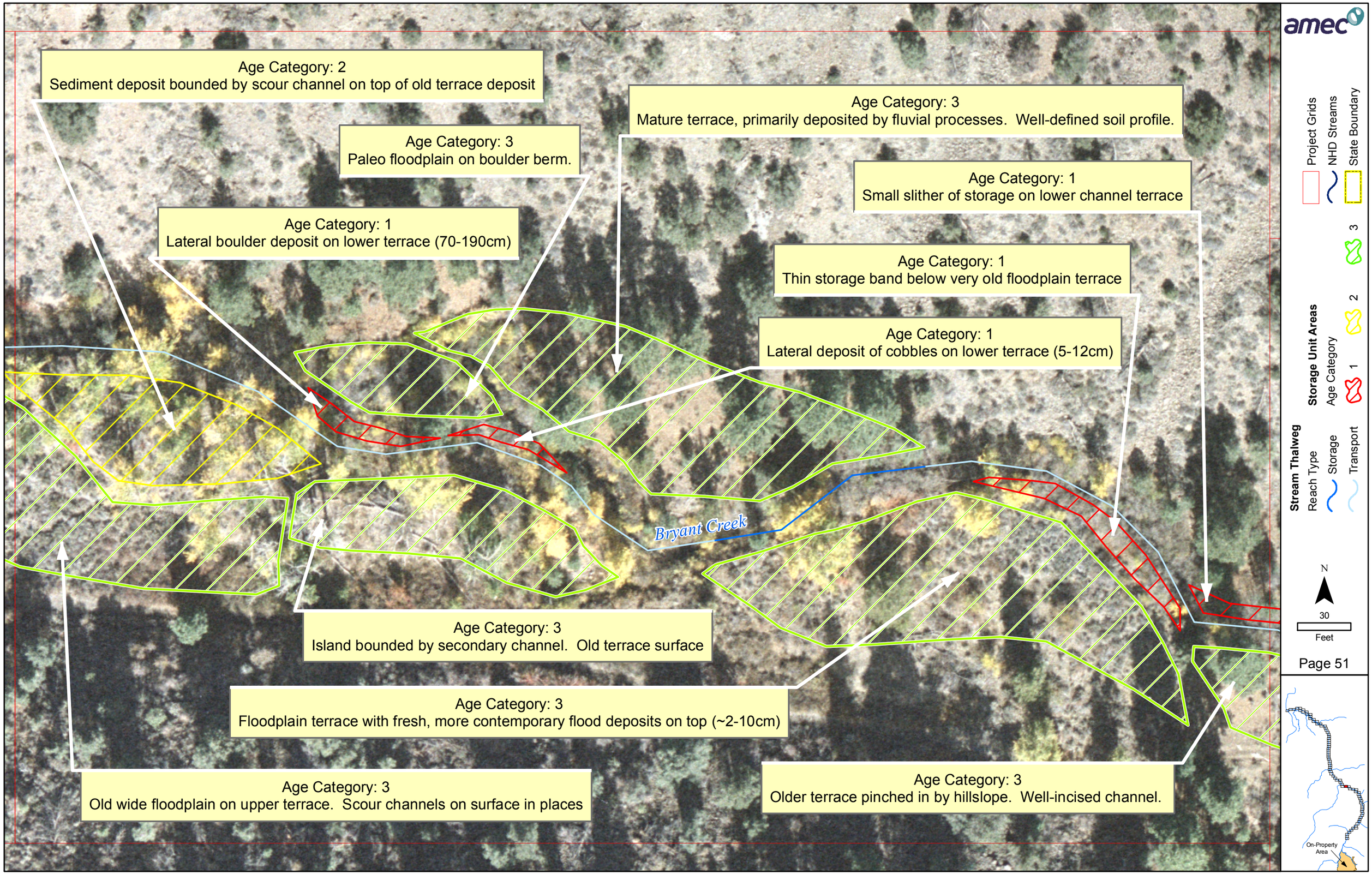
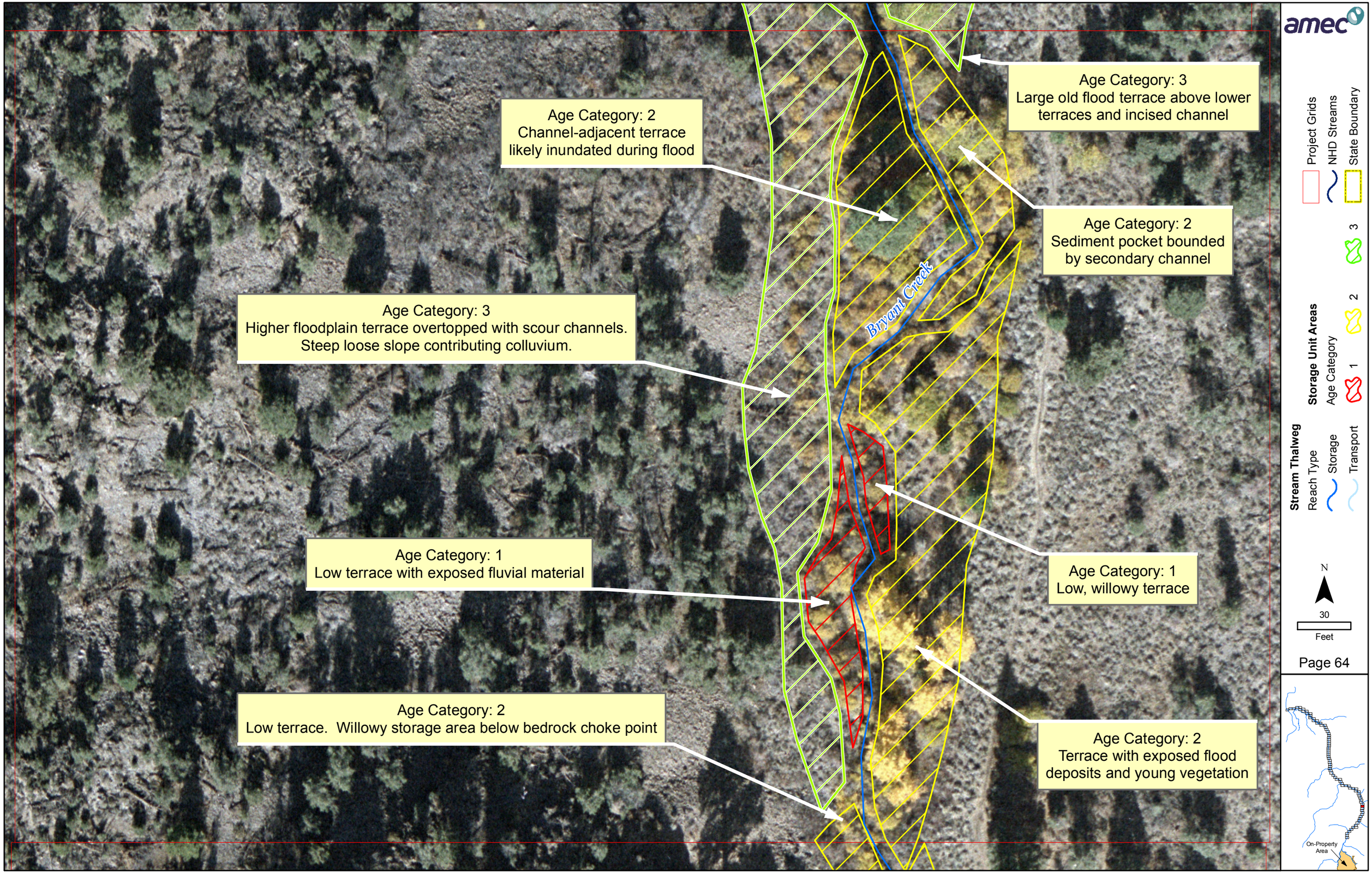
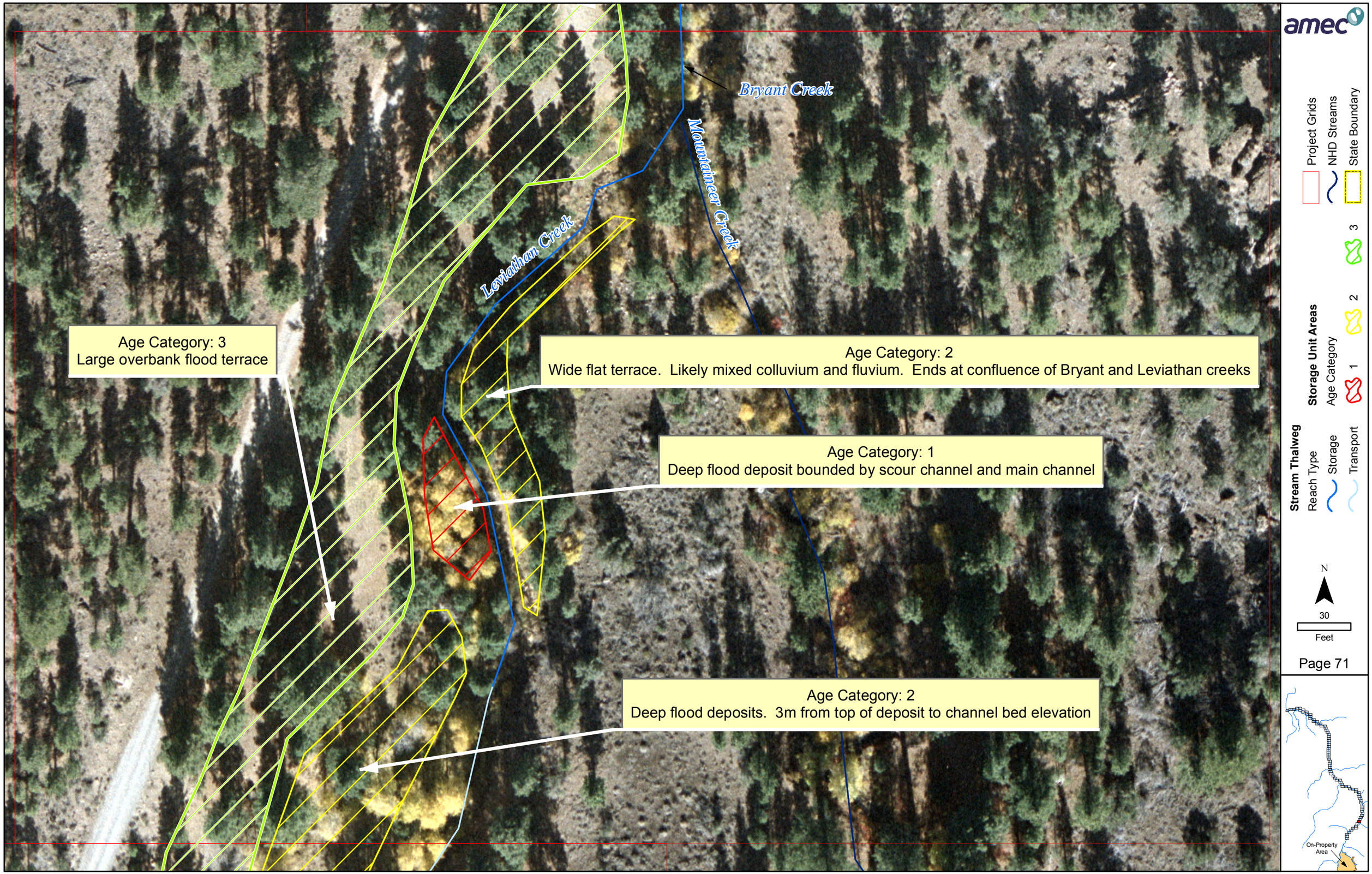
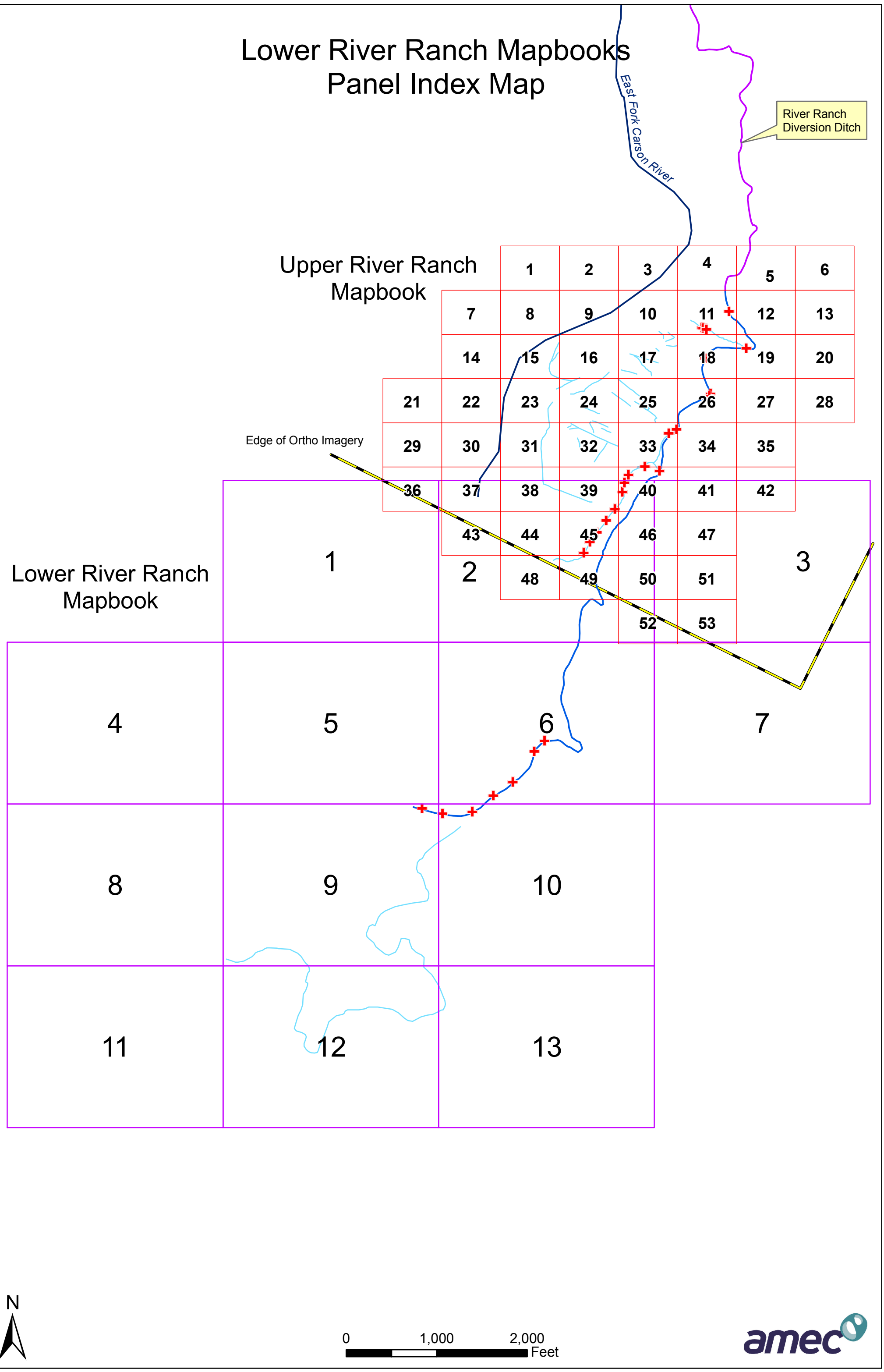
Leviathan Ortho Upper Mapbook
Panel Index Map
East Fork Carson River
River Ranch
Diversion Ditch
Bryant Creek
Barney Riley Creek
Leviathan Creek
Mountaineer Creek
Poison Creek
Aspen Creek
On-Property
Area
amec


Age Category: 2
Sediment deposit bounded by scour channel on top of old terrace deposit
Age Category: 3
Mature terrace, primarily deposited by fluvial processes. Well-defined soil profile.
Age Category: 3
Paleo floodplain on boulder berm.
Age Category: 1
Small slither of storage on lower channel terrace
Age Category: 1
Lateral boulder deposit on lower terrace (70-190cm)
Age Category: 1
Thin storage band below very old floodplain terrace
Age Category: 1
Lateral deposit of cobbles on lower terrace (5-12cm)
Bryant Creek
Age Category: 3
Island bounded by secondary channel. Old terrace surface
Age Category: 3
Floodplain terrace with fresh, more contemporary flood deposits on top (~2-10cm)
Age Category: 3
Old wide floodplain on upper terrace. Scour channels on surface in places
Age Category: 3
Older terrace pinched in by hillslope. Well-incised channel.
amec
Project Grids
NHD Streams
State Boundary
Storage Unit Areas
Age Category
1
2
3
Stream Thalweg
Reach Type
Storage
Transport
N
30
Feet
Page 51
On-Property Area


Age Category: 3
Large old flood terrace above lower terraces and incised channel
Age Category: 2
Channel-adjacent terrace likely inundated during flood
Age Category: 2
Sediment pocket bounded by secondary channel
Bryant Creek
Age Category: 3
Higher floodplain terrace overtopped with scour channels. Steep loose slope contributing colluvium.
Age Category: 1
Low terrace with exposed fluvial material
Age Category: 1
Low, willowy terrace
Age Category: 2
Low terrace. Willowy storage area below bedrock choke point
Age Category: 2
Terrace with exposed flood deposits and young vegetation
amec
Project Grids
NHD Streams
State Boundary
Storage Unit Areas
Age Category
1
2
3
Stream Thalweg
Reach Type
Storage
Transport
N
30
Feet
On-Property Area


Bryant Creek
Mountaineer Creek
Leviathan Creek
Age Category: 3
Large overbank flood terrace
Age Category: 2
Wide flat terrace. Likely mixed colluvium and fluvium. Ends at confluence of Bryant and Leviathan creeks
Age Category: 1
Deep flood deposit bounded by scour channel and main channel
Age Category: 2
Deep flood deposits. 3m from top of deposit to channel bed elevation
amec
Project Grids
NHD Streams
State Boundary
Storage Unit Areas
Age Category
1
2
3
Stream Thalweg
Reach Type
Storage
Transport
N
30
Feet
On-Property Area

Lower River Ranch Mapbooks
Panel Index Map



Canal Diversion Structures

Ortho Imagery Edge

Upper River Ranch Grids

Reach Type

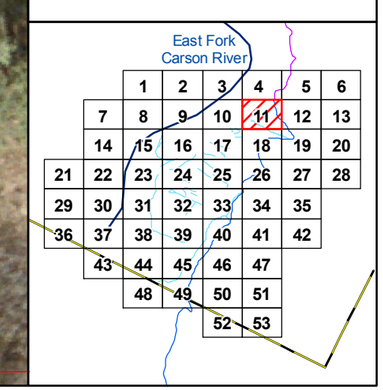
Main Diversion Canal (above Ranch)

Main Diversion Canal

Lateral Diversion Canals

N

0 25 50 Feet



Canal Diversion Structures

Ortho Imagery Edge

Upper River Ranch Grids

ReachType

Main Diversion Canal (above Ranch)

Main Diversion Canal

Lateral Diversion Canals

N

0 25 50 Feet