Sampling and Analysis Plan/ Quality Assurance Project Plan Monte Cristo Mining Area

Prepared for
Washington State
Department of Ecology

August 10, 2011
17800-06

HARTCROWSER

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SAMPLING AND ANALYSIS PLAN/ QUALITY ASSURANCE PROJECT PLAN MONTE CRISTO MINING AREA

1.0 INTRODUCTION

This combined Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) describes the recommended general sampling locations, field sampling procedures, laboratory analytical methods, data evaluation procedures, and quality control criteria to support the Washington State Department of Ecology (Ecology) in performing a Remedial Investigation/Feasibility Study (RI/FS) at the Monte Cristo Mine site area (Site).

A schedule for implementing the SAP has been prepared and submitted to Ecology as part of the proposal.

1.1 Background

The Site is located approximately 38 air miles east of Everett, Washington, on the steep mountainsides of the Cascade Range at the head of the South Fork Sauk River. The abandoned or inactive mine workings include about 54 mine entries, prospects, and related facilities. The principal commodities produced were gold and silver, with an estimated 310,000 tons of ore produced between 1889 and the closure of the mines in 1907.

The Site was discovered by Joe Pearsall and Frank Peabody during the summer of 1889. A townsite was quickly established, consisting of stores, hotels, a school, and a newspaper. A railroad was completed in 1893 to transport ore to the smelter in Everett. Mineral production flourished for a few years until massive floods destroyed rail access in 1897. Mine production was reduced and intermittent, and was operated by a number of smaller companies until 1920 (Woodhouse 1997). Currently, the area is a popular hiking destination during the summer months with an extensive network of trails.

2.0 SAMPLING OBJECTIVES, AND FIELD TEAM

The purpose of the RI/FS is to evaluate the potential environmental impacts from historical mining operations and the extent of potential ongoing releases of contaminants at the Site. This SAP addresses data gaps that were identified during review of historic Site documents.

2.1 Sampling Objectives

The scope of work described in this SAP is designed to aid in evaluating if there are impacts to human health and the environment from historical mining and milling activities at the Site. The objectives of this SAP are to:

1. Establish background concentrations for Contaminants of Concern (COCs) in the soil (media of concern) throughout the three watersheds of interest.
2. Collect environmental data to fill data gaps and help identify the extent of site contamination and the range of COC concentrations exceeding background and screening levels.
3. Collect environmental data by media and observation, sufficient to conduct the Human Health Risk Assessment and Terrestrial Ecological Evaluation (HHRA/TEE).

Soil analytical results will be compared to applicable MTCA Method A cleanup levels; MTCA Method B cleanup levels for soil ingestion; soil ingestion and dermal contact combined; and criteria for ecological protection of plants, soil biota, wildlife, and background.

Chemical analysis will be performed by TestAmerica Laboratories, Inc. in Tacoma, Washington. The laboratory project manager is Kristine Allen.

The quality assurance data validation review will be performed on all analytical sample results. Validated data will be entered into Ecology's Environmental Information Management (EIM) system. Sampling results and laboratory data will be compiled and evaluated. Sampling locations, procedures, analytical methods, and evaluation of results are discussed in subsequent sections of this SAP/QAPP.

2.2 Field Team

Key staff members and their project functions shall be identified in the schedule submitted to Ecology based on an authorization to proceed. The staff conducting the initial site reconnaissance and sampling trip include:

- Michelle Havey – Project Manager, Fisheries Biologist
- Celina Abercrombie – TEE inventory and field work, Ecologist
- Andrew Kaparos – TEE inventory and field work, Environmental Engineer

In addition to the persons named above, the people listed below may be involved in future soil sampling, laboratory data validation, and/or GIS support:

- Anne Conrad - Chemist/Data Quality Review
- Emily Duncanson - Environmental Scientist
- Phil Cordell - Geologist
- Ward McDonald - Geologist

If staff changes occur during the project, the Ecology Project Manager and Contract Specialist will be notified.

3.0 SAMPLE COLLECTION

This section presents: 1) areas of the Site in which field environmental data will be collected; and 2) a description of the sample and data collection methods.

3.1 Sampling Locations

Based on a review of historic site documents, environmental samples of soil and mine features will need to be collected. All mines and prospects listed in Table 1 of the Monte Cristo Mining Area Spatial Analysis report will be included as part of this investigation. Cass Lode, Comet, Eighty-Nine, Meridian, O&B Upper and Lower, Philo, and Zeta Lode from Table 2 will also be included.

The total number of samples to be collected during four sampling trips is assumed to be approximately 200 (50 background soil samples and 150 mine feature samples). The number of samples collected may be modified. For example, a mine may have an extensive number or volume of features and require more samples than previously estimated. Background and mine feature sampling protocol details are discussed in detail later in this document.

3.2 Environmental Data Collection

3.2.1 TEE Field Protocol and Documentation

During field investigations, we will complete a specific valuation of ecological receptors and habitats for each of the sampling locations visited during our reconnaissance visit to the three watershed areas (Glacier, Weden, and Seventysix) included as part of this project.

Upon identification of a sample location, we will collect data including: 1) observed impacts associated with the site; 2) a specific evaluation of ecological receptors/habitat; and 3) an evaluation of receptor-pathway interactions within approximately 5 to 25 feet of the sampling feature (waste rock pile, adit, other). Larger features may require a larger area of investigation. Specifically, the following information will be gathered to support preparation of the TEE:

Observed impacts associated with background sampling of a mine feature site

- Vegetation type (none, limited, extensive)
- Vegetation impacts or distress (none, limited, extensive)
- Wildlife on and near the site including macroinvertebrates, reptiles, amphibians, birds, mammals, and others (none, limited, extensive)

Specific evaluation of ecological receptors/habitat

- Habitat will be described in the area of each sample or mine feature, including;
- Terrestrial: percentage of site that is wooded, scrub/shrub, ruderal; dominant vegetation type (evergreen, deciduous, mixed, scrub, shrub, grasses, landscaped, agricultural, bare ground, other); prominent height of vegetation; density of vegetation (dense, patchy, sparse); and evidence/observation of wildlife (macroinvertebrates, reptiles, amphibians, birds, mammals, other).
- Aquatic (non-flowing and flowing): percentage of site that is covered by lakes, ponds, rivers, stream (perennial or intermittent), dry wash, ditches, other; type of water bodies (lakes, ponds, impoundments, rivers, streams) present at the site; size, average depth; source water (surface water runoff, groundwater, other); water discharge point (none, surface water body, groundwater, wetlands impoundment); vegetation present (yes/no); obvious wetlands present (yes/no); and evidence/observation of wildlife (macroinvertebrates, reptiles, amphibians, birds, mammals, other).
- Ecologically important species/habitats observed: description of species observed, adequate habitat conditions present, and evidence of species using the area (tracks, scat, burrowing, other).

We will provide photographic documentation of each sample location and important features identified in the field.

Additional items we will evaluate during the field investigation in order to identify receptor-pathway interactions include:

- Are hazardous substances present or potentially present in surface water, sediment, groundwater, prey or food items of terrestrial receptors, or surficial soil?

- Are ecologically important species or habitats present?

- Could hazardous substances reach these receptors via surface water, groundwater, contact with sediment, consumption of food items, incidental ingestion of or dermal contact with surface soil, or fugitive dust carried in surface air or in burrows?

Specific survey items include:

- Qualitative soil invertebrate survey - document invertebrates observed crawling on the ground, turn over wood/debris/rocks/other cover, and note species that are present (earthworms, pillbugs, ants, millipedes, etc.), in the upper soil horizon (A horizon).

- Soil conditions - coarse-grained, loam, silt, low organic matter, color, presence of roots, moisture conditions.

- Habitat types and major vegetation communities present in the undisturbed areas - forest (primary or secondary), shrub, meadow, talus/rock, other.

- Location of habitat types or communities in relation to sample location (downgradient, upgradient, within, or immediately adjacent).

3.2.2 Background Soil & Mine Feature Sampling

A first task of the SAP will be to implement mine feature sampling. During the initial site visit from July 8 through 13, several proposed background sampling locations in each watershed were evaluated for access, mine disturbances or potential contamination. The field team was able to get on station for seven of the locations. Two mines were positively located and sampled in the field. Snow cover and steep, unstable slopes were factors in being unable to locate some of the mine sites. Five samples were collected from the two mine sites;

these were screened with the X-ray Fluorescence (XRF) instrument and submitted to a laboratory for analysis.

Three additional sampling events will be conducted in August and September 2011 to collect background soil samples and to collect the remaining mine feature samples. Some analytical results from sampling events 2 through 4 may require expedited analysis (e.g., mine features where both MIS and discrete samples are collected).

If changes are required in sampling locations these will be discussed with Ecology and revised in the SAP.

In addition to sample collection, the locations will be mapped by GPS and visual observations. Site features, including the size and extent of a location, miscellaneous debris, ongoing erosion, sources of contamination, and the presence or absence of signs of water, plants, animals, or recent human activity will be documented if possible.

Data collected during sampling will include:

- Sample locations (GPS);
- Soil type and texture;
- Site topography; and
- Presence or absence of signs of water, plants (identify to species-level when possible), animals (identify to species-level when possible), or recent human activity.

3.3 Field Sampling Methods

During field work, sample locations will be documented in the field using a GPS and the approximate located will be noted on a topographic map based on visual observations made at the time of sampling.

The locations of explorations and sampling points will be surveyed based on GPS measurements referenced to Washington State Plane, South Zone, NAD83 HARN coordinates and elevations will be based on NAVD88 and interpreted from elevations shown on existing maps and site surveys.

The following sections describe the sampling methods that will be used for collection of environmental samples/data.

3.3.1 Background Soils, Surface Soil, Tailings, Waste Rock, Stained Area, or other Mine Feature Sampling

Soil sample collection will be performed in a consistent manner by field personnel at all sampling locations to ensure data are representative. Surface samples collected should be representative of the targeted 0- to 6-inch-depth profile for background samples. A minimum of two discrete mine feature samples will be taken; one from 0 to 6 inches deep and one greater than 6 inches deep.

Multi-increment sampling (MIS) of waste rock piles will be collected at one or two mine feature locations, if field conditions permit, during the next sampling event. MIS samples will be taken from a depth of 0 to 6 inches over a 30-point grid. The 30-point grid consists of 30 equal areas covering the entire waste rock pile. The samples collected over this grid will be of equal volume (approximately one tablespoon) and will attempt to capture material from the entire soil profile. Care should be taken to collect all size fractions and avoid loss of fine material.

Locations where MIS samples are collected will also have discrete samples collected for comparison. A correlation can be calculated to decide whether the increased field time required for MIS collection and increased cost (approximately $125) for lab analysis is justified for more MIS sampling in the future. Based on analytical and correlation results, MIS could be implemented at more locations during future sampling events.

Sampling protocol details are described below. Lab analysis for MIS samples will follow Appendix A of the Method 8330B (with modifications for metals sampling). It has been verified that TestAmerica can analyze samples following this method.

3.3.1.1 Background Soil Sample Collection

Sampling will be conducted during three sampling events in late summer/early fall 2011. Samples will be stored in coolers and transported off-site by helicopter to adhere to standard holding times. The helicopter will be coordinated with the local Forest Service District Ranger. We understand that a Forest Service building located near the townsite will be available to store equipment and supplies during and between field sampling events.

Fifty background soil samples will be collected. The general location of the background soil samples will be determined based on areas identified before field activities. These locations may be modified during the field visit. Samples will be located outside of areas potentially impacted by historical mining activity.

For each watershed, forested and non-forested areas can be identified from aerial images. Larger forested areas with more mature trees will be selected over smaller areas with younger trees. Samples are to be collected from both forested and non-forested areas where possible. If only one type of area is present, only one sample will be collected.

Sampling points must avoid the following problem areas:

- Disturbed areas (e.g., historical mining activity areas, landscaped or maintained areas, and areas of animal burrowing activity);
- Areas composed primarily of rocks or gravel, with no significant fines;
- Areas near wooden structures, where the wood may have been treated;
- Areas near painted structures;
- High-traffic areas (e.g., roads and hiking trails);
- Large or dense vegetation, e.g., trees, bushes, and turf grass;
- Areas of steep slopes or floodplains with significant erosion or deposition; and
- Forested areas dominated by immature trees, areas that were recently reforested, and areas where there is evidence of recent fires.

Softer soil samples will be collected using a dedicated, disposable plastic scoop. Other samples will be collected using a shovel, hand auger, trowel, or stainless steel spoon. Samples may be sieved using an ASTM No. 10 screen, if required, to obtain fine-grained material so that more representative samples are submitted to the laboratory. Enough soil will be collected to fill the 4-ounce sample jar. Background soil samples will be collected from mineral horizons (i.e., below the duff layer or O horizon if present) from a depth of 0 to 6 inches. GPS will be used to identify the background sampling point. If problem areas are encountered at any of these locations, the sampling point shall be relocated up to ten feet in any direction. The final sampling point locations, measurements, and modifications will be recorded in the field notebook. The sampling location will be photo documented.

3.3.1.2 Mine Feature Sample Procedure

We plan to collect a total of 150 samples at the 33 mine sites. For the site reconnaissance, we planned to visit two to three mine sites in each of the three watersheds for a total of six to nine sites. Snow levels and safety concerns limited which mines were accessible, but the field crew was able to reach seven sites for at least two samples in each watershed. Five samples were collected at two mine sites. These samples were sieved, screened with an XRF, and submitted to a laboratory for expedited analysis. The remainder of the sites will be visited and sampled during subsequent field trips outlined in Task 3 of the work plan.

At each mine location, Hart Crowser will visually assess features and prepare a field sketch showing the approximate size and relative location of excavation(s), waste rock pile(s) and other waste-like soil, relic structures, and local drainage features. Observations will be recorded on field data forms, see Appendix B.

Samples of soil and waste rock will be collected using the decision tree framework described below to determine the number and location of samples to be collected at a feature during the field trips. A minimum of two samples will be collected at each mine feature, with a potential to collect more samples if warranted. If excess mine feature samples are collected at each location, an XRF instrument will be used on excess samples collected to help select which samples to send to the laboratory for total metals analysis. A high reading may prompt sending the sample for further lab analysis.

1. A soil sample should be collected if any of the following are observed:

    - Adit/drainage way – collect a sample on the downslope;
    - Visible staining;
    - Distressed vegetation; or
    - One or more waste rock pile(s).

2. If there are one or more waste rock pile(s):

    - Collect a sample on the downslope side of each pile.
    - Collect additional samples locally if there is visible:

- Chemical alteration (e.g., mineralization) (0 to 6 inches and 6 to 12-inch depths);

- Physical alteration (e.g., erosion) (0 to 6-inch depth); or

- Drainage from the pile (Sample soil could be impacted by drainage at 0 to 6 inches. If there is chemical alteration of the material that has moved downslope, an additional subsurface sample will be collected from the 6- to 12-inch depth).

- Note which pile is nearest to a creek or water body.

Discrete samples will be collected from each of the waste dumps encountered. In addition, the next field event will include sampling a 30-point MIS following appropriate sampling methods from one or two waste rock piles, depending on conditions determined by the field team. These MIS samples will be sent to the lab for expedited analysis along with the discrete samples from the same location. Depending on the lab results for the two sample types, the SAP could be revised before the third sampling event.

The following is the general procedure for MIS sampling:

1. Equal volumes of soil are collected from numerous locations (30 recommended though fewer are often collected) within a "decision area" and placed into a single container.

2. Samples are shipped to the laboratory for subsequent processing. The lab will follow Method 8330B for metals.

3. The entire sample container is spread in a shallow pan to air dry, if needed.

4. The sample is sieved through an ASTM No. 10 sieve (2 mm) and the fraction > 2 mm is discarded (MTCA specifies that the 2mm - fraction is analyzed though few people rigorously follow this)

5. For analyses that use a very small sample (e.g., metals, TOC) the sample may be crushed or ground.

6. The sample is spread in a shallow pan with ~30 to 50 grid cells.

7. Using a small spatula, equal volumes of soil are taken from each grid cell (taking care to collect the sample through the soil depth to obtain the distribution of particle sizes) and placed into a small sample jar.

8. The entire contents of the small jar are extracted and then analyzed.

The number of samples collected at each of the 33 locations will be determined by field staff at the time of sampling and will be based upon the estimated volume of the waste dump or other observed site characteristics that appear to be worth sampling as outlined in the decision tree above.

Each mine feature sampled will have a minimum of two discrete samples taken: one from a depth of 0 to 6 inches (below any surficial duff or the O horizon or organic material), and one from greater than 6 inches. Samples will be collected using a stainless steel spoon or trowel and placed in a plastic bag, (larger gravel will be removed by hand) for transporting back to the Hart Crowser soil lab. The samples will be air dried and efforts made to break up clods before sieving with an ASTM No. 10 screen.

Once sieved, the minus No. 10 fraction will be placed into either a plastic sample receptacle for XRF analysis or a 4-once plastic jar to be shipped for lab analysis. Following XRF analysis (section 3.3.2) in the Hart Crowser lab, the selected sample will be placed in a 4-ounce plastic jar. The sample will be transported to the laboratory under the proper chain of custody for chemical analysis.

While sampling within a mine waste pile, the sampling spoon (or trowel) will be wiped clean with a paper towel between each sample point. Spraying with deionized (DI) water may be used if soil residue cannot be removed by wiping. The sample spoons will be cleaned with a liquinox solution, rinsed with potable water, wiped with a Kimwipe or paper towel, and rinsed with DI water prior to beginning a sample at a new feature. Wastewater and liquinox solution will be disposed of on the mine waste piles; paper waste will be packed out of the site.

Where safe to access, waste dump size will be estimated by pacing or tape measure. The height of each waste pile will be estimated visually, or measured where possible. Measurements may be made with a range finder and clinometer where the wastes are on steep slopes or potentially unstable. As time and ground conditions permit, a hand auger hole may be advanced through the interior of the piles to determine depth of the waste rock over native soil at selected points.

3.3.2 XRF Screening Procedure

The purpose of the XRF screening is to help guide sample collection for laboratory analysis. For future sampling trips, XRF will only be used if excess samples are collected from mine features. Samples that have high XRF readings

will be sent to the lab for total metals analysis. Field personnel have been trained on using the equipment. The XRF User Manual is included as Appendix C. The following are the XRF screening procedures we use in the Hart Crowser soil lab to test the samples prior to laboratory submittal.

1. Calibrate the XRF instrument using the provided calibration disk.

2. Scan the reference soil samples provided by Olympus. Two of the samples have detections with certified values and one is a blank sample. These reference soil samples have been analyzed by a laboratory and have provided certified values for many elements we are testing for. The reference samples can be used as a metric to gauge the accuracy of the instrument for readings from the collected soil samples.

3. The collected soil samples should already be dried, sieved with an ASTM No. 10 screen, and placed into a zip lock bag. Use the XRF instrument to scan the sample through the zip lock bag.

4. After screening through the zip lock bag, the sample will be carefully placed onto a glass Petri dish. Position the XRF lens directly on the soil sample and scan an additional two times. Each soil sample with have three readings from the XRF. Then place the sample into a 4-ounce plastic jar. Excess soil will be retained in the Hart Crowser sample refrigerator in case it is needed at a later date.

5. After screening all soil samples three times, export and download the data onto a computer for review. The data can be checked for consistency and the highest reading from each sample should be selected as a conservative measure.

6. Selected samples will be sent to TestAmerica laboratory for analysis.

3.4 Equipment Decontamination Procedures

Pre-cleaned equipment will be used for all soil sampling. All reusable or nondedicated field equipment (e.g., sampling spoons, mixing bowls, spade/shovel, split spoons) will be decontaminated before reuse. Equipment will be cleaned in the following manner:

- Nitrile gloves (or equivalent) must be worn during decontamination.

- Excess soil will be removed using paper towels or by dry brushing.

- Rinse with potable water, collecting rinse water in one of the decontamination buckets.

- Wash with a spray bottle containing Liquinox™ (or equivalent nonphosphate detergent) and water and clean with the stiff-bristle brush until all evidence of soil/sediment or other material has been removed.

- Rinse with deionized or distilled water three times, ensuring that all soap from the previous step has been removed.

- If necessary, place the equipment on a piece of aluminum foil to air dry.

- A trash bag should be provided for waste paper towels, aluminum foil, and used nitrile gloves.

3.5 Disposal of Investigation-Derived Waste

3.5.1 Disposal of Incidental Trash

Incidental trash generated during this investigation (including discarded nitrile gloves, aluminum foil, paper towels, and disposable equipment) will be placed in plastic trash bags and disposed of as solid waste.

3.5.2 Decontamination Water Disposal

Soap and water decontamination solutions will be poured onto the ground at respective mine site feature.

3.6 Sample Containers and Labels

Precleaned sample containers will be obtained from the analytical laboratory. Sample containers shall be cleaned following the requirements described in Specifications and Guidance for Contaminant-Free Sample Containers (EPA 1992a, OSWER Directive 92.0-05a). Sample containers, preservatives, and holding times are summarized in Table 1.

3.7 Field Documentation

Field notes will be maintained during sampling and processing operations. The following will be included in the field notes:

- Site name and location;

- Date and time of entry;
- Names of the field sampler collecting and logging the samples;
- Weather conditions;
- Date, time, and identification of each sample, including number of jars and tests requested;
- Documentation of photographs;
- Details of sample collection, including GPS coordinates; actual sampling point locations will be recorded on a sketch map;
- Any deviation from the approved SAP; and
- General observations.

3.8 Sample Handling Procedures

3.8.1 Sample Preservation and Holding Times

Samples will be preserved according to the requirements of the specific analytical methods to be employed, and all samples will be extracted and analyzed within method-specified holding times. Sample containers, screening levels, analysis methods, reporting and detection limits, preservatives, and holding times are summarized in Table 1.

3.8.2 Chain of Custody Procedures

Chain of custody forms will be used to document the collection, custody, and transfer of samples from the collection location to Hart Crowser's soil laboratory, then to the analytical laboratory, and their ultimate use and disposal. A subset of samples will be collected and transferred directly to the analytical laboratory. Entries for each sample will be made on the custody form after each sample is collected.

Sample custody procedures will be followed to provide a documented record that can be used to follow possession and handling of a sample from collection through analysis. A sample is considered to be in custody if it meets at least one of the following conditions:

- The sample is in someone's physical possession or view;

- The sample is secured to prevent tampering (i.e., custody seals); and/or

- The sample is locked or secured in an area restricted to authorized personnel.

A chain of custody form will be completed in the field as samples are packaged. At a minimum, the information on the custody form shall include the sample number, date and time of sample collection, sampler, analysis, and number of containers. Two copies of the custody form will be placed in the cooler prior to sealing for delivery to the laboratory with the respective samples. The other copy will be retained and placed in the project files after review by the Project Chemist. Custody seals will be placed on each cooler or package containing samples so the package cannot be opened without breaking the seals.

3.8.3 Delivery of Samples to Analytical Laboratory

Samples delivered to Hart Crowser's soil laboratory for XRF analysis will be re-packaged for subsequent delivery. A subset of these samples will be delivered to the analytical lab. The original chain-of-custody form will be included with selected samples denoting samples not included for analysis with strikeout and full record of chain-of-custody.

After sample containers have been filled, they will be packed on ice in coolers. Two cooler sets will be used; one for MIS samples, and one for discrete samples. The coolers will be transferred to TestAmerica Laboratories, Inc. in Tacoma, Washington, for chemical analysis following the field visit. Specific procedures are as follows:

- Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24;

- Individual sample containers will be packed to prevent breakage;

- The coolers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the cooler, and the Hart Crowser office name and address) to enable positive identification;

- A sealed envelope containing custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler;

- Signed and dated custody seals will be placed on all coolers prior to shipping;

- Samples will either be shipped by overnight courier or will be hand delivered to the laboratory by Hart Crowser personnel; and

- Upon transfer of sample possession to the testing laboratories, the custody form will be signed by the persons transferring custody of the coolers. Upon receipt of samples at the laboratory, the shipping container custody seal will be broken and the laboratory sample-receiving custodian will compare samples to information on the chain of custody form and record the condition of the samples received.

4.0 LABORATORY ANALYTICAL METHODS

Table 1 identifies all analytes that will be tested for by the laboratory for background and mine feature samples. Samples will be analyzed according to EPA methods as described in Update III to Test Methods for Evaluating Solid Waste; Physical/Chemical Methods, SW-846 (EPA 1986) as summarized in Table 1. Laboratory methods, method reporting limits (MRL) and method detection limits (MDL) are also presented in Table 1 along with the individual analytes requested for the different tests.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

The quality of analytical data generated is assessed by the frequency and type of internal QC checks developed for analysis type. The quality of laboratory measurements will be assessed by reviewing results for analysis of method blanks, matrix spikes, laboratory control samples, surrogate compound recoveries, instrument calibrations, performance evaluation samples, interference checks, etc., as specified in the analytical methods to be used. The following general procedures will be followed for all laboratory analyses:

- Laboratory blank measurements at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix;

- Matrix spike (MS) analysis to assess accuracy at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix;

- Matrix spike duplicate or laboratory duplicate to assess precision at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix;

Laboratory quality control procedures, criteria, and corrective action are summarized in Table 2 for the various analyses.

5.1 Data Quality Indicators

The overall quality assurance objectives for field sampling, field measurements, and laboratory analysis are to produce data of known and appropriate quality. The procedures and quality control checks specified herein will be used so that known and acceptable levels of accuracy and precision are maintained for each data set. This section defines the objectives for accuracy and precision for measurement data. These goals are primarily expressed in terms of acceptance criteria for the quality control checks performed.

The quality of analytical data generated is controlled by the frequency and type of internal quality control checks developed for analysis type. Laboratory results will be evaluated by reviewing results for analysis of method blanks, matrix spikes, laboratory control samples, calibrations, performance evaluation samples, interference checks, etc., as specified in the analytical methods to be used.

5.1.1 Precision

Precision is the degree of reproducibility or agreement between independent or repeated measurements. Analytical variability will be expressed as the relative percent difference (RPD) between laboratory replicates and between matrix spike and matrix spike duplicate analyses. RPD will be used to measure precision for this investigation and is defined as follows:

$$RPD = \frac{(D_1 - D_2)}{(D_1 + D_2)/2} \times 100$$

Where,

D_1 = Sample value
D_2 = Duplicate sample value

Precision will be assessed by analysis of laboratory duplicates. Field variability will be assessed by analysis of numerous field samples rather than field duplicates.

5.1.2 Accuracy

Accuracy is the agreement between a measured value and its true or accepted value. While it is not possible to determine absolute accuracy for environmental samples, the analysis of standards and spiked samples provides an indirect assessment of accuracy.

Laboratory accuracy will be assessed as the percent recovery of matrix spikes, matrix spike duplicates, surrogate spiked compounds (for organic analyses), and laboratory control samples. Accuracy will be defined as the percentage recoverable from the true value and is defined as follows:

$$\%\text{Recovery} = \frac{(SSR - SR)}{SA} \times 100$$

Where,

SSR = spiked sample result
SR = sample results (not applicable for surrogate recovery)
SA = amount of spike added

5.1.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Care will be taken in the design of the sampling program to ensure sample locations are selected properly, sufficient numbers of samples are collected to accurately reflect conditions at the site, and samples are representative of sampling locations. A sufficient volume of sample will be collected at each sampling point to minimize bias or errors associated with sample particle size and heterogeneity. The MIS procedure is designed to reduce variability associated with concentration and grain size differences within a "decision unit" or set area. This results in a more precise estimate of average concentrations.

5.1.4 Completeness

Completeness is the percentage of measurements made that are judged to be valid. Completeness will be calculated separately for each analytical group, e.g., metals or PAHs. Results must also contain all quality control check analyses required to verify the precision and accuracy of results to be considered complete. Data qualified as estimated during the validation process will be

considered complete. Nonvalid measurements will be results that are rejected during the validation review or samples for which no analytical results were obtained. Completeness will be calculated for each analysis using the following equation:

$$\text{Completeness} = \frac{\text{valid data points obtained}}{\text{total data points planned}} \times 100$$

The target goal for completeness is a minimum of 95 percent. Completeness will be monitored on an on-going basis so that archived sample extracts can be reanalyzed, if required, without remobilization.

5.1.5 Comparability

Comparability is the degree to which data from separate data sets may be compared. For instance, sample data may be compared to data from background locations, to established criteria or guidance, or to data from earlier sampling events. There has been little consistency among historical studies used to estimate background chemical concentrations. For example, intervals defined as surface soil have varied often ranging from one inch to six or more inches in depth. In addition, analytical methods have not been consistent across studies.

As discussed in Section 3.3.1, sample collection will be performed in a consistent manner by field personnel at all sampling locations to ensure all data collected as part of this study are comparable. Comparability is attained by careful adherence to standardized sampling and analytical procedures, based on rigorous documentation of sample locations (including depth, time, and date).

The use of standardized methods to collect and analyze samples, along with instruments calibrated against National Institute for Standards and Technology (NIST) and US EPA traceable standards will also ensure comparability, particularly for comparison of data collected from this study (within-study comparability).

Comparability also depends on other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with confidence.

5.2 Data Quality Assurance Review

A project chemist at Hart Crowser will perform an independent data quality review of the chemical analytical results provided by TestAmerica. This report

will assess the adequacy of the reported detection limits in achieving the project screening levels for soil; the precision, accuracy, representativeness, and completeness of the data; and the usability of the analytical data for project objectives. Exceedances of analytical control limits will be summarized and evaluated.

A data evaluation review will be performed on all results using QC summary sheet results provided by the laboratory for each data package. The data evaluation review is based on the Quality Control Requirements previously described and follows the format of the EPA National Functional Guidelines for Inorganic (EPA 2010) Superfund Data Review, and EPA National Functional Guidelines for Organic (EPA 2008) Superfund Data Review modified to include specific criteria of individual analytical methods. Raw data (instrument tuning, calibrations, instrument printouts, bench sheets, and laboratory worksheets) will be available for review if any problems or discrepancies are discovered during the routine evaluation. The following is an outline of the data evaluation review format:

- Verify that sample numbers and analyses match the chain of custody request;
- Verify sample preservation and holding times;
- Verify that instrument tuning, calibration, and performance criteria were achieved;
- Verify that laboratory blanks were performed at the proper frequency and that no analytes were present in the blanks;
- Verify that laboratory duplicates, matrix spikes, surrogate compounds, and laboratory control samples were run at the proper frequency and that control limits were met; and
- Verify that required detection limits have been achieved.

Data qualifier flags, beyond any applied by the laboratory, will be added to sample results that fall outside the QC acceptance criteria. An explanation of data qualifiers to be applied during the review is provided below:

U The compound was analyzed for but was not detected. The associated numerical value is the sample reporting limit.

J The associated numerical value is an estimated quantity because QC criteria were slightly exceeded.

UJ The compound was analyzed for, but not detected. The associated numerical value is an estimated reporting limit because QC criteria were not met.

T The associated numerical value is an estimated quantity because reported concentrations were less than the practical quantitation limit (lowest calibration standard).

R Data are not usable because of significant exceedance of QC criteria. The analyte may or may not be present; resampling and/or reanalysis are necessary for verification.

6.0 DATA ANALYSIS AND REPORTING

6.1 Evaluation of Chemistry Data

Analytical results for soil concentrations will be compared to the screening criteria listed in Table 1 of the MCMA Remedial Investigation Data Report (Hart Crowser 2011). If exceedances occur, the respective ARAR (applicable or relevant and appropriate requirements) will be indicated.

6.2 Laboratory Reports

The laboratory data reports will consist of complete data packages that will contain complete documentation and all raw data to allow independent data reduction and verification of analytical results from laboratory bench sheets, and instrument raw data outputs. Each laboratory data report will include the following:

- Case narrative identifying the laboratory analytical batch number, matrix and number of samples included, analyses performed and analytical methods used, and description of any problems or exceedance of QC criteria and corrective action taken. The laboratory manager or their designee must sign the narrative.

- Copy of chain of custody forms for all samples included in the analytical batch.

- Tabulated sample analytical results with units, data qualifiers, percent solids, sample weight or volume, dilution factor, laboratory batch and sample number, Hart Crowser sample number, and dates sampled, received, extracted, and analyzed all clearly specified.

- All calibration, quality control, and sample raw data including quantitation reports and other instrument output data.

- Blank summary results indicating samples associated with each blank.

- MS/MSD result summaries with calculated percent recovery and relative percent differences.

- Surrogate compound recoveries, when applicable, with percent recoveries.

- Laboratory control sample results, when applicable, with calculated percent recovery.

- Electronically formatted data deliverable (CD) results will be uploaded into Ecology's EIM data management system.

7.0 HART CROWSER REPORTS

Hart Crowser will prepare a draft report summarizing sampling procedures and laboratory testing results. The report will include a map(s) with sampling locations, tabulated analytical testing data, and laboratory analytical documentation. A final report will be completed following discussions with Ecology.

8.0 REFERENCES

EPA 1986. Test Methods for Evaluating Solid Waste; Physical/Chemical Methods, SW-846, 3rd Update.

EPA 1992a. Specifications and Guidance for Contaminant-Free Sample Containers. OSWER Directive 92.0-05A.

EPA 2010. US EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review. EPA-540-R-10-011, January 2010.

Hart Crowser 2011. Monte Cristo Mining Area, Remedial Investigation Phase I, Data Report, Task 2.4. Prepared for the Washington State Department of Ecology. April 5, 2011.

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Table 1 - Sample Containers, Preservation, and Holding Times

Analyte	MTCA Method B Screening Level	Prep Method	Analysis Method	MRL	MDL	Units	Min Sample	Preservative	Holding Time
Aluminum	8.00E+04	EPA 3050B	EPA 6020	30.0	3.00	mg/Kg	1 - 4 oz plastic bottle (10 gms)	ice	6 months; mercury - 28 days
Antimony	3.20E+01	EPA 3050B	EPA 6020	0.2	0.042	mg/Kg			
Arsenic	NA	EPA 3050B	EPA 6020	0.5	0.18	mg/Kg			
Barium	1.60E+04	EPA 3050B	EPA 6020	0.2	0.022	mg/Kg			
Beryllium	1.60E+02	EPA 3050B	EPA 6020	0.2	0.022	mg/Kg			
Cadmium	8.00E+01	EPA 3050B	EPA 6020	0.2	0.01	mg/Kg			
Calcium	NA	EPA 3050B	EPA 6010B	55.0	3.10	mg/Kg			
Chromium	2.40E+02	EPA 3050B	EPA 6020	0.2	0.072	mg/Kg			
Cobalt	NA	EPA 3050B	EPA 6020	0.2	0.019	mg/Kg			
Copper	3.20E+03	EPA 3050B	EPA 6020	0.2	0.098	mg/Kg			
Iron	5.60E+04	EPA 3050B	EPA 6010B	10.0	0.61	mg/Kg			
Lead	NA	EPA 3050B	EPA 6020	0.2	0.011	mg/Kg			
Magnesium	NA	EPA 3050B	EPA 6010B	55.0	3.20	mg/Kg			
Manganese	1.12E+04	EPA 3050B	EPA 6020	0.5	0.105	mg/Kg			
Mercury	2.40E+01	EPA 7471A	EPA 7471A	0.02	0.0063	mg/Kg			
Nickel	1.60E+03	EPA 3050B	EPA 6020	0.2	0.071	mg/Kg			
Potassium	NA	EPA 3050B	EPA 6010B	165.0	16.00	mg/Kg			
Selenium	4.00E+02	EPA 3050B	EPA 6020	0.7	0.202	mg/Kg			
Silver	4.00E+02	EPA 3050B	EPA 6020	0.2	0.007	mg/Kg			
Sodium	NA	EPA 3050B	EPA 6020	100.0	14.70	mg/Kg			
Thallium	NA	EPA 3050B	EPA 6020	0.5	0.13	mg/Kg			
Vanadium	5.60E+00	EPA 3050B	EPA 6020	0.7	0.473	mg/Kg			
Zinc	2.40E+04	EPA 3050B	EPA 6020	0.7	0.32	mg/Kg			
Soil pH		9045C		± 0.1		std pH units			

Note: soil moisture is also determined automatically by the lab for each sample. Moisture = (wet weight - dry weight)/wet weight.

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Table 2 - Quality Control, Acceptance Criteria, and Corrective Actions for Metal Analysis

Inorganics			
Quality Control Check	**Fequency**	**Acceptance Criteria**	**Corrective Action**
Laboratory Quality Control			
Initial calibration verification	Daily or each time instrument is set up	90 to 110% of initial calibration	Recalibrate instrument
Initial calibration blank	Following each instrument calibration	All analytes < reporting limit	Correct source of contamination
Continuing calibration verification	Every 10 analytical samples or every 2 hours and at the beginning and end of each run	90 to 110% of initial calibration	Correct instrument calibration and re-analyze affected samples
Continuing calibration blank	Following each continuing calibration verification	All analytes < reporting limit	Correct source of contamination
Method blank	1 per batch of every 20 or fewer samples	All analytes < reporting limit	Re-extract and reanalyze associated samples unless concentrations are > 3 times the blank level
Matrix spike	1 per batch of every 20 or fewer samples	75 to 125% recovery	Evaluate data for usability
Laboratory duplicate	1 per batch of every 20 or fewer samples	≤ 35% RPD	Evaluate data for usability
Laboratory control sample	1 per batch of every 20 or fewer samples	80 to 120% recovery	Evaluate data for usability

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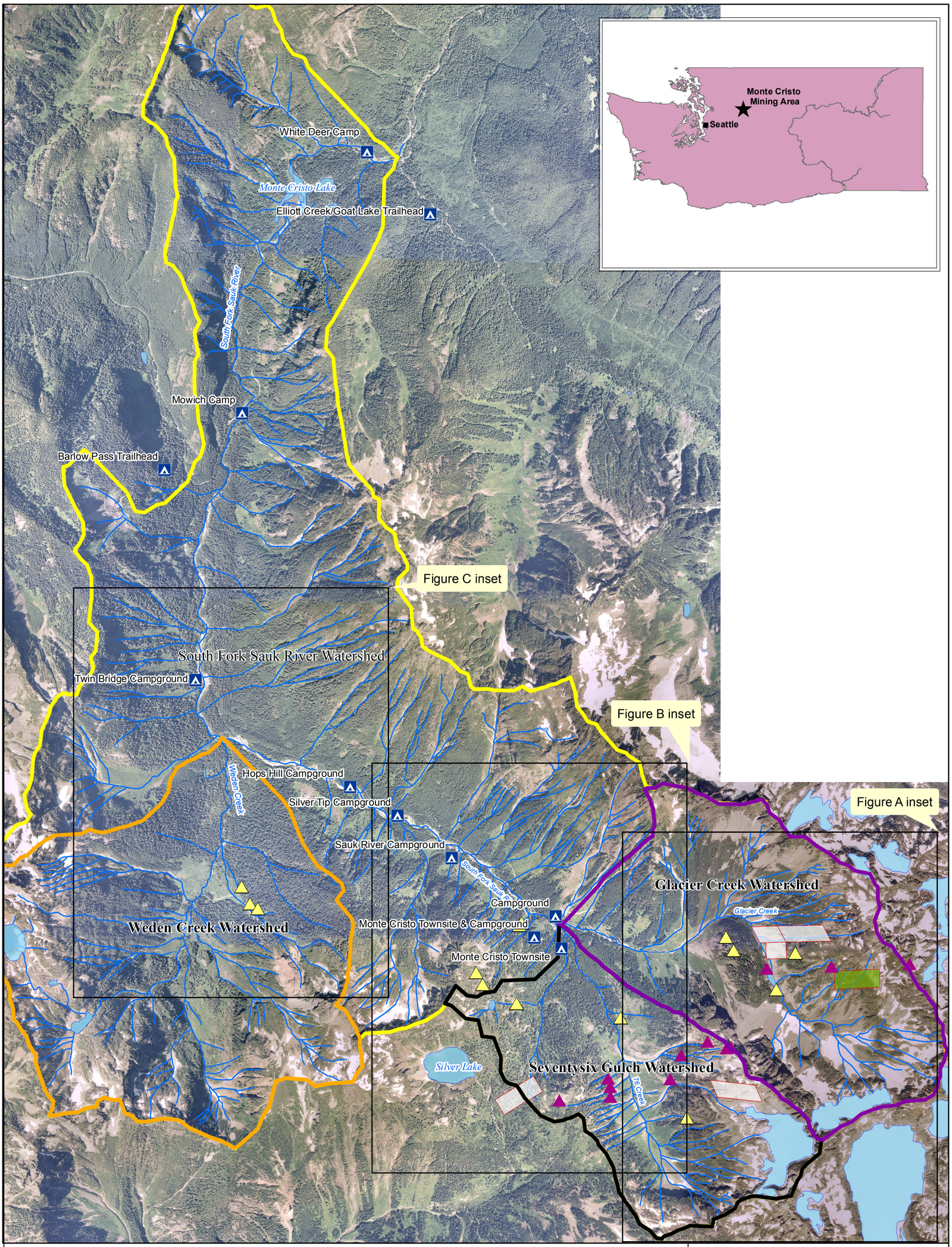

Legend

- Campgrounds
- Weden Watershed
- Glacier Creek Watershed
- Seventysix Gulch Watershed
- South Fork Sauk River
- Streams
- Lakes

Mine features to be sampled

Mining Claims

- Patented
- Unpatented/unknown

Claims with mines to be sampled

Owner

- Forest Service
- Private

1 inch = 3,000 feet

0 0.3 0.6 1.2 Miles

N

Notes: Map prepared from data provided by Washington Department of Ecology, US Forest Service, and Department of Natural Resources.

Vicinity Map

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HARTCROWSER

Figure 1

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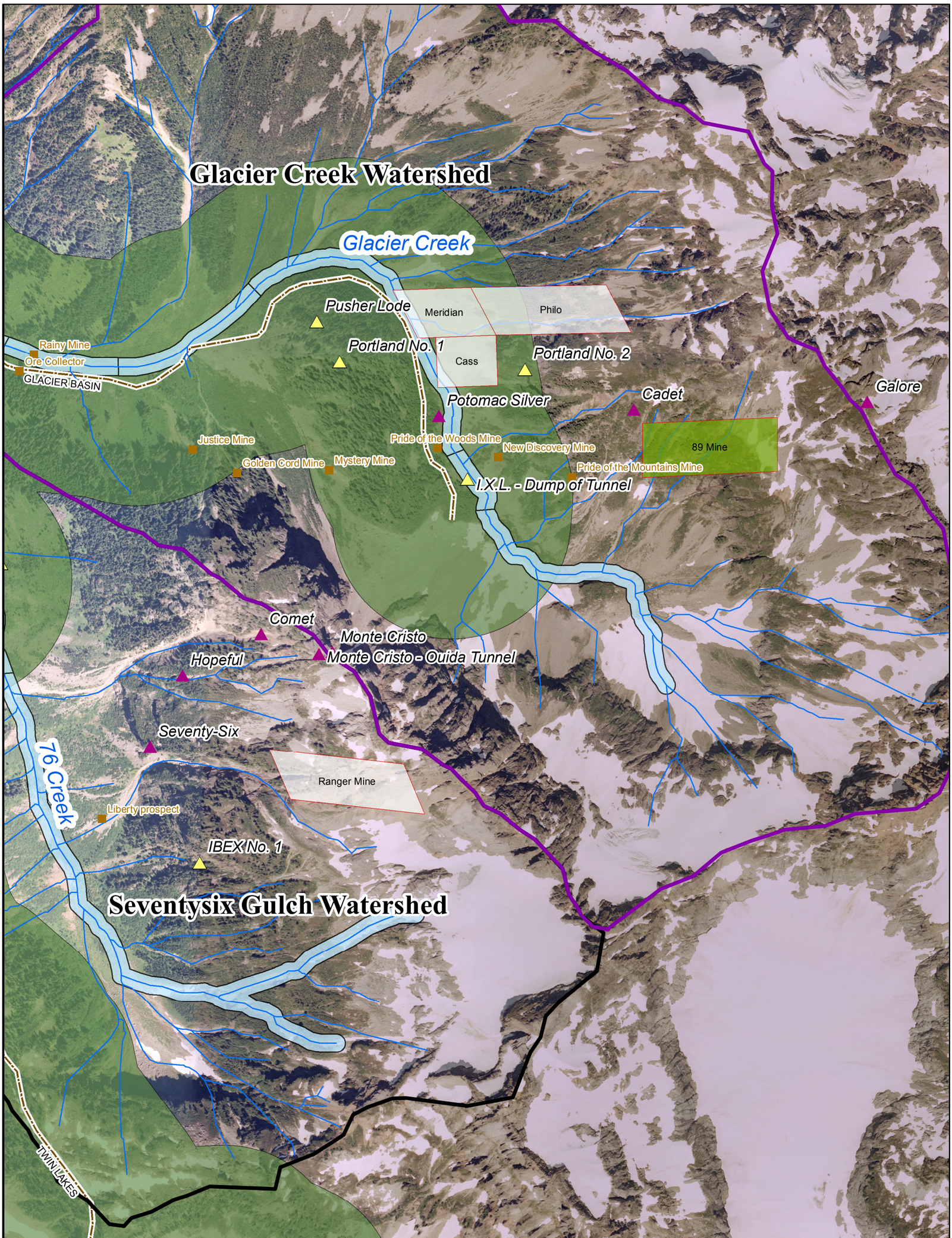

Legend

- Glacier Creek Watershed
- Seventysix Gulch Watershed
- Streams
- Roads
- Trails
- Stream buffer - 100 ft
- Campground buffer - 1/4 mi
- Trail and road buffer - 1/4 mi
- Mine features previously sampled

Claims with mines to be sampled

Owner

- Forest Service
- Private

Mine features to be sampled

Mining Claims

- Patented
- Unpatented/unknown

1 inch = 1,000 feet

0 0.1 0.2 0.4 Miles

N

Notes: Map prepared from data provided by Washington Department of Ecology, US Forest Service, and Department of Natural Resources.

Mine Features and Claims To Be Sampled

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HARTCROWSER

Figure 2 A

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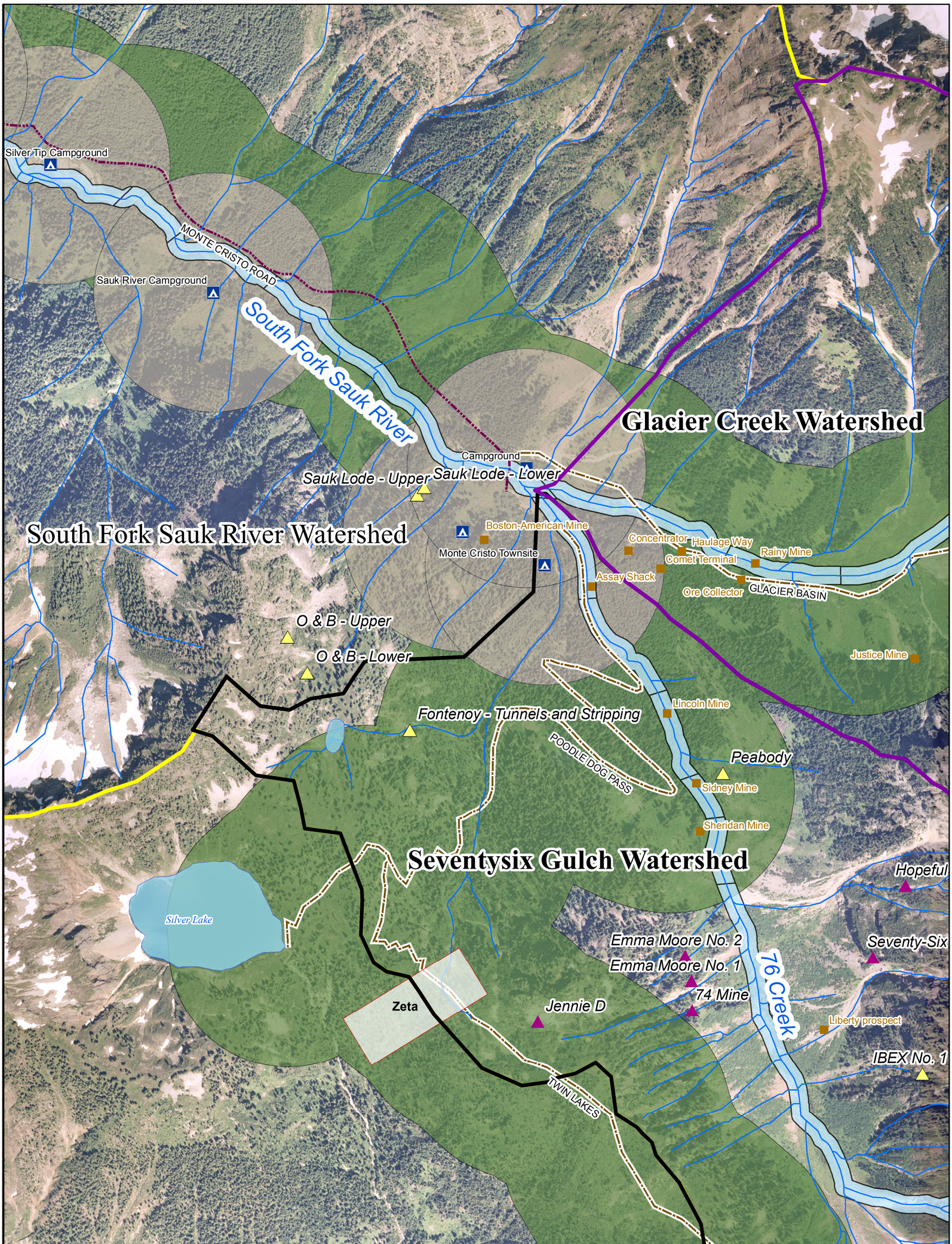

Legend

- Glacier Creek Watershed
- Seventysix Gulch Watershed
- South Fork Sauk River
- Campgrounds
- Lakes
- Streams
- Roads
- Trails
- Stream buffer - 100 ft
- Campground buffer - 1/4 mi
- Trail and road buffer - 1/4 mi
- Mine features previously sampled

Claims with mines to be sampled

Owner

- Forest Service
- Private

Mine features to be sampled

Mining Claims

- Patented
- Unpatented/unknown

1 inch = 1,000 feet

0 0.1 0.2 0.4 Miles

N

Notes: Map prepared from data provided by Washington Department of Ecology, US Forest Service, and Department of Natural Resources.

Mine Features and Claims To Be Sampled

17800-06 07/2011

HARTCROWSER

Figure 2 B

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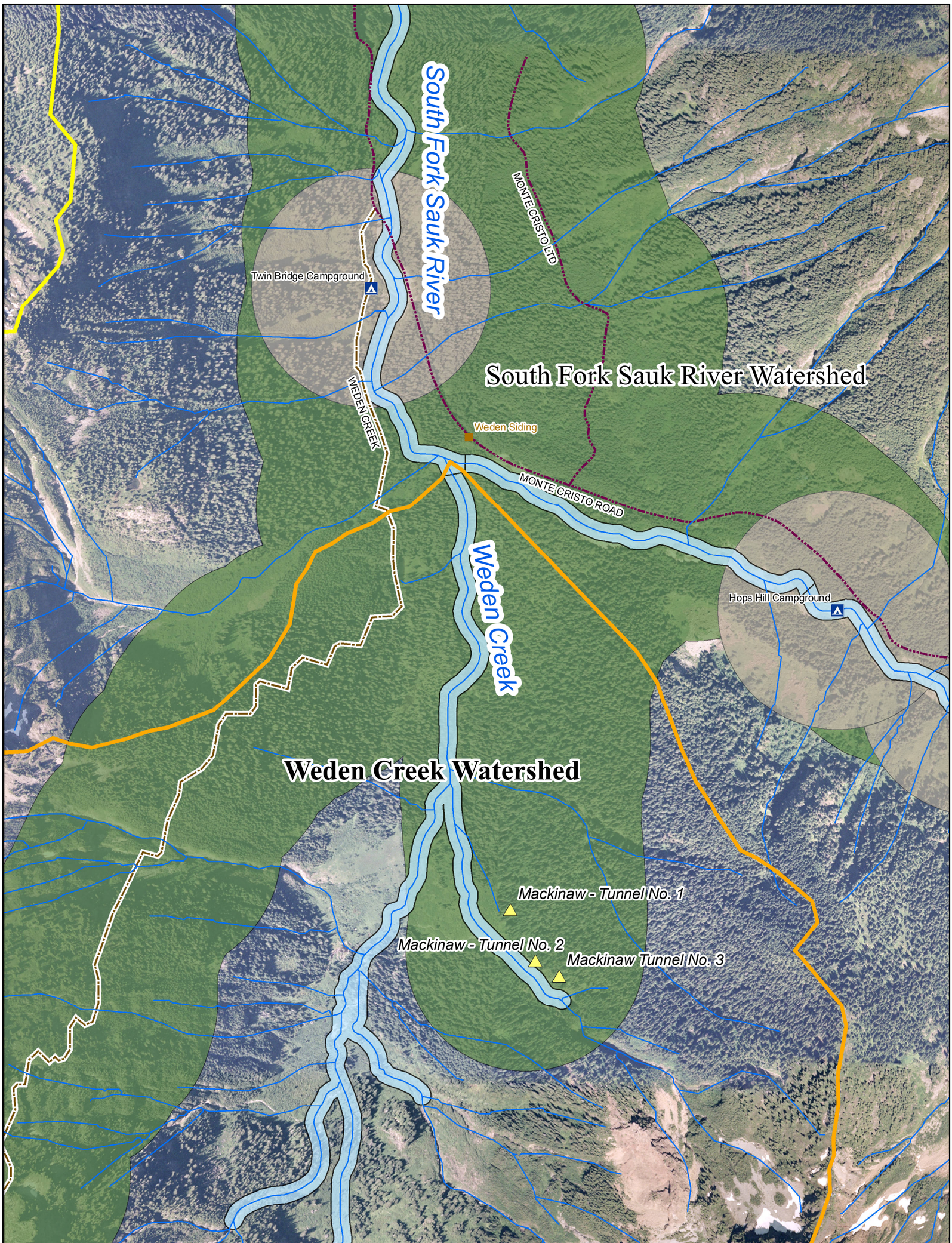

Legend

- Weden Watershed
- South Fork Sauk River
- Campgrounds
- Streams
- Roads
- Trails
- Stream buffer - 100 ft
- Campground buffer - 1/4 mi
- Trail and road buffer - 1/4 mi
- Mine features previously sampled

Claims with mines to be sampled

Owner

- Forest Service
- Private

Mine features to be sampled

Mining Claims

- Patented
- Unpatented/unknown

1 inch = 1,000 feet

0 0.1 0.2 0.4 Miles

N

Notes: Map prepared from data provided by Washington Department of Ecology, US Forest Service, and Department of Natural Resources.

Mine Features and Claims To Be Sampled

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HARTCROWSER

Figure 2 C

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APPENDIX A
HEALTH AND SAFETY PLAN

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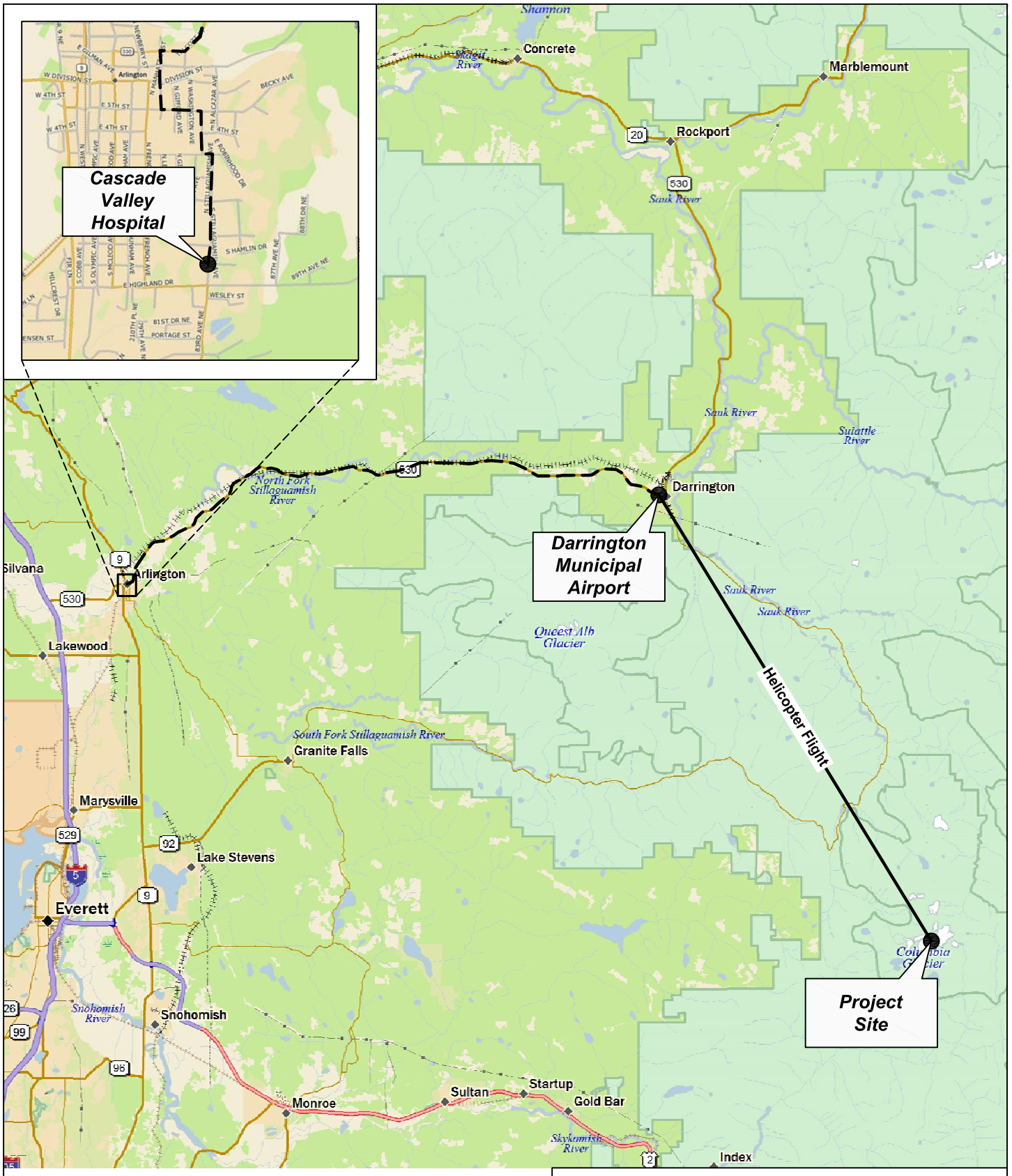
HEALTH AND SAFETY PLAN
MONTE CRISTO MINING AREA PHASE 2
GRANITE FALLS, WASHINGTON
DATE PREPARED: AUGUST 10, 2011
EMERGENCY CONTINGENCY INFORMATION

SITE LOCATION	South Fork Sauk River Watershed near Granite Falls, Washington The project site is located approximately 38 air miles east of Everett, Washington.
NEAREST HOSPITAL SECONDARY HOSPITAL	Cascade Valley Hospital (Figure 1) 330 South Stillaguamish Avenue Arlington, WA 98223 (360) 435-2133 Harborview Medical Center 325 Ninth Avenue Seattle, WA 98104 (206) 744-3300 This location has a Helipad and life flight services
EMERGENCY RESPONDERS	Police Department.....911 Fire Department.....911 Ambulance.....911
EMERGENCY CONTACTS	Hart Crowser, Seattle Office.....(206) 324-9530 (office) Hart Crowser, Edmonds Office.....(425) 775-4682 (office) Mike Bailey.....(206) 826-4411 (office) .....(206) 419-8160 (mobile) .....(206) 367-4986 (home) Roger McGinnis.....(206) 612-5732 (cell) Jason Shira, Ecology PM .....(509) 454-7834 (office) Rod Lenz USDA Forest Service On-Scene Coordinator.....(509) 826-3274 (office) Hi Line Helicopters .....(360) 436-1302 (office) .....(360) 436-0344 (hanger)
IN EVENT OF EMERGENCY, CALL FOR HELP AS SOON AS POSSIBLE	Give the following information: ➔ **Where You Are**. Address, cross streets, or landmarks ☎ **Phone Number** you are calling from ?? **What Happened**. Type of injury, accident # **How many persons** need help ?? **What is being done** for the victim(s) !! **You hang up last.** Let whomever you called hang up first



Source: Base map prepared from DeLorme Topo 7.0, 2007.

0 6 12

Scale in Miles

N

Monte Cristo Phase 2
Monte Cristo, Washington

Route to Hospital Map

17800-06 8/11

HARTCROWSER

Figure
A-2

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SITE HEALTH AND SAFETY PLAN SUMMARY

SITE NAME: Monte Cristo Mining Area.

LOCATION: South Fork Sauk River Watershed from approximately 2,000 feet to 6,800 feet in elevation near Granite Falls, Washington.

CLIENT: Washington State Department of Ecology.

PROPOSED DATES OF ACTIVITIES: Beginning on July 8 to September 30, 2011.

TYPE OF FACILITY: Abandoned mines.

LAND USE OF AREA SURROUNDING FACILITY: Heavily forested, primarily undeveloped land.

SITE ACTIVITIES: Soil sampling and TEE inventory in areas of former mining operations.

SITE HAZARDS: Steep to vertical slopes, falling rock, hunting activities, helicopter travel, drowning, animals (bears), plants (Devil's Club), heat stress, hypothermia, and inclement weather.

POTENTIAL SITE CONTAMINANTS: Metals - antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.

ROUTES OF ENTRY: Dust inhalation, skin contact with soil or surface water, and incidental ingestion of soil or surface water.

PROTECTIVE MEASURES: Sturdy hiking boots, work gloves, nitrile gloves, warm and protective clothing, field safety vest, personal protective equipment, climbing helmets, bear spray, hand radios, satellite phone, survival kits, and firearms.

1.0 INTRODUCTION

1.1 Purpose and Regulatory Compliance

This Health and Safety Plan (H&S Plan) addresses procedures to minimize the risk of chemical exposures, physical accidents to on-site workers, and environmental contamination. The H&S Plan covers each of the 11 required plan elements as specified in 29 CFR 1910.120 or equivalent state regulations. The following table lists the sections of this plan, which apply to each of these required elements. When used together with the Hart Crowser General H&S Plan, this site-specific plan meets all applicable regulatory requirements.

Location of Required Health and Safety Plan Elements in This Site-Specific Health and Safety Plan

Required H&S Plan Element	Section in this Health and Safety Plan
Confined Space Entry	2.7 Other Physical Hazards
Decontamination	7.0 Decontamination
Emergency response plan	11.0 Emergency Response Plan
Medical surveillance	12.0 Medical Surveillance
Monitoring program	2.3 Air Monitoring and Action Levels
Bears/firearms	2.6 Wildlife
Names of key personnel	1.3 Chain of Command
Personal protective equipment	3.0 Protective Equipment, 4.0 Safety Equipment List
Safety and hazard analysis	2.0 Hazard Evaluation and Control Measures
Site control	5.0 Exclusion Areas, 9.0 Site Security and Control
Spill containment	10.0 Spill Containment
Training	13.0 Training Requirements

1.2 Distribution and Approval

This H&S Plan will be made available to all Hart Crowser personnel involved in field work on this project. It will also be made available to subcontractors and other non-employees who may need to work on the site. For non-employees, it must be made clear that the plan represents minimum safety procedures and that they are responsible for their own safety while present on site. The plan has been approved by the Hart Crowser Corporate Health and Safety Manager. By

signing the documentation form provided at the end of plan, project workers also certify their approval and agreement to comply with the plan.

1.3 Chain of Command

The chain of command for health and safety on this project involves the following individuals:

Corporate H&S Manager: Anne Conrad

The Hart Crowser Corporate H&S Manager has overall responsibility for preparation and modification of this H&S Plan. In the event that health and safety issues arise during site operations, she will attempt to resolve them in discussions with the appropriate members of the project team.

Project Manager: Michelle Havey

The Project Manager has overall responsibility for the successful outcome of the project. The Project Manager, in consultation with the Corporate H&S Manager, makes final decisions about the implementation of the site-specific H&S Plan. The Project Manager may delegate this authority and responsibility to the Project and/or Field H&S Managers.

Project H&S Manager: Roger McGinnis

The Project H&S Manager has overall responsibility for health and safety on this project. This individual ensures that everyone working on this project understands this H&S Plan. This individual will maintain liaison with the Hart Crowser Project Manager and the Field H & S Manager so that all relevant health and safety issues are communicated effectively to project workers.

Field H&S Manager: Michelle Havey

The Field H&S Manager is responsible for implementing this H&S Plan in the field. This individual also observes subcontractors to verify that they are following these procedures. The Field H&S Manager will also assure implementation of this plan during field operations, that proper personal protective equipment (PPE) is available and used in the correct manner, decontamination activities are carried out properly, and that employees have knowledge of the local emergency medical system should it be necessary.

1.4 Site Work Activities

The following work tasks will be accomplished:

- Soil sampling at remote locations; and
- Sketching or photographing and characterizing mine features.

The expected time frame of this project is 5 days for the Site Reconnaissance and three subsequent 5-day sampling trips, from July through September 2011.

1.5 Site Description

The MCMA is located approximately 38 air-miles east of Everett, Washington, in the steep mountainsides of the Cascades at the head of the South Fork Sauk River. Mining operations ended in 1907, leaving many of the facilities and mine features to degrade over time. Potential hazards include open or collapsed mine openings, contact with waste-rock material, steep slopes, uneven terrain, fast-flowing streams and rivers, and wildlife. Currently, the area is a popular hiking destination during the summer months with an extensive network of trails, but precautions should be taken whenever working at a remote field site.

2.0 HAZARD EVALUATION AND CONTROL MEASURES

2.1 Toxicity of Chemicals of Concern

Based on previous site information and knowledge of the types of activities conducted at this location, the following metals may be present at this site: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Collectively, these thirteen metals are known as the priority pollutant metals.

Health hazards of these metals are discussed below. This information covers potential toxic effects, which might occur if relatively significant acute and/or chronic exposure were to happen. This information does not mean that such effects will occur from the planned site activities. In general, the chemicals, which may be encountered at this site, are not expected to be present at concentrations that could produce significant exposures. The types of planned work activities and use of protective measures will limit potential exposures at this site.

These standards are presented using the following abbreviations:

PEL Permissible exposure limit.

TWA Time-weighted average exposure limit for any 8-hour work shift.

STEL Short-term exposure limit expressed as a 15-minute time-weighted average and not to be exceeded at any time during a work day.

Metals

Exposure to metals may occur via inhalation or accidental ingestion of metal-containing dust. Certain metals may be absorbed through the skin. Metals have been shown to exhibit a wide range of adverse acute and chronic health effects in humans and animals. The PELs for metals vary by element. If metals are discovered on site, activities should be tailored to protect against exposure to the specific metals and levels encountered.

Antimony

Antimony exposure can occur via inhalation of dust or fume, and through skin or eye contact. Dusts and fumes are irritants to the eyes, nose and throat, and antimony is considered a primary skin irritant. Symptoms of exposure include a dry throat, nausea, headache, dizziness, and loss of appetite. A severe dermatitis can result from exposure to antimony trioxide. Target organs following exposure to antimony via the lungs are the heart, lungs, and respiratory tract. Liver and kidney damage can also occur following exposure. Severe respiratory irritation can result from inhalation, and circulatory or respiratory collapse can follow, culminating in death. The current PEL-TWA for antimony is 0.5 mg/m^3.

Arsenic

Arsenic is toxic by inhalation and ingestion of dusts and fumes or by inhalation of arsine gas. Trivalent arsenic compounds are the most toxic to humans, with significant corrosive effects on the skin, eyes, and mucous membranes. Dermatitis also frequently occurs, and skin sensitization and contact dermatitis may result from arsenic trioxide or pentoxide. Trivalent arsenic interacts with a number of sulfhydryl proteins and enzymes, altering their normal biological function. Ingestion of arsenic can result in fever, anorexia, cardiac abnormalities, and neurological damage. Liver injury can accompany chronic exposure. Skin and inhalation exposure to arsenic has been associated with cancer in humans, particularly among workers in the arsenical-pesticide industry or copper smelters. The EPA currently classifies arsenic as a Class A, or confirmed, human

carcinogen. Arsine is a highly toxic gaseous arsenical, causing nausea, vomiting, and hemolysis. The current PEL-TWA for organic and inorganic forms of arsenic is 0.01 mg/m^3.

Beryllium

The major hazards encountered in the use and handling of beryllium stem from its toxicologic properties and flammability. Toxic primarily by inhalation and dermal contact (as fumes, aerosolized salt solutions, or finely divided dust), exposure to this odorless, grayish white metal may occur from its use as an alloy or metal in materials for manufacturing aircraft and spacecraft, nuclear reactors, electrical equipment, and electronic components. Effects from exposure may include contact burns to the skin and eyes, skin ulceration, nausea, headache, weakness, chest pain, shortness of breath, fever, bronchitis, acute pneumonitis, and possibly death from heart failure. The OSHA PEL and ACGIH TLV are set at a TWA of 2 ug/m^3.

Cadmium

Cadmium is toxic via inhalation or ingestion of fumes or dust. Fumes are contacted normally during exposure to heated metals (plating operations, welding, etc.). Acute effects resulting from such exposures include respiratory distress and irritation that may culminate in chronic emphysema. Chronic exposure to fumes or dust may also result in emphysema and kidney damage. These effects may be potentiated by smoking. Cadmium is considered to be a probable human carcinogen, and is currently classified as a Class B1, or probable, human carcinogen via the inhalation route. The current PEL-TWA for all cadmium compounds is 0.005 mg/m^3.

Chromium

Chromium metal and insoluble chromium salts can affect the body if inhaled or swallowed. Ferrochrome alloys have been associated with lung disease in humans. Certain forms of chromium (VI) compounds have been found to cause increased respiratory cancer among workers. EPA classifies chromium (VI) as a Class A, or confirmed, human carcinogen via the inhalation exposure route. Unless it can be demonstrated that no chromium (VI) compounds are present, chromium should be treated as a carcinogen. The PEL-TWA for chromium (III) compounds is 0.5 mg/m^3, and for chromic acids and chromates (chromium VI) the PEL-TWA is 0.005 mg/m^3.

Copper

Copper exposure can occur via inhalation of dust or fume, ingestion, or skin and eye contact. Copper salts can act as skin irritants, causing itching and dermatitis. Eye contact can result in severe damage, including corneal damage. Contact with metallic copper can result in skin thickening, but is not associated with dermatitis in industrial settings. Fumes and dusts can irritate the respiratory tract and result in metal fume fever in severe exposures. Ingestion can result in irritation, but industrial exposure seldom results in damage because copper salts normally induce vomiting. Extensive exposure can damage the lungs, kidneys, skin, and liver. The current PEL-TWA for copper as dust and mists is 1.0 mg/m^3, while the limit for copper as fume is 0.1 mg/m^3.

Lead

Inorganic Lead. Inorganic lead exposure can occur via inhalation of dusts or metal fumes, ingestion of dusts, and skin and eye contact. The principal target organs of lead toxicity include the nervous system, kidneys, blood, gastrointestinal, and reproductive systems. Generalized symptoms of lead exposure include decreased physical fitness, fatigue, sleep disturbances, headaches, bone and muscle pain, constipation, abdominal pain, and decreased appetite. More severe exposure can result in anemia, severe gastrointestinal disturbance, a "lead-line" on the gums, neurological symptoms, convulsions, and death.

Neurological effects are among the most severe of inorganic lead's toxic effects and vary depending on the age of individual exposed. Effects observed in adults occur primarily in the peripheral nervous system, resulting in nerve destruction and degeneration. Wrist-drop and foot-drop are two characteristic manifestations of this toxicity.

The EPA also currently lists inorganic lead as a Group B2 probable human carcinogen via the oral route. This conclusion is based on feeding studies conducted in laboratory animals. The current PEL-TWA for inorganic lead is 0.05 mg/m^3. Occupational exposure to lead is also specifically regulated under WAC 296-62-07521, with an action level established at 0.03 mg/m^3 that triggers monitoring and other requirements.

Mercury

The health effects of mercury exposure are dependent on the chemical form of mercury involved. Elemental mercury is toxic by inhalation, skin absorption, eye, and skin contact. Symptoms of exposure include coughing, chest pains,

headache, fatigue, salivation, weight loss, and skin and eye irritation. The primary target organ of elemental mercury is the central nervous system, resulting in damage to sensory systems. The PEL-TWA for exposure to mercury vapor is 0.05 mg/m^3.

Inorganic mercury compounds are toxic by inhalation, ingestion, and skin and eye contact. Acute poisoning results in lung damage. Chronic poisoning typically produces four classical symptoms: gingivitis, salivation, increased irritability, and muscular tremors. Delirium and other psychological abnormalities can also result from chronic exposures. Inorganic mercurials also have a corrosive effect on the alimentary tract, and kidney damage can result from exposure. The current PEL-C (Ceiling) limit for inorganic mercury is 0.1 mg/m^3.

Nickel

Nickel exposure can occur via inhalation of dust or fume, ingestion, and eye and skin contact. Nickel and its compounds are irritating to the eye and mucous membranes, and skin exposure frequently leads to sensitization and a chronic eczema referred to as "nickel itch." Elemental nickel and nickel salts are considered probable carcinogens via inhalation, and nickel carbonyl is clearly recognized as a human carcinogen. Animal studies have demonstrated health effects on the kidneys, liver, brain, and heart muscle. The current PEL-TWA for soluble nickel and insoluble nickel are 0.1 and 1.0 mg/m^3, respectively. The PEL-TWA for nickel carbonyl is 0.007 mg/m^3 as nickel.

Silver

Local effects from metallic silver include implantation of particles into the skin, resulting in permanent discoloration. Silver nitrate is highly corrosive to tissues and may cause severe eye damage. Silver is strongly bioaccumulated and excretion is very low. Chronic exposure to silver dusts can cause lung irritation. Kidney and liver damage can also result from repeated exposure. The current PEL-TWA for silver metal is 0.01 mg/m^3.

Zinc

Zinc compounds can be hazardous by inhalation of dust and fumes, ingestion, and skin and eye contact. Zinc chloride is corrosive to skin and mucous membranes, and sensitization can occur resulting in dermatitis. Eye contact can produce inflammation and corneal ulceration. Ingestion can result in corrosive damage to the digestive tract. The current PEL-TWA for exposure to zinc chloride fume is 1 mg/m^3. Zinc chromate exhibits potential carcinogenic effects

and is currently limited with a PEL-TWA of 0.05 mg/m^3. Zinc oxide is toxic via inhalation of fumes and dusts and may cause dermatitis. The current PEL-TWA for zinc oxide is 10 mg/m^3 as total dust and 5 mg/m^3 as the respirable fraction.

2.2 Potential Exposure Routes

Inhalation

Exposure via this route is unlikely at these sites. No volatile chemicals are known to exist at the sites. Inhalation of dusts contaminated with metals could occur. However, control measures specified in this plan will minimize the possibility for inhalation of site contaminants.

Skin Contact

Exposure via this route could occur if contaminated soil or water contacts the skin or clothing. Dusts generated during soil movement may also settle on exposed skin and clothing of site workers. Protective clothing and decontamination activities specified in this plan will minimize the potential for skin contact with the contaminants.

Ingestion

Exposure via this route could occur if individuals eat, drink, or perform other hand-to-mouth contact in metals-impacted soils or waters on the site. Decontamination procedures established in this plan will minimize the inadvertent ingestion of contaminants.

2.3 Air Monitoring and Action Levels

Air monitoring will not be conducted since airborne concentrations of contaminants of concern are not expected to approach action levels in worker airspace.

2.4 Heat and Cold Stress

Use of impermeable clothing reduces the cooling ability of the body due to evaporation reduction. This may lead to heat stress. Cold stress, or hypothermia, can result from abnormal cooling of the core body temperature.

Heat Stress

Signs of Heat Stress

"Heat stress" is a term that is used to describe progressively more serious symptoms, as follows:

- An initial rise in skin temperature due to increased blood flow to the skin (skin redness);
- Increase in heart rate, to more than 30 beats/minute above the resting level;
- Collapse, or heat exhaustion, due to inadequate blood flow to the brain;
- Dehydration, due to excessive sweating;
- Hyperventilation, resulting in a reduction of the normal blood carbon dioxide concentrations;
- Tingling around the lips, dizziness, cramping of muscles of hands and feet, and blackout; and finally
- "Heat stroke," characterized by unconsciousness, hot dry skin, and absence of sweating.

Control of Heat Stress

On hot, sunny days (high radiant heat load), if using impermeable work clothing, maintain appropriate work-rest cycles (progressively longer rest breaks in a cool location or the shade as temperature and work tasks increase) and drink water or electrolyte-rich fluids (Gatorade or equivalent) to minimize heat stress effects. Impermeable clothing will only be worn when absolutely necessary for control of hazardous chemicals.

Also, when ambient temperatures exceed 70° F, employees will conduct monitoring of their heart (pulse) rates, as follows:

- Each employee will check his or her own pulse rate at the beginning of each break period;
- Take the pulse at the wrist for 6 seconds, and multiply by 10; and
- If the pulse rate exceeds 110 beats per minute, then reduce the length of the next work period by one-third.

Example: After a one-hour work period at 80 degrees, a worker has a pulse rate of 120 beats per minute. The worker must therefore shorten the next work period by one-third, resulting in a work period of 40 minutes until the next break.

Treatment of Heat Stress

Individuals affected by mild forms of heat stress (heat exhaustion, dehydration, or cramping) should take a break in a cool or shaded location, drink liquids, and sit or lay down until feeling better. Shorter work periods should be used until temperature cools off.

Individuals affected by heat stroke are in critical condition. Summon emergency aid immediately, remove clothing, and bathe individual in cool water continually to bring down body temperature.

Hypothermia

Signs of Hypothermia

Hypothermia can result from abnormal cooling of the core body temperature. It is caused by exposure to a cold environment, and wind-chill as well as wetness or water immersion can play a significant role. The following discusses signs and symptoms as well as treatment for hypothermia.

Typical warning signs of hypothermia include fatigue, weakness, incoordination, apathy, and drowsiness. A confused state is a key symptom of hypothermia. Shivering and pallor are usually absent, and the face may appear puffy and pink. Body temperatures below 90° F require immediate treatment to restore temperature to normal.

Treatment of Hypothermia

Current medical practice recommends slow rewarming as treatment for hypothermia, followed by professional medical care. This can be accomplished by moving the person into a sheltered area and wrapping them with blankets in a warm room. In emergency situations where body temperature falls below 90° F and heated shelter is not available, use a sleeping bag, blankets and/or body heat from another individual to help restore normal body temperature.

2.5 Stream Safety

Working in and around streams poses human health and safety risks which can be prevented through proper training, risk awareness, and detailed safety guidelines. These threats to human safety can be obvious, such as fast moving water, inclement weather, or working in remote locations. Not so obvious safety hazards can include slippery surfaces, potential of glass or metal debris out of sight on the stream bed, presence of toxic substances, or pathogens. This

section of the Health and Safety Plan is intended to provide a guideline for properly conducting stream work in any capacity but is by no means comprehensive. Additional resources on this subject can be obtained through the Environmental Protection Agency (EPA) Environmental Monitoring and Assessment Program (EMAP).

Considerations

Field surveys and habitat assessments near rivers, streams, and creeks should always be approached with caution. Human health and safety is the highest priority. Each individual should come to the project site with prior knowledge of obvious and potential threats to human health. Team members working in remote locations or for extended periods of time should be in good physical condition and participate in regular physical exams. It is a good idea for the project team to be aware of every member's health issues (allergies, medications, pre-existing conditions etc.,) and abilities (can they swim?). Also, team members should be familiar with field equipment, instruments, and sampling methods, as distractions caused by uncertainty can be a tremendous threat to human health and safety. Just as dangerous to human health is fatigue, poor environmental conditions, and malfunctioning equipment. Knowledge of potential weather conditions and having proper field clothing are important considerations when preparing for any field effort. See section 2.4 above for heat and cold stress hazards. This work will not include sampling within a stream, but work will be conducted near streams and rivers.

2.6 Wildlife

General

Do not approach, attempt to touch, or assist any wild animal. Remember that all wild animals are more dangerous if their young are nearby. Do not hesitate to retreat from any situation that seems dangerous. You can always come back later to finish your work.

Bears

All bears are considered potentially dangerous. Sow bears with cubs are considered an **IMMINENT THREAT**; retreat to a safe distance immediately (see below for retreat methods). Black bears are common in the Cascades and will be very active in the lower elevations foraging for fish and berries.

Avoidance Tactics

Avoid bear contact by warning them of your presence. Surprising a bear is very dangerous. **BE NOISY!** Blowing a whistle, wearing bells, blowing an air horn, or talking and singing are all effective ways of giving warning.

Keep yourself clean (wash after meals or snacks) and clear your work area or camp of food waste or open food containers.

Avoid foods such as dried or smoked fish and other foods with a strong odor that could entice bears. When camping, never take food inside your tent. Always store food by hanging it from a high tree away from the camp or storing it in a proper container.

When working in black bear habitat, each team member will carry a whistle, a spray can of bear repellant, and any other PPE that may be warranted. Transportation of bear repellant is controlled by regulations controlling the shipment of hazardous materials. Bear repellant is prohibited on passenger aircraft. Fill out proper shipping documents prior to shipment or, if possible, obtain bear repellant upon arrival at your destination. Chemical bear repellents and bear sprays contain a derivative of cayenne pepper. When sprayed directly into an animal's face, these products cause eye and upper respiratory tract irritation. Although such sprays can be effective when used properly, wind and other conditions may alter their effect on the animal. Therefore, use them with caution and always follow the manufacturer's directions. Bear sprays do not guarantee your safety.

In high-risk areas, such as rivers during spawning season or heavily vegetated trails during peak berry season, a bear guard may be designated at the Project Manager's or field team leader's discretion. The bear guard must demonstrate firearms competence, familiarity and willingness to deploy before being issued a firearm, which will be a 12-gauge, pump-action or semi-automatic shotgun. Ammunition can include cracker shells, 00 buckshot, and slug shells. A preferred mix of ammunition is one cracker shell, followed by alternating slug shells and buckshot shells. It is important to remember that firearms **DO NOT** offer a greatly increased level of protection. Improper, unfamiliar, or inexperienced use of firearms may result in a situation more dangerous than being unarmed and poses a danger to others. Handguns may be used on the project as PPE and selection of the firearm and ammunition will be done on an individual basis considering each team member's familiarity with the items (See Firearms section below). The basic rules of gun safety, offered by the National Rifle Association, are attached for reference.

Surviving Bear Encounters

Never run from a bear! Back away slowly while maintaining eye contact.

Defensive Attack: If you are attacked by a bear, drop to the ground, curl into a fetal position, and interlock your fingers behind your neck to protect yourself. Do not fight or scream once you have been attacked; play dead. After the attack stops, do not move until you are sure that the bear has left the area. Bear attacks are rarely fatal if these guidelines are followed.

Offensive Attack: (From website for Parks Canada (http://www.pc.gc.ca/docs/v-g/oursnoir-blackbear/page4_E.asp) This is the most serious and potentially deadly attack a black bear might make. It occurs when a bear appears to stalk or follow you for a period of time and then chooses to attack, or the bear attacks you at night. **In this situation, playing dead is not appropriate.** Try to escape to a secure place such as a vehicle or hard-sided camper.

Climbing a tree is an option, but remember that **black bears can climb trees easily**. If you cannot escape and if a bear continues its pursuit, react aggressively and try to intimidate the bear. If this fails, fight back with anything at hand such as bear spray, rocks, sticks, knives or other possible weapons to let the bear know that you are not easy prey. Act as a group if you are part of one. Don't forget to yell; help may be close by.

Firearms

Firearm possession is prohibited while on company business except for weapons assigned to designated bear guards; one or more bear guards may be assigned to each field team. The bear guard must use common-sense firearms safety procedures at all times. These procedures include, but are not limited to, the following:

- Always keep the gun pointed in a safe direction and never point a firearm at or in the general direction of another person.
- Always keep your finger off the trigger until ready to shoot.
- Always keep the gun unloaded until ready to use.
- Do not toggle the Safety off until ready to fire.
- Unload all weapons before boarding any vehicle, boat, or aircraft.
- The bear guards are responsible for seeing that the assigned firearm is kept clean and in good operating condition.
- The bear guards are responsible for the safety and use of the firearm at all times.

Incidental Take of Problem Animals

If a bear or other wildlife is or seems likely to become a problem, these procedures will be followed:

If a bear or other wild animal is seen consistently in a work area, and especially if it shows threatening behavior, the USDA Forest Service On-Scene Coordinator (Rod Lenz – contact information included as an emergency contact on page 1) will be notified to seek advice on the situation. Should wildlife be killed in defense of life or property, WDFW will be notified immediately and the carcass will be handled according to state regulations.

Rabies

Foxes are the primary carriers of rabies. Avoid any fox that appears sick, aggressive, or unusually tame (i.e., fearlessly approaches humans). If you suffer any bite or scratch by a wild animal, no matter how minor the wound, seek medical treatment IMMEDIATELY.

Bee Stings

Bee stings can produce life-threatening allergic reactions. Symptoms include pain, swelling of the throat, redness or discoloration of the wound, itching, hives, decreased consciousness, and labored or noisy breathing. If you know you are allergic to bee stings, carry an anaphylactic shock kit, which can be obtained from your physician.

2.7 Helicopter Safety

Approaching and Departing the Aircraft

General

Approaching and departing aircraft is always conducted from the front or forward side areas of the craft and should only be done after receiving an indication from the Pilot in the aircraft to do so. Approaching and departing may be done either; a) while aircraft is shut down or b) while aircraft is on the ground but not completely powered down (rotors are turning). When rotors are turning special precautions shall be taken during approach and departure; these precautions are covered at the end of this section. It is important to remain in full view of the Pilot at all times if he is sitting in the aircraft. Make sure the Pilot is aware of your location when you are approaching and departing the aircraft. If available, ground-to-air radios shall be tested for proper operation before first

boarding and after departing. Turn all "field" radios and electronic equipment off before boarding.

Approach and Boarding

During approach, proceed at a walk and observe the ground area for uneven or slippery surfaces. Gear being carried to the aircraft should be carefully placed on the ground next to the landing gear and behind the rear doors. Passengers will not attempt to load any gear unless directed and observed by the Pilot or aircraft company personnel. Aircraft metal and airframes are made of very high strength but very thin materials. Do not attempt to open and close any helicopter doors, windows, latches or hatches nor enter or exit unless trained in proper procedure and use. During boarding, move seatbelts out of the seating area; seatbelts and harnesses must be locked as soon as you are seated. Loose objects should be held or stowed. Helicopters with expandable pontoons and aircraft with fixed pontoons typically have specific procedures for boarding, check with pilot for additional instruction regarding these and other less typical aircraft features. While boarding the aircraft and during the flight, passengers shall remain calm, refrain from unsettling activities (such as loud noises, constant chatter, unnecessary questions or sharp movements) that may distract the Pilot. Wearing ear protection is encouraged while in flight.

De-board and Depart

Seatbelts should be unlatched only after the Pilot indicates passengers may de-board. Once unlatched, seatbelts should be placed on the seat and locked so they are not left loose in the cabin of the aircraft. Check that no straps or other articles from the aircraft are left loose or dangling from the doorway. Watch where your feet are planted upon leaving the aircraft and do not rush your exit. Do not reach for or attempt to retrieve gear from the aircraft unless instructed otherwise.

Approaching and Departing While Rotors are Turning

If approaching or departing while the aircraft rotors are turning, passengers will only operate in an area that is forward of the aircraft. This area is defined by an imaginary "work cone" that extends forward from the rear doors at an angle of 45 degrees so that the Pilot can easily view all activities. Maintain eye contact at all times while in the "work cone." Under no circumstances are passengers allowed rearward of this area. No passengers are allowed near the tail boom, tail rotor or rear cargo areas. No passengers will be allowed under the aircraft while it is on the ground. All hats, gloves, bandannas, straps and potentially loose gear shall be secure before entering the area of rotor wash. Passengers

shall have protective eyewear and maintain a slight crouch while walking to or from the aircraft while being mindful of the footing and rise/fall of the ground. Passengers shall remain a safe distance from the rotor wash in a "staging area" unless motioned to approach by the Pilot. Any gear held by passengers while in the work cone will be held low, with long objects kept roughly parallel to the ground.

2.7 Other Physical Hazards

Trips/Falls

As with all field work sites, caution will be exercised to prevent slips on rain-slick surfaces, stepping on sharp objects, etc., Work will not be performed on excessively steep slopes (>75 percent) or in the vicinity of vertical drop-offs without fall protection.

Confined Spaces

Hart Crowser personnel will not enter any confined space, such as mine shafts or adits.

2.8 Hazard Analysis and Applicable Safety Procedures by Task

The work tasks and associated hazards, which may be anticipated during the operations described elsewhere in this work plan, and suitable control measures are presented in The Hazard Analysis by Task table.

Hazard Analysis by Task

Work Task	Hazards	Protective Measures[a,b]
Soil sample collection	Skin contact, inhalation, ingestion, trips and falls, wildlife.	Level D or C PPE, Nitrile gloves, climbing helmets, bear spray, firearms.
Hiking	Trips and falls, wildlife, devil's club	Buddy teams, work gloves, exposure protection, climbing helmets, bear spray, firearms.

[a]Protection levels are defined in The Minimum Personal Protection Level table. Level C is typically modified to include respiratory protection only as warranted by contaminants.
[b]Protection levels may require upgrade based on site monitoring or other information.

3.0 PROTECTIVE EQUIPMENT

The Minimum Personal Protection Level table (below) presents a summary of minimum personal protection equipment (PPE) requirements based on the potential route of contact and the potential contaminants. These requirements are classified in the designated Level D or C categories as discussed below. Situations requiring Level A or B protection are not anticipated for this project.

As noted previously, should they occur, work will stop and the H&S Plan will be amended as required prior to resuming work.

3.1 Level D Activities

Workers performing general site activities where skin contact with contaminated materials is not likely and inhalation risks are not expected will wear regular work clothes or regular or polyethylene-coated Tyvek®, eye protection (if splash or dust hazards are encountered), hard hat (recommended for in forest work), and safety boots. Work gloves will be nitrile or neoprene-coated where incidental skin contact may occur (e.g., sampling waste piles).

3.2 Level C Activities

Workers performing site activities where significant skin contact with contaminated materials is likely will wear chemical-resistant gloves (nitrile, neoprene, or other appropriate outer gloves, surgical inner gloves) and polyethylene-coated Tyvek® or other chemical-resistant suits or rain gear. Make sure the protective clothing and gloves are suitable for the types of chemicals, that may be encountered on site. Use face shields or goggles as necessary to avoid splashes in the eyes or face.

Minimum Personal Protection Level Requirements

Potential Route of Contact: Types of Contaminants	Required Protection Level	Required Equipment							
		Safety Glasses	Hard Hat	Safety Boots	Tyvek	Poly Tyvek	Nitrile Gloves	Neoprene Gloves	Respirator
									Half-Face
None Anticipated	Level D(a)	X	b	X					
Minor Skin Contact Possible	Level D(a)	X	b	X	f		X		
Skin Contamination Likely:	Level C(c)								
Metals		X	b	c		X	X		
Inhalation Possible:	Level C(c)								
Metals		X	b	c	X		X		d, e

Notes:

a. Level D protection required when atmosphere contains no known hazard and work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.
b. Hard hat is required where risk of striking overhead objects exists.
c. Level C protection required when the atmospheric contaminants, liquid splashes, or other direct contact will adversely affect any exposed skin; the types of air contaminants have been identified, concentrations measured, an appropriate respirator cartridge is available; and all air-purifying respirator criteria are met.
d. Appropriate respirator cartridges include: organic vapor/particulate (P100), combination (MSA GME super or equivalent), and others as required by contaminants.
e. Half-face respirator required when visible dust is present.
f. Tyvek should be worn if body contact with impacted materials is likely.

When performing activities in which inhalation of chemical vapors (none are anticipated) and dusts is a concern, wear half-mask or full-face air-purifying

respirators as specified in The Minimum Personal Protection Level table. If respirators are used, cartridges should be changed on a daily basis, at a minimum. They should be changed more frequently if chemical vapors are detected inside the respirator or other symptoms of breakthrough are noted (respiratory irritation, dizziness, breathing difficulty, etc.,).

4.0 SAFETY EQUIPMENT LIST

The following Safety Equipment must be available on site:

- First Aid Kit;
- 10 Essentials Survival Kit;
- Eye and Ear Protection;
- Eye Wash Fluid;
- Satellite Telephone;
- Hand Radios;
- Rain Gear;
- Climbing helmet;
- Bear repellant and bear bells;
- Firearms
- Field Safety Vest;
- Field Boots; and
- Nitrile or Leather Outer Gloves/Nitrile or Latex Inner Gloves

5.0 EXCLUSION AREAS

Fieldwork being performed as part of this project consists primarily of low-impact sampling activities that will not result in migration of contaminants or increased exposure to human health or the environment. Therefore, establishment of formal exclusion, contaminant reduction, and support zones is not necessary for this field investigation.

6.0 MINIMIZING CONTAMINATION

To minimize contaminant migration and exposure to surrounding areas, the amount of equipment and number of personnel allowed in contaminated areas should be minimized. In addition, the amounts of soil collected should not exceed what is needed for laboratory analysis and record samples. Avoid

kneeling on contaminated ground whenever possible. Do not stir up unnecessary dust, or perform any practice that increases the probability of hand-to-mouth transfer of contaminated materials. Use plastic drop cloths and equipment covers where appropriate. Eating, drinking, chewing gum, smoking, and using smokeless tobacco are forbidden while in potentially contaminated areas.

7.0 DECONTAMINATION

Decontamination is necessary to limit the migration of contaminants from the work zones onto the site or from the site into the surrounding environment. Equipment and personnel decontamination are discussed in the following sections, and the following types of equipment will be available to perform these activities:

- Spray Rinse Applicator;
- Plastic Garbage Bags; and
- Alkaline Decon Solution.

7.1 Equipment Decontamination

Proper decontamination (decon) procedures will be employed to ensure that contaminated materials do not contact individuals and are not spread from the site. These procedures will also ensure that contaminated materials generated during site operations and during decontamination are managed appropriately.

All non-disposable equipment will be decontaminated prior to leaving site. Soil and water sampling instruments should be cleaned with detergent solutions or placed in plastic bags for decon after demobilization.

7.2 Personnel Decontamination

Personnel working in potentially contaminated areas will perform a mini-decontamination prior to changing respirator cartridges (if worn), taking rest breaks, drinking liquids, etc. They will decontaminate fully before eating lunch or leaving the site. The following describes the procedures for mini-decon and full decon activities.

Mini-Decon Procedure

1. Inspect protective outer suit, if worn, for severe contamination, rips, or tears.

2. If suit is highly contaminated or damaged, full decontamination as outlined below will be performed.

3. Remove outer gloves. Inspect and discard if ripped or damaged.

4. Remove respirator (if worn) and clean off sweat and dirt using premoistened towelettes. Deposit used cartridges in plastic bag.

5. Replace cartridges and outer gloves, and return to work.

Full Decontamination Procedure

1. Remove outer gloves and protective suit and deposit in container for disposable clothing.

2. Remove respirator, and place used respirator cartridges (if end of day) in container for disposable clothing.

3. If end of day, thoroughly clean respirator and store properly.

4. Remove inner gloves and discard into container for disposable clothing.

5. Remove work boots without touching exposed surfaces, and put on street shoes. Put boots in individual plastic bag for later reuse.

6. Immediately wash hands and face using clean water and soap, as soon as possible.

7. Shower as soon after work shift as possible.

8.0 DISPOSAL OF CONTAMINATED MATERIALS

All disposable sampling equipment and materials will be placed inside of 10 mil polyethylene bags or other appropriate containers and removed from the site with the personnel. Dispose of in local municipal waste disposal facility.

9.0 SITE SECURITY AND CONTROL

Site security and control will be the responsibility of the Project Manager. The "buddy system" will be used when working in designated hazardous areas. Any security or control problems will be reported to appropriate authorities.

10.0 SPILL CONTAINMENT

Sources of bulk chemicals subject to spillage are not expected to be encountered in this project. Accordingly, a spill containment plan is not required for this project.

11.0 EMERGENCY RESPONSE PLAN

The Hart Crowser Emergency Response Plan outlines the steps necessary for appropriate response to emergency situations. The following paragraphs summarize the key Emergency Response Plan procedures for this project.

11.1 Plan Content and Review

The principal hazards addressed by the Emergency Response Plan include the following: medical emergencies, wildlife, hypothermia, and aircraft. However, to help anticipate potential emergency situations, field personnel shall always exercise caution and look for signs of potentially hazardous situations, including the following as examples:

- Visible or odorous chemical contaminants;
- Drums or other containers;
- General physical hazards (traffic, moving equipment, sharp or hot surfaces, slippery or uneven surfaces, etc.,);
- Live electrical wires or equipment;
- Underground pipelines or cables;
- Inherently hazardous stream locations/crossings;
- Adverse weather conditions; and
- Poisonous plants or dangerous animals.

These and other potential problems should be anticipated and steps taken to avert problems before they occur.

The Emergency Response Plan shall be reviewed and rehearsed, as necessary, during the on-site health and safety briefing. This ensures that all personnel will know what their duties shall be if an actual emergency occurs.

11.2 Plan Implementation

The Field H&S Manager shall act as the lead individual in the event of an emergency situation and evaluate the situation. He/she will determine the need to implement the emergency procedures, in concert with other resource personnel including client representatives, the Project Manager, and the Corporate H&S Manager. Other on-site field personnel will assist the Field H&S Manager as required during the emergency.

In the event that the Emergency Response Plan is implemented, the Field H&S Manager or designee is responsible for alerting all personnel at the affected area by use of a signal device (such as a hand-held air horn) or visual or shouted instructions, as appropriate.

Emergency evacuation routes and safe assembly areas shall be identified and discussed in the on-site health and safety briefing, as appropriate. The buddy system will be employed during evacuation to ensure safe escape, and the Field H&S Manager shall be responsible for roll call to account for all personnel.

11.3 Emergency Response Contacts

Site personnel must know whom to notify in the event of Emergency Response Plan implementation. The following information will be readily available at the site in a location known to all workers:

- Emergency Telephone Numbers: see list at the beginning of this plan;
- Route to Nearest Hospital: see list and route maps (Figure 1) at the beginning of this plan;
- Site Descriptions: see the description at the beginning of this plan; and
- If a significant environmental release of contaminants occurs, the federal, state, and local agencies noted in this plan must be immediately notified. If the release to the environment includes navigable waters also notify:
    - National Response Center at (800) 424-8802
    - EPA at (908) 321-6660

In the event of an emergency situation requiring implementation of the Emergency Response Plan (fire or explosion, serious injury, tank leak or other material spill, presence of chemicals above exposure guidelines, inadequate personal protection equipment for the hazards present, etc.,), cease all work

immediately. Offer whatever assistance is required, but do not enter work areas without proper protective equipment. Workers not needed for immediate assistance will decontaminate per normal procedures (if needed) and leave the work area, pending approval by the Field H&S Manager for restart of work. The following general emergency response safety procedures should be followed.

11.4 Fires

Hart Crowser, Inc., personnel will attempt to control only very small fires. If an explosion appears likely, evacuate the area immediately. If a fire occurs which cannot be controlled with the 10-pound ABC fire extinguisher located in the field equipment, then immediate intervention by the local fire department or other appropriate agency is imperative. Use these steps:

- Evacuate the area to a previously agreed upon, upwind location;
- Contact fire agency identified in the site specific plan; and
- Inform Project Manager or Field H&S Manager of the situation.

11.5 Medical Emergencies

Contact the agency listed in the site-specific plan if a medical emergency occurs. If a worker leaves the site to seek medical attention, another worker should accompany the patient. When in doubt about the severity of an accident or exposure, always seek medical attention as a conservative approach. Notify the Project Manager of the outcome of the medical evaluation as soon as possible. For minor cuts and bruises, an on-site first aid kit will be available.

- If a worker is seriously injured or becomes ill or unconscious, immediately arrange helicopter evacuation from the field to the Harborview Medical Center. Keep victim warm and comfortable. Apply appropriate first-aid until assistance arrives.
- In the event that a seriously injured person is also heavily contaminated, use clean plastic sheeting to prevent contamination of the inside of the emergency vehicle. Less severely injured individuals may also have their protective clothing carefully removed or cut off before transport to the hospital.

11.6 Potentially High Chemical Exposure Situations/Inadequate Protective Equipment

In some emergency situations, workers may encounter localized work areas where exposure to previously unidentified chemicals could occur. A similar hazard includes the situation where chemicals are present above permissible exposure levels and/or above the levels suitable for the PPE at hand on site. If these situations occur, immediately stop work and evacuate the work area. Do not reenter the area until appropriate help is available and/or appropriate PPE is obtained. Do not attempt to rescue a downed worker from such areas without employing confined space entry procedures. Professional emergency response assistance (fire department, HAZMAT team, etc.,) may be necessary to deal with this type of situation.

11.7 Other Emergencies

Depending on the type of project, other emergency scenarios may be important at a specific work site. These scenarios will be considered as part of the site-specific plan and will be discussed during the on-site safety briefing, as required.

11.8 Plan Documentation and Review

The Field H&S Manager will notify the Project H&S Manager as soon as possible after the emergency situation has been stabilized. The Project Manager or H&S Manager will notify the appropriate client contacts, and regulatory agencies, if applicable. If an individual is injured, the Field H&S Manager or designate will file a detailed Accident Report with the Corporate H&S Manager within 24 hours.

The Project Manager and the Field, Project, and Corporate H&S Managers will critique the emergency response action following the event. The results of the critique will be used in follow-up training exercises to improve the Emergency Response Plan.

12.0 MEDICAL SURVEILLANCE

A medical surveillance program has been instituted for Hart Crowser employees having exposure to hazardous substances. Exams are given before assignment, annually thereafter, and upon termination. Content of exams is determined by the Occupational Medicine physician in compliance with applicable regulations and is detailed in the General H&S Plan.

Each team member will have undergone a physical examination as noted above to verify that he/she is physically able to use PPE, work in hot environments, and not be predisposed to occupationally induced disease. Additional exams may be needed to evaluate specific exposures or unexplainable illness.

13.0 TRAINING REQUIREMENTS

Hart Crowser employees who perform site work must understand potential health and safety hazards. All employees potentially exposed to hazardous substances, health hazards, or safety hazards will have completed 40 hours of off-site initial hazardous materials health and safety training or will possess equivalent training by past experience. They will also have a minimum of three days of actual field experience under the direct supervision of a trained supervisor. Employees will also complete annual refresher, supervisor, and other training as required by applicable regulations. Training records will be maintained by the Hart Crowser Human Resources Department.

Prior to the start of each work day, the Field H&S Manager will review applicable health and safety issues with all employees and subcontractors working on the site, as appropriate. These briefings will also review the work to be accomplished, with an opportunity for questions to be asked.

14.0 REPORTING, REPORTS, AND DOCUMENTATION

The Field Health and Safety Report (Figure 2) will be completed daily by the Hart Crowser Field Health and Safety Manager or designated individual. In the event that accidents or injuries occur during site work, the Project Manager will be informed, who will notify the client immediately. Hart Crowser staff and subcontractors on this site will sign the Record of H&S Communication document, which will be kept on site during work activities and recorded in the project files.

Job No._____
Date_____
S M T W Th F S
Arrival Time:_____
Departure Time:_____

Field Health & Safety Report

Job_____
Location_____
Client_____
Field Representative_____ Project Manager_____
Field H&S Manager_____ Project H&S Manager_____

Names of personnel on site_____

Site Activities_____

Potential Hazards_____

Hazard Control Used_____

Protective Measures Taken_____

Comments of Observations_____

Sketch position of equipment relative to exploration
Indicate monitoring point(s) and prevailing wind direction

Exploration No._____

Air Monitoring Log

Meter Number 1, Type_____ Calibrated_____ Checked_____
Meter Number 2, Type_____ Calibrated_____ Checked_____
Background Reading: Meter 1_____ Meter 2_____

Time	Meter 1	Meter 2	Comments

Monte Cristo Phase 2
Monte Cristo, Washington

Field Health & Safety Report

17800-06

8/11

HARTCROWSER

Figure
A-29

Record of Health and Safety Communication*

PROJECT NAME: Monte Cristo Mining Area, Monte Cristo, WA	PROJECT NUMBER: 17800-06

SITE CONTAMINANTS: Metals: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc.

PPE REQUIREMENTS (check all that apply):

_X_Safety glasses	**_X_Gloves (specify)**	**Nitrile gloves**
_X_Safety boots	**_X_Clothing (specify)**	**Appropriate field clothing**
_X_Climbing helmet	**_X_Respirator (specify)**	**Half Face with Combination Cartridges**
	_X_Other (specify)	**Firearms, bear repellant, hearing protection**

The following personnel have reviewed a copy of the Site-specific Health and Safety Plan. By signing below, these personnel indicate that they have read the plan, including all referenced information, and that they understand the requirements which are detailed for this project.

PRINTED NAME	SIGNATURE	PROJECT DUTIES	DATE

***PROJECT MANAGER: PLEASE ROUTE A COPY OF THIS FORM TO THE CORPORATE H&S MANAGER WHEN COMPLETED.**

L:\Jobs\1780006\SAP and HASP Submittal\Final\MCMA Appendix A HASP.doc

APPENDIX B
FIELD FORMS

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TEE Checklist

Site Name	
Date of Site Visit	
Site Location	
Site Visit Conducted by	

OBSERVED IMPACTS ASSOCIATED WITH THE SAMPLE LOCATION	**Finding**
Onsite vegetation (**N**one, **L**imited, **E**xtensive)	
Vegetation in the locality of the site (**N**one, **L**imited, **E**xtensive)	
Onsite wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other (**N**one, **L**imited, **E**xtensive)	
Wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other in the locality of the site (**N**one, **L**imited, **E**xtensive)	
Other readily observable impacts (**N**one, **D**iscuss below)	
Discussion:	

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	**Finding**
Terrestrial – Wooded	
Percentage of site that is wooded	
Dominant vegetation type (**E**vergreen, **D**eciduous, **M**ixed)	
Prominent tree size at breast height, i.e., four feet (<6", 6" to 12", >12")	
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther) –	
Terrestrial - Scrub/Shrub/Grasses	
Percentage of site that is scrub/shrub	
Dominant vegetation type (**Sc**rub, **Sh**rub, **G**rasses, **O**ther)	
Prominent height of vegetation (<2', 2' to 5', >5')	
Density of vegetation (**D**ense, **P**atchy, **S**parse)	
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther) –	
Terrestrial – Ruderal	
Percentage of site that is ruderal	
Dominant vegetation type (**L**andscaped, **A**griculture, **B**are ground)	
Prominent height of vegetation (0', >0' to <2', 2' to 5', >5')	
Density of vegetation (**D**ense, **P**atchy, **S**parse)	
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	
Aquatic	
Proximity of the site to surface water bodies (streams, lakes, ponds, ditches, dry wash)	
Type of water bodies (**L**akes, **P**onds, **V**ernal pools, **I**mpoundments, **Lag**oon, **R**eservoir,	

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AML Feature Inventory

Feature ID | **USGS Quad:** | **Survey Date**

Surveyor(s)

Directions to Site (from a main road or landmark appearing on map)

Terrain Slope (Circle where applicable): **1. Flat** **2. Vertical** **3. Sloped (if sloped, report approx slope angle)**

slope angle: deg

Physical Features / Sources

Mine Openings: ☐ **shaft(s)** ☐ **adit(s)** ☐ **pit(s)** ☐ **other (explain)**

Opening Type / Count ID	Open / closed / collapsed / flooded / other?	Nominal Dimensions in feet	Water Present (Y / N)	Flowrate in GPM	Animals Present (ie: bats, other)	Photo # (Site-Photo#-Date)	Description	GPS
(i.e.) Adit 1	open	5 x 10 x 8	Y	0.5 L/min	n	Butte - P3 - 6/15	Adit on northeast side of WR-2	G7: 1278956, 476985

*Elevation Measurement Method: B=barometer, T = Topo Map, O = Other (explain)

Mining Activity-Related Piles: ☐ **waste rock pile(s)** ☐ **tailings pile(s)** ☐ **ore / leach pile(s)** ☐ **debris pile(s)** ☐ **other (explain)**

Pile Type / Count ID	Dimensions in ft (L X W X H)	Slope in degrees	Seepage Visible? (Y / N)	Seepage: Active / Inactive?	% Vegetative Cover (trees / brush / grass, moss)	Distressed Vegetation (Y / N)	Recent Human Activity (Y / N)	Sample Name(s)	Estimated Particle Gradation	Soils Classification:	GPS
(i.e.) WR-1	150 x 50 x 3	38	Y	inactive	20% / 30% / 15%	N	bottles, footprints	Butte - WR1 - S1:	0.5" - 4"	moist, gray, sl silty, v sandy, Gravel	G1:G4 (see below)

Sample Inventory

Sample Name (Site - Feature - Sample Number)	Location	GPS Name	Soil Description	Seived?	GPS
(I.e.) Butte - WR1-S1	Southern end of WR-1, top.	G9: Butte - WR1 - S1	moist, gray, silty, v. gravelly, Sand	Y, ASTM #10	G7: 1278965. 4796821

Miscellaneous Notes:

AML Feature Inventory

Feature ID _____ **Survey Date** _____

Surveyor(s) _____

Physical Features / Sources (Continued)

Mining Activity-Related Ponds or Liquid Containment Structures: ☐ **leach pond(s)** ☐ **tailings pond(s)** ☐ **tailings impoundment(s)** ☐ **other (explain)**

Pond Type / Count ID	Dimensions in ft (L x W x D)	Lined (Y / N)	Liquid Present (Y / N)	Animals Present (e.g. bats,	Sample Name(s)	GPS
(i.e.) LP 1	50 x 30 x 4	N	N	N	Butte - LP1 - S1:S2	G5: 1278965, 476985

☐ **Seep(s)** ☐ **Creek(s)** ☐ **Pond(s)** ☐ **Lake(s)**

Type / Count ID	Location	Sample Name	Flowrate in GPM	Odor, sheen, discoloration?	GPS
(i.e.) Flume Creek	southern site border	Butte - Flume Creek 1	0.1	None	G3: 1278496, 479865

☐ **Soil Staining** ☐ **Seep Staining**

Type / Count ID	Location	Color	Distance from Potential Contaminant Source to Receptor	Source & Receptor	Notes	GPS
(ie) Stain 1	soil downslope of Adit 1	orange/brown	100' upslope of Flume Creek	fish	ferricrete-like	G5: 1278965, 476985

Seasonal Flow Paths or Channels

Count / ID	Water Present (Y / N)	Sample Name	Flowrate in GPM	Distance from Potential Contaminant Source to Receptor	Source & Receptor	GPS
(ie) Drainage 1	N	Butte - Sed 1	-	discharges into Flume Creek	fish	G1: 1279645, 476985

Wetlands

Count / ID	Flowrate in GPM	Distance from Potential Contaminant Source to Receptor	Source & Receptor	GPS
(ie) Wetland 1	1 L/min	50' N of Pend Oreille River	None	G7: 127856, 476985

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding
Canal, **Ri**vers, **S**treams, **I**ntermittent **S**treams, **D**ry wash, **Di**tches, **Ch**annel Waterway)	
Size (acres), average depth (feet), flow rate (cfs), trophic status of water bodies	
Source water (**R**iver, **St**ream, **G**roundwater, **I**ndustrial discharge, **Su**rface water runoff)	
Water discharge point (**N**one, **R**iver, **St**ream, **G**roundwater, **W**etlands impoundment)	
Nature of bottom (**M**uddy, **R**ocky, **S**and, **C**oncrete, **O**ther)	
Vegetation present (**S**ubmerged, **E**mergent, **F**loating, **Sc**rub/shrub, **W**ooded)	
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	
Bank environment (cover: **V**egetated, **B**are / slope: **S**teep, **G**radual / height (in feet))	
Obvious or designated wetlands present (**Y**es / **N**o)	
Wetlands suspected as site is/has (**A**djacent to water body, in **F**loodplain, **S**tanding water, **D**ark wet soils, **M**ud cracks, **D**ebris line, **W**ater marks)	
Size (acres) and depth (feet) of suspected wetlands	

*** P**: Photographic documentation of these features is highly recommended.

SPECIES / HABITATS OBSERVED

When answering the above questions, consider the following:

- Ability of hazardous substances to migrate to surface waters, groundwater, or surficial soils.
- Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters. Aquatic receptors may be exposed through osmotic exchange, respiration or ventilation of surface waters.
- Contaminants may be taken-up by terrestrial plants whose roots are in contact with surface waters, groundwater, or soils.
- Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.
- Contaminants may be taken-up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1m depth).
- Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.
- Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).
- Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil or while grooming themselves clean of soil.

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AML FEATURE INVENTORY/MONITORING

Feature ID _____
Date _____
Weather _____

Plan View Sketch

= ft

_____

INCLUDE THE FOLLOWING IN THE FIELD SKETCH FOR:

North Arrow
Scale Bar
Photo Location(s) and View Direction(s)
Sample Location(s) and ID(s):
- W-# Water
- S-# Soil
- T-# Tailings
- R-# Rock (Waste)
- O-# Ore
- S-# Other (Describe)

FOOTPRINT(S) OF:
- MILLS
- BUILDINGS
- STRUCTURES
- MINING-RELATED PILES
- OTHER

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APPENDIX C
XRF USER MANUAL

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OLYMPUS

Innov-X Delta

User Interface Guide

PN 103202 — Rev. 2.5.15

Olympus Innov-X, 100 Sylvan Road, Woburn, MA 01801, USA

English original edition: *Delta Handheld XRF Analyzer User Interface Guide*
PN_103202 - Revision 2.5.15, December 2010

This document was prepared with particular attention to usage to ensure the accuracy of the information contained therein. It corresponds to the version of the product manufactured prior to the date appearing on the title page. There could, however, be some differences between the manual and the product if the product has been modified thereafter.

The information contained in this document is subject to change without notice.

Printed in USA

CONTENTS

Delta Family End User Documentation Resources

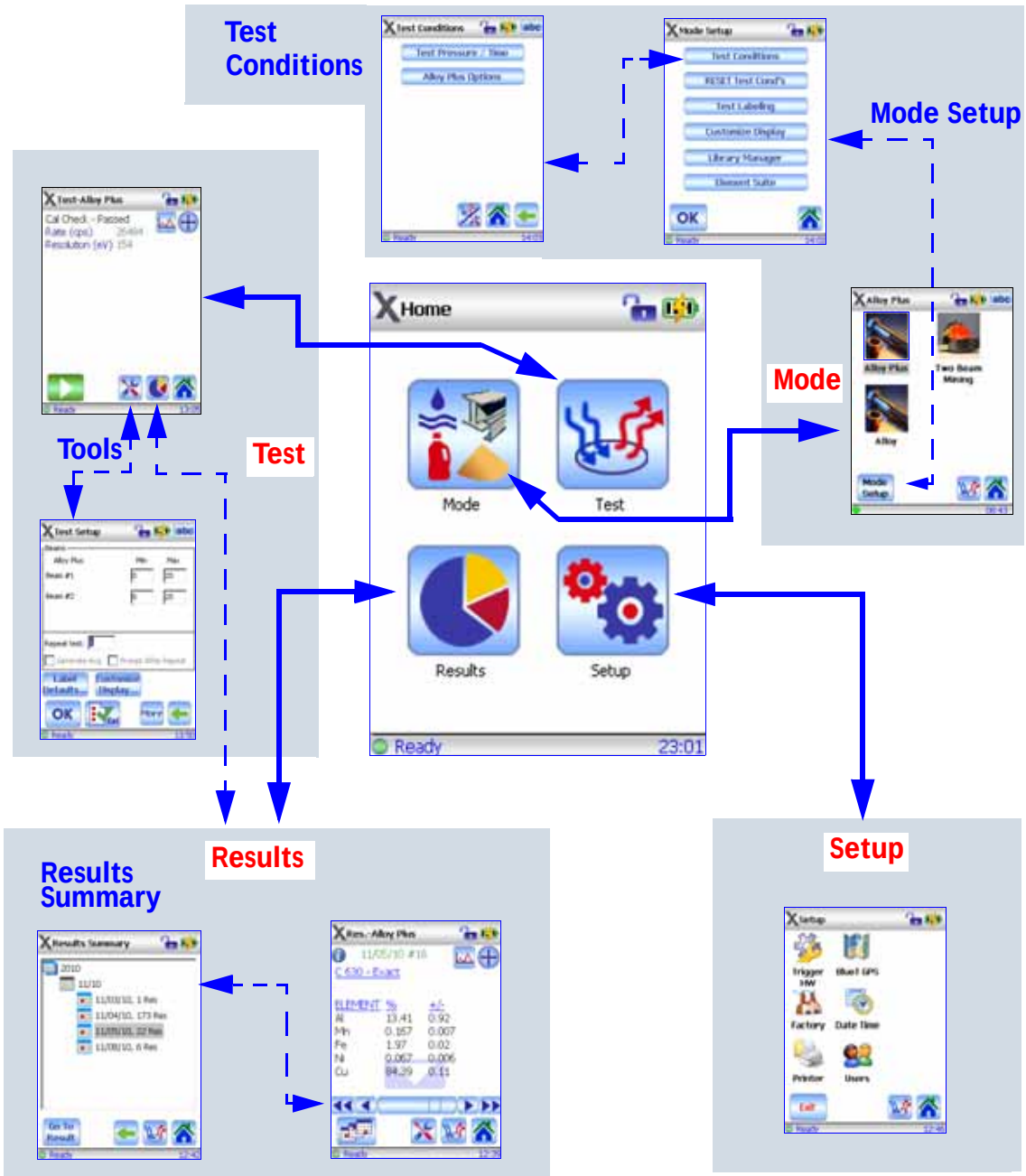
During Delta’s development and initial product shipments several End User documents have been created. They are listed in the table below.

Delta Documentation Resources

Innovx Part #	*Release Date*	*----------Title----------*
103202_RevA	Dec/2010	Delta User Interface Guide (UI version 2.5.15--This document)
103201_RevR	May/2010	Delta Family User Manual
103076_RevA	3/2010	Delta Family Quick Start
101593_RevA	11/2007	Window Replacement: Hinged Plate HandHeld Analyzers
102922_RevA	2/2010	Delta Family User Manual (Canadian Edition)
103158_RevA	3/2010	HOW TO: Setup and Configure A-020-D Teststand/Workstation for Delta Analyzer

Home Screen and UI Roadmap

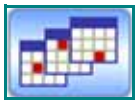
The Delta User Interface is built around its *Home* screen. It displays four icons (Mode, Test, Results, Setup) which control access for managing the entire Innov-X Delta XRF application.



Graphic Elements

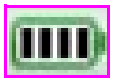
The Graphic Elements of the user interface are presented here.

Graphic	Name	Description/Action
	**Home**	Return to UI main screen.Then direct access to Setup, Mode, Test, and Results facilities
	**Mode**	Shows Modes available; Allows Mode selection
	**Tools**	Go to Test Setup; set Testing Times; Repeats, CalCheck, Label Defaults; Custom Display
	**Combo-Test/Tools**	Shortcut from Test Conditions to Test Setup
	**CalCheck**	Perform CalCheck procedure
	**Start Test**	Start a test; clear previous screen; show status
	**Stop Test**	Stop current test immediately; return to Ready status
	**Exit**	Leave Innov-X Delta sw w/Confirm
	**Trigger Lock**	Trigger is locked by (a) S/W control or (b) manual over-ride. See Setup> Trigger Settings
	**Trigger Unlock**	Trigger is not currently locked. Trigger may be pulled to allow X-rays to be emitted. Tapping icon can lock the unit.

Graphic	Name	Description
	**Setup**	System-wide setup including Trigger Hardware, Printer, BT GPS, Users, Date-Time, Exit
	**Test**	Go to Test screen; see Section 3.0 for details
	**Results**	Go to Result screen; see Section 4.0 for details
	**Results Navigation**	Access to Result navigation facility
	**Display Spectrum**	Go to spectral plot of current elemental test A toggle with Chemistry
	**Display Chemistry**	Go to elemental list from the current spectral plot view; A toggle with Spectral plot.
	**Return No Save**	Return (without saving) to previous screen
	**Return Save**	Return to previous screen; Save any new data entry
	**Print**	Used on Test & Results screens
	**Live Video**	{Toggle to) Real-time display from camera
	**Camera View**	{Toggle to} Display of last image taken

Graphic Elements, continued.

Graphic	Name	Description
	**Display - Expand**	Expands either the List or Spectral Plot displays
	**Display - Minimize**	Returns List or Spectral Plot displays to original layout
	**Zoom/ Unzoom**	Used with Spectral Plots to focus on narrower ranges
	Information Indicators	
	**Info Icon**	Provides access to test label data and entry
	**Black**	Messages: GO TO Error Log
	**Red**	Errors: GO TO Error Log
	**Export Results**	Send the chosen set of Results to output device

Graphic	Name	Description
	**Display Keyboard**	Data entry toggle function; provides access to or removes **Input Panel**
	**Battery**	Black bars give graphic indication of battery charge status.
	**Battery**	Tap on graphic indicator and get a Percentage Charge
	**Battery**	Solid Red is indicator of Low battery charge status
	**Battery**	AC power is installed and its power supply is on

Status Indicators

A Delta screen displays key information via upper and lower status areas.

Upper Status Area: Title Bar

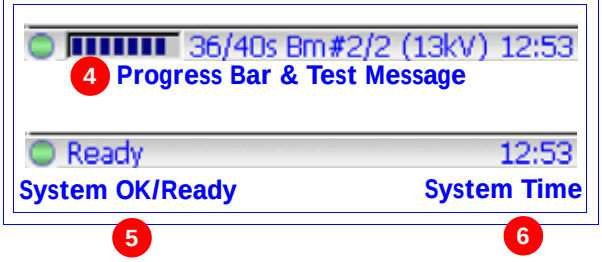
1. Shows current operation and Mode; Tap Title Bar to display Software and Firmware versions.
2. Shows Trigger Lock and Battery status
3. Shows the Battery Status

Lower Status Area: Progress and Message Bars

4. Shows a progress bar with graphical and digital info; also indicates what Beam is active.
5. The Green Dot and text message indicates that the System is ready for a command.
6. Indicates the system time.

Upper Status Area

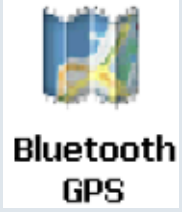
Lower Status Area



Setup: System-wide

System-wide Setup functions are usually established with an **initial configuration**.
> > *They typically are rarely accessed and are infrequently modified.*
An exception is the **Exit** function which may be regularly used.

Functions accessed from the Home screen via the Setup button:



Factory Settings are not available to end-users.

Mode-specific Setup functions and variables

A **second** type of Setup function is *Mode-specific*

After an application **Mode** is chosen, the **Mode Setup** button 

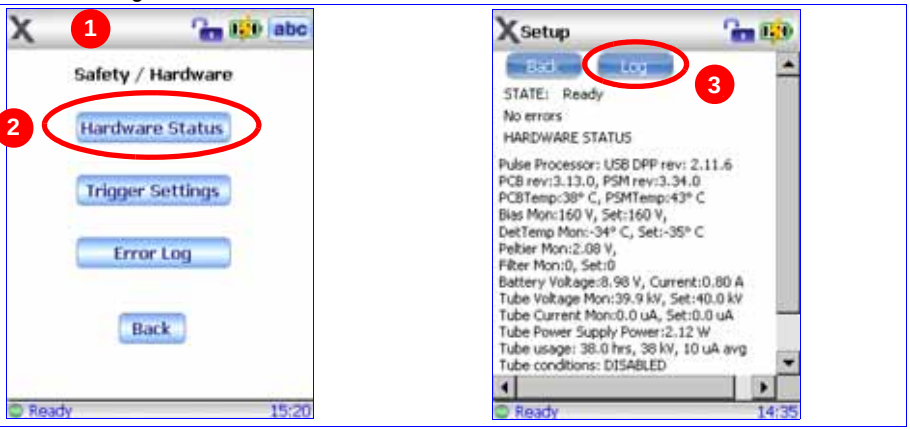
permits numerous parameters to be selected and edited from the Mode Setup screen and Mode-specific sub-menus.

GO TO Section 2 discusses **Mode-specific Setup** functions.

Trigger Hardware

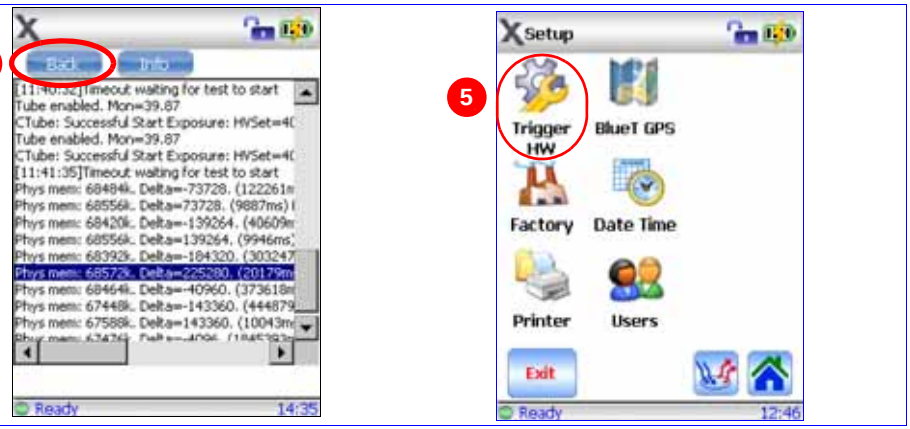
Invoke **Setup > Trigger Hardware** to view information and configuration screens with this sequence:

1. Select the Trigger Hardware icon from the **Setup** pane.
   This calls the *Safety/Hardware* menu.
2. Choose *Hardware Status*
   View the constantly updated status of the instrument on the Info screen.
   Use the vertical and horizontal sliders to see all items.
3. Select the *Log* button:



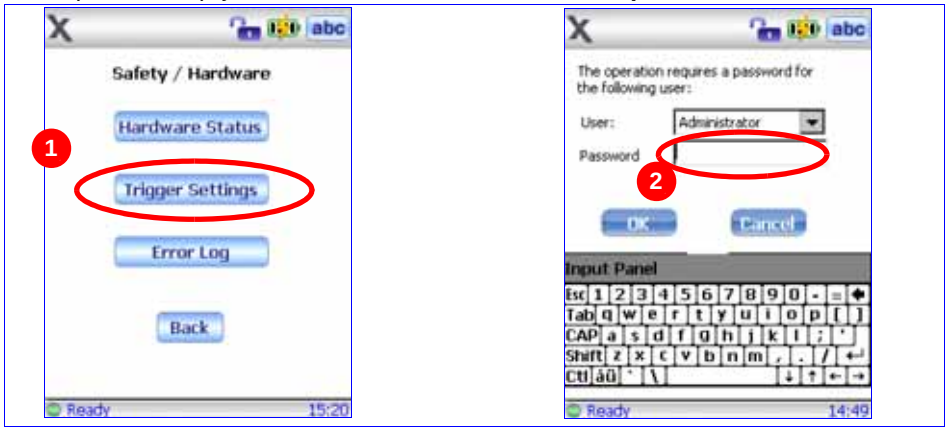
View a list of logged events that have occurred on the analyzer, both user-driven and system-driven.

Use the vertical and horizontal sliders to see all items.

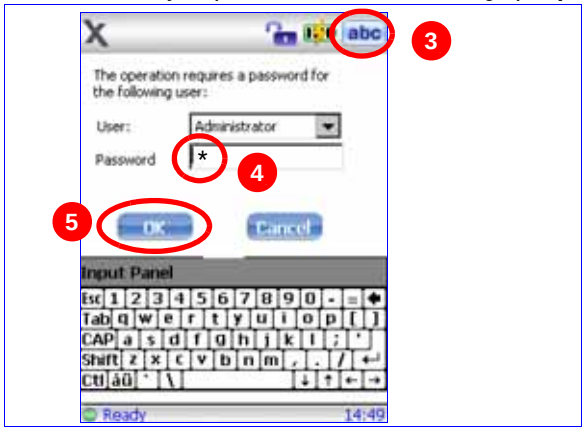


4. Tap **Back** to return to the **Setup** pane**.**
   Note: Choosing **Info** returns to **Hardware Status** screen.
5. Select the **Trigger Hardware** icon again to call the *Safety/Hardware* menu

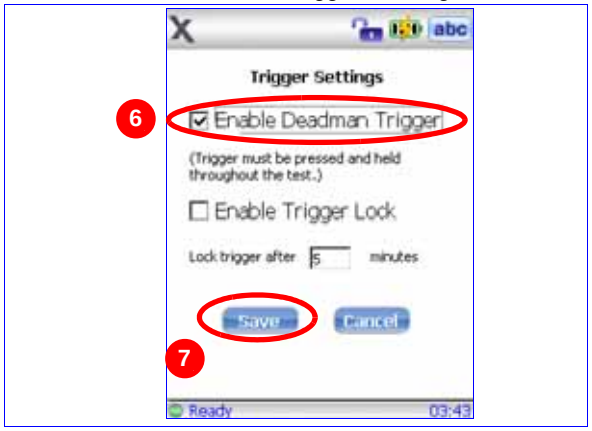
1. Choose *Trigger Settings* to access a **password security** screen.
2. Tap in the empty **Password** text window to call the **Input Panel**



3. If necessary, tap the **abc** button to bring up **Input Panel**.



4. The Password (default Password is lower case z).
5. Select **OK** to call the *Trigger Settings* screen.



6. If this option is desired, check **Enable Deadman Trigger**.
   See next page for"Deadman Trigger" information

Deadman Trigger

The trigger must be held for the **duration** of the test.
This ensures that the analyzer is **attended at all times** while x-rays are emitted.

- If the deadman trigger is **disabled**, test initiation is in a "Toggle" mode.
  - Pulling the trigger once starts a test, pulling it again stops it.
  - A test can also be controlled from the display screen by tapping the Start Test and Stop Test buttons to toggle the X-rays ON and OFF

WARNING

Canadian Regulations require using the deadman trigger at all times.
Canadian users should refer to document *PN 103124, "User Manual, Canadian Edition, Delta Family of Handheld XRF Analyzers"* for information regarding the regulations and usage protocols that are required in Canada.

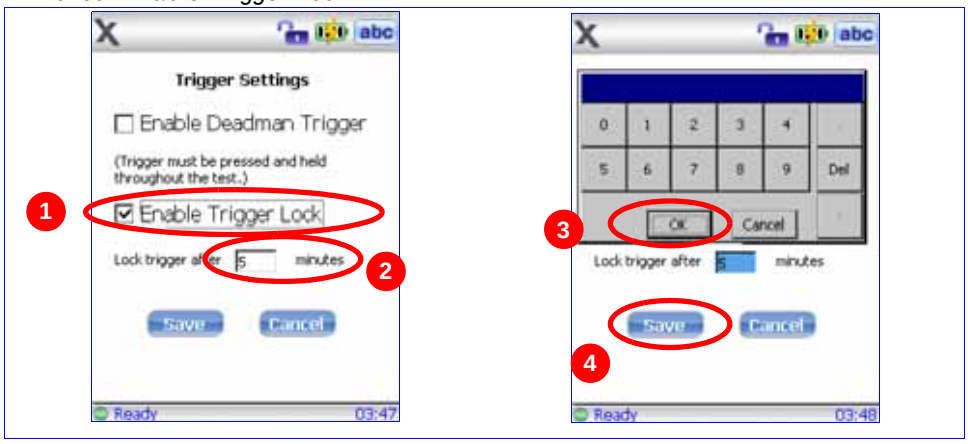
7. Select *Save* button; return to *Safety/Hardware* menu.

Trigger Lock

Trigger Lock is a safety feature that disables the trigger after a set idle time.

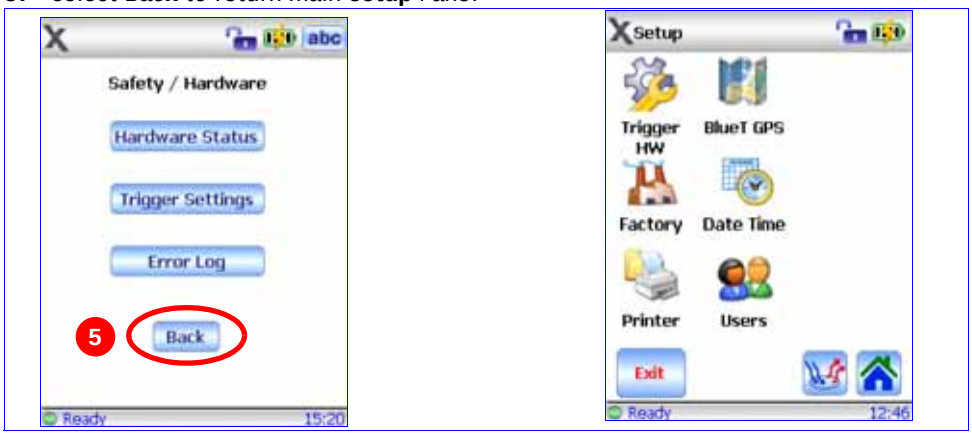
Select *Trigger Settings* button again; complete the *Password* screen as in steps **3** and **4** to access the **Trigger Settings** data entry screen.

1. Check *Enable Trigger Lock*



2. *Tap* in the "*minutes box*" and the input numeric pad appears.
3. Enter the time delay required and select **OK** on the pad.
   Trigger Settings screen returns.
4. Tap *Save* to return to *Safety/Hardware* screen

5. Select **Back** to return main **Setup** Pane.

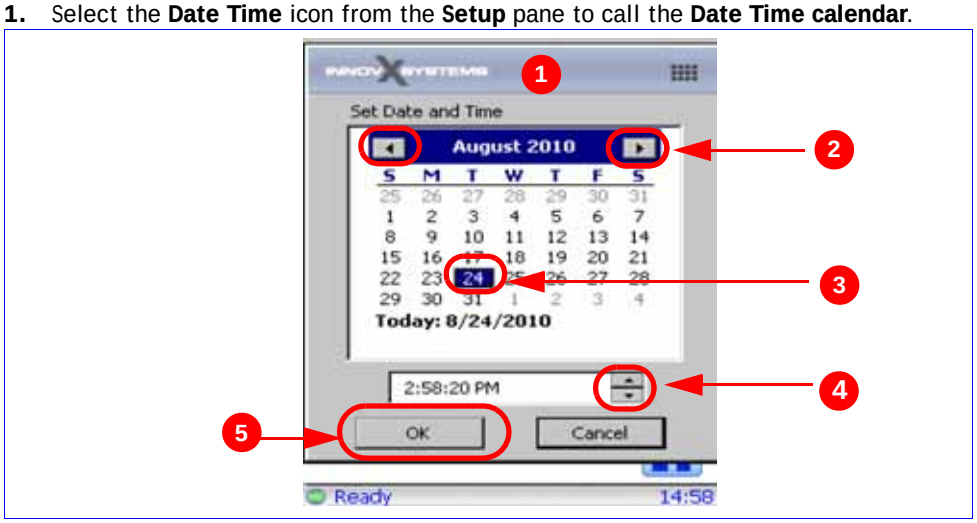


TIP

Use the Lock/Unlock toggle function to change the state of the Trigger Lock.
The Lock or Unlock icon is always available on the Title Bar.

Date Time

1. Select the **Date Time** icon from the **Setup** pane to call the **Date Time calendar**.



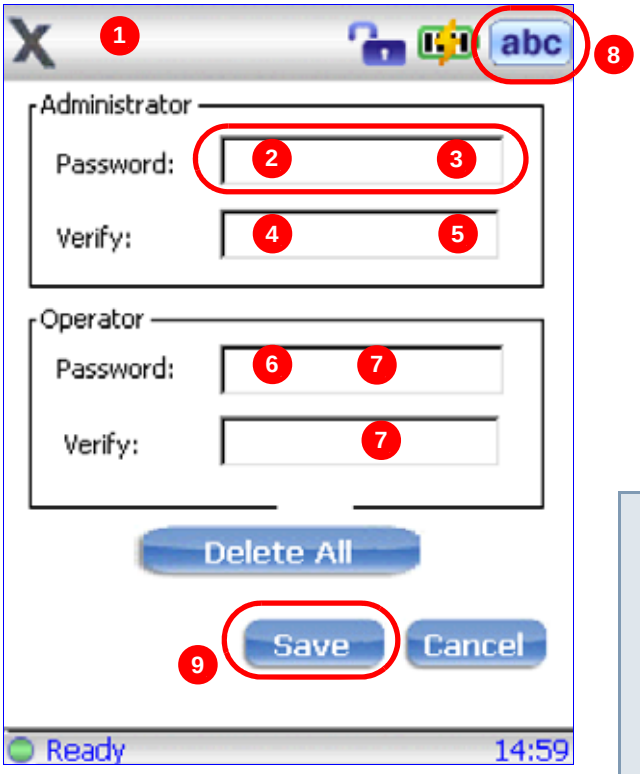
2. Tap the right/left arrows on the upper bar to move to the proper **Month** and **Year.**
3. Use the touch screen to select the **Date**
4. Use the up/down arrows to set the **Time.**
5. Tap **OK**.

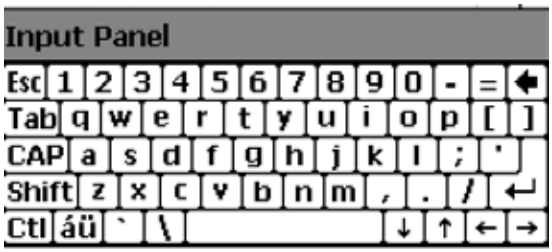
Users

1. Select the **Users** icon from the **Setup** pane to call the **Users** data entry screen.

To configure **Users** follow this sequence of instructions:

2. Tap in the **Administrator Password** text box to call the **Input Panel.**
3. Enter the Administrator Password **text**.
4. Tap in the **Verify** text box.
5. Repeat the text data entry.
6. Press Tab to advance to next field (Operator Password)
7. Repeat this data entry technique for the **Operator Password** and to **Verify** it.
8. When completed, select **abc** icon to clear the **Input Panel**
9. Select **Save** to return to the main **Setup** screen.





User Privileges

Applying the Administrator and Operator privileges permits supervisory management to maintain control over their sorting activities.

Administrators can set (and modify):

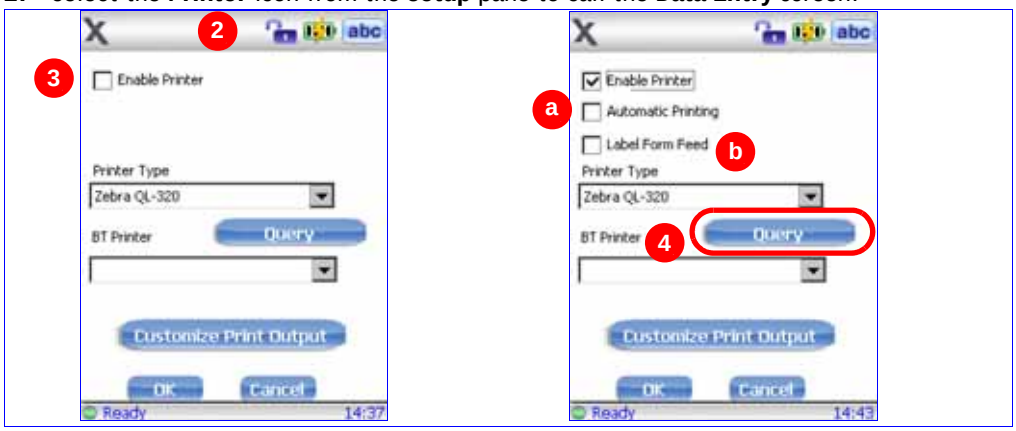
- Trigger hardware options
- Mode test conditions
- Display parameters
- Library Manager functions

Operator privileges permit them to view most options and parameters, but they are **inhibited** from making any changes.

Printer

Instructions for Pairing with a Bluetooth Printer

1. Ensure that your printer is turned **ON**.
2. Select the **Printer** icon from the **Setup** pane to call the **Data Entry** screen.

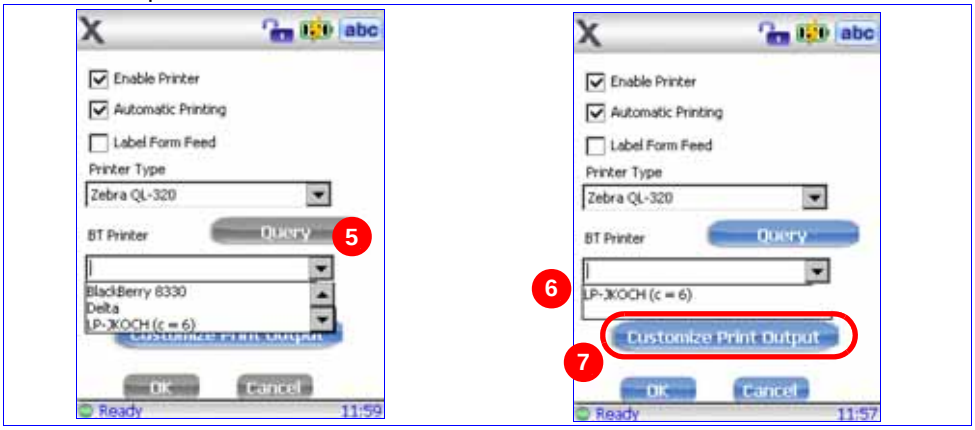


3. Check the **Enable Printer** box; this choice places the Print icon on all subsequent Test and Record screens.

Select the options as needed:

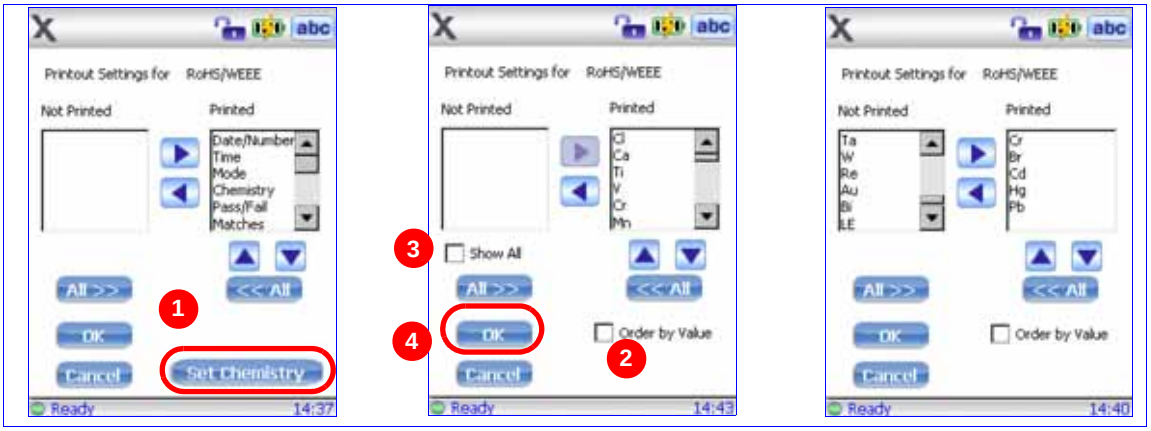
   a. Check **Automatic Printing** if you have an available (Blue Tooth) printer and want test results printed as they are completed. No operator intervention is required.
   b. Check **Label Form Feed** if you are using labels with the printer.

4. Tap **Query** to search for available BT printers.
   The Query button turns from blue to grey during the search; it returns to blue when completed.
5. Tap the **down arrow** to show a printer drop-down list.
6. Select a printer.

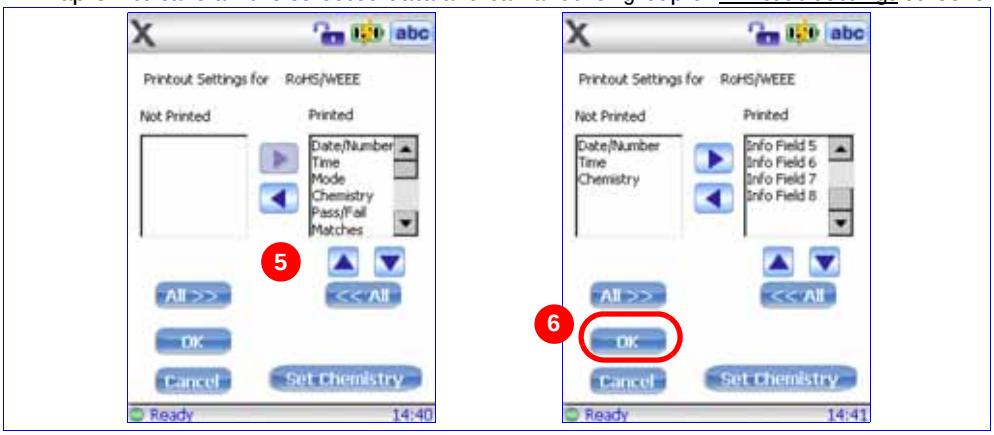


7. Tap **Customize Print Output.**

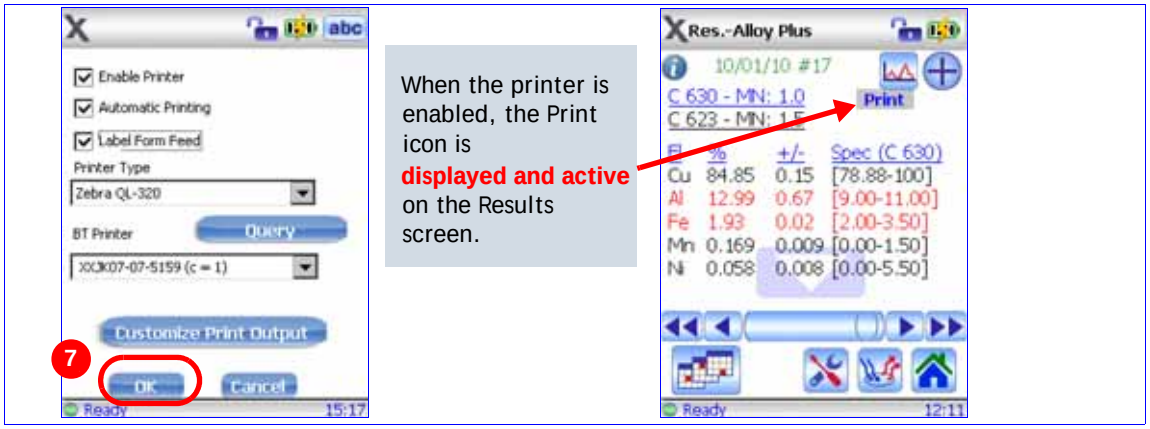
This invokes a series of **Printout Settings** screens.



1. Tap **Set Chemistry**
   Use the arrows and slider to develop a selected list of elements to be printed.
2. Select the option **Order by Value** to show descending order of concentration.
3. Select the option **Show All** to display all of the elements in the chosen mode's Element Suite.
4. Tap **OK** to save all the selected data and call another group of Printout Settings screens.



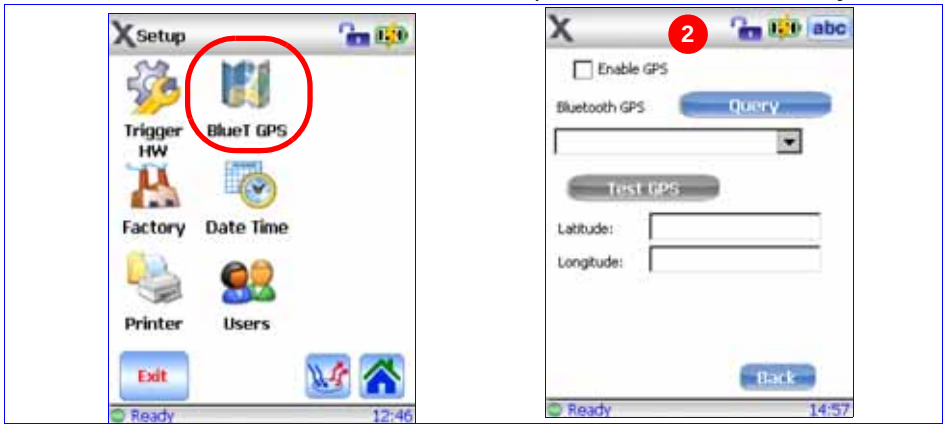
5. Use the arrows and slider for a selected list of Info Field (Label) items to be printed.
   Note: Info Fields 7 and 8 should be reserved for GPS data.
6. Tap **OK** to save the selected data and return to the main Printer configuration screen.
7. Ensure that all the configuration information is correct;
   tap **OK** to return to the **Setup** pane**.**



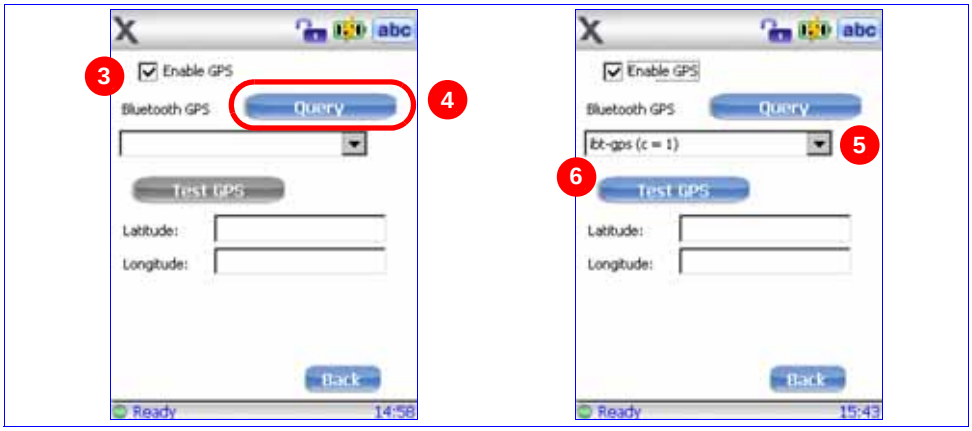
Bluetooth GPS

Instructions for configuring BT GPS capability with a Delta instrument.

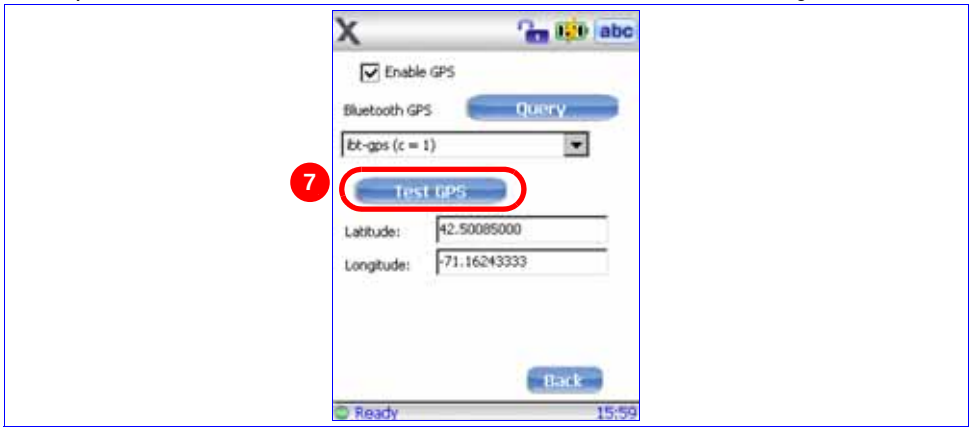
1. Ensure that you have the BT GPS device turned **ON**.
2. Select the **Bluetooth GPS** icon from the Setup Pane to call the **Data Entry** screen.



3. Check the **Enable GPS** box.

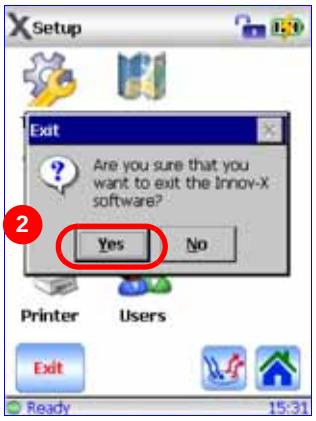


4. Select the **Query** button; this button turns from blue to grey during the search. It returns to blue when completed.
5. Tap the **down arrow** to show a Bluetooth GPS device drop-down list.
6. Select the appropriate device
7. Tap **Test GPS** to test the unit; it will return the local latitude and longitude values.



Exit

1. Select the **Exit** icon from the **Setup Pane** to call an **Exit** confirmation screen.

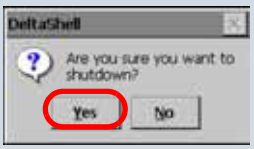


2. Press **Yes** to display the main **Exit** screen which presents **three** options.

Restart OS and restart INX application

Relaunch the INX application.

Turn instrument Off after making one more positive confirmation.



NOTES

MODE SETUP

Users must consider "Mode Setup" the **key procedure** for **each** mode they use.
In many cases, procedures and parameter choices can be identical (mode-to-mode).
In all cases, however, careful selections are necessary to achieve optimum results.
The Mode pane contains **one or more** icons which represent the modes that are currently installed on a Delta instrument.
Three graphical icons are used. A text label beneath the picture creates the specific Mode icon.

SOIL Analysis
- Soil

MINING
- Mining
- Mining Plus

ALLOY Analysis
- Alloy
- Alloy Plus
- FastID

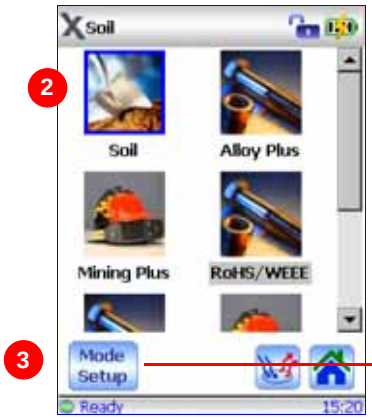
CONSUMER GOODS
- RoHS/WEEE
- Consumer Products

LEAD Paints
- Lead in Paint (HUD)

THINS
- Filter Analysis
- Dust Wipe

Initial Mode Setup procedure

HOME



Mode Pane(s)

Mode Setup

1. Tap the **Mode** icon on the **Home** screen
   This calls the **Mode Pane**
2. Select the desired mode,
   It becomes high-lighted
3. Tap the **Mode Setup** button to call the six button **Mode Setup** menu.
   Several selections are mode-specific and some have data entry fields that are applicable to all modes. See the Matrix on next page

Mode Setup UI Matrix

Use the **Mode Setup UI Matrix** to navigate to the page for a given configuration and mode.

Configuration Buttons | **Modes**

Test Conditions	Alloy	Alloy Plus	RoHS / WEEE	Soil	Mining Plus	Mining
Beam Times	21	21	48	26	26	26
Camera	22	22	48/22	22	22	22
Test Pressure/Altitude	23	23	23	27	27	27
Alloy Plus Options		24				
SmartBeam/AI Mode	25					
User Factor			53/28	28	28	28
RoHS Mode & Classification			49-52			
RESET Test Conditions	29	29	29	29	29	29
Test Labeling	30	30	30	30	30	30
Customize Display	33	33	33	33	33	33
Library Manager						
Match Settings	38	38				
Load Library	39	39				
Edit Library	39	39				
Edit Existing Grades	40	40				
Add New Grade	42	42				
Rename Library	43	43				
Import	44	44				
Export	45	45				
Pass-Fail / Sel Grade	46	46				
Element Suite	35	35	36	36	37	37

--- Not Applicable ---

TIP

Entered data is **Mode-specific**.
For example, a change in Beam Times while in Soil mode does **not** change the Beam Time values previously set for Alloy Plus mode.

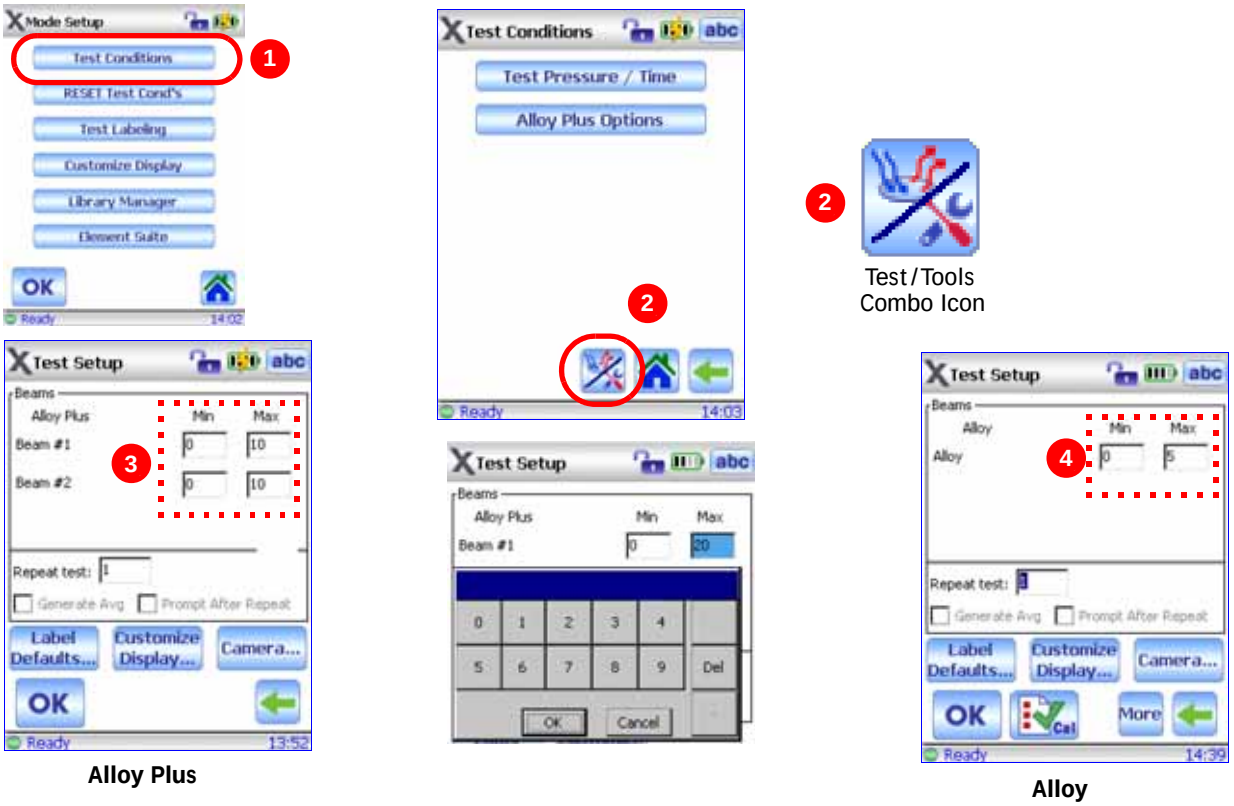
Mode Setup: Alloy Plus and Alloy

Test Conditions

Test Conditions permits several variables to be defined. The data entry screens for both modes are identical except for specifying the testing times. Each mode has a different number of beams.

The first set of variables are the Test times .

1. Select **Test Conditions** button from the **Mode Setup** menu
2. Tap the "**Test/Tools Combo**" icon to access the **Test Setup** screen.
3. Enter the test times for each beam of the Alloy Plus mode.
   Click in the field to access a virtual numeric keyboard for data entry



Alloy Plus

Alloy

4. Enter the test times for the single beam of the Alloy mode.

- *Min. testing time* - This is the minimum testing time before test results are actually calculated and displayed. For earlier InnovX instruments (Alpha and Omega models) this was commonly set at two seconds. However, because Delta analyzers have faster key components, this value can be set to zero.

- *Max testing time* - This is the length of time a test runs. If configured too short, the test can fail or imprecisely calculate results.

GO TO

Section 5 has more information concerning **Testing Time** issues.

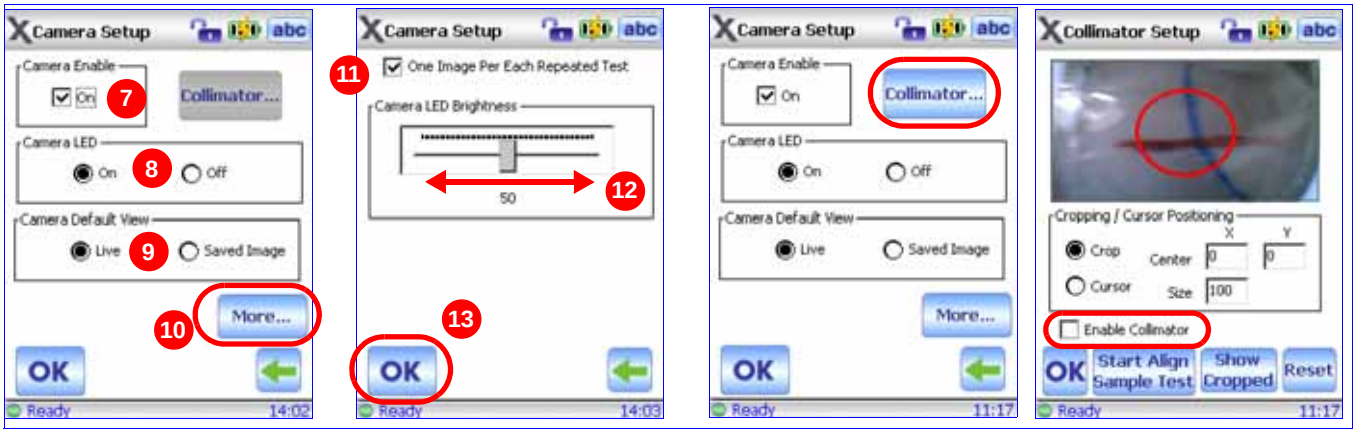
5. Enter other testing variables as needed

Identical for Alloy & Alloy Plus

- If more than one test is required on a given sample test, enter the quantity in the **Repeat Test** text box.
- If an average of test results is required for a given sample test set, select **Generate Avg** checkbox.
  Each subsequent test in the set is averaged against the previously received data.
- If you want to have control over continuing more tests, select **Prompt After Repeat** checkbox.
  A confirmation box appears on the Test screen after each test.

NOTE: If the "Averaging" facility is selected, spectrum results (plots) are NOT available for the average result.

6. Tap **Camera** to configure the internal camera (if your instrument is equipped with one).



7. Check **On** in the Camera Enable box.

8. Choose the **On** or **Off** option button in the Camera LED box. This controls the internal LED light which illuminates a section of the test sample.

9. Choose the **Live** or **Saved Image** option icons in the Camera Default View box. This is a "toggle" function, the icon shows what camera condition you switch to.

Live view	Test screen displays continuously what the camera "sees" in front of the XRF window.	Saved Image	Test screen displays the last image taken, not the current view in front of the XRF window.

10. Tap **More...** button to access a second **Camera Setup** screen.

11. Check One Image Per Each Repeated Test or only get one image for multiple repeats.

12. Use the slider to adjust the Camera LED Brightness.

13. Tap **OK** to return to the **Test Conditions** menu.

If the camera-equipped instrument has the "Collimator" option installed, use these instructions:

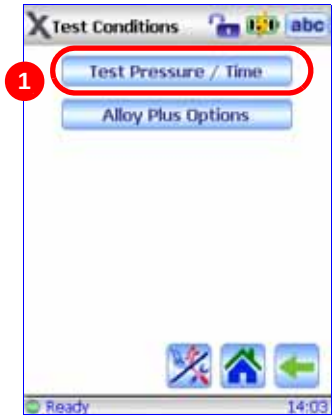
14. Tap the **Collimator** button to call the **Collimator Setup** screen.

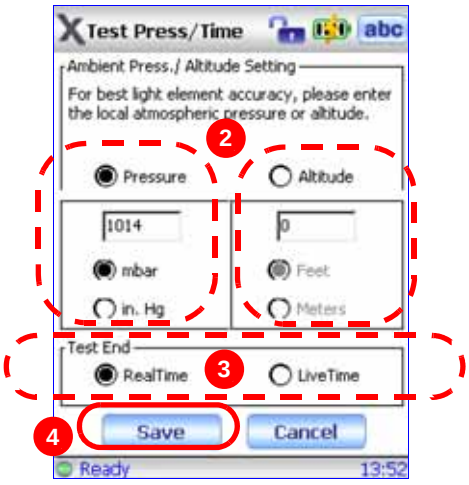
15. Check the Enable Collimator option.

To review the extensive Cropping, Cursor Positioning, and Alignment features, go to **Section 5,** *"Camera Issues."*

Test Pressure/Time

1. Select the **Test Pressure/Time** button.





2. For best light element accuracy, enter the Pressure or Altitude parameters. Tap in the data box and use the virtual numeric keyboard .

Test End

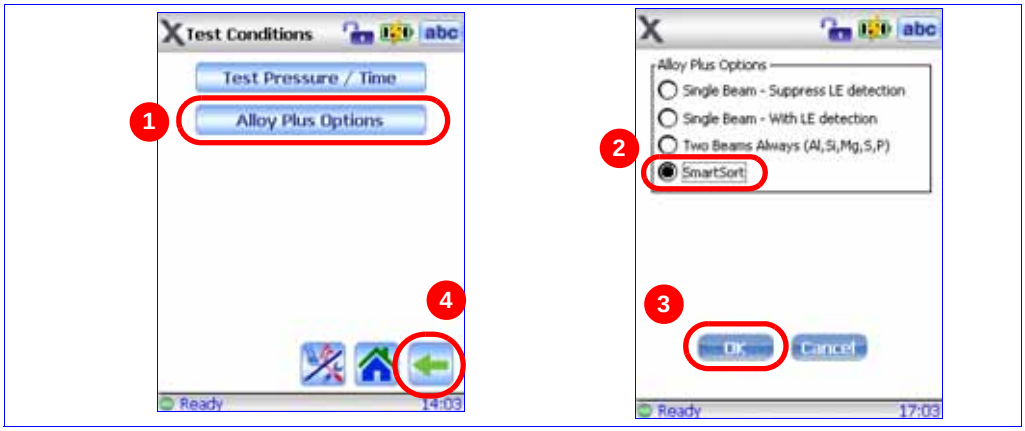
Within the analyzer there are **two** specific testing **time intervals**: RealTime or LiveTime

3. Use an **Option** button to select "RealTime" or "LiveTime"
   - *RealTime* - the *total* interval that the analysis takes when measured on a standard clock.
     - This is selected by most operators
   - *Livetime* - the interval that the analyzer hardware collects data. This parameter is stored with each result.
     - Since there is some detector *dead time* associated with a measurement, *Livetime* is less than the *Time Elapsed* interval.
     - This is selected primarily for laboratory calibration applications where precise and repeatable results are demanded.
4. Tap **Save** to return to **Test Conditions** menu

Alloy Plus Options

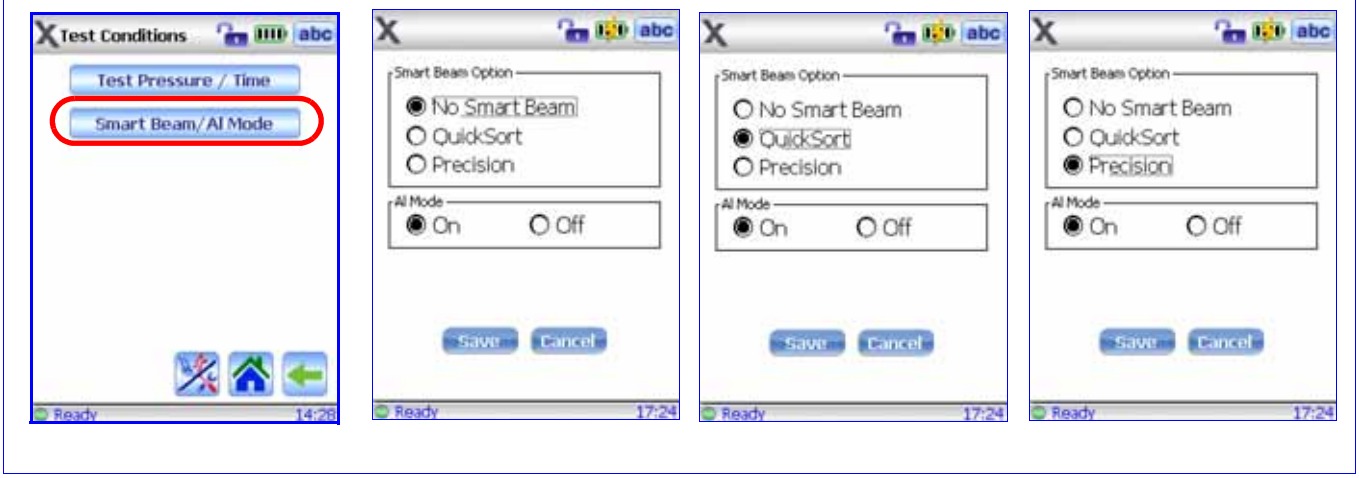
1. Select **Alloy Plus Options**
2. A Delta analyzer with Alloy Plus mode enabled is a **two** beam instrument; the default option (SmartSort) is shown.
   a. SmartSort uses a second beam *when needed* to determine a grade based on grade library.
   b. Single Beam - Suppress LE detection is chosen when using a Weld Mask
   c. Single Beam - With LE detection is used when only interested in information for Ti (Atomic Number 22) and above.
   d. Two Beams Always (Al, Si, Mg, S, P) is used when information about Mg, Al, Si, P, S (Atomic Numbers 12 - 16, respectively) is desired.

   For many grade separations this actually provides an unwanted excess of data



3. Tap **OK** to access Alloy Plus Test Conditions menu.
4. Select the  to return to the main **Mode Setup** menu

Smart Beam / Al Mode



SMART BEAM OPTION

This capability is can be employed by:

Classic models (**only**) configured with **Alloy** mode.

With *Smart Beam* enabled the analyzer starts testing using standard beam conditions, then, if appropriate, automatically switches to a second beam condition.

This screen configures the type of beam used:

- *No Smart Beam* - Instrument will never switch to Beam 2. This is not commonly use.
- *QuickSort* - Activate this parameter and, if a sample is found to match two alloys, differing only by a small amount of Ti or V, the instrument switches to a second beam condition. The second beam is used until the maximum testing time for *Beam 2* has elapsed. When the analyzer switches to the second beam conditions, the names of the two alloys being separated appear.

  If the alloy has a unique ID or if the best matches differ by something other than a small amount of Ti or V, the analyzer functions as it does with *Smart Beam* deactivated.
- *Precision* - Activate this parameter and the instrument automatically switches to the second beam condition after the first beam set time. The second beam is active for the time specified in the *Test Time* screen. At completion, a final result reflecting information from both beam settings appears. This option provides better precision on Ti and V results, if they are present in the alloy.

AL MODE OPTION

The option buttons are:

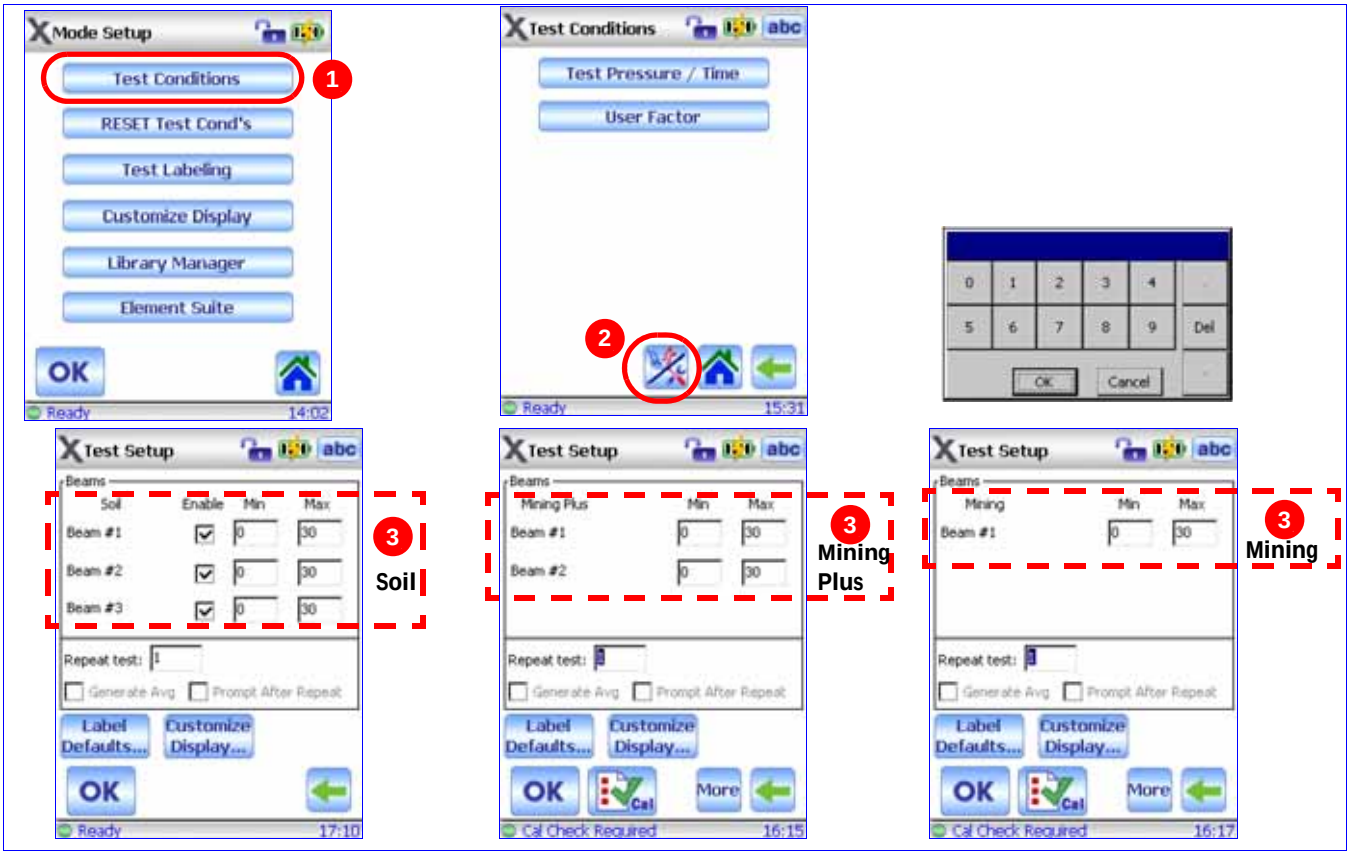
- **On -** Detect LE with Beam 1
- **Off** - Suppress LE (for use with Weld Mask)

Mode Setup: Soil, Mining Plus, and Mining

Test Conditions

Test Conditions permits several variables to be defined. The data entry screens for modes including **Soil, Mining Plus**, and **Mining** are identical except for specifying the testing times. Each mode has a different number of beams

1. Select **Test Conditions** button from the **Mode Setup** menu
2. Tap the "Test/Tools**/Tools Combo**" icon  to access the **Test Setup** screen.
3. Enter the test times for each beam.
   Click in the field to access a virtual numeric keyboard for data entry.



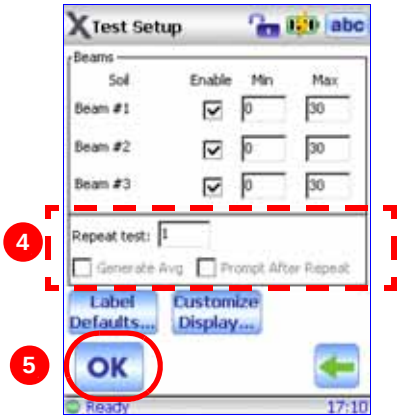
TIP

Test times selected depend on the degree of precision desired.

Maximum Test time for a soil or mining samples typically range up to 120 seconds.
Occasionally an operator selects up to 300 seconds to apply greater precision in an attempt to capture an elusive result.

See the Element Suite screens to determine what elements are available.

4. Enter other testing variables as needed; this applies to all modes



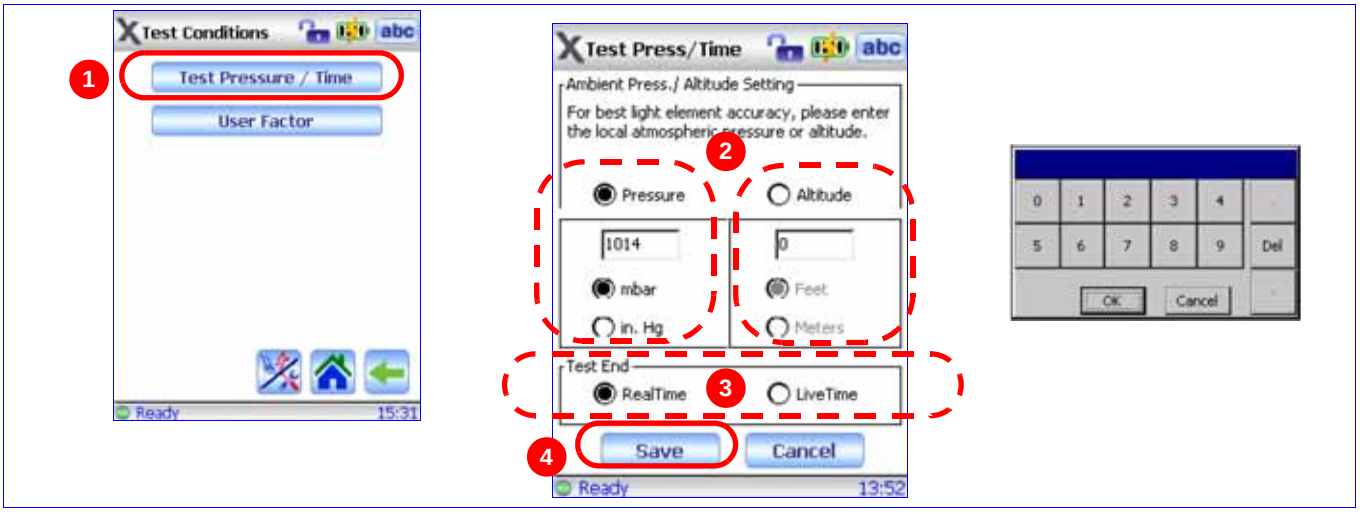
- If more than one test is required on a given sample test, enter the quantity in the **Repeat Test** text box.
- If an average of test results is required for a given sample test set, select **Generate Avg** checkbox.
  Each subsequent test in the set is averaged against the previously received data.
- If you want to have control over continuing more tests, select **Prompt After Repeat** checkbox.
  A confirmation box appears on the Test screen after each test.

NOTE: If the "Averaging" facility is selected, no spectrum results are available for the averaged results.

5. Tap OK to return to the **Test Conditions** menu.

Test Pressure/Time

1. Select the **Test Pressure/Time** button
2. For best light element accuracy, enter the Pressure or Altitude parameters.
   Tap in the data box and use the pop-up virtual numeric keyboard .



Test End

Within the analyzer there are **two** specific testing **time intervals**: RealTime or LiveTime

3. Use an **Option** button to select "RealTime" or "LiveTime"
   - *RealTime* - the *total* interval that the analysis takes when measured on a standard clock.
     - This is selected by most operators
   - *Livetime* - the interval that the analyzer hardware collects data.
     This parameter is stored with each result.
     - Since there is some detector *dead time* associated with a measurement, *Livetime* is less than the *Time Elapsed* interval.
     - This is selected primarily for laboratory calibration applications where precise and repeatable results are demanded.
4. Tap **Save** to return to **Test Conditions** menu

User Factors

Background

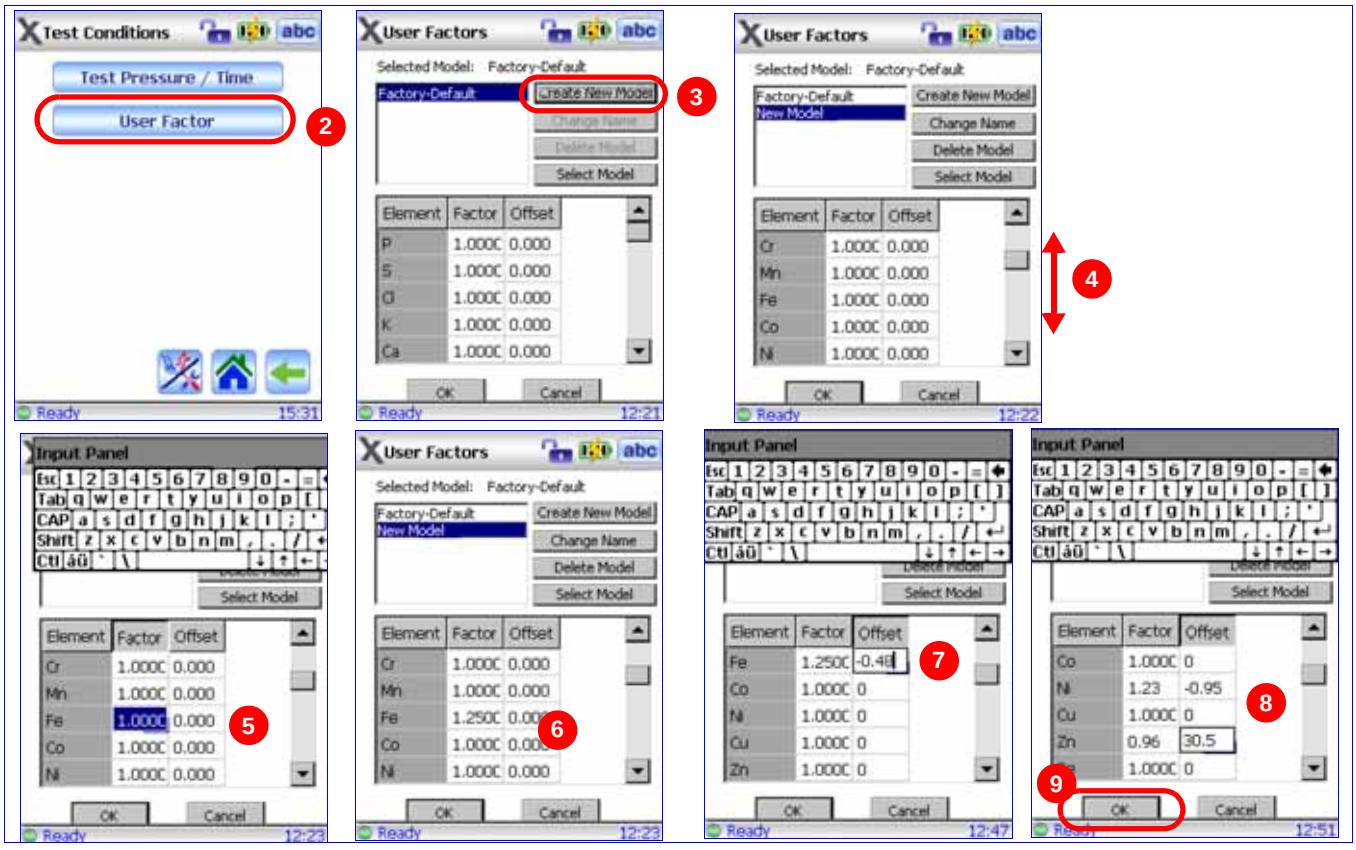
A Delta instrument is factory calibrated with a specific sample matrix. In the field this is can present a problem. By incorporating **Factor** and **Offset** variables that focus on particular elements in particular environments, the operator can leave the default settings alone and customize the analysis for unique field conditions.

This capability is employed by **Soil, Mining, Mining Plus, and RoHS/WEEE** Modes.

You can create several different *Factor* tables. See **Section 5** "Appendix" for tutorial on creating Factor and Offset variables from your known assay samples.

Procedure for configuring new User Factors:

1. Ensure that you have determined the appropriate Factor and Offset values for the elements of interest.
2. Select **User Factor** button to access the initial **User Factors** data entry screen.
3. Tap the **Create New Model** button
4. Using the slider, scroll to the Element of interest;
5. Tap on the associated Factor **cell**;
   cell's background turns blue and a pop-up virtual numeric keyboard appears.
6. Enter the Factor **value**.
7. Tap on the associated Offset **cell** and enter the Offset **value**
8. Continue in this manner until all elements of interest have their respective Factor and Offset values entered.
9. Select **OK** to save the new data and return to the **Test Conditions** menu.

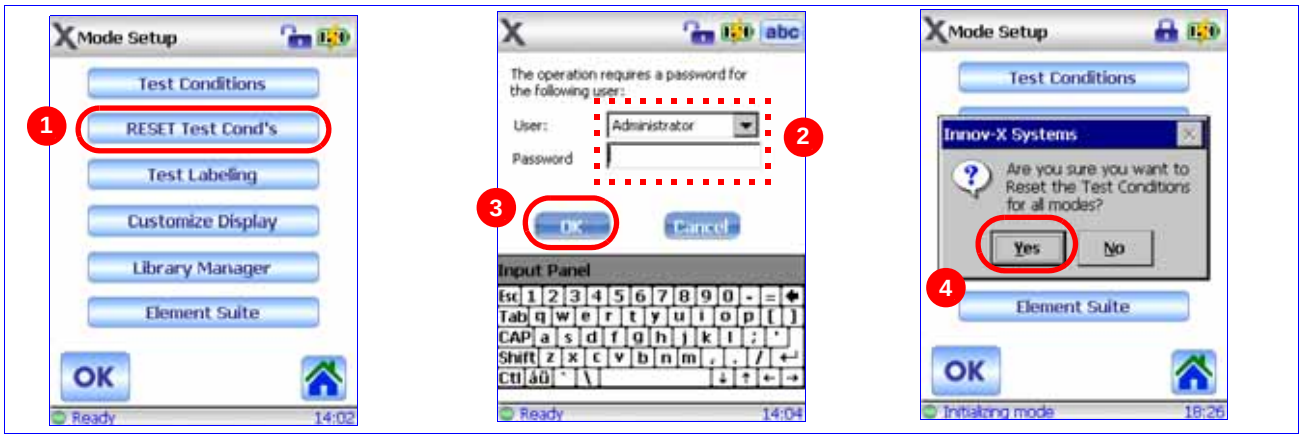


RESET Test Conditions

This facility is used by ALL modes.

Choose this menu selection to return all the test conditions to their default values.

1. Select **RESET Test Cond**'s button to call the permission screen
2. Tap in the empty fields to enter the User and Password with the **Input Panel**.
3. Tap **OK**
4. Select **Yes** on the confirmation popup screen.



Default Test Times for Various Modes

MODE	Min Time All Beams	Default Max Time Beam 1	Beam 2	Beam 3
Alloy	0	5	30	n/a
Alloy Plus	0	5	30	n/a
Fast ID	0	5	n/a	n/a
Mining	0	30	n/a	n/a
Mining Plus	0	30	30	n/a
RoHS	0	30	120	n/a
Soil	0	30	30	30
Pb Paint	0	30	20	n/a
Filter	0	30	n/a	n/a
Dust Wipe	0	30	n/a	n/a

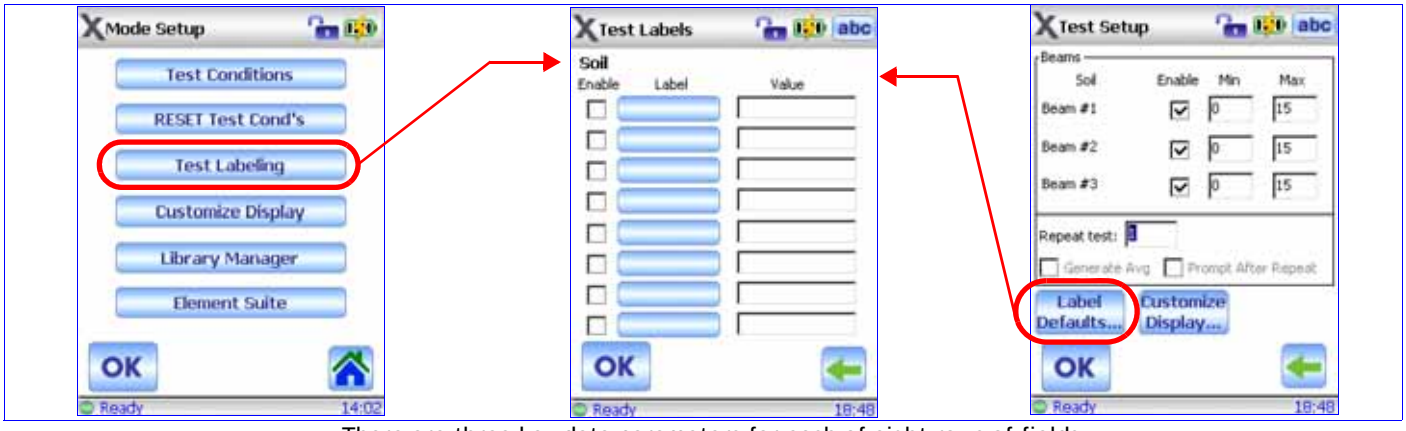
Other Default Parameters

MODE	Parameter	MODE	Parameter
RoHS	End of Test = Max. Time	Alloy Plus	Two Beams Always Al, Si, Mg, S, P
RoHS	Classification = Auto	Alloy	Quicksort
RoHS	Action Level = IEC Guideline	Alloy	Al Mode = On

Test Labeling

This facility is used by ALL modes.

The Test Labels data entry screen is shown below. It can be accessed in two ways, from the **Mode Setup** screen or the **Test Setup** screen.



There are three key data parameters for each of eight rows of fields:

- **Enable** - This checkbox directs that the particular field should be displayed via the **Info** icon. To display a field's label on the Test screen, check the "Show with Result" option.
- **Label** - This is the "assigned name" of the field. Examples are "Employee" or "Shift"
- **Value** - This is information related to this label. It can take one of three styles.
  - Text
  - Fixed List
  - Auto Incrementing Number

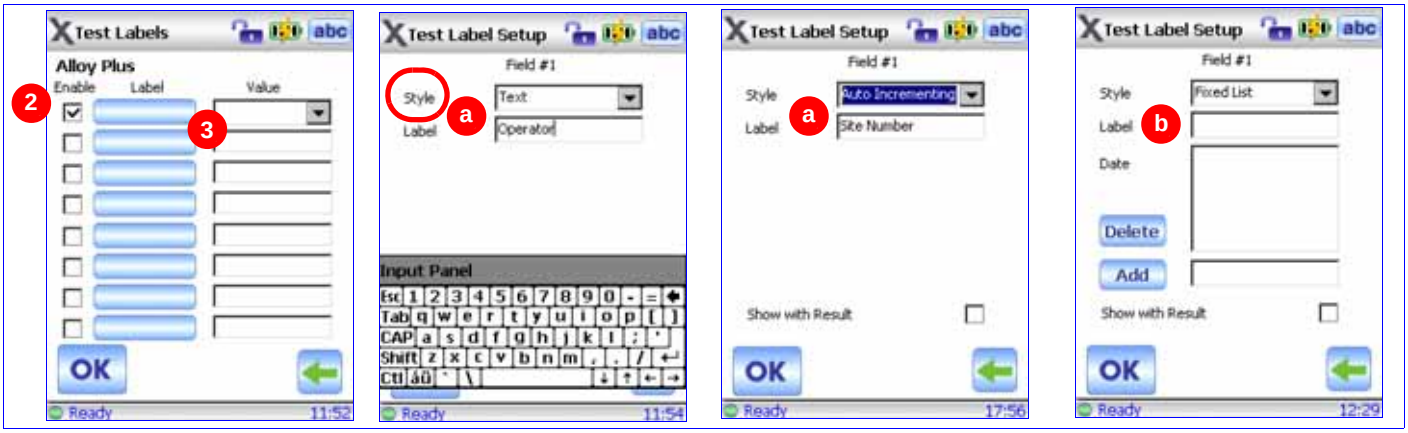
Test **Label Defaults** can be used to enter data that remains the same from shot to shot. If you want the entry to be cleared after each shot, the default should be blank.

A factory option provides the capability of editing labels after a shot on both Test and subsequent Results screens.

A typical Test Label setup sequence:

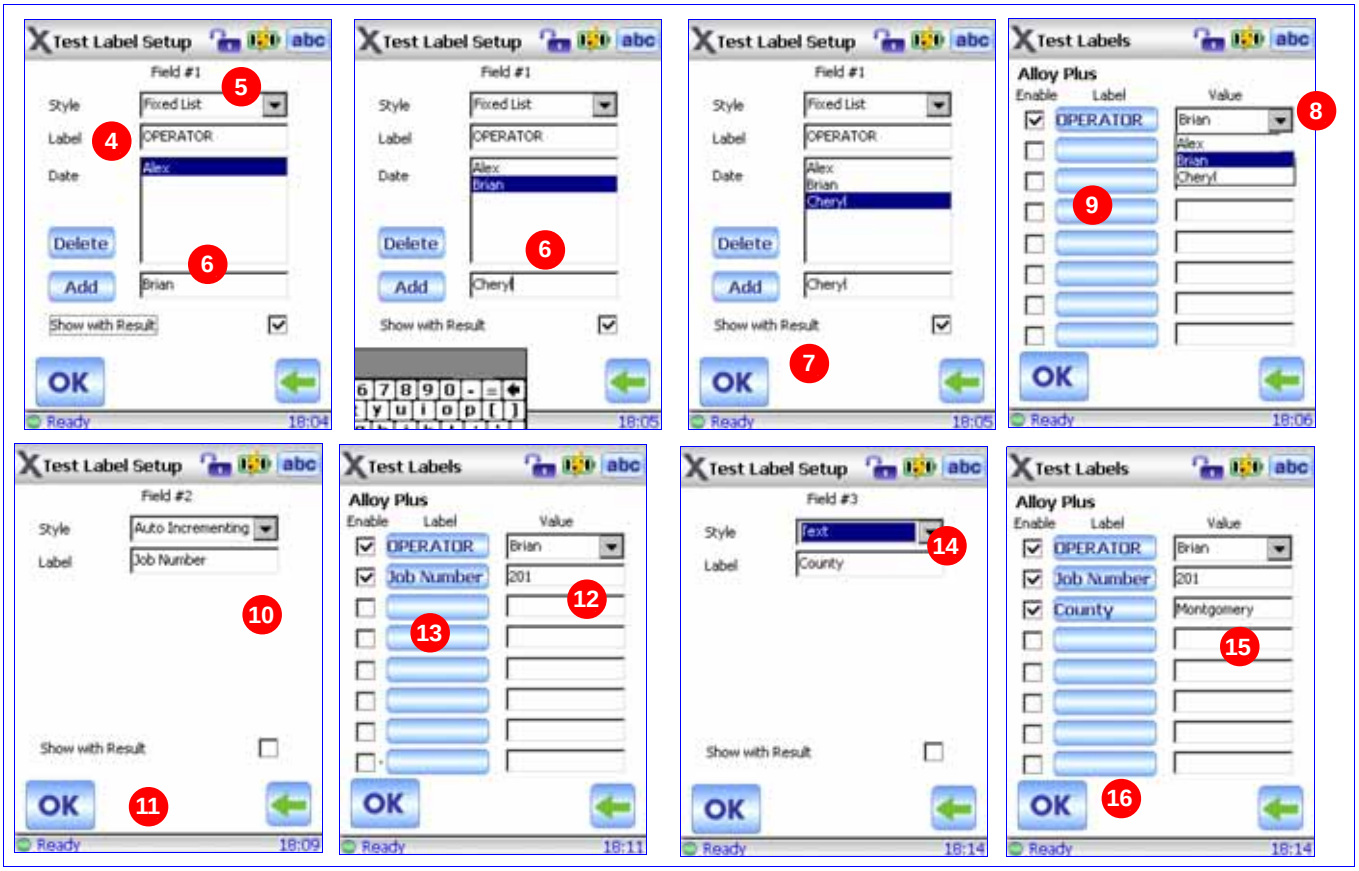
1. Tap **Test Labeling** from the **Mode Setup** menu to access the data entry screen.
2. Place check in **Enable** checkbox to activate Field #1.
3. Select top Label entry box to call Field #1 **Test Label Setup** screen.
   This screen takes one of two forms
   a. Screen for Text or Auto Incrementing Number
   b. Screen for Fixed List

   Note that "Style" on the entry screens refers to the Style of the **Value** parameter



Typical Test Label Setup Sequence, continued

4. In this example, enter Label name "OPERATOR" with the virtual keyboard in the **Test Label Setup** screen.
5. Select Fixed List for the "Style" of this field
6. Enter first entry for the list in the text box adjacent to button "**Add**"
   Continue to enter the names to appear on the OPERATOR list by typing them in the text box and tapping **Add**
7. When the list is complete, tap **OK** to return to the main **Test Labels** screen.
8. Choose the appropriate Operator from the drop-down Mixed List
9. Select Field #2 to access its **Test Label Setup** screen
10. Enter "Job Number" as the Label and select Auto Incrementing for its Style.
11. Tap **OK** to return to the main **Test Labels** screen.
12. Enter the initial numeric value for Field #2 in its Value field.
13. Select Field #3 to access its **Test Label Setup** screen.
14. Enter "County" as the Label and select Text for its Style
15. Enter "Montgomery" for this field.
16. Tap **OK**:



TIP

1. Value/Style Field Sizes: Text = 15 characters, maximum; Mixed List entries = 20 characters, maximum.
2. Remember to use the check boxes: Enable and Show with Result.
3. If the GPS facility is active, Fields #7 and #8 display the GPS coordinates.
   If #7 & #8 are configured for other test information, the GPS coordinate values over-write that data.
4. To enter data to persist after more than one test, use "Label Defaults" button, see page 30.

After test label edits

A Delta instrument can be Factory configured to allow “after test edits.”

GO TO

See *Section 5, Page 87* for the procedure to use the after test label capability.

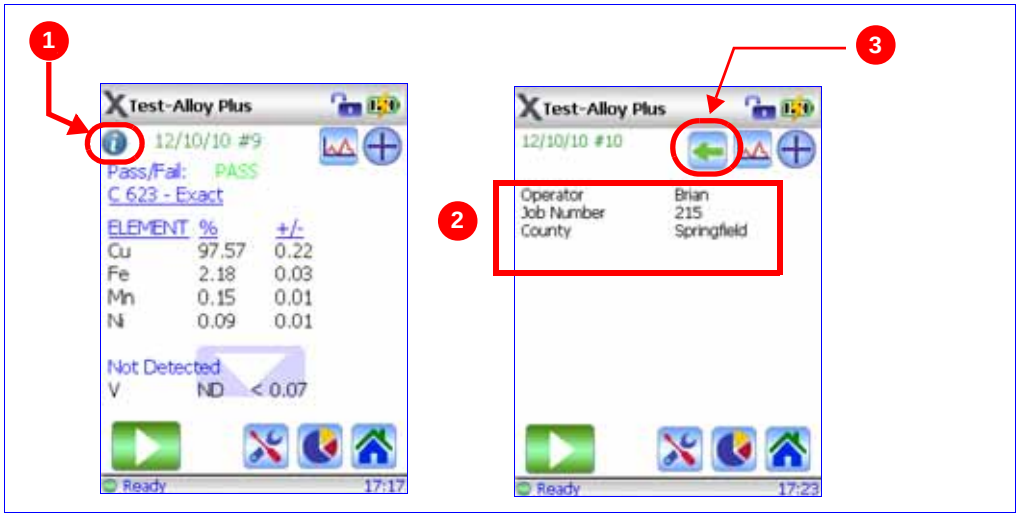
Information Icon

This visual indicator is coupled to the Test Labeling facility and Test or Result displays.

After Test Labels are configured every subsequent test shows the Information icon in the upper left corner of the screen.

Use this technique for Test Information display:

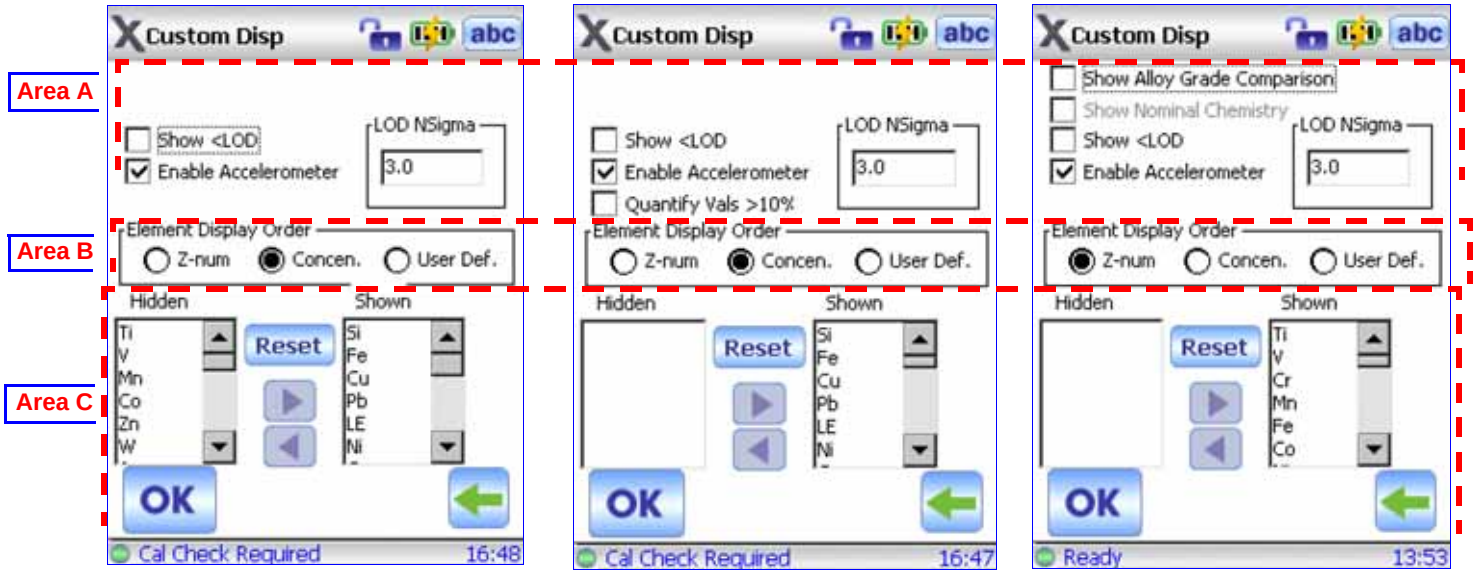
1. Select the **Information** icon
2. The Test Label information is listed on a separate screen. All enabled fields are displayed.
3. Tap the **Return** icon to go back to the Test Screen



Customize Display

This facility is used by ALL modes.

Typical screens to support various modes are shown (slightly enlarged) below:
Instructions are divided into **three** entry areas, noted as A, B, and C :



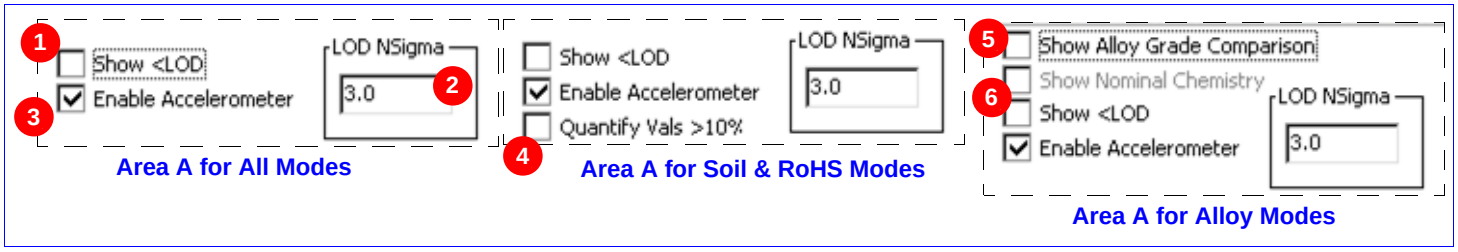
MODEs: Mining Plus & Mining | MODEs: Soil & RoHS/WEEE | MODEs: Alloy Plus & Alloy

Configure the Customize Display entry screen:

Area A

All modes have three common variables

1. Select the **Check Box** to display elements of the selected Mode that are *Below the Limit of Detection*.



2. Ensure that the NSigma = 3.0 parameter is acceptable for your testing requirements. This value gives the "statistical confidence" for detection; 3.0 is typical for most applications.
3. Select "*Enable Accelerometer*" to use the Delta facility that rotates the main touchscreen display when the instrument is inverted.

Additional variable for Soil or RoHS Modes

4. Select "*Quantify Vals > 10%*" to display the Element values that are greater that 10%. {In practice this is generally not useful because these modes are calibrated for trace elements}

Additional variables for Alloy or Alloy Plus Modes

5. Check "*Show Alloy Grade Comparison*" to have Test or Result screens indicate Match parameters. {May use too much area on the display screen.}
6. Check "*Show Nominal Chemistry*" to have Test of Result screens list the elements inferred to be in a test shot based on the grade match.

Area B

For the **Element Display Order**, all modes may choose between these three methods:

- Z-num(ber) >> atomic number
- Concen(tration) >> concentration in the test sample
- User Def(ined)

Z-number and Concentration results can be sorted at the **Test** or **Results** screens.

.

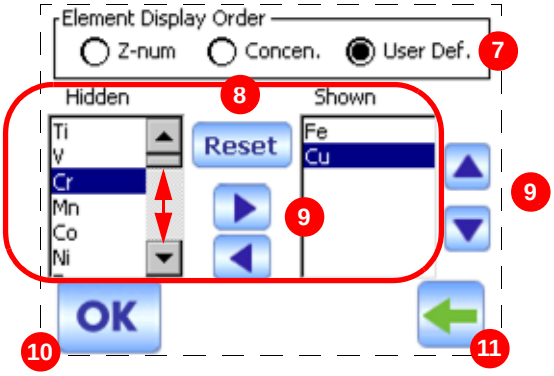
Area B for All Modes

Area C

7. Implement the "**User Def**" option

This area permits user to choose what elements to show or hide on the **Test** or **Results** screens.

Area C for All Modes



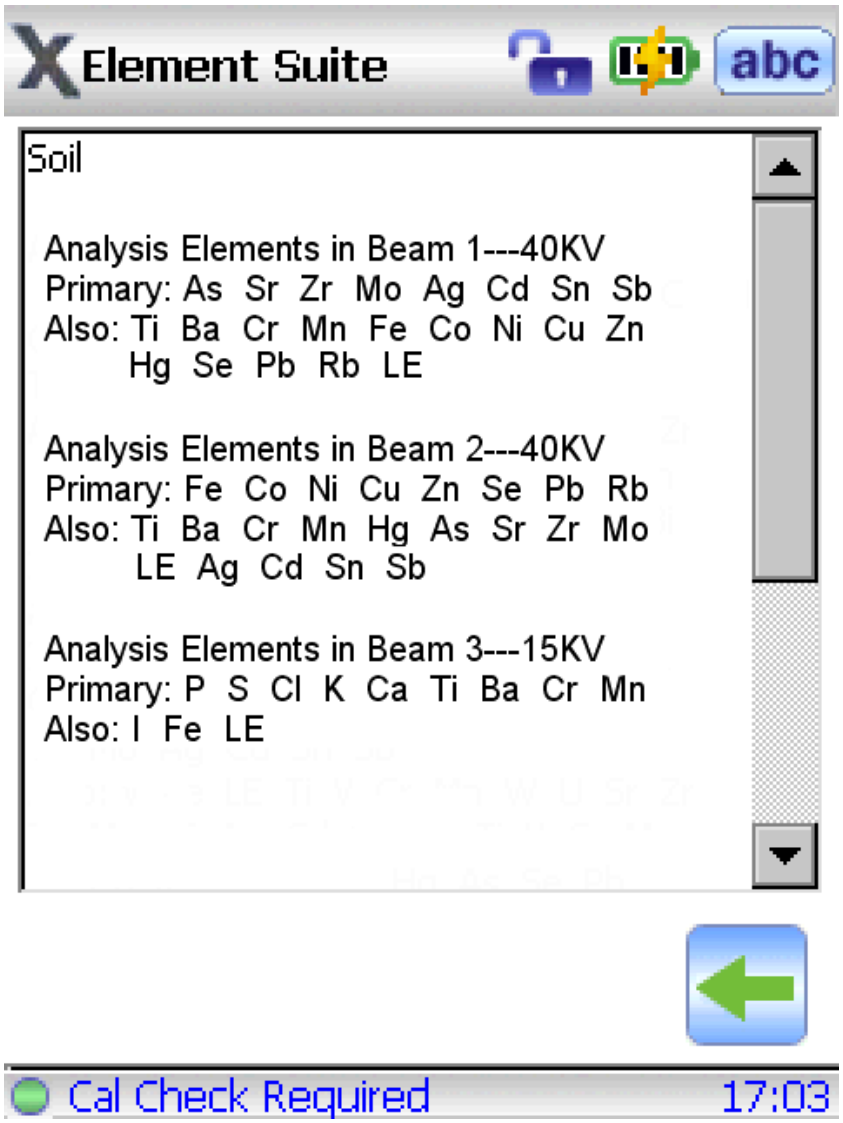
8. Use the screen facility to move the listed elements between the two panes, "Hidden" and "Shown"
9. Touchscreen control is provided by control arrows (Up/Down and Right/Left) and slider
10. When all the selections have been made, tap **OK** to save them and return to main **Test Conditions** screen.
11. Choosing the green "**Back Arrow" returns** to main **Test Conditions** screen, but any newly entered selections are not saved.

Element Suites

This facility is used by ALL modes.

Tap this button to get a listing of all the Analysis Elements that are provided by the chosen mode and its associated beam(s). An example (enlarged screen) is shown below:

Example, Element Suite Screen



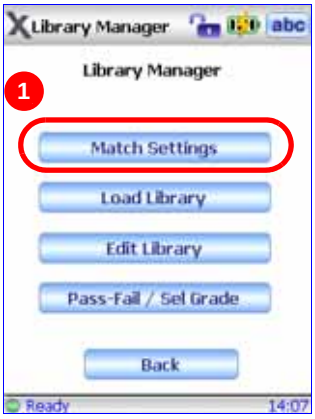
Library Manager

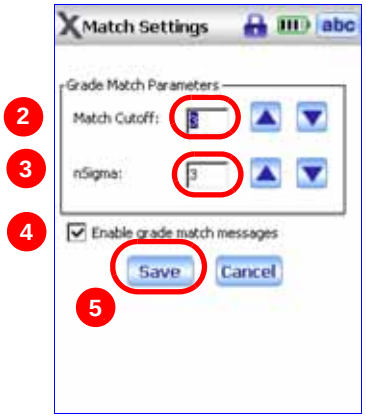
This function is used by "Alloy-oriented" modes such as Alloy, Alloy Plus, and Fast ID. There are four segments to Library Manager:

- Match Settings including —
  Grade Match Message option
- Load Library
- Edit Library
- Pass-Fail / Select Grade

Match Settings

1. From *Library Manager*, tap **Match Settings** to call **Grade Match** data entry screen.





Most users select the default values, but Olympus Innov-x recommends that you visit **Section 5** to get an understanding of **Match Issues,** particularly the concept of **Match Numbers.**

2. Enter the **Match Cutoff** value using the up/down arrows
3. Enter the **nSigma** value using the up/down arrows.
4. Select the "Enable grade match messages" checkbox if you want to use this feature. See segment "*Edit Existing Grades*" for the sequence of screens that implements **GMM**.
5. Tap **Save**.

Screens Showing Various Match Conditions

Match Number = MN

Good Match for 5052
Fair Match for 5454
(Aluminum Alloy Grades)

Exact Match for C623
(Copper Alloy Grade)

Exact Match for 5052-plus
Good Match for 6061
(Aluminum Alloy Grades)

Load Library

Load Grade Libraries data entry screen configures the types of libraries that are referenced during testing.

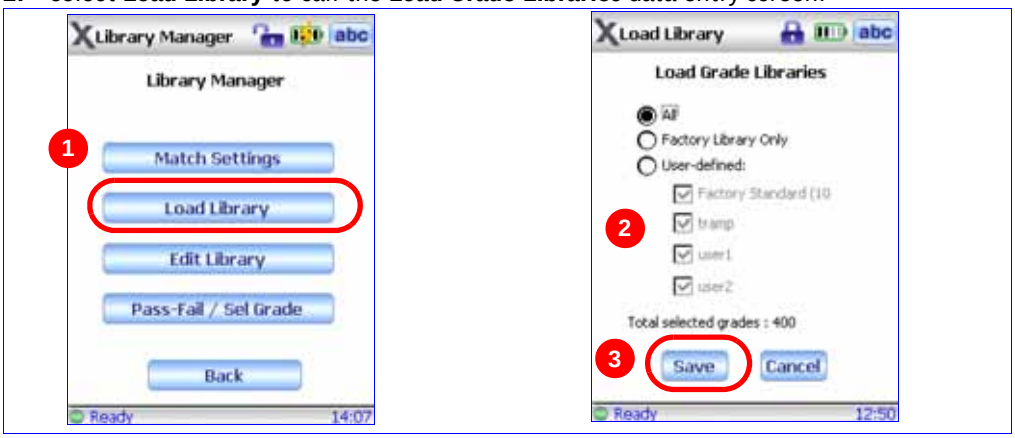
There are several choices:

- *All* - loads all four libraries for use during a test
- *Factory Library Only* - loads only the Factory Library (supplied by Olympus Innov-X)
- *User-defined* - loads selected libraries, which can include
  - Factory {Model} Library (contains over 400 grades)
    - Factory libraries are correlated to the instrument model
  - Tramp Library, (containing seven alloy bases; supplied by Olympus Innov-X)
  - Up to two User Libraries (each capable of holding over 500 grades).

GO TO

A complete listing of all the alloy grades that are contained in the Factory Library and Tramp Library is available in *Section A8* of "*Delta User Manual*," PN 103201 Rev A - May 2010.

1. Select **Load Library** to call the **Load Grade Libraries** data entry screen.

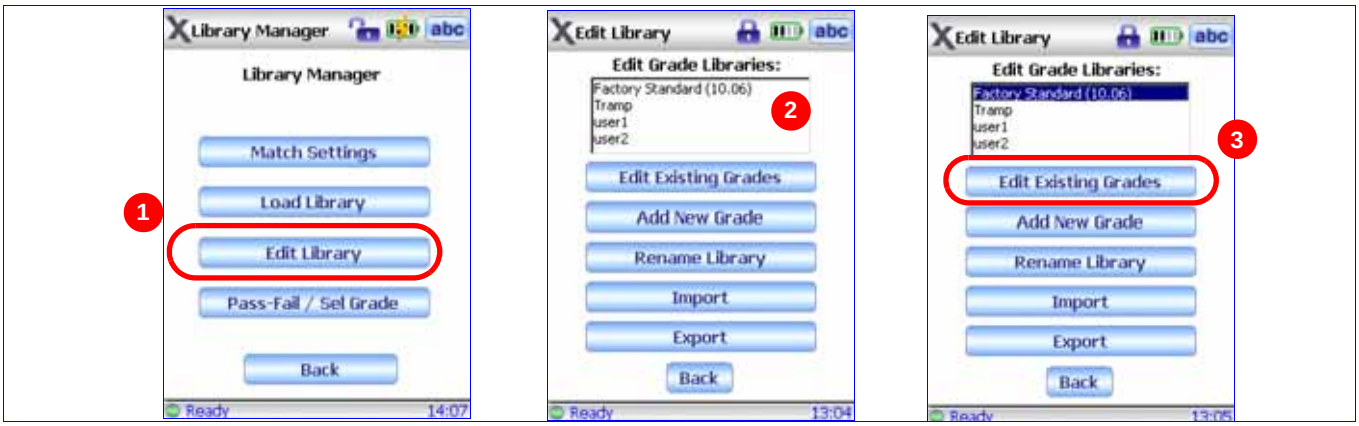


2. Use the **Option** buttons and **Checkbox** to make a selection
3. Tap **Save**

Edit Library

Edit Grade Libraries sub-menu introduces several configuration options that may be applied to Delta libraries. Grades can be **added** to **any** library and existing grades can be edited, including *Min/Max* values and grade names. Additionally, the two user-defined libraries can be renamed.

1. Choose **Edit Library** to access the **Edit Grade Libraries:** screen that has (a) window to select a library and (b) sub-menu of configuration options.



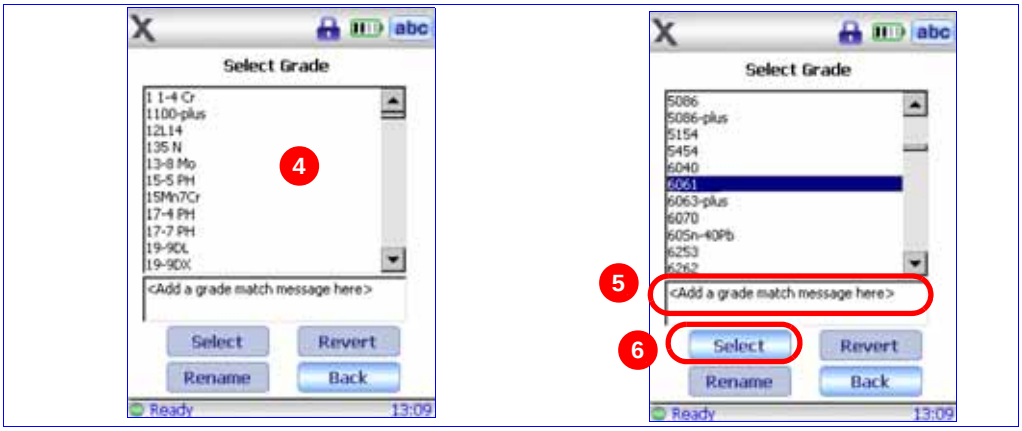
2. Via the touch screen select a library from the list of four; then choose a configuration task from the five options.

   For this Guide we choose **Standard** and examine every sub-menu option.

   Note that every chosen library has the same options.

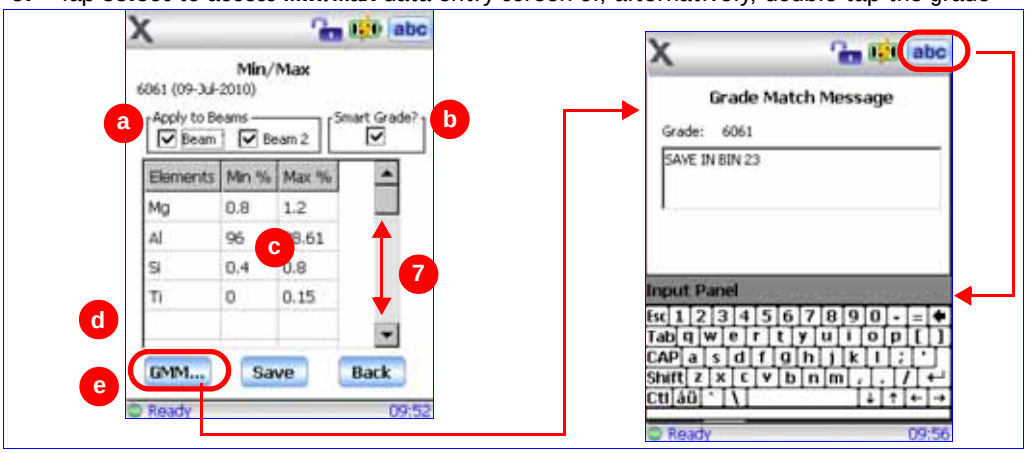
3. Choose **Edit Existing Grades** to call the **Select Grade Library** screen.
4. Use the slider (or up/down arrows) to scroll to the desired grade.

Edit Existing Grades including *Grade Match Message* Option



5. As an option, create a **Grade Match Message (GMM)** to apply to the selection.

6. Tap **Select** to access **Min/Max** data entry screen or, alternatively, double tap the grade



From this screen you have access to other features including:

a. Choose **one or both beams** for the subsequent changes to apply.
b. Select the **SmartGrade** option.
c. Edit an existing element by changing the element selected or the *Min* or *Max* values it is assigned.
   - All three fields are activated by tapping in the field.
d. Add a new element and assign it values for use during a test.
e. Tap **GMM** button for another way to enter a Grade Match Message.
   - Tap the **Input Panel** icon; use it to enter the appropriate message.

7. Configure an element by:

- Tapping in an existing item and changing the *Element*, *Min* or *Max* value.
- Using the slide bar to find the first *empty* field and adding an *Element*, *Min* and *Max* value.

8. Tap **Save** and the changes are added; the *Edit Grade Libraries* screen reappears.

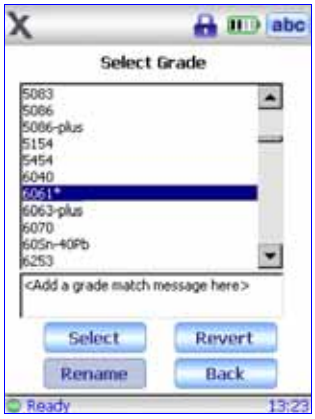
Other Editing functions from the Edit Grade Libraries > Select Grade screen:

Delete - **remove** a **grade** from a selected User-defined library (**NOT** the Factory or Tramp Libraries)

Rename - **change** the name of a **grade** from a selected User-defined library. (**NOT** the Factory or Tramp Libraries)

Revert - Return to the original grade composition.

Note: A grade with an asterisk means that an element in its composition has been changed.

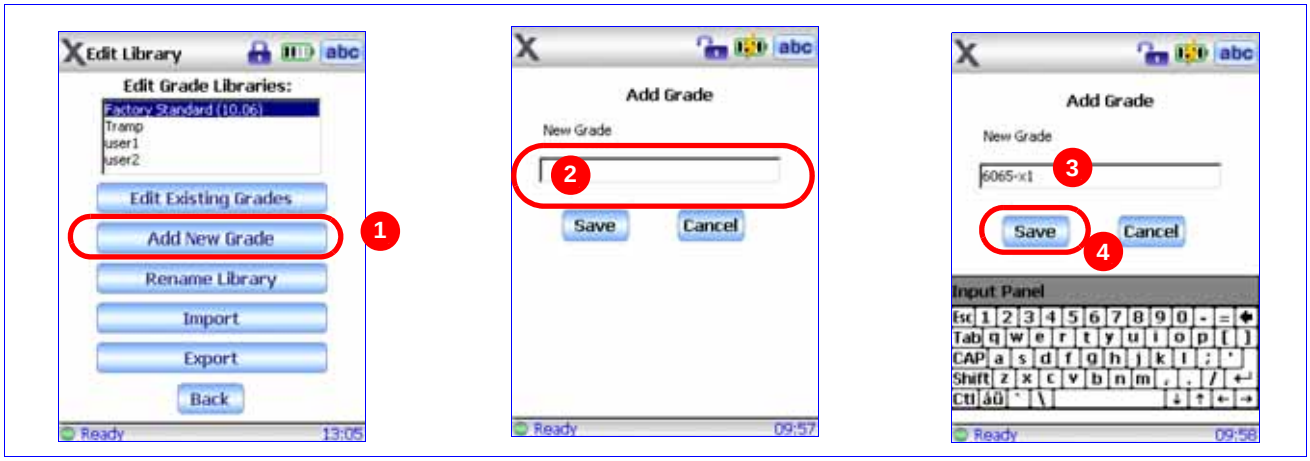


Typical Confirmation Screen

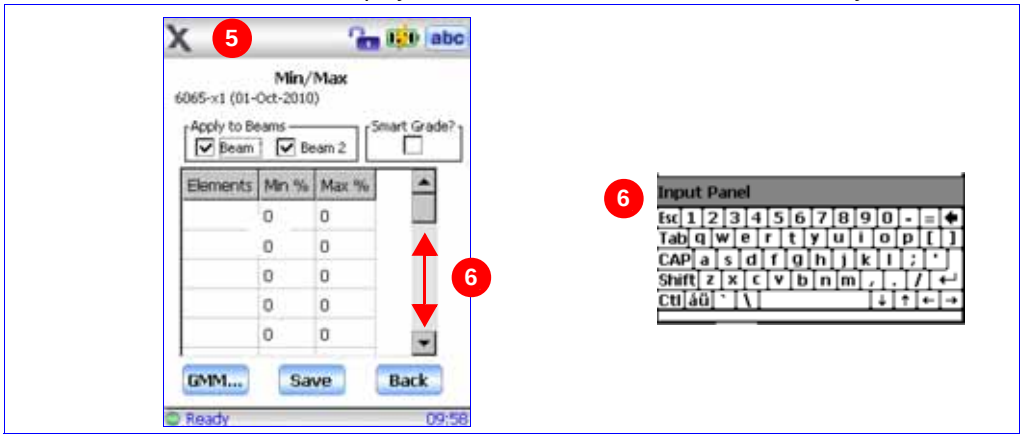
Add New Grade

Procedure to add a new grade to an existing library.:

1. From the **Edit Grade Libraries** select **Add New Grade** button to access the **Add Grade** entry screen.
2. Tap in the empty New Grade field to call the **Input Panel.**
3. Enter the new grade's name**.**



4. Tap **Save.**
5. A new **Min/Max** screen is displayed with all fields **blank** for new data entry.



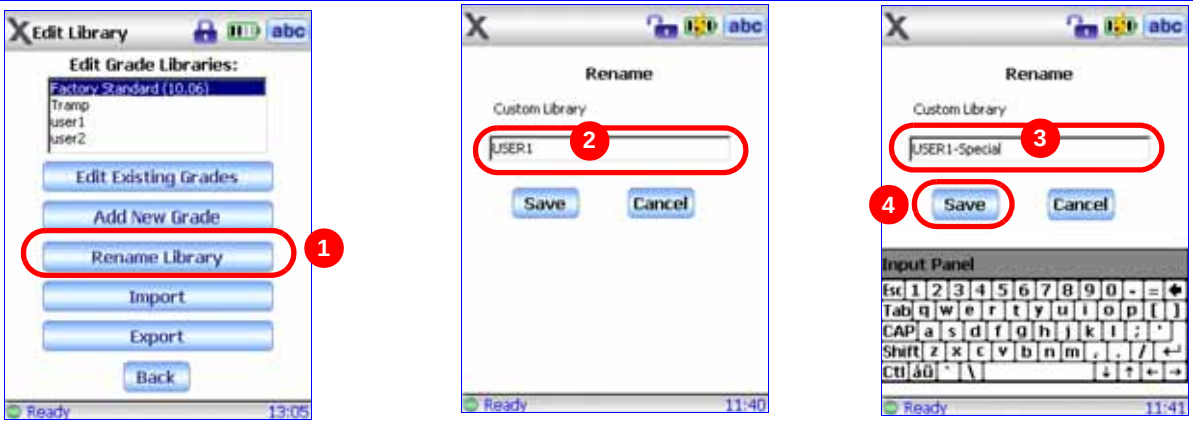
To accurately complete the **Add New Grade** function you must have a list of the minimum and maximum allowable concentrations of each element in the new grade. It is important to include *ALL* elements that may be present in an alloy, including the balance elements.

6. When entering data for this Min/Max screen, use the **Input Panel** for Element symbols and parameter values; use the slider to show more empty rows for additional elements.

Rename Library

Procedure to rename an existing library:

1. From the **Edit Grade Libraries** select **Rename Library** button to access the **Rename** entry screen**.**
2. Tap in the Custom Library field to call the **Input Panel.**
3. Enter the new library's name
4. Tap Save



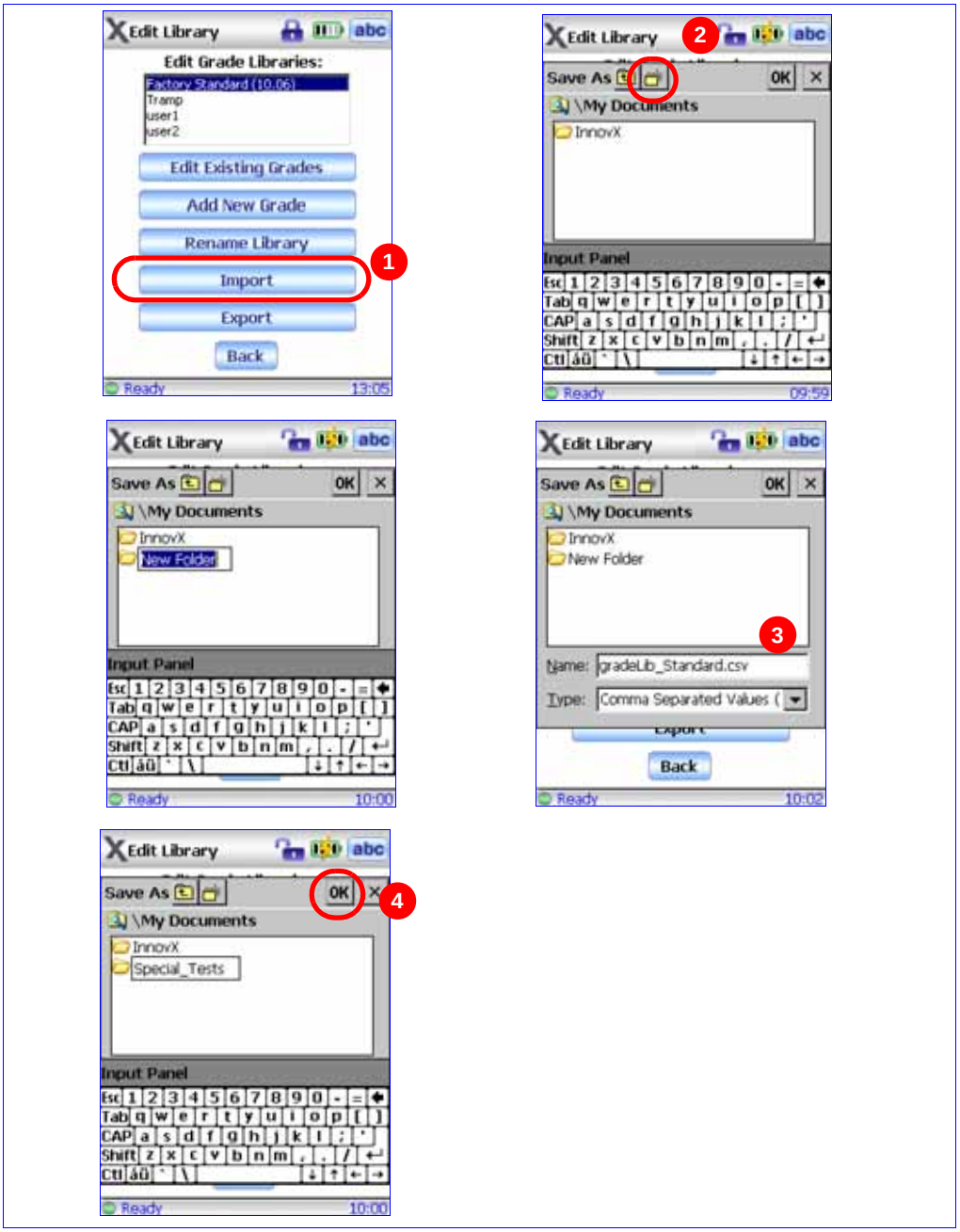
IMPORTANT

The software will **NOT** allow the ***Factory Libraries*** to be **renamed**.
See screen shown below.

Import

Procedure to import a Grade Library :

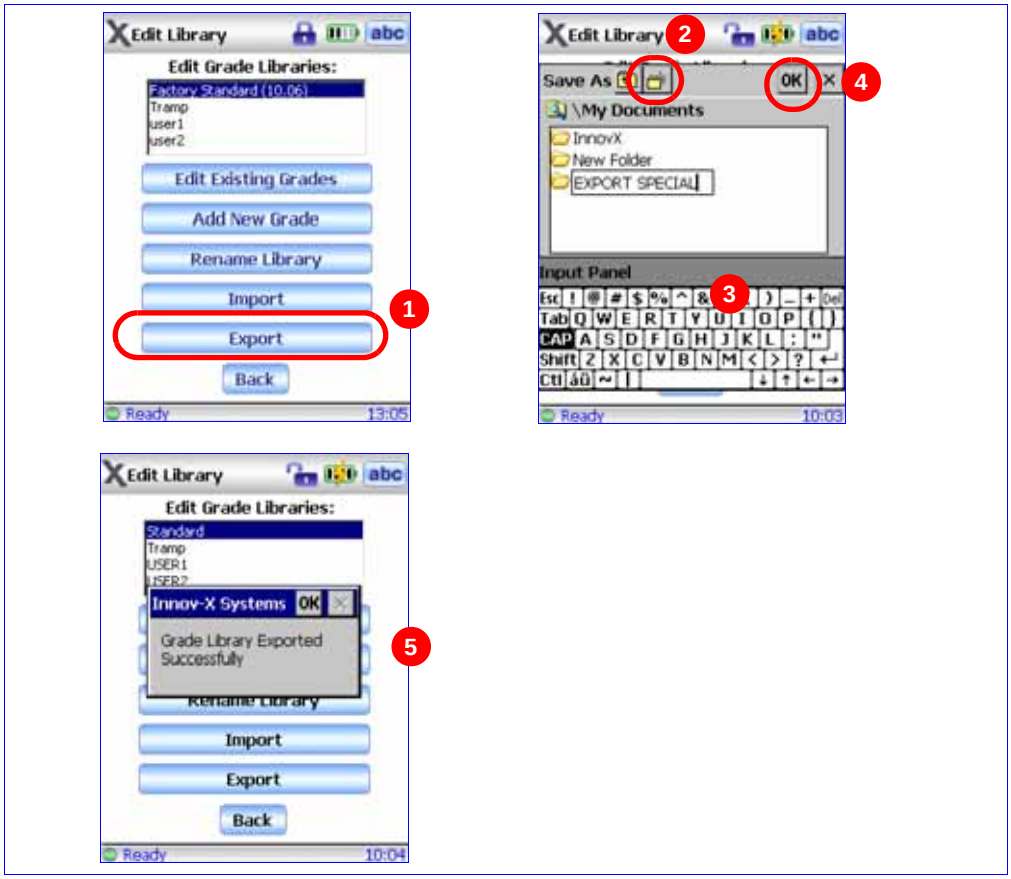
1. From **Edit Grade Libraries** select **Import** button to access the **Import** data entry screen**.**
2. Tap the New Folder icon to create a "New Folder" in the "My Documents" folder.
3. Use the **Input Panel** to enter the file to be imported.
4. Tap **OK**



Export

Procedure to Export a Grade Library :

1. From the **Edit Grade Libraries** select **Export** button to access the **Export** data entry screen**.**
2. Tap the New Folder icon to create a “New Folder” in the “My Documents” folder.
3. Use the **Input Panel** to enter the file to be exported.
4. Tap OK
5. Confirmation screen gives result of Export



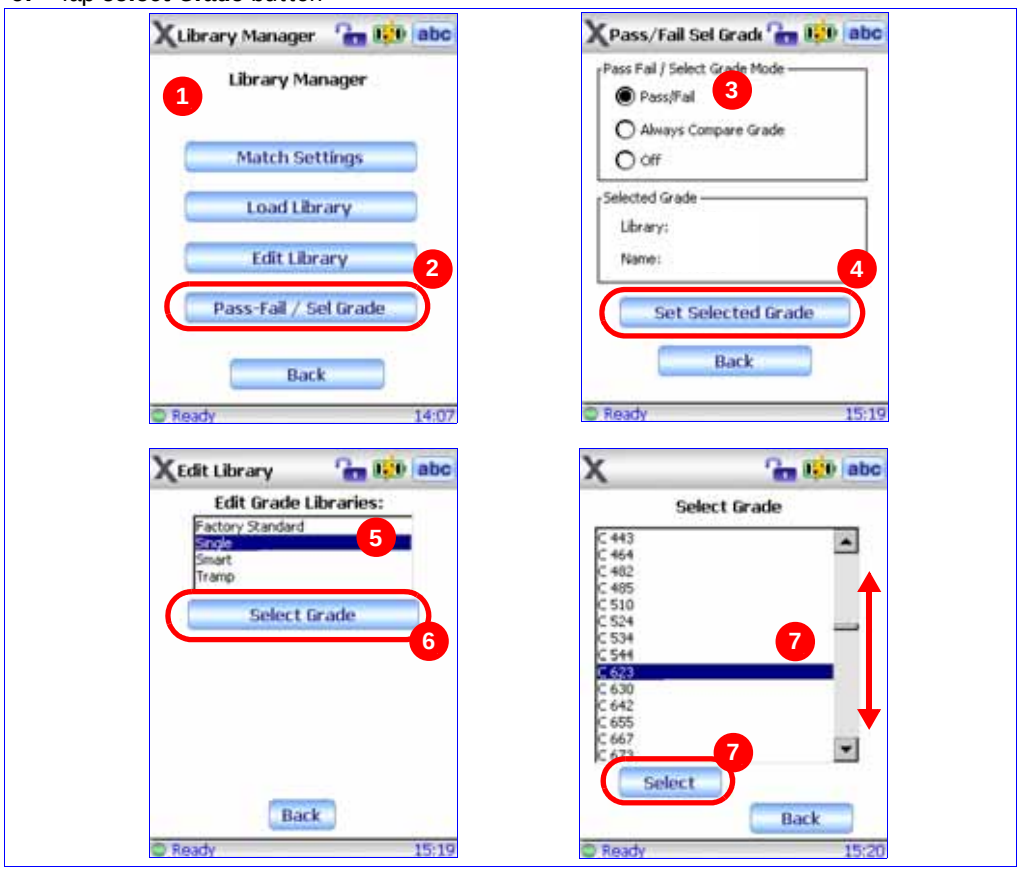
Pass-Fail / Sel Grade

The Pass-Fail capability is one of the most useful features within the Alloy or Alloy Plus modes. Note this prerequisite:

- Ensure that "*SmartSort*" is selected in the Alloy Plus Options

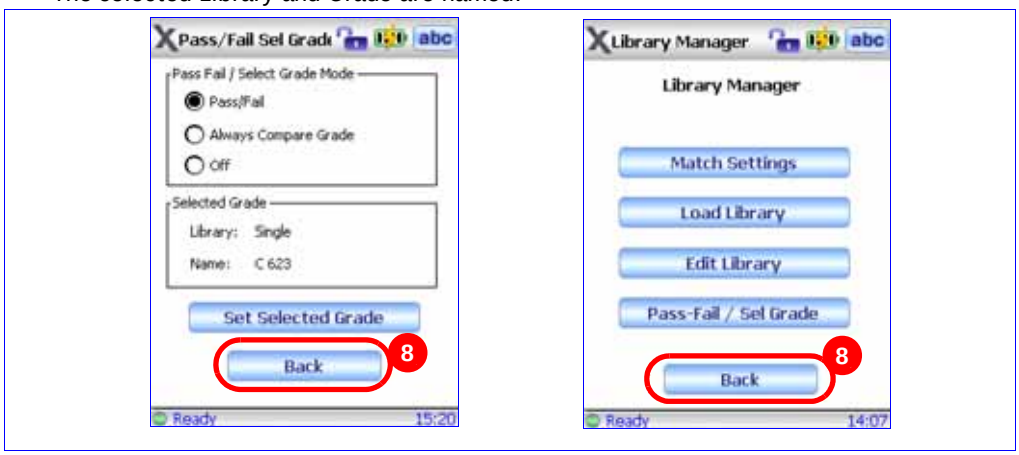
Procedure to create a typical **Pass-Fail** operation

1. Select **Library Manager** from the **Mode Setup** menu
2. Select **Pass-Fail / Sel Grade** from the **Library Manager** menu.
3. Check **Pass/Fail** in the upper option area
4. Tap **Set Selected Grade** button
5. Choose the Grade Library that contains the target alloy grade from the **Edit Library - Edit Grade Libraries:** screen.
6. Tap **Select Grade** button



7. Scroll down to highlight the target grade and tap **Select**.
   Returns you to the **Pass/Fail Sel Grade** screen

The Selected Library and Grade are named.



8. Tap **Back** to return to the **Library Manager** menu; then **Back** to return to **Mode Setup** main menu.

9. Tap **OK** to return to the **Setup** Pane.

10. Choose the **Test** icon to move to the main test screen

11. Tap **Go** to initiate a test

12. The Test result in this example is a "**PASS**" for copper alloy C623.

Mode Setup: RoHS/WEEE

An instrument using the RoHS/WEEE mode has many special configuration considerations and several configuration areas that are **identical** to other areas of previously described modes. This segment describes the RoHS-specific areas.
Pointers for configuring identical functions are provided as appropriate.

After choosing the RoHS/WEEE mode icon, tap the **Mode Setup** button.

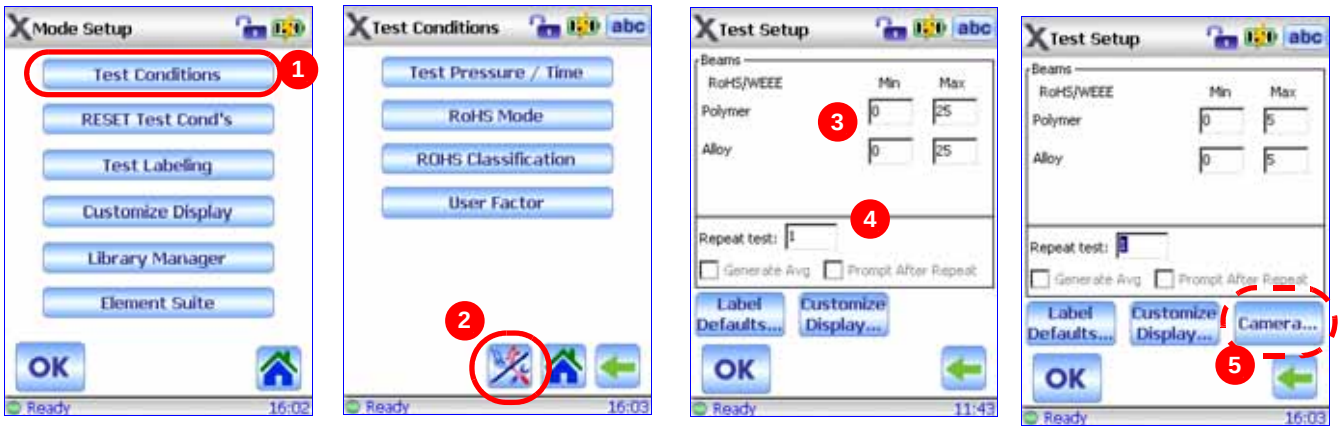
Test Conditions

Test Conditions permits several variables to be defined. Data entry screens are as follows. The first set of variables are the Test times .

1. Select **Test Conditions** button from the **Mode Setup** menu
2. Tap the "**Test/Tools Combo**" icon to access the **Test Setup** screen.
3. Enter the test times for each beam.

NOTE: Sample classification does not occur before Min Test Time is achieved; with SDD-based units (with Min set at 0 or 1) this is not an issue.

4. Insert a value into the Repeat Test text box.
5. Configure camera, if installed.



GO TO

Pointer List for IDENTICAL Mode Setup Screens

Mode Setup Feature	Configuration Page
Test Pressure / Time	23
Camera	22
User Factors	28

TIP

Section 5, "Appendix" has a discussion of these topics:

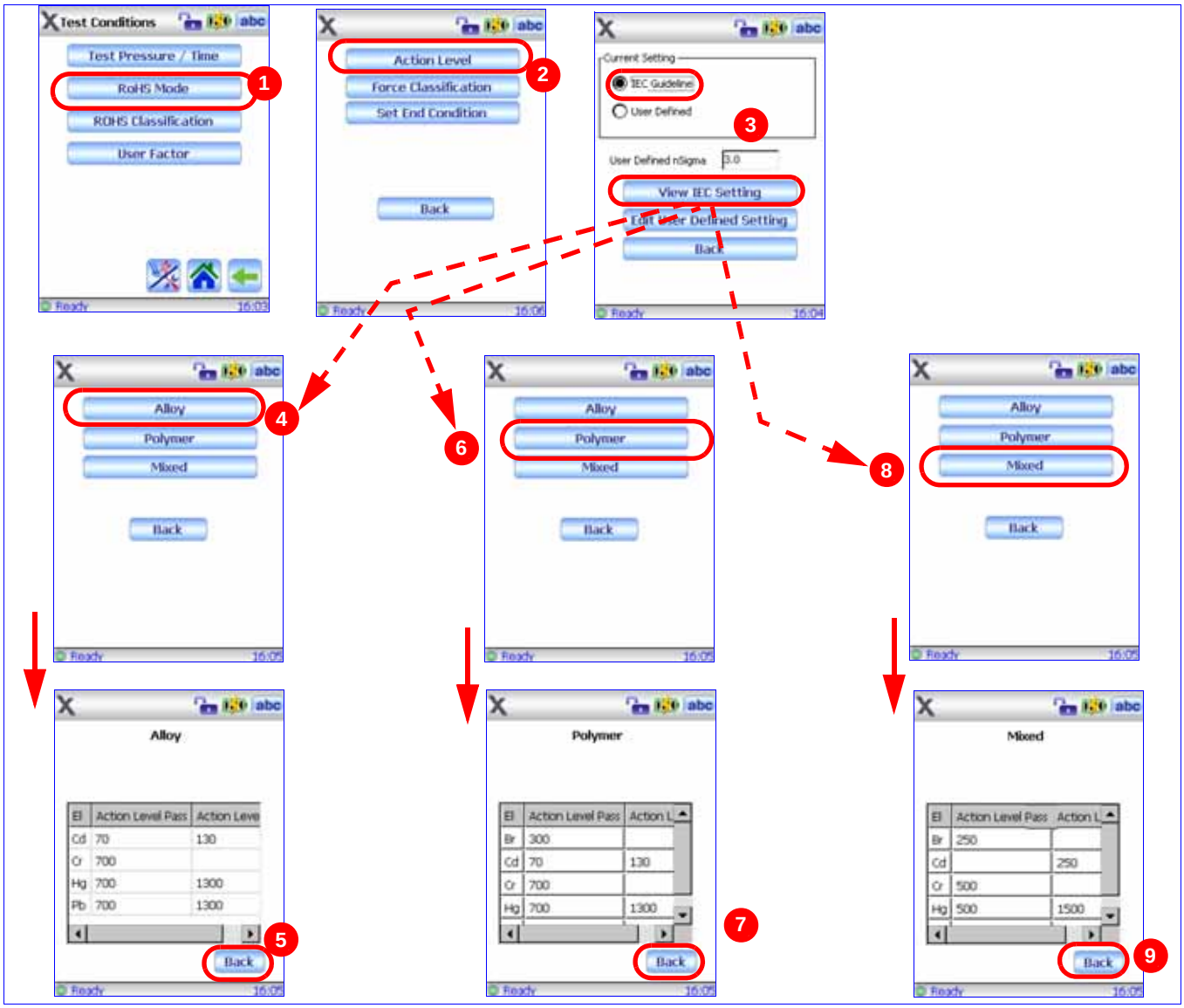
- **RoHS/WEEE**
- **Camera**
- **User Factors**

Test Conditions Configuration, continued

1. Select **RoHS Mode** to access the first screen of a set of RoHS-specific menus and data entry screens.
2. Select **Action Level** to access the second screen

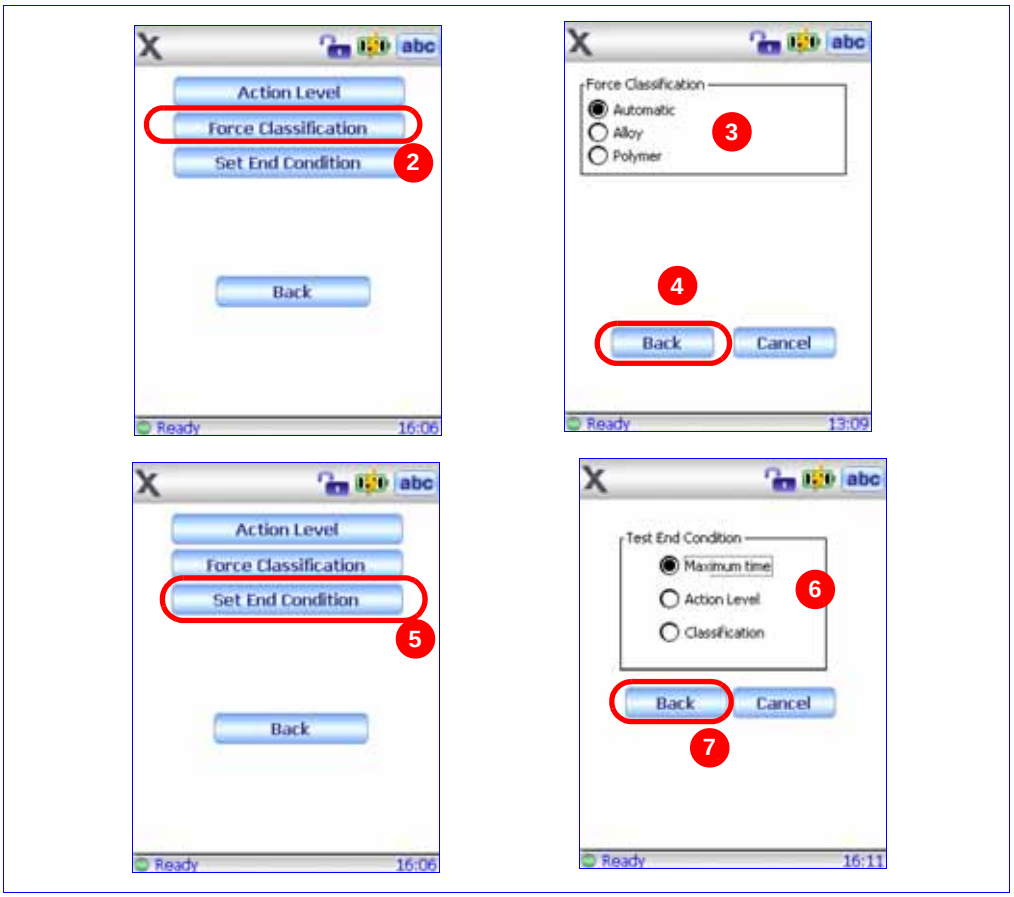
IEC GUIDELINE SETTINGS

3. Check IEC Guideline and tap **View IEC Setting**
4. Select **Alloy**
5. View the official IEC "Alloy" complement of Elements and Action Level Pass/Fail values. tap **Back**.
6. Select **Polymer**
7. View the official IEC "Polymer" complement of Elements and Action Level Pass/Fail values; tap **Back**.
8. Select **Mixed**
9. View the official IEC "Mixed" complement of Elements and Action Level Pass/Fail values; tap **Back**.



After reviewing the **Action Level** parameters, use these instructions:

1. Navigate back to the first RoHS-specific menu.
2. Select **Force Classification**
3. Choose a type of Force Classification that meets your testing requirements.
   - Automatic (Allow application to choose)
   - Alloy (Beam 2) (Useful since Al won't classify)
   - Polymer (Beam 1) (Useful for specific sorts)
4. Tap **Back**
5. Select **Set End Condition**
6. Choose a type of Test End Condition that meets your testing requirements.
   - Maximum time (as configured by Test Setup)
   - Action Level (One element "Fail" or All elements "Pass")
   - Classification (example, Polymer-Beam1; Two second sort for PVC)
7. Tap **Back**



USER DEFINED SETTINGS

IEC Guidelines are commonly accepted screening values for XRF testing. In some circumstances, users may choose to apply their own screening values. Items (one or both) requiring modification are:

- List of test elements
- Pass/Fail/Inconclusive levels

— The procedure for making changes is:

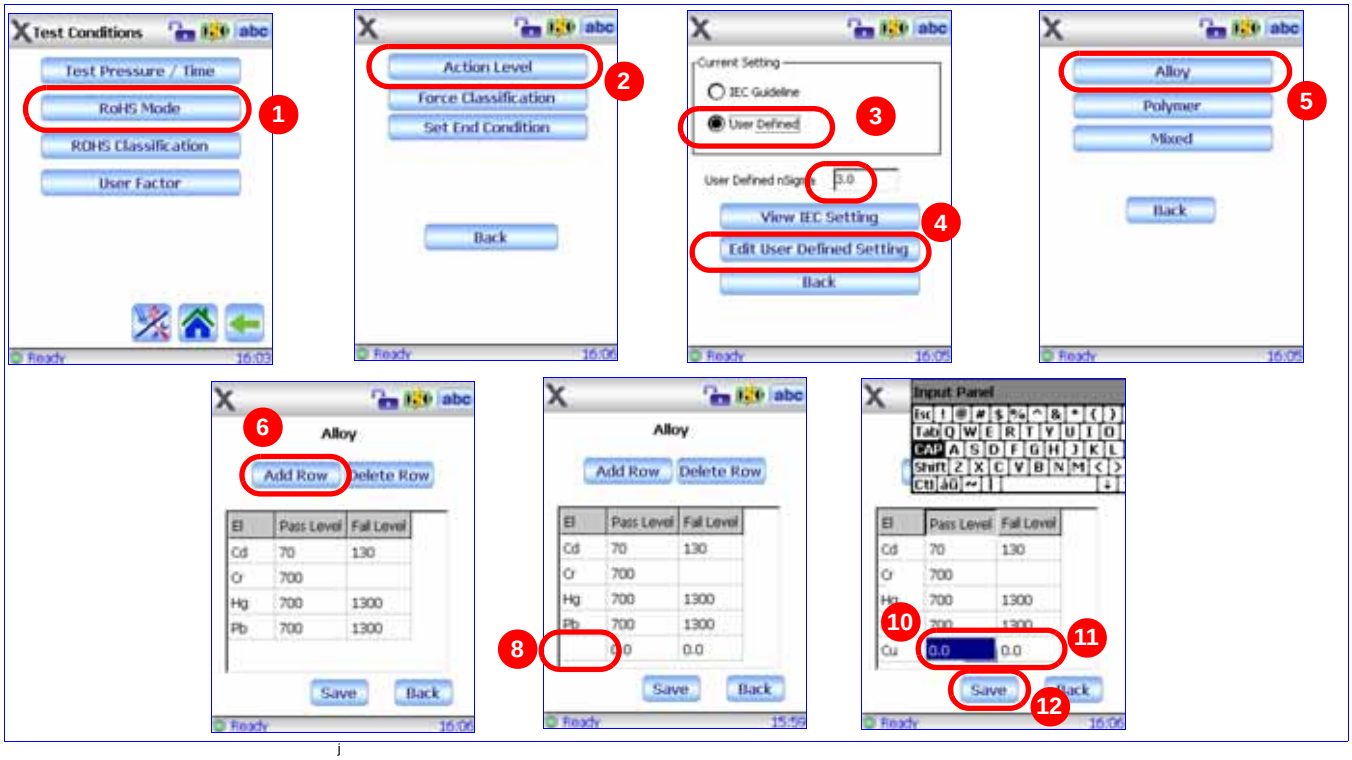
1. Select **RoHS Mode** to access the first screen of a set of RoHS-specific menus and data entry screens.
2. Select **Action Level** to access the second screen
3. Check User Defined; enter a **User Defined nSigma** number (default is 3.0);
4. Tap **Edit User Defined Setting**
5. Select **Alloy**

— To change the list of Test Elements

6. Select **Add Row** or **Delete Row** button

— To Add Row and Change Pass/Fail Levels

7. Select **Add Row** button; a new empty row is added to the list
8. Tap in the empty **Element** cell to call a drop-down list of elements (in alphabetical order)
9. Scroll down to the desired element and select it.
10. Tap the **Pass Level** cell; enter the **value**
11. Tap the **Fail Level** cell; enter the **value**
12. Select **Save;** returns to the Action Level sub-menu.



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TIP

- If you set Pass and Fail action levels EQUAL to each other, and set nSigma to ZERO, this effectively eliminates the Inconclusive range, giving only a Pass or Fail result.
- Each classification (Polymer/Mixed/Alloy) has its OWN set of Action Levels.
  - For example, changing for Polymer settings will NOT affect Mixed samples.

— To Delete Row

13. Select **Alloy** again

14. Highlight the row on the data entry screen

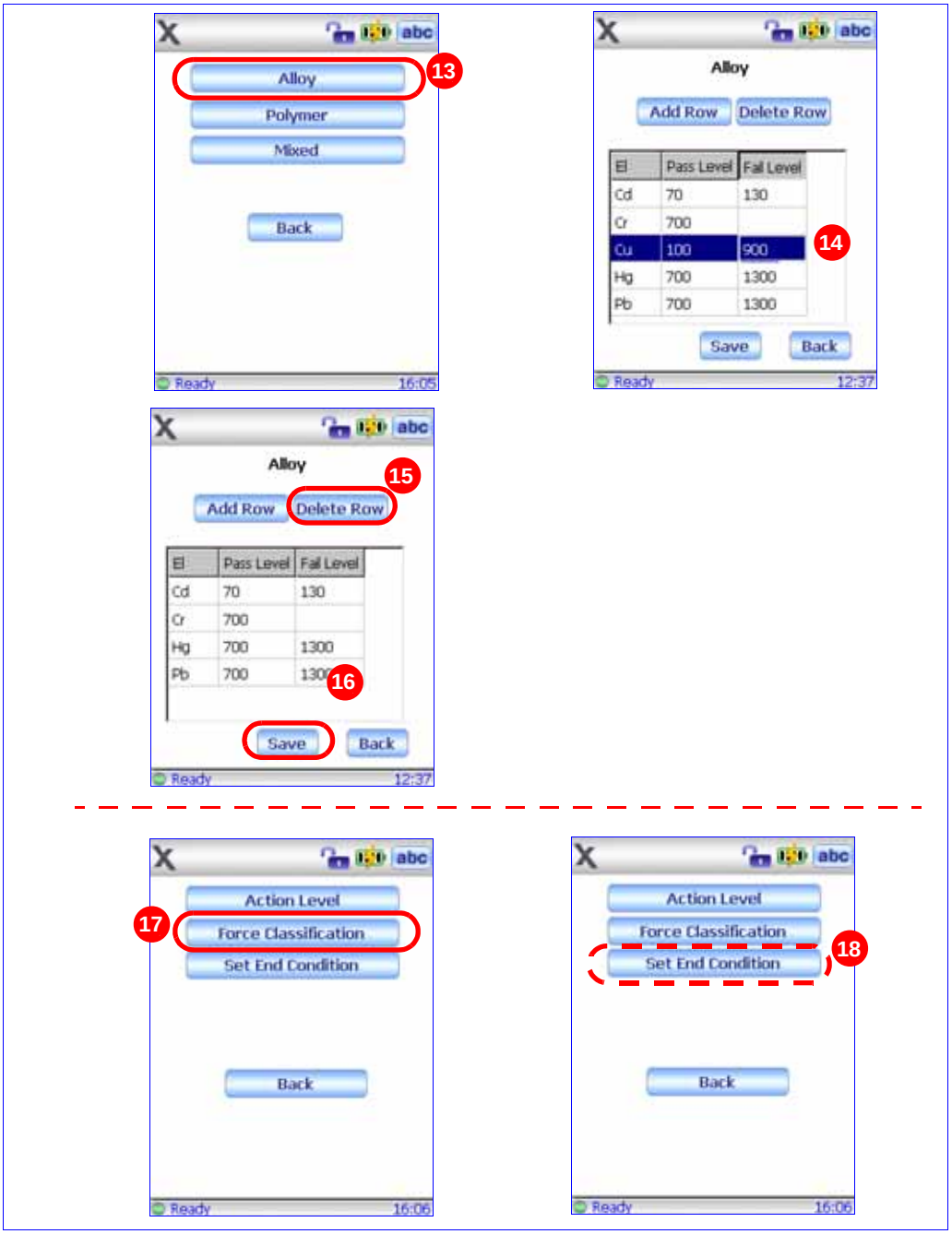
15. Tap **Delete Row** to remove it.

16. Select **Save: return** to the Action Level sub-menu

For Polymer and Mixed categories, use the same data entry techniques.

17. Navigate back to the first RoHS Mode.

18. Enter data values for Force Classification and Set End Condition using same procedure as described above for the IEC selection



User Factor (RoHS/WEEE Specific)

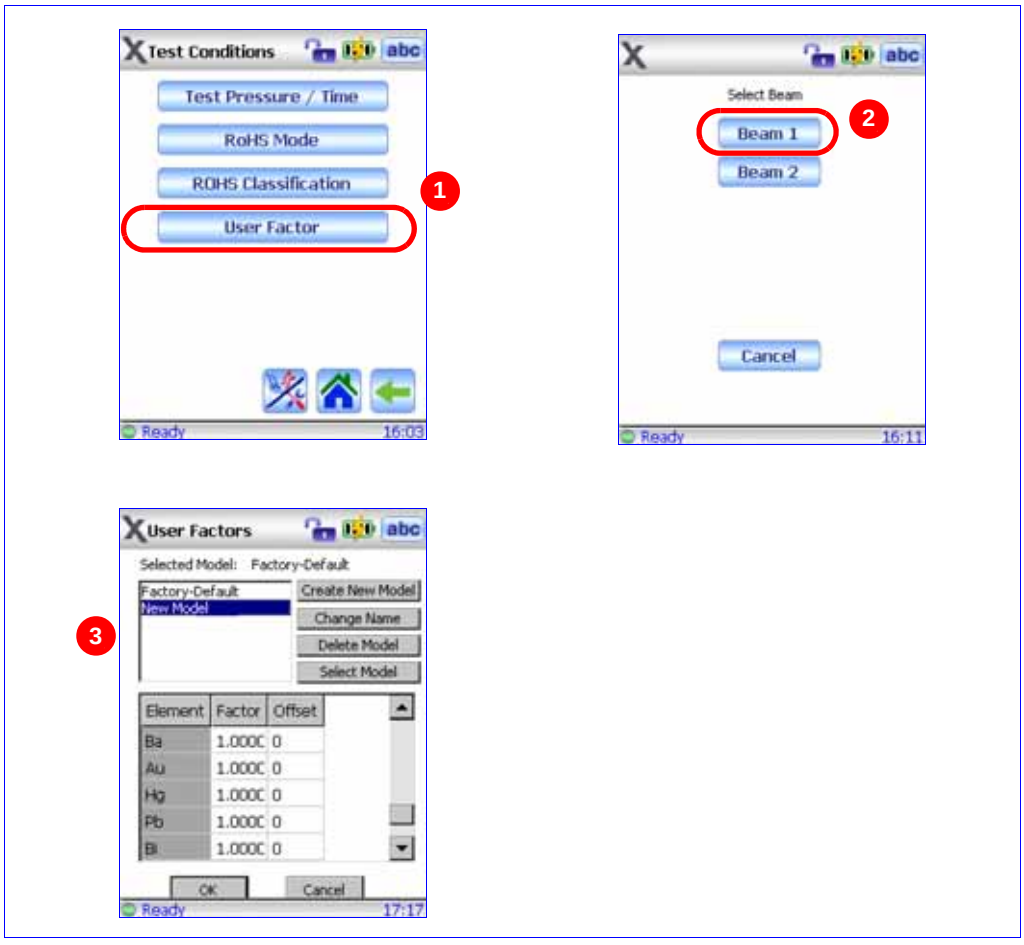
Method for configuring **User Factor** in RoHS/WEEE mode is similar to the procedure used for Soil and Mining modes with one additional variable choice.

1. Select **User Factor** from **Test Conditions** menu
2. Choose the appropriate Beam
   - Beam 1 for Polymer/Mixed testing
   - Beam 2 for Alloy testing
3. After the beam selection, the **User Factors** data entry screens are identical to those utilized by Soil and Mining modes. See Page 14.

Prerequisite:

Prior to using the User Factors data entry screens, it is necessary to create "factors" and "offsets" from known assay samples.

See **Section 5** for an application note concerning techniques to establish these "translation" variables.



TEST

A **Test** screen can show content in **two** forms:

- An **elemental (chemistry) list** with key parameter values
- A **graphic view** of spectrum plots

Test screens for the various modes have **similar, but not always identical**, characteristics.

Follow these **guidelines t**o work with the Test facility:

1. Ensure that the mode's **Test Conditions** are properly chosen.
2. Tap the **Test** icon on the **Home** screen
   This calls the **Test screen** which displays the most recent test activity.
3. To start a test:
   a. Pull the trigger (this toggles the instrument to X-ray ON state)
   — **or** —
   b. Tap **Start** button on the UI (this toggles the instrument to X-ray ON state)
   — **or** —
   c. Pull-and-hold the trigger with the "Deadman Trigger" active.

GO TO

See **"***Delta User Manual,"* **PN 103201** for description of trigger operations

An elemental Test screen has **three** functional areas:

- Upper status region
- Main test content
  - Elemental list
- Lower navigation region
  - Start/Stop button plus access to Test, Results, and Home facilities.

These areas are displayed with presentation details on the next three pages.

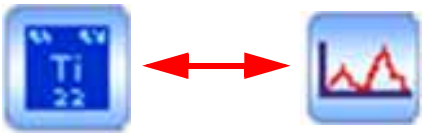
A completed Test displays the following key information (depending on selected mode):

- **Detected elements** are posted first, followed by a list of **non-detected** elements and calculated Limits of Detection for these elements.
- **Concentration** of the elements
  - **PPM** for Soil,
  - **Percent** for Alloy and Mining,
    — followed by the error on the measurement (+/-).
- **Pass/Fail** within various modes
  - Alloy and Alloy Plus: decision-making on a selected element
  - RoHS/WEE: decision-making relative to IEC or user-defined guidelines.

The elemental (chemistry) content can be displayed by its **x-ray fluorescence spectrum**.

Using on-screen icons you toggle between the display methods

.

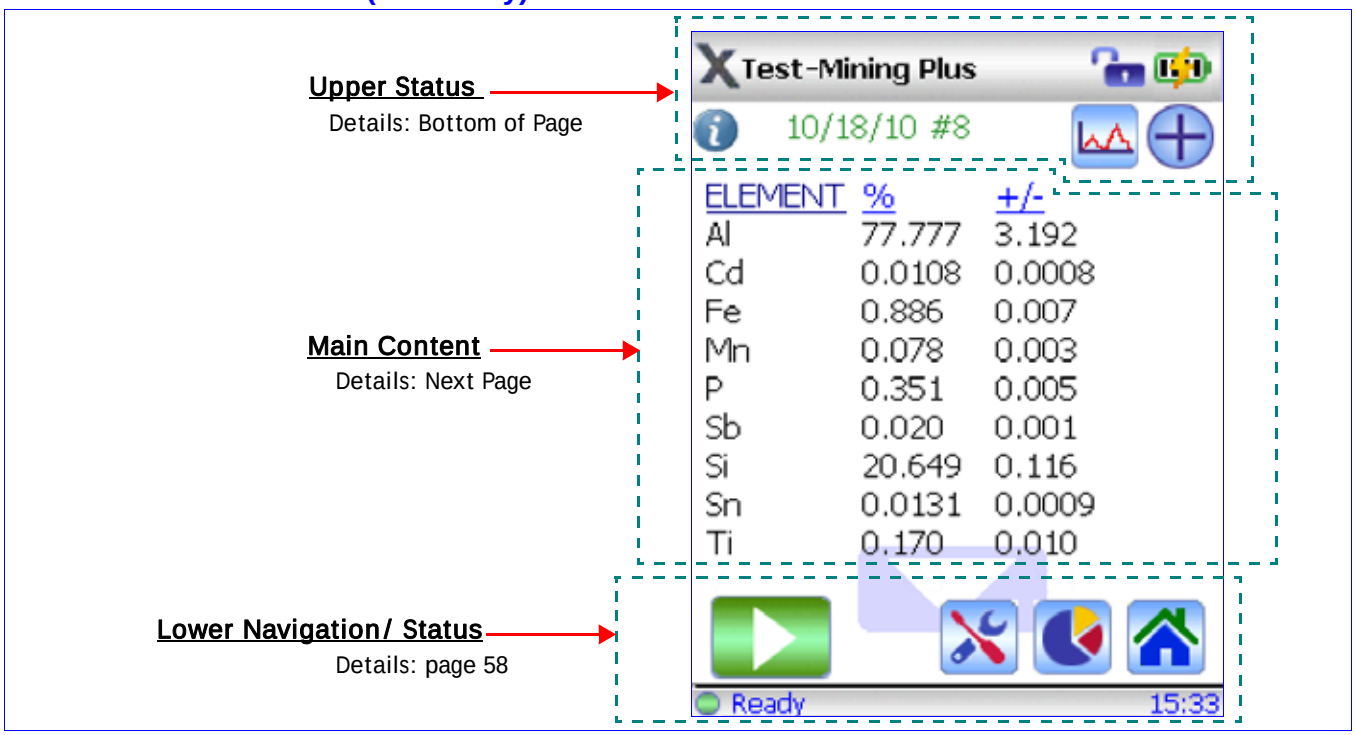


Typical Test screens are shown on pages 62 to 63.

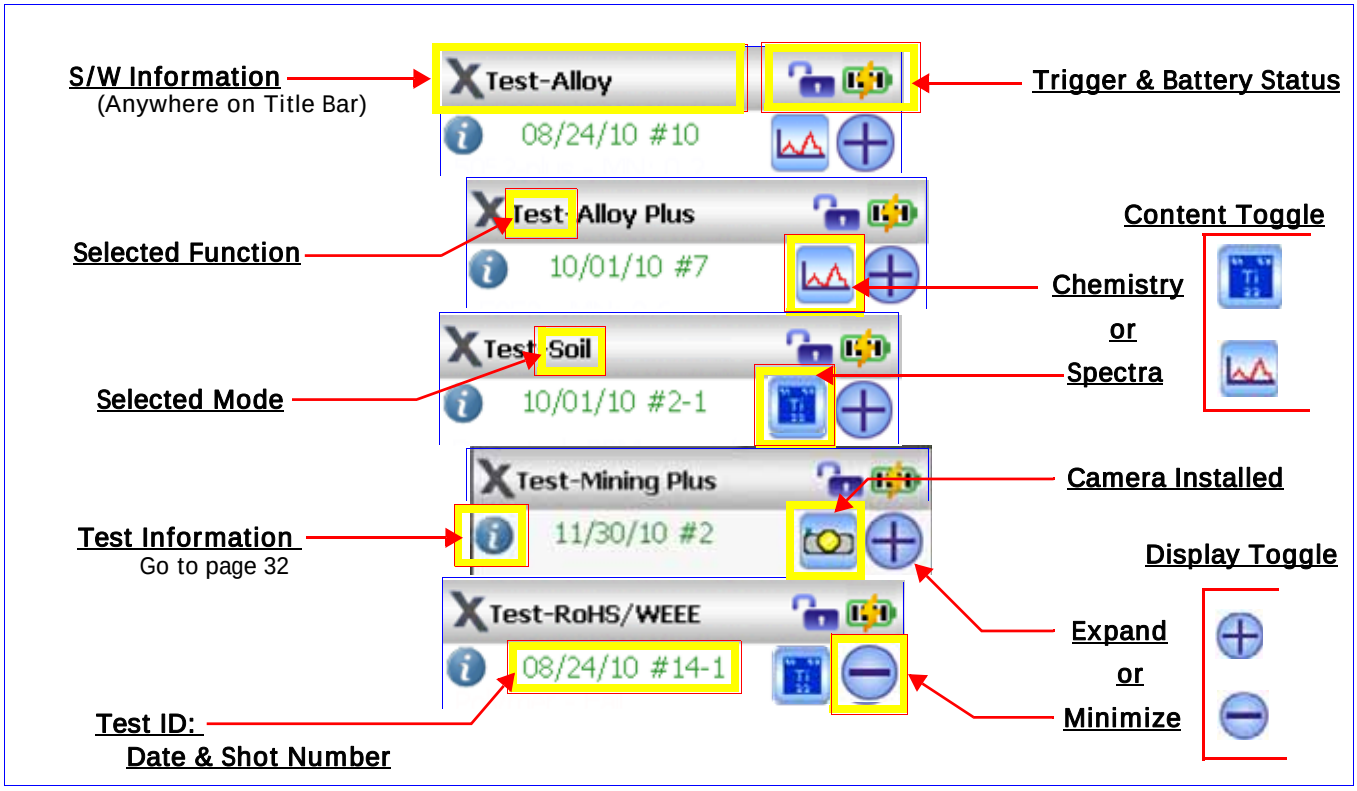
Tour of Test Screens

Three areas of the Elemental Test screen are described here:

Element (Chemistry) Test Screen - Three Main Areas

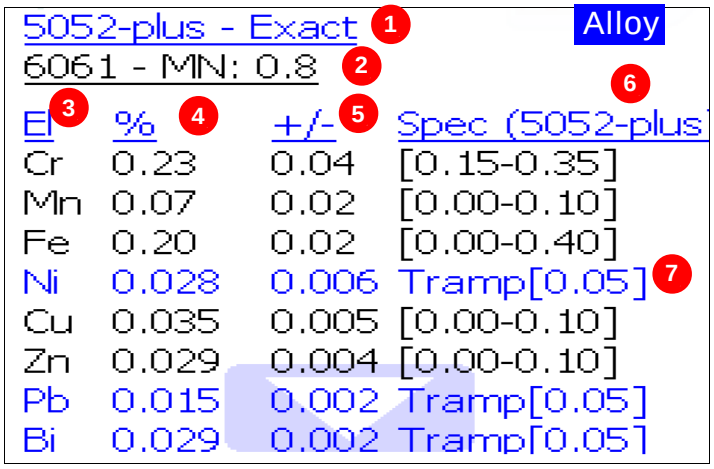


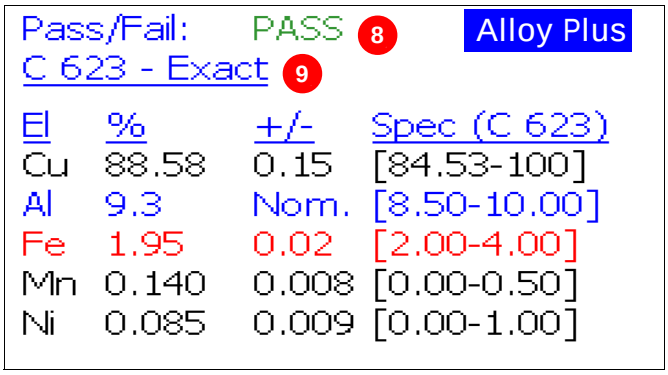
Upper Status Area

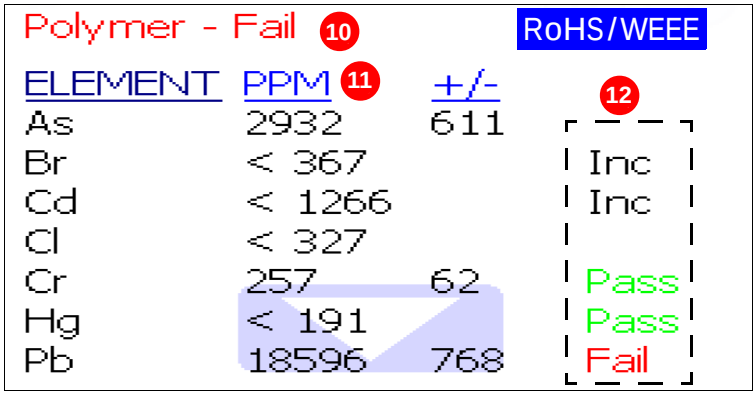


Main Content Area

This is the key information display area. Examples shown below in left column are from several modes. The column on the right clarifies the labels, results, and fields.







GRADE MATCH RESULTS

1. **Exact** Match to selected grade
2. **MN** - Match Number; under 2.0 is a close grade match

ELEMENTAL ANALYSIS RESULTS

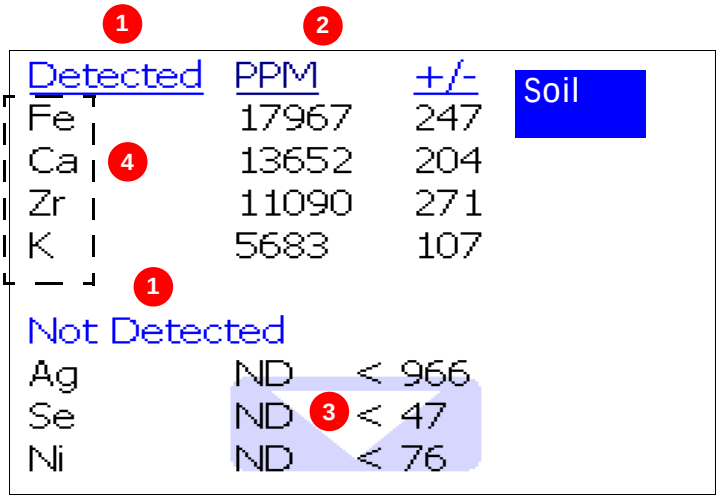
3. **El**(ement) symbol for the element; click header to sort the El list.
   Click to sort columns 4 & 5, as well.
4. **%** (detected): percent of the element detected in the test.
5. **+/-** the uncertainty of the measurement, calculated as the one-sigma error.
6. **Spec**(ification) - chosen from a Grade Lib
7. Tramp element; see Appendix for Factory Library lists
8. Outcome of Pass / Fail test
9. Exact match to selected grade

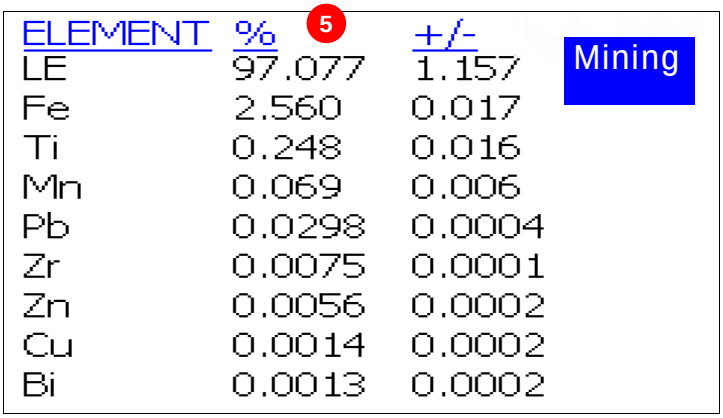
ROHS ANALYSIS

10. Outcome of test using IEC specifications for defined elements.
11. **PPM** Part per million of the element detected. This means that statistically speaking the ppm was low enough to be considered "not present."
12. Outcome of testing for each of five IEC defined elements: Br, Cd, Cr, Hg, Pb

Main Content Area, continued

This is the key information display area. Examples shown below in left column are from several modes. The column on the right clarifies the labels, results, and fields.





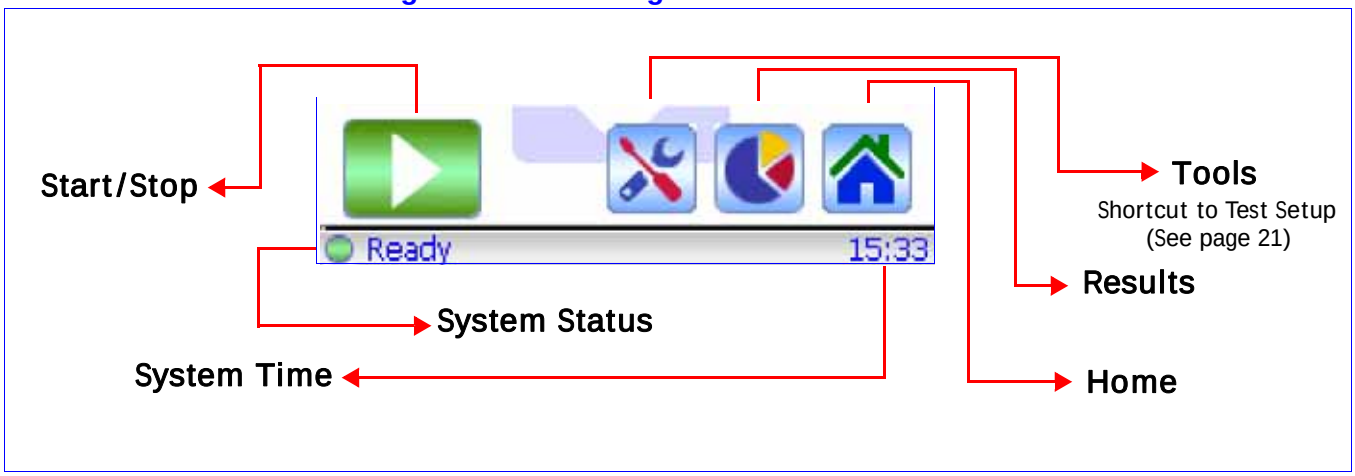
SOIL FEATURES

1. Both Detected & Not Detected are shown
2. Elements are in PPM order
3. Keep scrolling down to see more ND elements - tap or press and hold
4. Custom Display used to specify major elements of interest

MINING FEATURES

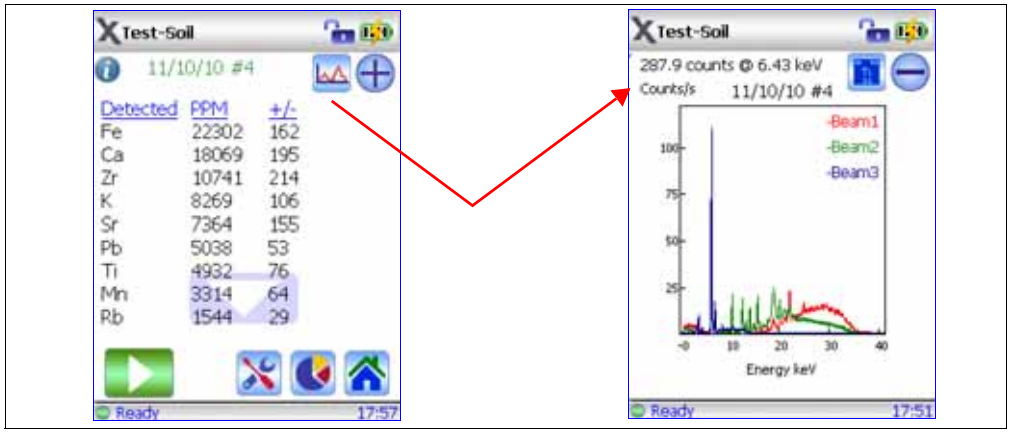
5. Elements are in **% detected** order. All these columns may be sorted by selecting the heading.

Lower Navigation / Status Region

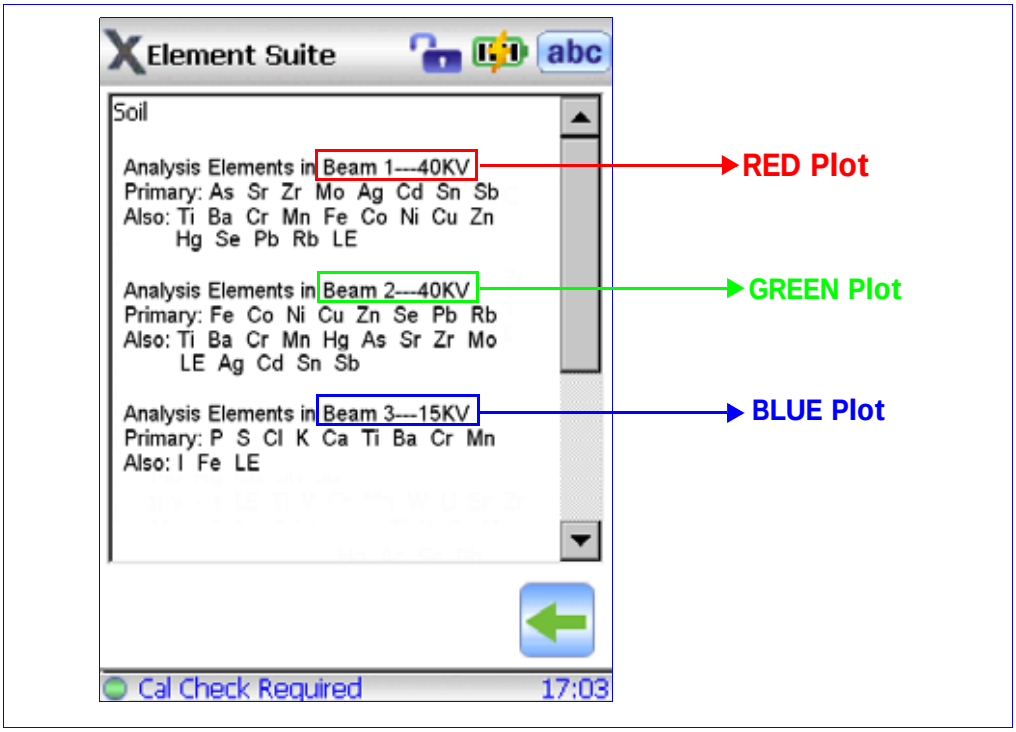


Spectrum Display Screen

A **Test** screen can show **either** Elements {Chemistry} and Spectra. Using on-screen icons you **toggle** between the two information displays.
The spectra screen shows the x-ray fluorescence spectrum for an individual test, plotting the intensity on the y-axis versus the energy of the fluorescence x-rays on the x-axis.



As an example, the Soil mode supports three beams. The spectrum plot displays a test result with three colors. Each plot can be referenced to the Analysis Elements for that beam.



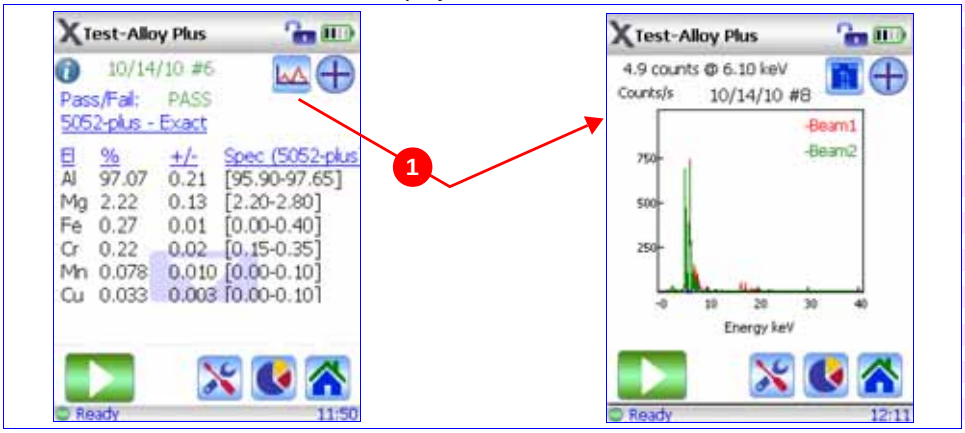
The spectral plot screen, in conjunction with the instrument's membrane keypad buttons, contains several features useful for customizing graphical results. These include:

- Emission Lines Display
- Zoom/Unzoom

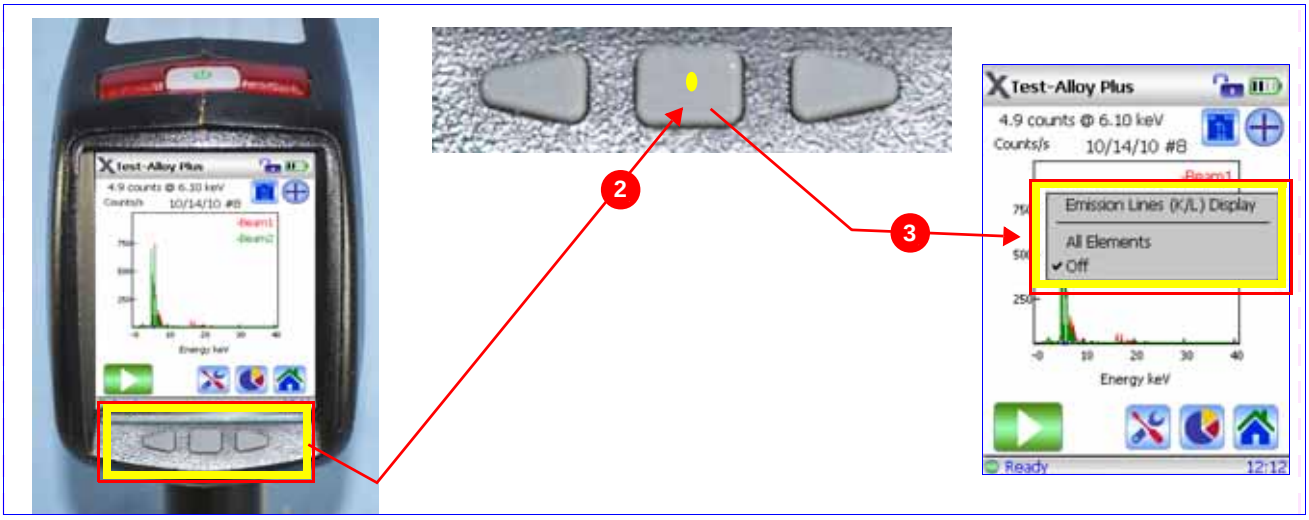
Emission Lines Display

Procedure to exhibit emission lines for your current completed test.

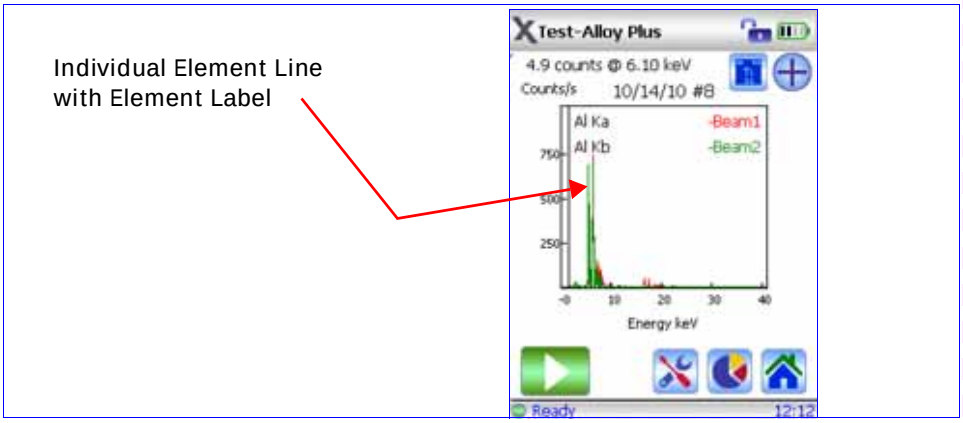
1. From the **Test** screen, tap the **Spectrum** icon to replace the Elemental list with the corresponding Spectral plots. Depending on the analyzer's model and mode, plots for one, two, or three beams are displayed



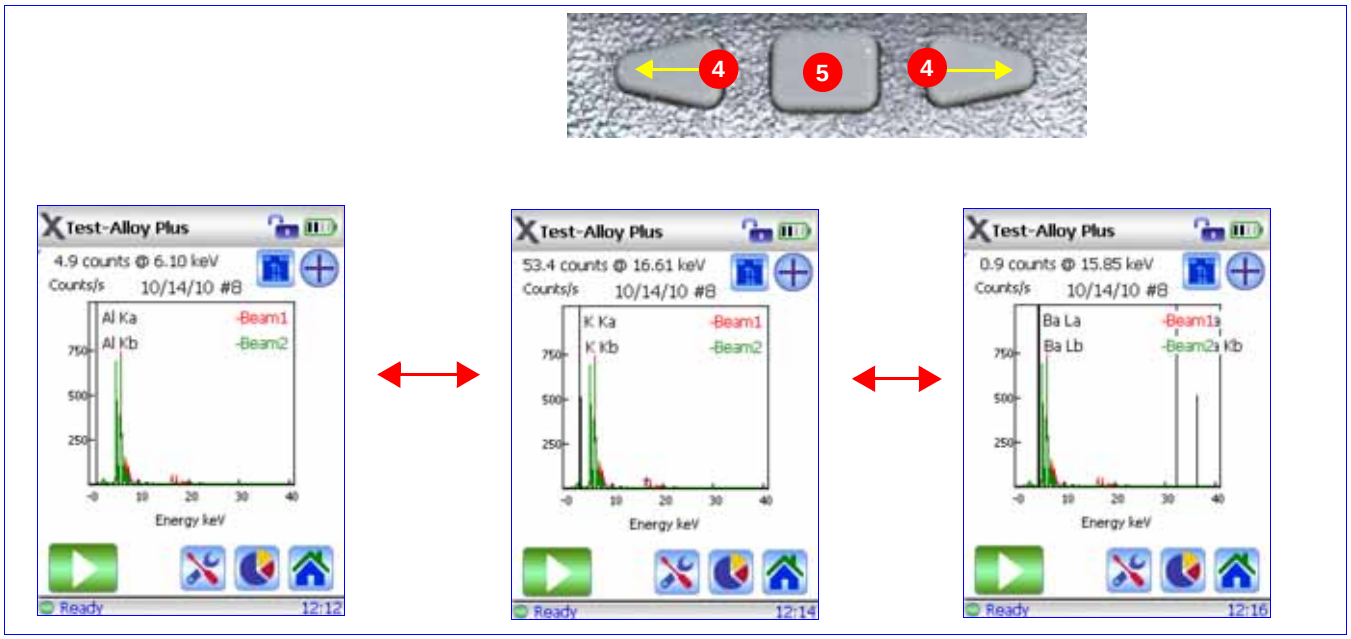
2. Press the center (square) key on the instrument's **Membrane Keypad;** this calls the **Emission Line Display Menu**



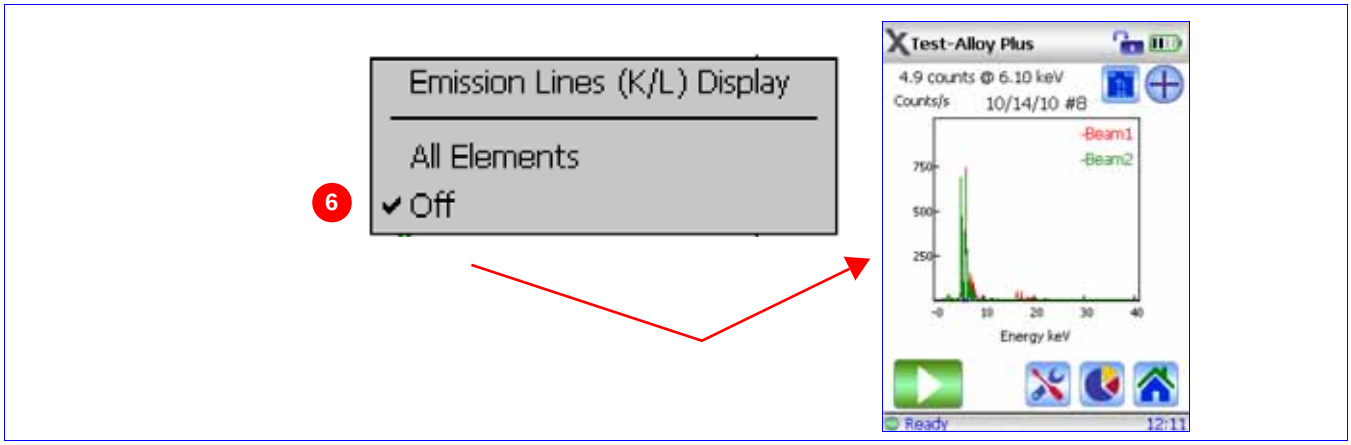
3. Tap **All Elements** and the graphical screen reappears with emission lines for individual elements:.



4. Use the left and right keys on the membrane keypad to scroll to additional line(s):



5. Press Membrane Keyboard Center Key to call the Emission Line Display (Popup) Menu again
6. Select Off to remove the Emission Lines from the original graphic display.



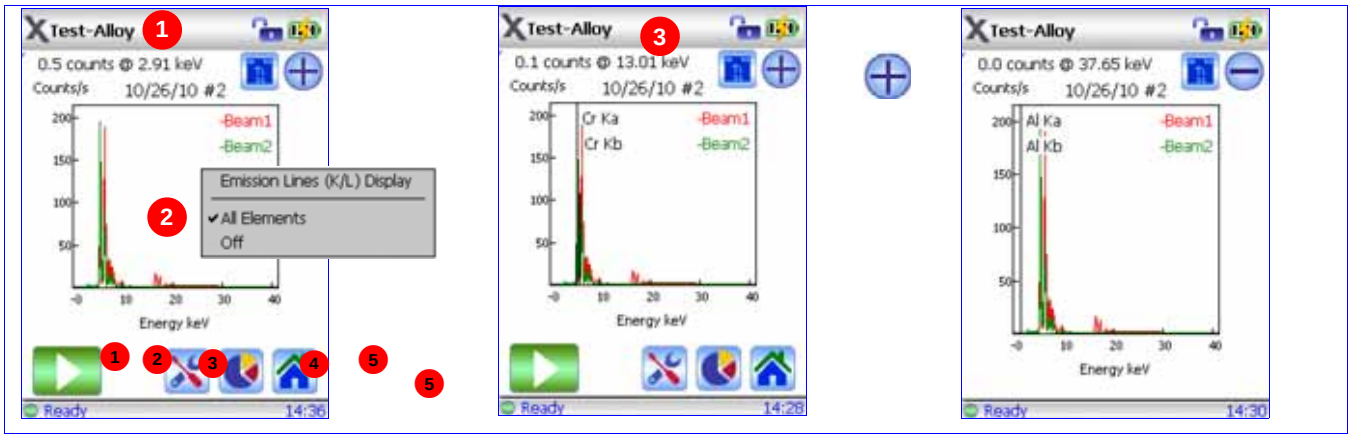
Zoom/Unzoom

To improve test analysis, the user can **magnify** a portion of the spectral plot using the zoom/unzoom tool as well as **apply** the emission line facility.

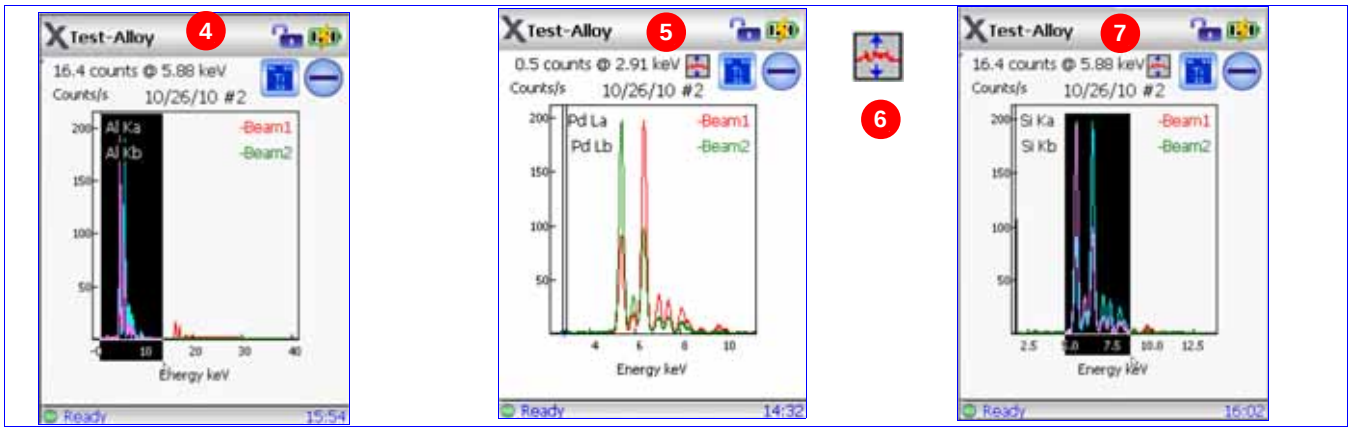
Procedure for Zoom/Unzoom capabilities with your current test.

1. Beginning with a normal spectral display, press the **Center** key on the instrument's Membrane Keypad to call the Emission Line Display Menu.
2. Select **All Elements** to introduce the Emission Lines to the spectral display.

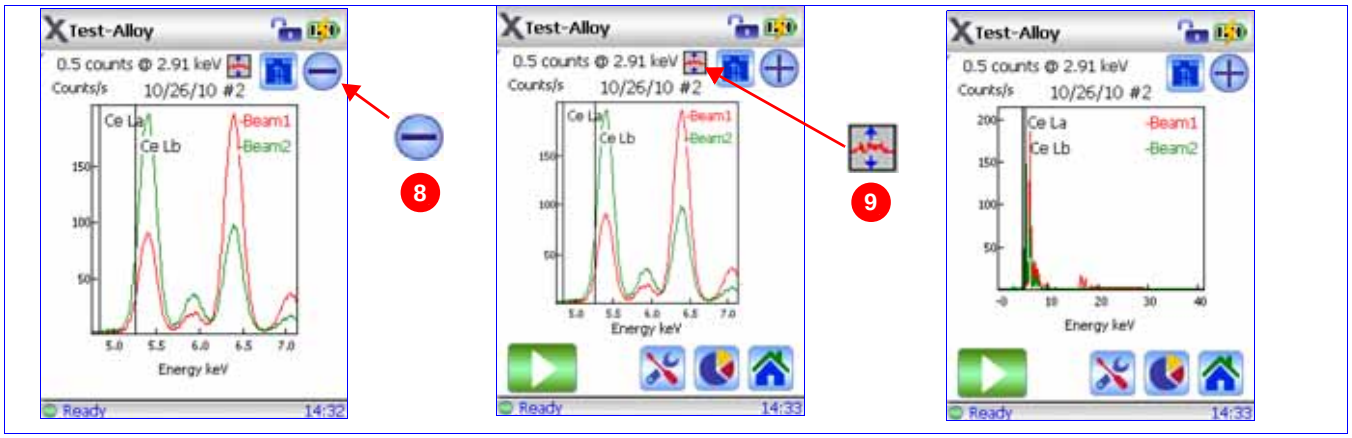
3. Increase the plot size with the **Display Expand** button.



4. For increased resolution, tap-and-drag the pointer (a stylus or your finger) on the screen to shade the area of interest.
5. Remove the pointer and the selected area appears magnified
6. Note that the Unzoom icon appears on the screen when the zoom action is applied. Tap this icon at any time to return to the normal size graph.
7. The user can continue to magnify a selected area



8. Tap Minimize button; expanded plot is displayed on full screen.



9. Tap Zoom/Unzoom button; normal plot is displayed on full screen.
10. Press **Center** key on Membrane Keypad to call the Emission Line Display Menu.
11. Press **Off** on Emission Line Display Menu to remove lines and designations.

CalCheck Test Procedure

CALCHECK (ALL MODES)

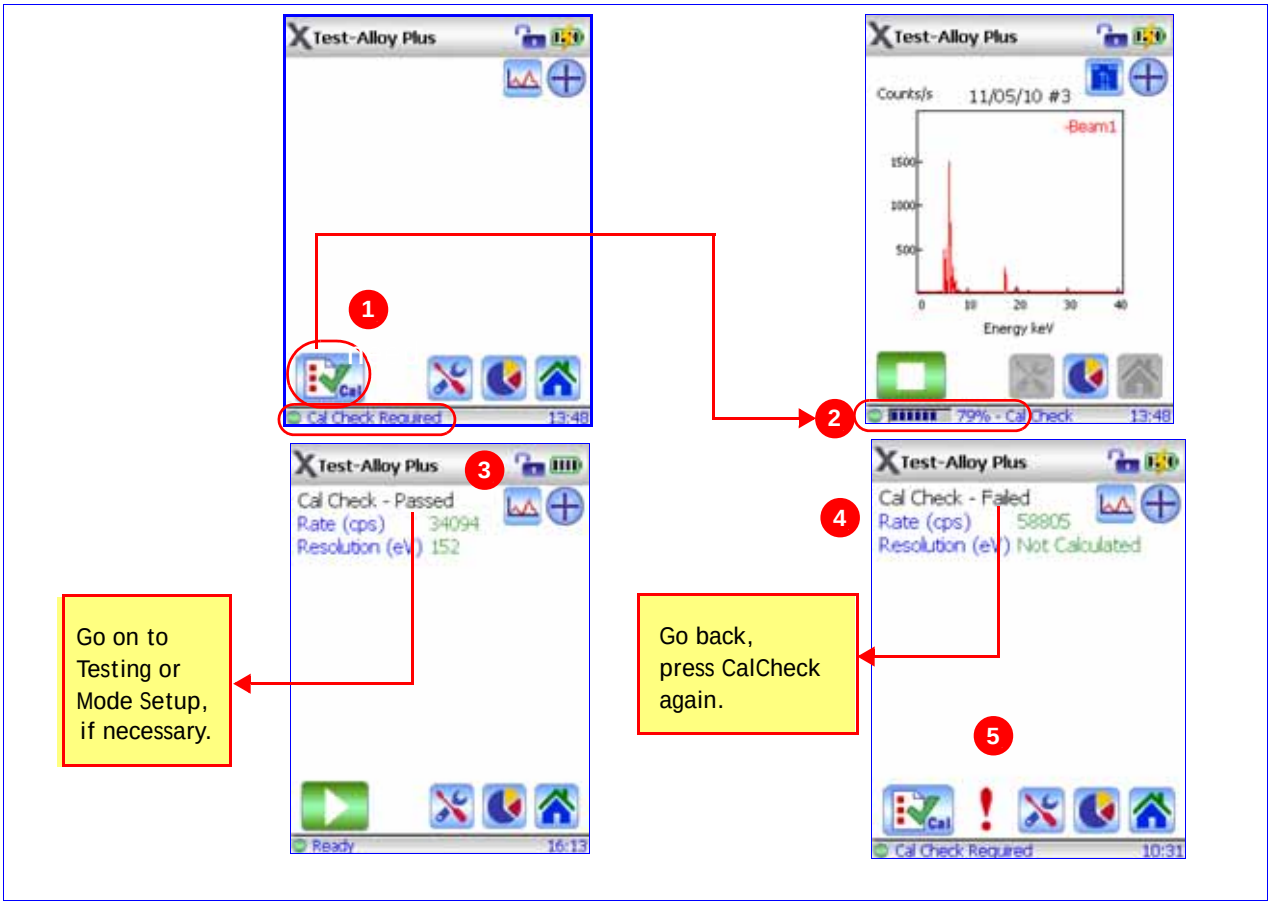
After the initial start-up, a Test screen reports (in the lower status area) that a CalCheck is required. This type test can be completed in a Delta Docking Station or by using a Standardization coupon/coin.

This is the **most common** Test procedure; it is used by all modes on a daily basis.

A successful CalCheck procedure is required **before** any sample testing can begin.

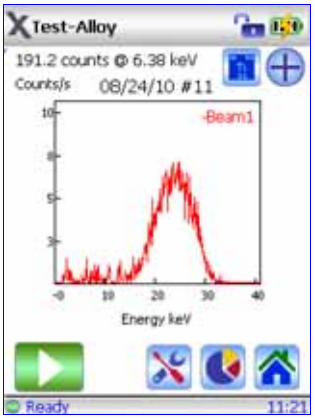
1. Lower Status Bar indicates that a **CalCheck** is required.
1. Tap **CalCheck** icon

   The CalCheck procedure begins **automatically.**
2. Status bar shows **progress** of the test.
3. When CalCheck has **passed**, user may begin sample testing.
4. When CalCheck procedure **fails**, user must try the test again.
   Remember that no sample testing can begin until analyzer has passed this test.
5. If the CalCheck fails, tap **Error** icon; this accesses the Error Log.

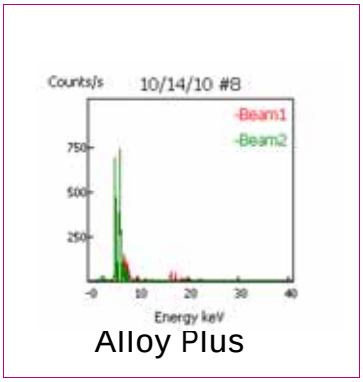


EXAMPLES: Test Screens by Mode

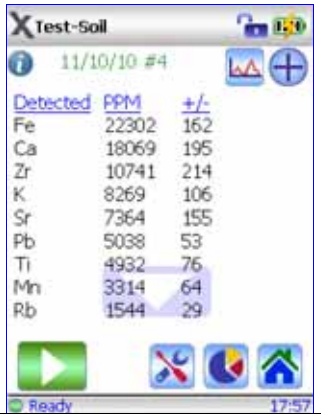
Test Screens for Alloy Mode

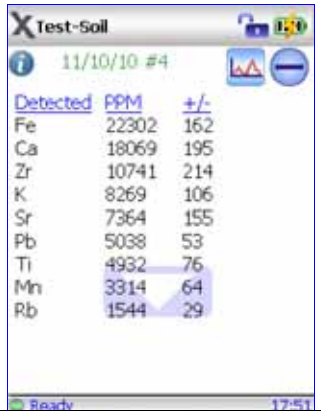


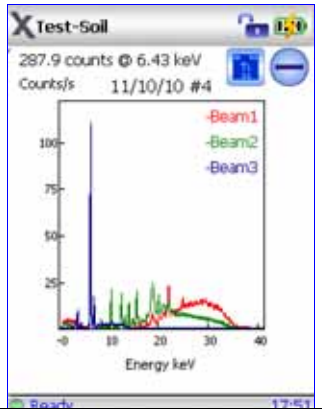
Test Screens for Alloy Plus Mode



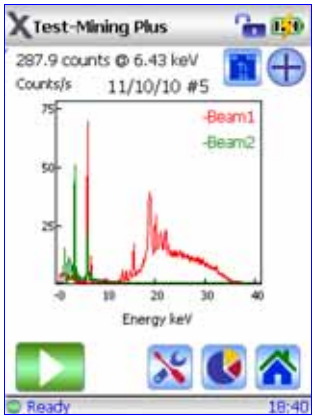
Test Screens For Soil Mode

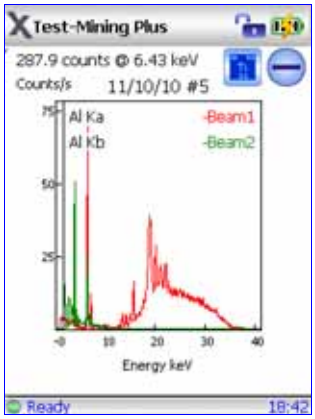




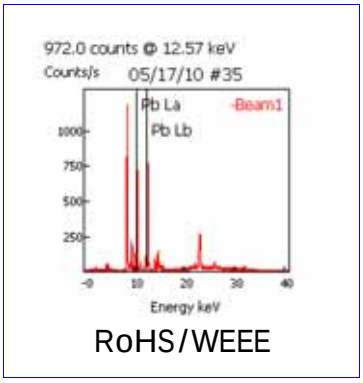


Test Screens for Mining Plus





Test Screens for RoHS/WEEE Mode



NOTES

RESULTS

Every individual test shot is stored in the analyzer as a **Results** screen.
The Results facility provides screen record management techniques including:

- finding
- displaying
- manipulating
- printing
- exporting

Tour of Results Screen

Results screen has **three** areas similar or identical to the **Test** screen.
Identical features include:

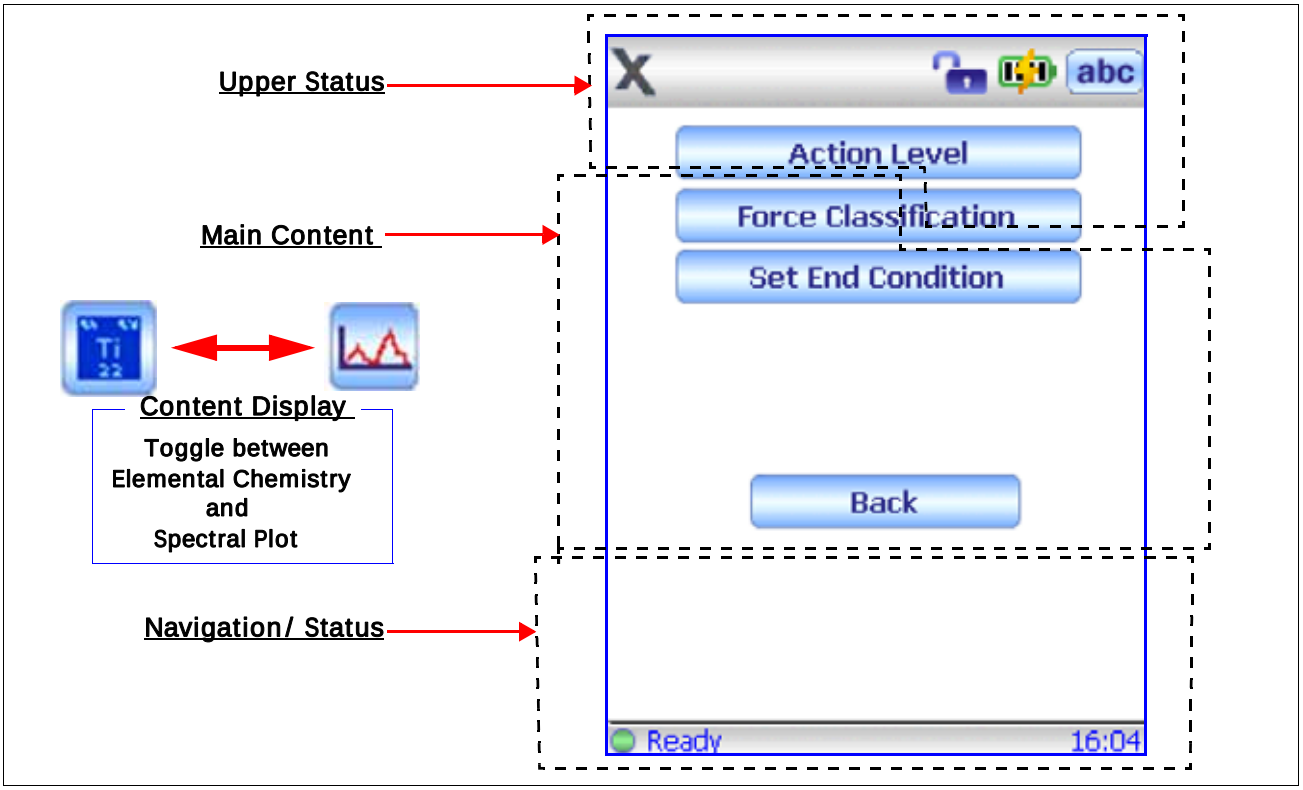
- screen layout
- field definitions
- icons
- buttons
- toggle functions

GO TO

See **Section 3.0** for details on the Test screen and its Elemental and Graphic display capabilities.

Navigating to current and past stored records is this facility's most important function. It is implemented by arrow buttons, a slider, and the Calendar icon located at the bottom of the screen.

Results Screen - Three Main Areas



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Upper Status Area

Information presented is the same as the Test screen.

Print

Consider the **Print** capability carefully.
It can be enabled with the **Test** facility only when you employ a portable Bluetooth-enabled printer.
When using **Results** with a BT printer, operators can enable this printer and the Print button is displayed.

Main Content Area

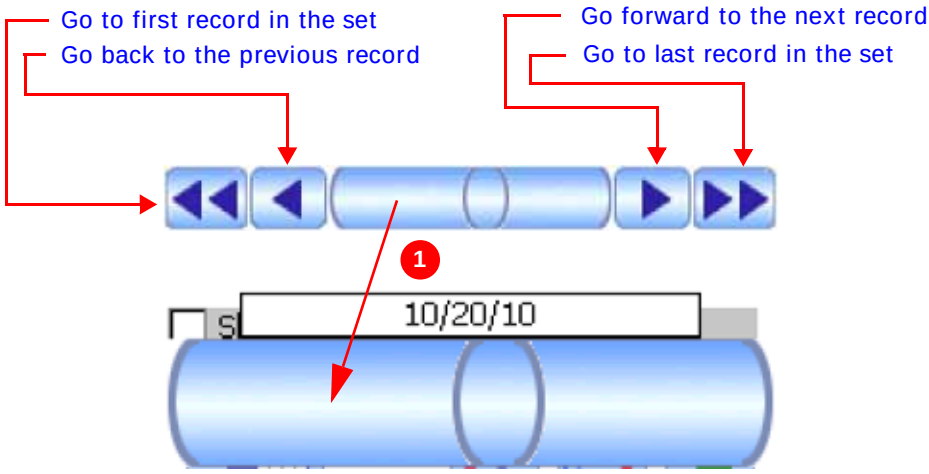
Information presented is the same as the Test screen.

Navigation/Status Area

This lower portion of the Results screen contains special navigation capabilities. Note the big finger slider for navigating the screens, and also Instrument Status and System Time

Navigation Arrows and Slider

ARROWS control actions within the selected day's set of results

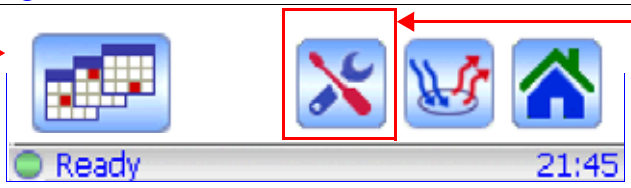


TIPS for slider and display manipulation

1. Tap on normal slider bar --> it changes to jumbo slider bar; this form-factor makes it easier to move the slider.
2. Tap on Expand Display --> slider bar goes back to normal size.
3. Toggle from normal main content to expanded content , the slider is removed from display.
4. Toggle content back to normal size -->slider returns to display.
5. Toggle from Element list to Spectrum plot --> Info icon is removed from display.

Navigation Icons

See next page, "*Instructions for Accessing Results*"

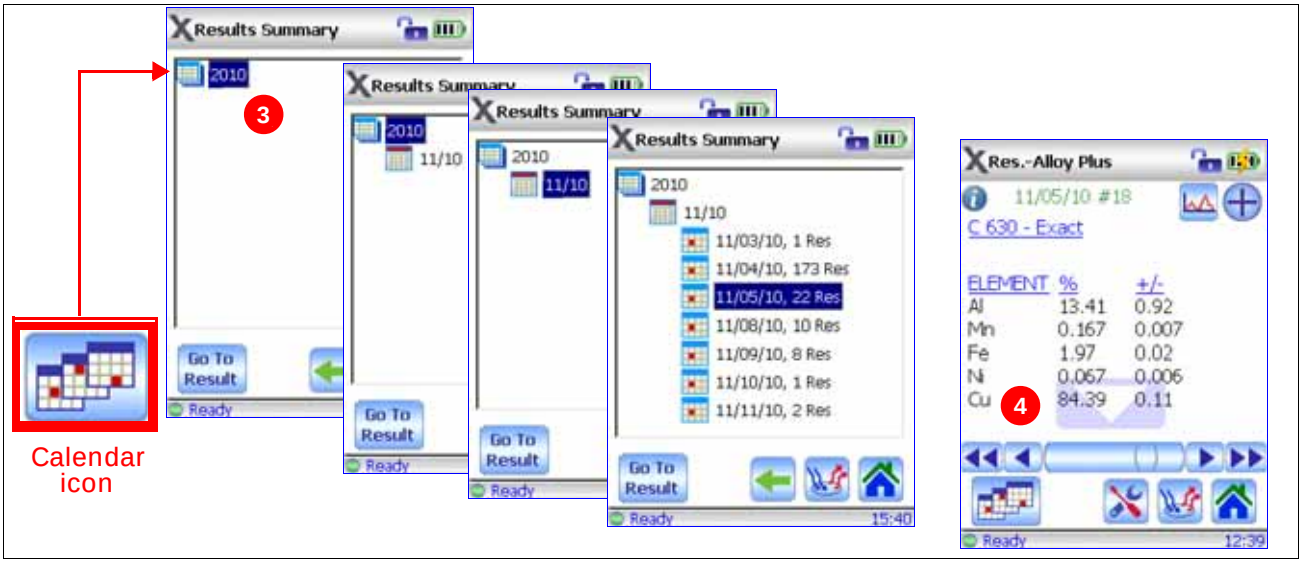


See "*Exporting Results,*" Page 69

Instructions for Accessing Results:

1. From the **Home** screen, tap the **Results** icon, the last accessed Result record is displayed.

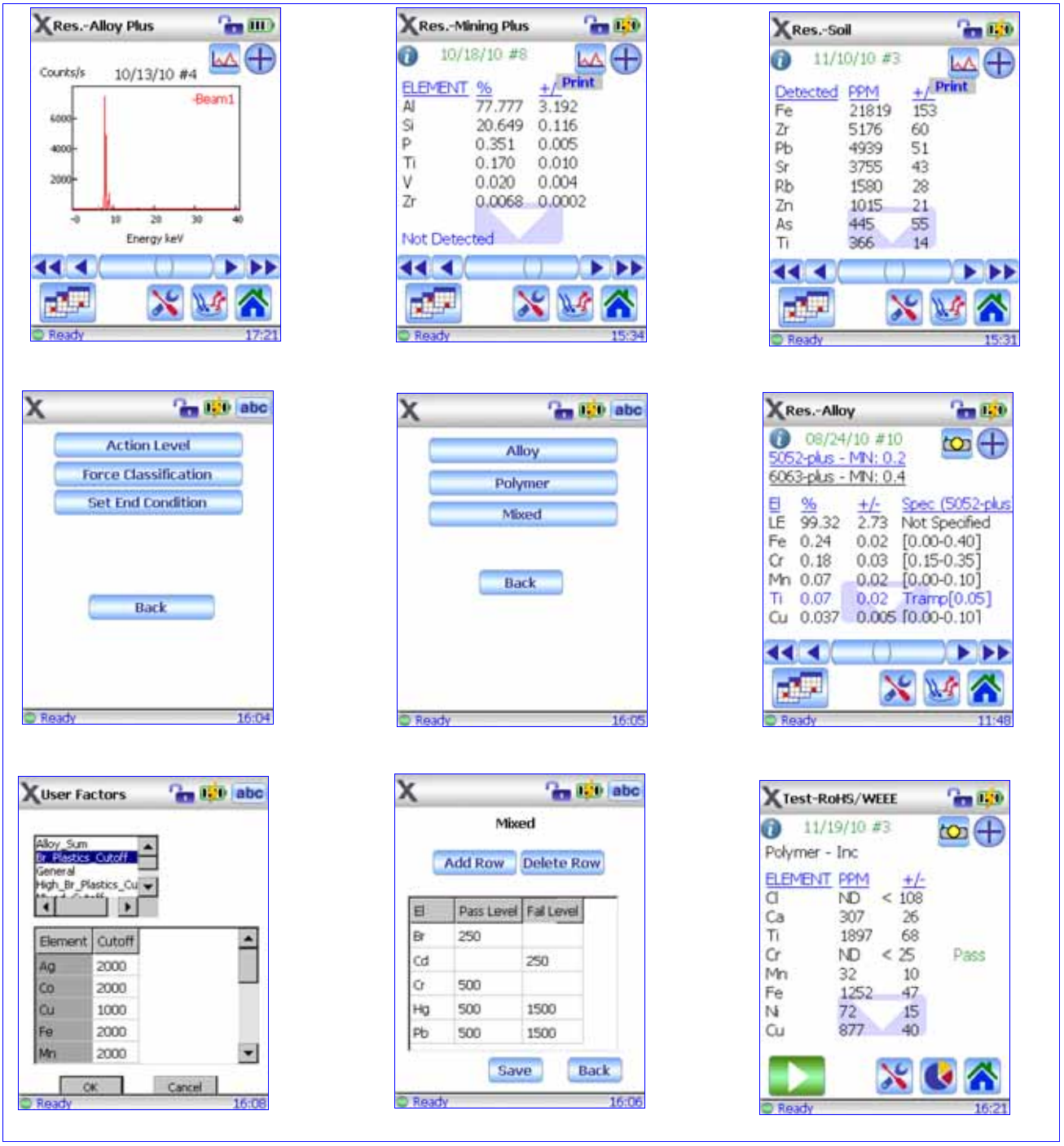
2. Tap the **Calendar** icon to access **Results Summary** screen that permits navigation to all results stored in the instrument.



3. Tap the Year indicator to show the Month indicator; then tap it to show the Day indicator. Each day shows the number of results captured for that day.
4. Use the arrows and slider to scroll through the daily shots. When you reach the final shot, the navigation reverts back to the first shot.

Samples of Result screens from various Modes are shown below at "*Typical Results Screens*."

Typical Results Screens



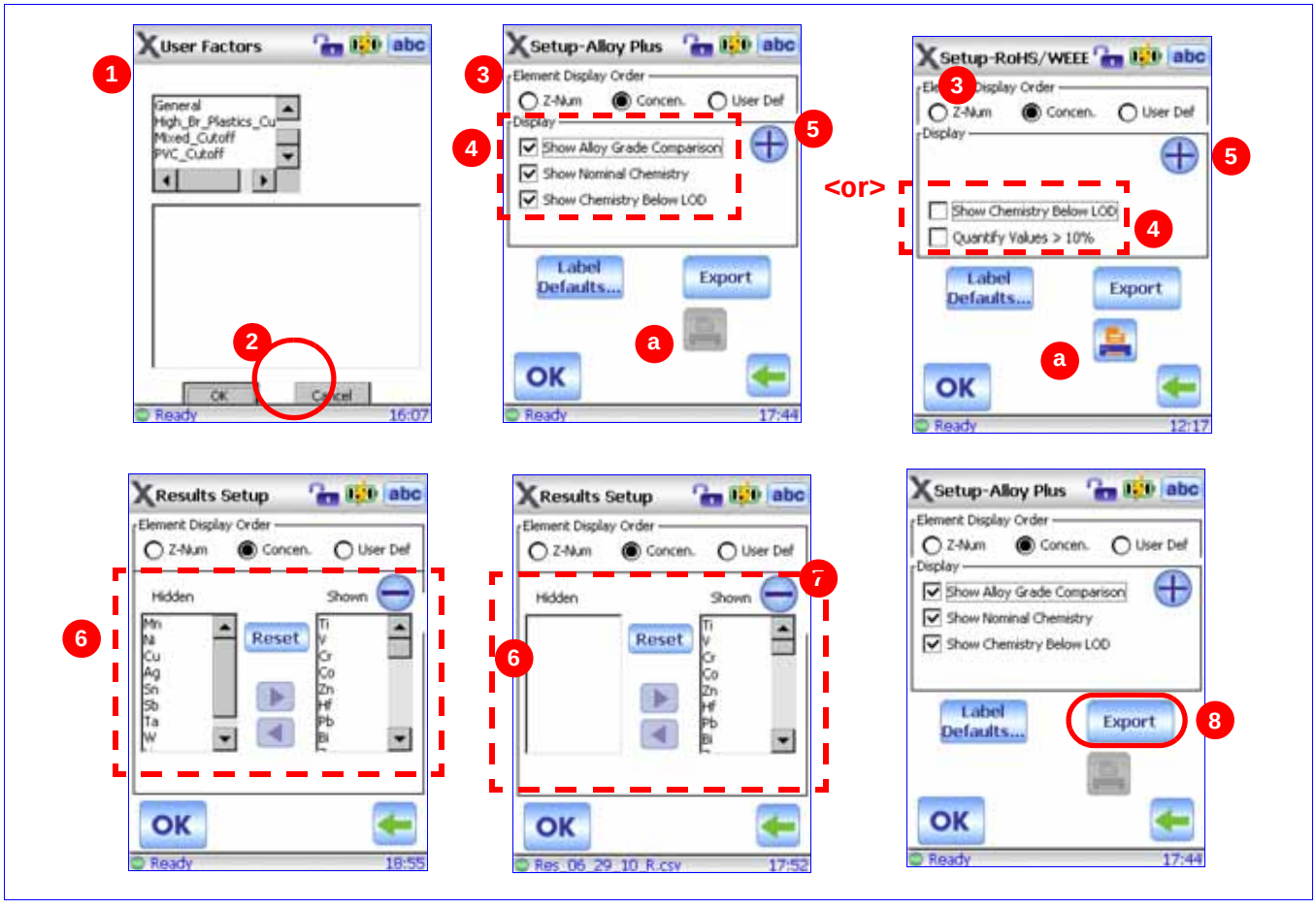
Exporting Results

Results may be exported to an external device (usually a PC) for several reasons including:

- Creating reports
- Providing a safe backup repository

INITIAL INSTRUCTIONS FOR EXPORTING RESULTS:

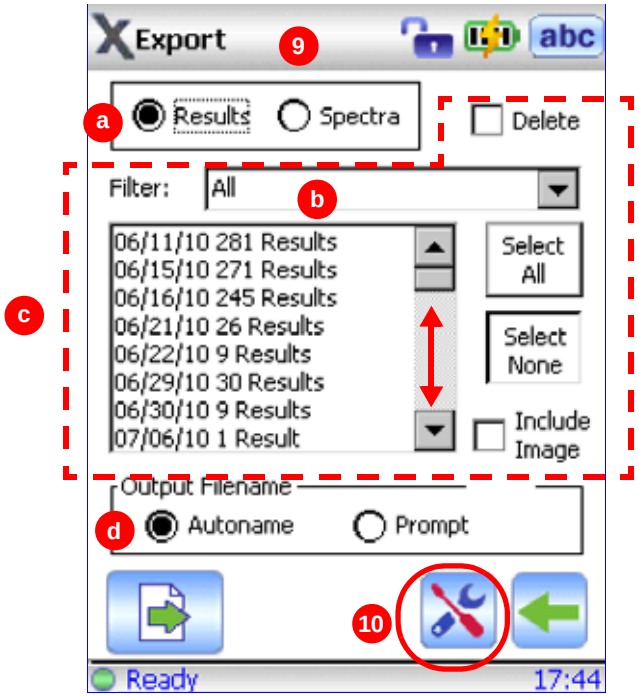
1. Navigate to a result record to be exported.
2. Select the **Tools** button to access **Setup-{Mode}** screen (in this example, **Setup-Alloy Plus** screen)
3. Choose the **Element Display Order**
4. Use **Display** check boxes to configure information on the Results screen. Information is similar to choices discussed in **Customize Display** on Page 33.
   a. Note that the **Printer** icon is greyed-out if a printer is not enabled.
5. Tap the **Expand** icon to call a screen that provides a listing of available elements.
6. Use the sliders, right-left arrows, and Reset button to configure the Hidden and Shown list of elements.
   This facility is similar to Customize- Display and Print facilities.
7. Tap the **Minimize** icon to return to the display Setup screen.
8. Select **Export** button to access a comprehensive **Export** data screen.



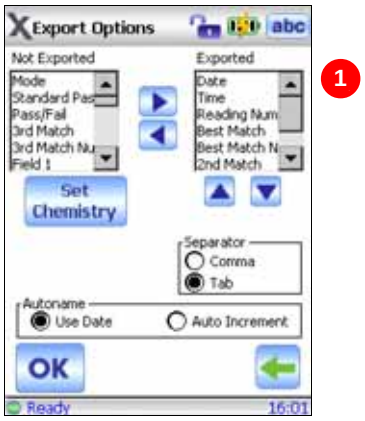
Export Results, continued

9. From the **Export** screen (shown below, enlarged) select the records (including images, if applicable)

a. Choose the result display style: List/Text or Spectra
b. Use the **Filter** text box with drop-down menu to select a Mode
When a particular mode is chosen the Results window displays only records which contain that mode.
c. Configure the desired results Export content by using the **Filter**, the **slider**, the **Delete** checkbox, **Select All** button, **Select None** button, and the **Include Image** checkbox
d. Choose the Output Filename option: Autoname or Prompt.



10. Select the Tools button to access an Export Options data entry screen **INSTRUCTIONS FOR EXPORT OPTIONS:**.



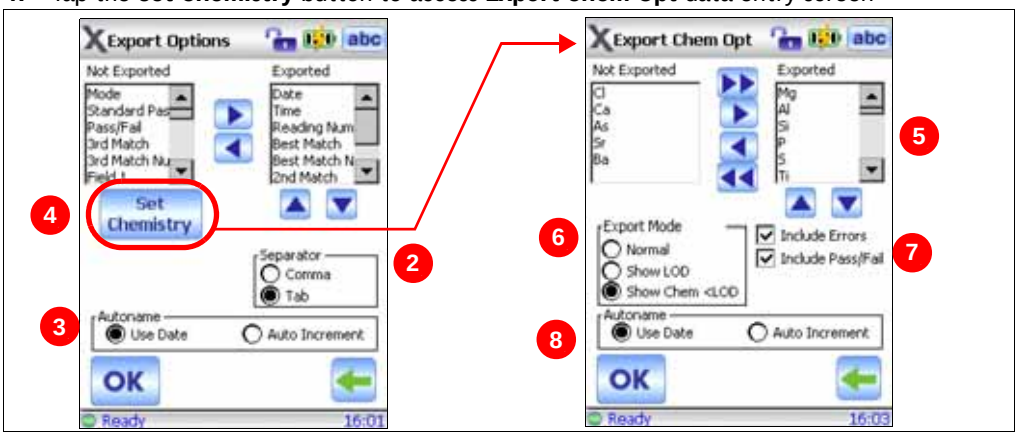
1. From the list of parameters, select the items to be exported.
Table (on next page) shows all 31 items.

Export Results, continued

List of Exportable Parameters

- Date
- Time
- Mode
- Record #
- Standard Pass
- Pass/Fail
- Best Match
- Best Match #
- 2nd Match
- 2nd Match #
- 3rd Match
- 3rd Match #
- Vacuum Press
- Pb Paint Result
- PD Result
- RoHS Sur Pb
- Field #1
- Field #2
- Field #3
- Field #4
- Field #5
- Field #6
- Field #7
- Field #8
- Live Time
- Elapsed Time
- Instrument Serial #
- Unit
- Method
- User Factor Set Name
- LOD Sigma

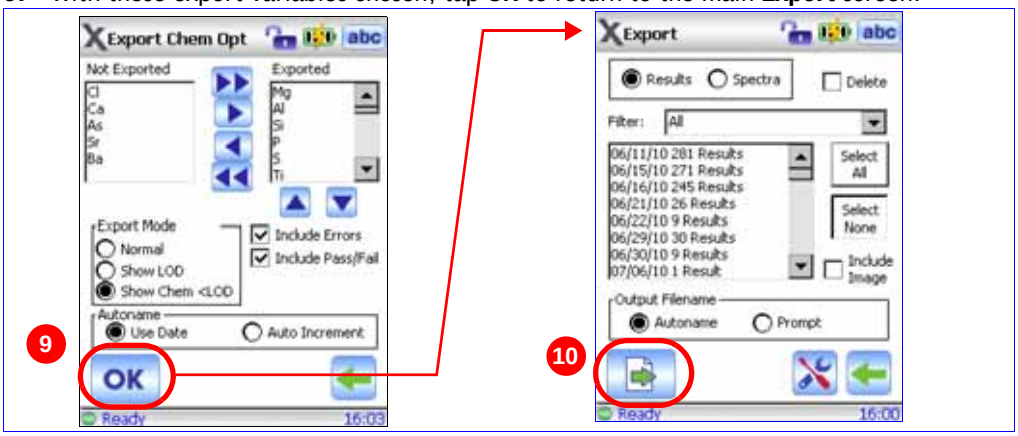
2. Choose the Separator method for the export records:
   - Comma delimited
   - Tab delimited
3. Choose the Autoname style:
   - Use Date
   - Auto Increment
4. Tap the **Set Chemistry** button to access **Export Chem Opt** data entry screen



5. Select the Elements to be Exported using the horizontal arrows.
   Use the vertical arrows to move these Elements into the order desired.
6. Choose the Export Mode from three options:
   - Normal
   - Show LOD
   - Show Chemistry less that LOD
7. Other options are:
   - Include Errors
   - Include Pass/Fail
8. Confirm the Autoname convention (see page 70, instruction 9d)

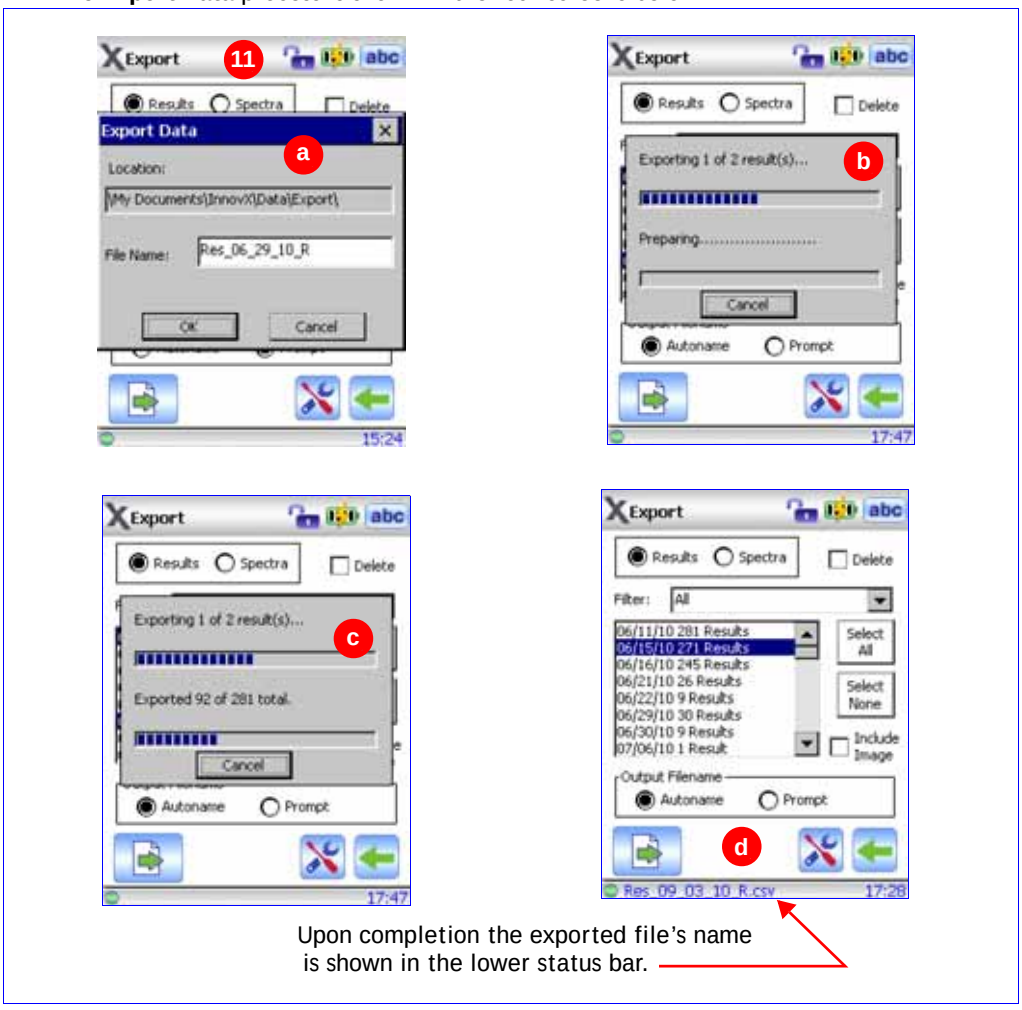
Export Results, continued

9. With these export variables chosen, tap **OK** to return to the main **Export** screen.



10. With all the Results content chosen, select the **Export Results** button

11. The **Export Data** process is shown in the four screens below:



Appendix

TOPIC: User Factors

Definition

User Factors are a stored set of scalar multipliers and offsets that are **applied directly to** factory calibrated results **before** they are displayed on screen.
Therefore, the information on the Test screen has been corrected by the "User Factor."
This is typically done to correct for Matrix Effects.

Purpose

User Factors provide two key benefits:

1. Allows the user to make linear slope and offset calibration **corrections without altering** factory calibrations.
2. Allows the user to **store multiple** slope and offset calibration factor sets within the software.

Applicable Modes

User Factor correction techniques can be applied for the following modes:

- Mining
- Mining Plus (2 beam mining)
- Soil (3 Beam Soil)
- Filter
- Dust Wipe

Calculating New RoHS/WEEE Factors and Offsets

PRIOR to accessing the User Factor data entry screens:

Generate the correction factors for the element(s) of interest.

Use a Linear Fit equation that is created from elemental assayed values and corresponding XRF results. The procedure is shown below in the Cadmium example.

EXAMPLE: CADMIUM FOR TESTING IN ROHS/WEEE MODE

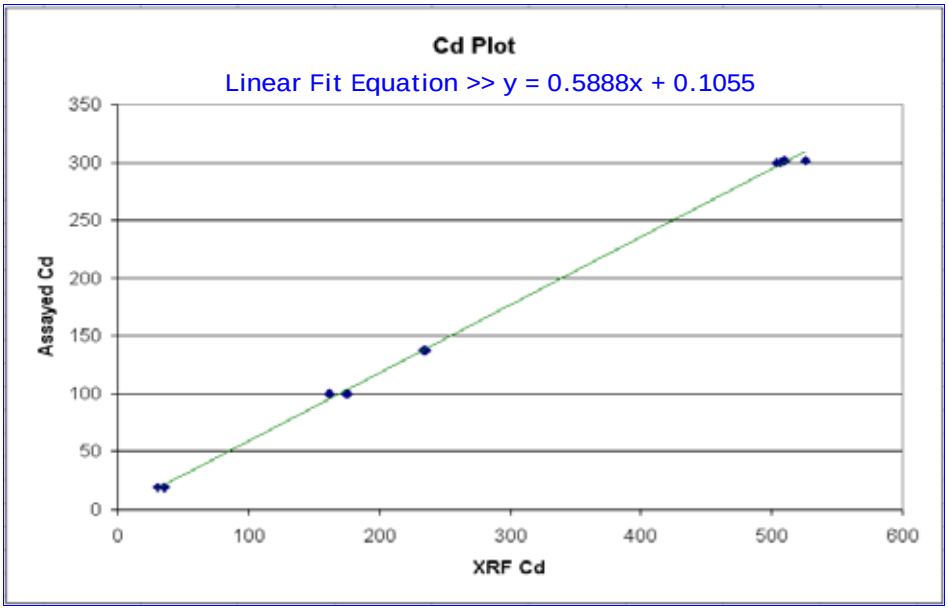
This example shows how to apply User Factor techniques to adjust for cadmium in a customer's laboratory assayed samples.
For this example, here is the sequence:

1. Gather known assayed Cd samples;
   Record their assayed values in a three column table
2. Shoot the corresponding samples with your Delta XRF analyzer;
   Record the XRF results in the table.
   Multiple tests of each sample are recommended.
3. Plot the data using Excel or other data analysis software to create a linear trendline.

See the table and plot shown on next page.

In this example, the XRF data is consistently higher than the assay by about 1.7 times.
From the Linear Fit equation, the value 0.5888 (say 0.59) is the "factor" that can be multiplied by the XRF result to get a close match to the assayed value.
The offset value (0.1055) is small enough to be disregarded.
Go to "**Software Operation**" on next page to see the data entry sequence.

Sample #	XRF Cd	Assayed Cd
1	31	19.6
1	35	19.6
1	36	19.6
2	236	137
2	235	137
2	234	137
3	504	300
3	504	300
3	506	300
4	175	100
4	174	100
4	176	100
5	510	301
5	526	301
5	509	301
6	162	100
6	161	100
6	162	100



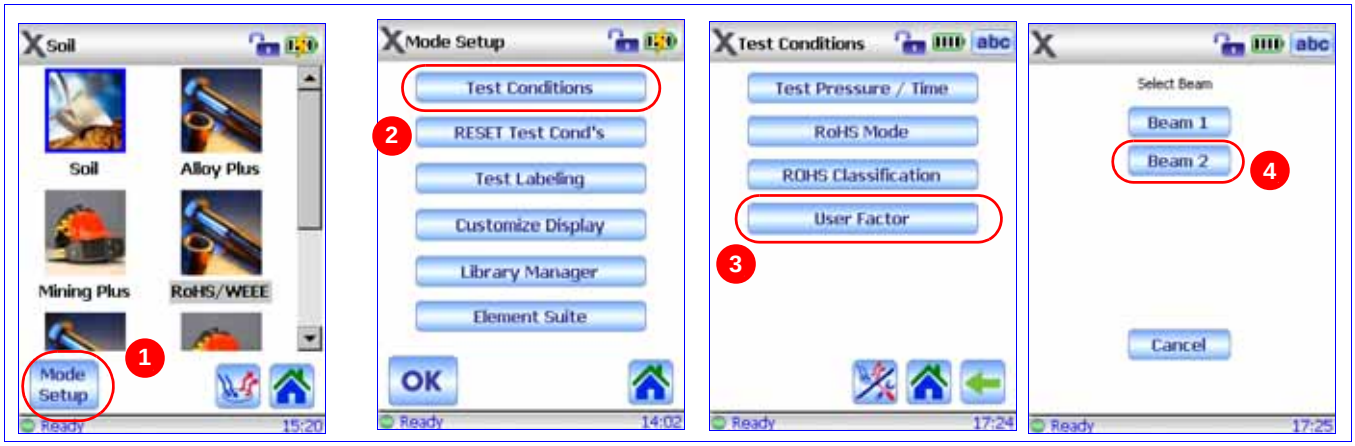
Software Operation

Once the factors and offsets (if required) are established, use this sequence to apply them.

Getting to User Factors

1. Select the correct mode for calibration from the mode screen and enter the **Mode Setup** screen.
2. Select **Test Conditions**
3. Select **User Factor**

   Note: RoHS/WEEE Mode contains two calibrations, Polymer (beam 1) and Alloy (beam 2). Ensure that the correct one is selected when adding factors.
4. For Cd choose **Beam 2**



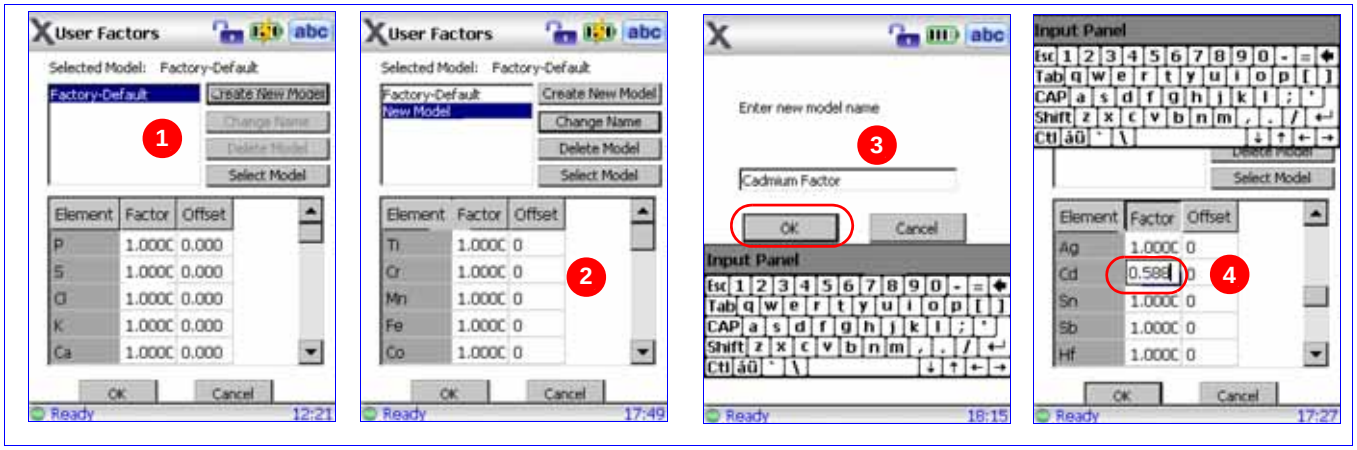
Creating a New User Factor Model

1. Select **Create New Model.**
2. Highlight the new model and **Select Change Name**.
3. Enter the new model name with the on screen keyboard and select **OK**.
4. Scroll through the table to find the element(s) for adjustment and enter new factor(s) and offset(s)

TIP

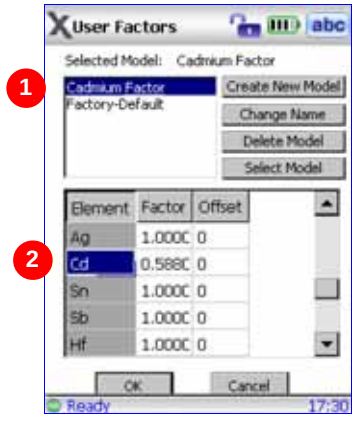
Consider whether **offsets are necessary** for a given calibration.
In many cases, only adjustment of the User Factor is necessary.
Recommendations for determining an offset:

- Use a minimum of three separate standards
- Ensure that lowest concentration value is <20% of the highest.



Applying User Factor Set Model

1. Highlight and select the model to apply to test results.
2. Selected model is displayed at the top of the screen and this User Factor Set is ready to be applied to XRF test results.



General Instructions for Determining User Factor Correction Factors

Single Point Calibration

- Determine the ratio of XRF result to known value. Then divide the current factor by this ratio to determine the new element factor.

Multi-Point Calibration with No Offset

- The results are exported and plotted against known values using Excel or other data analysis software. A linear equation with slope and intercept (if necessary) is determined from the plot. Y = mX.
- XRF response is plotted on the Y-axis and the **assayed value** plotted on the X-axis. Then your new factor = old factor/m, where the old factor is 1 when starting from the default set of user factors.

Multi-Point Calibration with Offset

- The results are exported and plotted against known values using Excel or other data analysis software. A linear equation with slope and intercept is determined from the plot. Y = mX + b.
  Take initial data in the "Factory-Default" User Factor set of factor = 0, offset = 1.
- XRF response is plotted on the Y-axis and the **assayed value** plotted on the X-axis. Then your new =old factor/m (where the old factor is 1 when starting from the default set of user factors) and the offset = - b.

Topic: Matching {Alloy & Alloy Plus Modes}

Match Settings Background Information

After calculating chemistry with the Fundamental Parameters algorithm, Delta compares the chemical composition values to grade tables stored in a grade library. The application calculates the value for a parameter called *Match Number* (displayed as **MN** on Test or Result screens.) This provides an indication of how close the measured alloy's chemistry is to library values. It is a measure of "match quality."

The lower the Match Number, the better the match.

- A Match Number of 0 is an exact match, meaning that the calculated chemistry for all elements falls within the grade table specifications.
- MN < 1 is a **Good** match
- MN between 1 and 2 is an **OK** match
- MN between 2 and 3 is a **Fair** match
- MN > 3 is a **Poor** Match

Match Possibilities

There are three Match determination possibilities provided.

1. Exact Match or Nearest Match

An unknown alloy is matched to one of the grades contained in the Grade Libraries, and a *Grade ID* appears on the **Test** screen. Often other grades are listed with their accompanying Match Numbers. The analyst has the opportunity to view their elemental chemistries and see how they differ from an exact match.

2. Multiple Matches

In some cases, several grades are shown as **possible matches**. This can signify one of two conditions:

- There was not enough statistical information to definitively separate two or more alloys. The actual identification of the unknown alloy is one of the grades listed. Often increasing the testing time makes it possible to separate the alloys.
- There was sufficient statistical information, but the test sample did not meet any of the existing specifications with enough precision to cause an exact match identification.

3. No Match

If no matches are found within the libraries, the words *NO MATCH* appear.

There are several causes for a NO MATCH result:

- The test sample does not meet any of the specifications in the Grade Library.
- The test sample is coated.
  Remove the coating by grinding, filing, or sanding and repeat the test.
- The testing time was too short.
  Increase the testing time and measure the sample again.
- The Match Number setting is too low.

EXAMPLES OF MATCH RESULTS

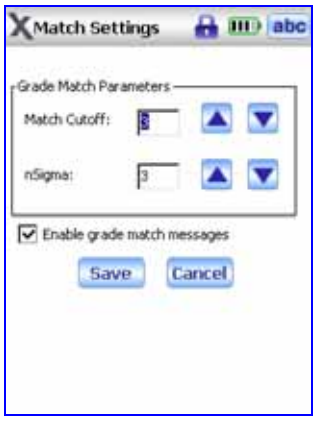
Exact Match or Nearest Match Troubleshooting

Sometimes valid matches do not register as *exact* due to:

- Uncertainties associated with any measurement.
- The presence of tramp elements (small amounts of unspecified elements).

The Delta UI addresses this situation by having the operator configure two fields in the **Match Settings** data entry screen:

- Match Cutoff
- nSigma



TIP

- Some sorting professionals suggest these settings:
  - Match Cutoff of 5
  - nSigma of 2
- The most frequent nSigma setting is between 0 and 2.
  - For scrap sorting, 0 or 1 are most common.
  - For PMI (Positive Materials Identification) applications, 1 or 2 are most popular.

This **Match Settings** screen and its associated instructions are located at *Section 2.0, page 36*. The calculation process for using these parameters is given on the next page.

Calculation Process

- *nSigma* - The software collects measurements and the *nSigma* value is used to calculate the amount of variation tolerable, relative to the target value. This range around the target value is configured using the *Min/Max* values in the Grade Tables, by element.
  - This parameter factors in the precision of the measurement when matching the measurement against a grade specification
    - When nSigma is set to zero the analyzer ignores the precision of the measurement and uses only the measured value when comparing the measurement to the grade specification in the grade library.
    - A setting of 1 or 2 or 3 factors in 1 or 2 or 3 **times** the precision (+/-) of each measurement when comparing the measurement to the grade specification in the grade library.
- *Match Cutoff* - Once the measured calculations are analyzed relative to the *nSigma*, the Match Number is calculated and compared to the user-configured *Match Number*.

Typically the software looks to find:

- **Exact Matches**, which having the following features:
  - Innov-X calculates chemistries using the Fundamental Parameters algorithm and searches the grade libraries
  - *All chemistry values must be within a user-definable error band of the min/max values specified in the Grade Libraries.*
- **Nearest Matches**, having the following features:
  - *Innov-X calculates chemistries using the Fundamental Parameters algorithm and searches the grade libraries*
  - *It determines which alloy(s) is (are) the closest match to the calculated results.*
  - *It determines whether a grade is considered a match by comparing the calculated Match Number for that alloy to a cutoff value.*
  - *This cutoff value typically is set at 3.*
    This is a value that supports a wide range of alloys.
    It is user-modifiable, however, except in very special circumstances, it should not be changed.

TOPIC: RoHS/WEEE Analysis

Background

Toxic metals in consumer electronics are the focus of EU regulations that have worldwide ramifications. These new directives currently include:

- *Restriction of Hazardous Substances* (**RoHS**)
  - Designates maximum allowable levels of Pb, Cd, Cr^{6+}, Hg and certain Br-containing flame retardants (PBB and PBDE) in new electrical and electronic equipment sold into the EU.
- *Waste Electrical/Electronic Equipment* (**WEEE**)
  - Requires separate collection and recycling of WEEE including items with Hg-containing components and polymers containing Br-flame retardant.

The limits for RoHS elements are:

- <0. 1% Pb, Cr6+, Hg, Br (as flame retardants, PBB and PBDE)
- <0.01% Cd

The Innov-X analyzer is a screening tool for RoHS Compliance. It is used to:

- Directly analyze the amount of toxic metals in electronics,
- Identify quickly whether a plastic is made of or contains:
  - PVC
  - A brominated flame retardant.

XRF measures *total elemental composition*, regardless of speciation of the element. Therefore, it reports

- Total chromium including the concentration of hexavalent chromium plus any other forms of Cr.
- Total bromine, however cannot distinguish the type of brominated flame retardant present in analyzed materials.

In order for XRF to be quantitative, samples must be:

- Homogeneous
- Have a certain minimum sample thickness
  - Five (5) mm for polymers and light alloys
  - Fifteen (15) mm for liquid samples
  - One (1) mm for other alloys

If samples are heterogeneous, too thin, or too small, only qualitative screening is possible.

The IEC-ACEA (International Electro-technical Commission – Advisory Committee on Environmental Aspects) recommends XRF screening.

Software Overview

The *DeIta* analyzer in RoHS/WEEE mode automatically executes a test sequence to determine:

- Whether a sample is an **alloy**, **polymer**, or **mixed**.
  - "Mixed" indicates heterogeneous samples consisting of both polymer and alloy, such as wires or circuit boards.
- Whether each RoHS element **passes**, **fails**, or is **inconclusive** when compared to a set of stored criteria.
  - These criteria are either those recommended by the IEC, or ones added by the user.

The sequence begins with the instrument utilizing settings appropriate for analyzing a polymer sample. The following logic applies:

- If the sample is determined to be a polymer or mixed, the test continues, and a calibration based on a polymer matrix is used.
- If the sample is found to be a metal alloy, the analyzer switches to a secondary test, using an alloy matrix calibration, in order to determine correct alloy concentrations.
-

Sample Presentation

Since many pieces of plastic analyzed for ROHS/WEEE compliance are very small, take care to measure them in a safe and accurate manner. See the IEC-ACEA recommendations for minimum thickness of test samples.

IEC Quantitative Screening Requirements

RoHS/WEEE requirements are derived from the *"Directive 2002/95/EC of the European Parliament and of the Council of the European Union on the restriction of the use of certain hazardous substances in electrical and electronic equipment."*
Dated 27 January 2003.

Important Current Issues

CAUTION

- At this User Guide's release date (December, 2010), the IEC requirements (including limits and exemptions) have **not been formally accepted.** A timetable for acceptance has not been established.
- Users must be aware that the information in Figure 1 (next page) concerning RoHS/WEEE screening limits has been extracted from **proposed/draft** IEC-ACEA documentation**.**
- Innov-X strongly advises users to have their own compliance departments determine the current status of the requirements that they must meet.

Grade Definitions for Screening

Grade	Proposed Screening Criteria
PASS	Results for ALL elements are lower than the lower limits shown in Figure 1.
FAIL	Result for ANY element higher than the higher limits shown in Figure 1.
INCONCLUSIVE	Result of the quantitative analysis, for any of the elements Hg, Pb, or Cd, is in the region defined as intermediate, OR if the result of the elements BR and Cr is higher than the higher limits shown in Figure 1, the analysis is inconclusive. Additional investigation must be performed.

Elemental Range/Limits for RoHS/WEEE Compliance

—RoHS— Elements	PASS	Lower Limit	Incon-clusive	Upper Limit	FAIL
		Polymer Materials			
Cd	P	≤(70-3σ)	< X <	(130 +3σ)≤	F
Pb	P	≤(700-3σ)	< X <	(1300+3σ)≤	F
Hg	P	≤(700-3σ)	< X <	(1300+3σ)≤	F
Br	P	≤(300-3σ)<	X		
Cr	P	≤(700-3σ)<	X		
		Metallic Materials			
Cd	P	≤(70-3σ)	< X <	(130 +3σ)≤	F
Pb	P	≤(700-3σ)	< X <	(1300+3σ)≤	F
Hg	P	≤(700-3σ)	< X <	(1300+3σ)≤	F
Br			N/A		
Cr	P	≤(700-3σ)<	X		
		Electronics			
Cd	P	LOD	< X <	(150 +3σ)≤	F
Pb	P	≤(500-3σ)	< X <	(1500+3σ)≤	F
Hg	P	≤(500-3σ)	< X <	(1500+3σ)≤	F
Br	P	≤(250-3σ)<	X		
Cr	P	≤(500-3σ)<	X		

Figure 1: Proposed Screening Limits for RoHS/Elements

TOPIC: Test Time Notes

Background

Test times for hand-held XRF analyzers are a function of several items, including:

- User chosen mode
- Desired precision
- Desired result speed or throughput time (a trade-off with precision)

Other technical design factors can include:

a. X-Ray producing hardware/electronics including type of detector.
b. Software and processor sophistication

A key difference for Delta instrument models is the type of detector

- **Classic** - PIN diode
- **Standard** and **Premium** - Silicon Drift Detector (SDD)

SDD-based units have much faster processing response times as compared to the PIN units.

Testing Time Issues - All Modes

- *Min. testing time is the interval that must elapse before results are calculated.*
  - *Results don't appear until the Min. testing time has elapsed.*
- *If a test is stopped before the Min. testing time has elapsed, the test is aborted.*
  - *No results are calculated.*
  - *No information related to the test is saved.*
- *Max. testing time automatically ends the test at a preset testing interval.*
  - *It may be two minutes (or more) depending on detection limits and desired precision.*

ALLOY COMMENTS

For most alloys, to obtain a unique grade ID and good alloy chemistry, the recommended testing time is 5-10 seconds.

For some alloys that only differ by small amounts of one or two elements, it may be necessary to perform longer tests. Examples include Low alloy steels 4140 and 4340.

For quick separation of alloys which differ by less than 1% of Ti or V require the optional SmartBeam feature (Al Mode) or SmartSort feature (Alloy Plus).

The maximum testing time determines the length of a test. The analysis automatically stops if the maximum testing time is reached. Normal maximum testing times range from 5 to 20 seconds.

Alloy Analysis Goals

Use shorter analysis times if goal is primarily grade identification,
Use longer test times if greater precision is required in the calculation of chemistry or if an alloy separation is particularly difficult, .

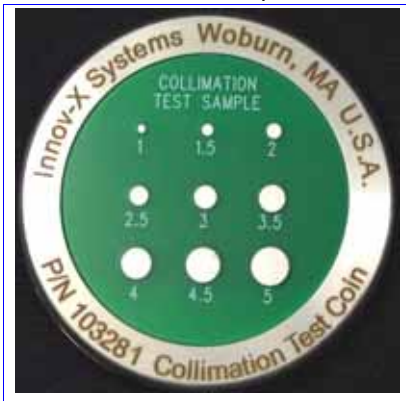
TOPIC: How to Use Camera Collimation Test Coin

Background

Innov-X provides a double-sided Collimation Test Coin (PN 103281) as a check sample with all Collimated DELTA analyzers.

- Side #1 used to verify the x-ray beam spot location.
- Side #2 used to set the cursor position.

Collimated beams have a spot diameter of approximately 3 mm.
An uncollimated beam spot diameter is approximately 10 mm.



Side #1

Side #2

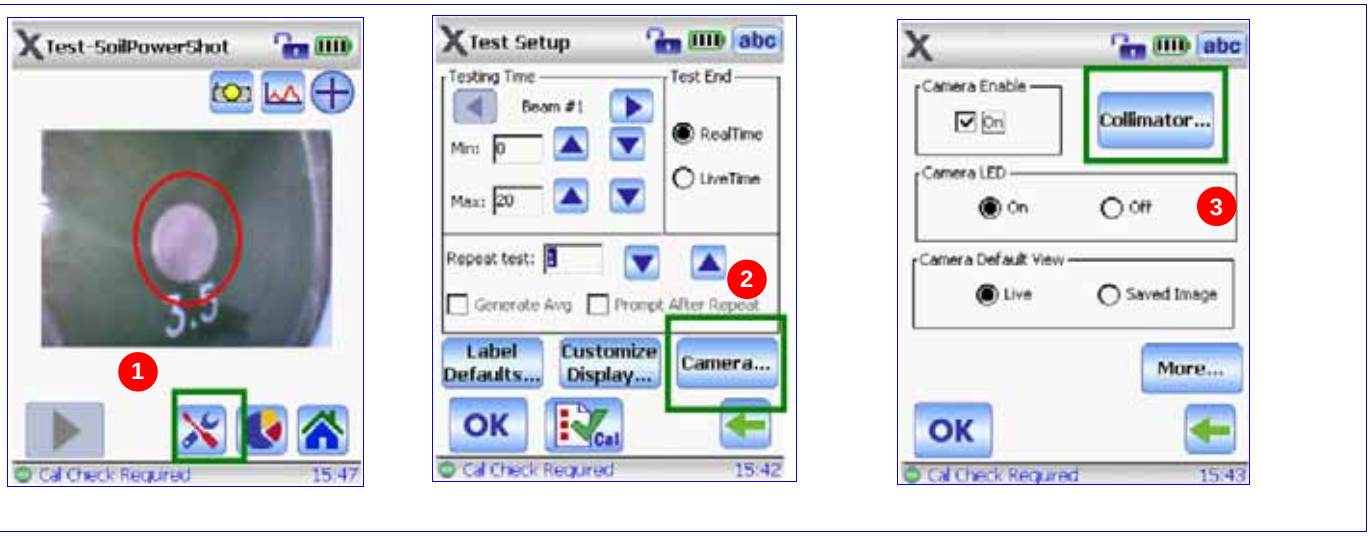
The Collimation Test Coin (Side #1) has varying sizes of copper dots containing solder in a field of bromine containing plastic. Collimation of the x-ray excitation is verified by testing and looking at the ratio of Cu to Br.

When using the Collimator with the **Test** page, tap inside the cursor as a shortcut to change the size of the x-ray beam spot.
Tap on the image outside of the cursor to toggle between live video view and stored image view.

Set the Cursor position:

From the **Test** page use this procedure:

1. Tap the **Tools** Icon
2. Tap the **Camera** button
3. Tap the **Collimator** button



4. Check the **Cursor** radio button.
5. Press **Start Align Sample Test** button.

   A dialog box appears that asks you to "Please put Phosphor Paper Sample in front of window". Side #2 of Collimation Test Coin has phosphor paper embedded in it.
6. Place the DELTA on the coin and Press **OK**.

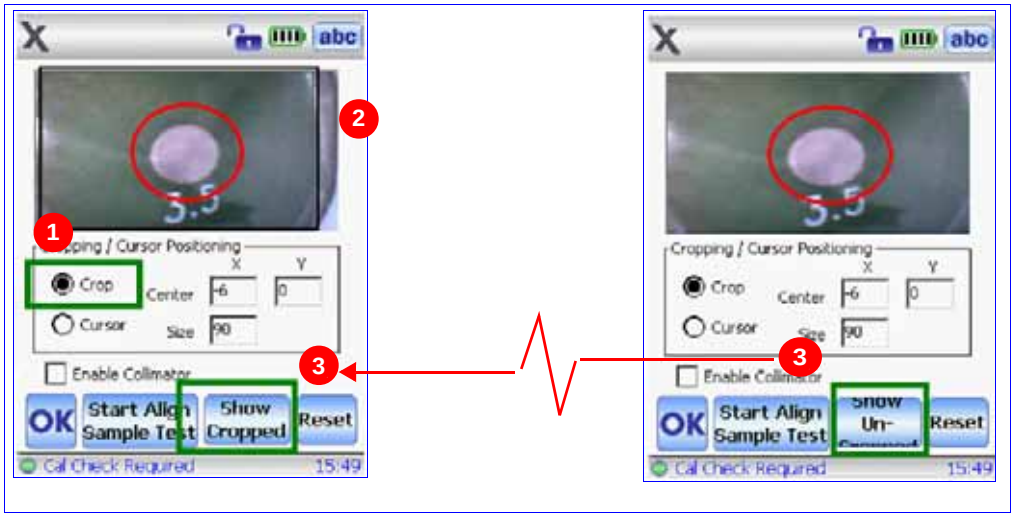
As the analyzer emits x-rays, the phosphor paper glows.

7. Press on the image to move the center of the cursor to the center of the x-ray beam spot.
8. Press **Stop Test** button when satisfied with the position of the cursor .
9. Press **OK** three times to return to Test Page

Set the Display Image Size:

The same screen can be used to set the amount of the camera image that is seen. This is useful when the camera "sees" a portion of the inside of the analyzer.

1. Select the **Crop** radio button.
2. Draw a box on the image to indicate the desired image size.
3. The **Show Cropped** button and **Show Un-Cropped** button can *toggle* the image display.



TOPIC: How to Use “After Test” Label Editing

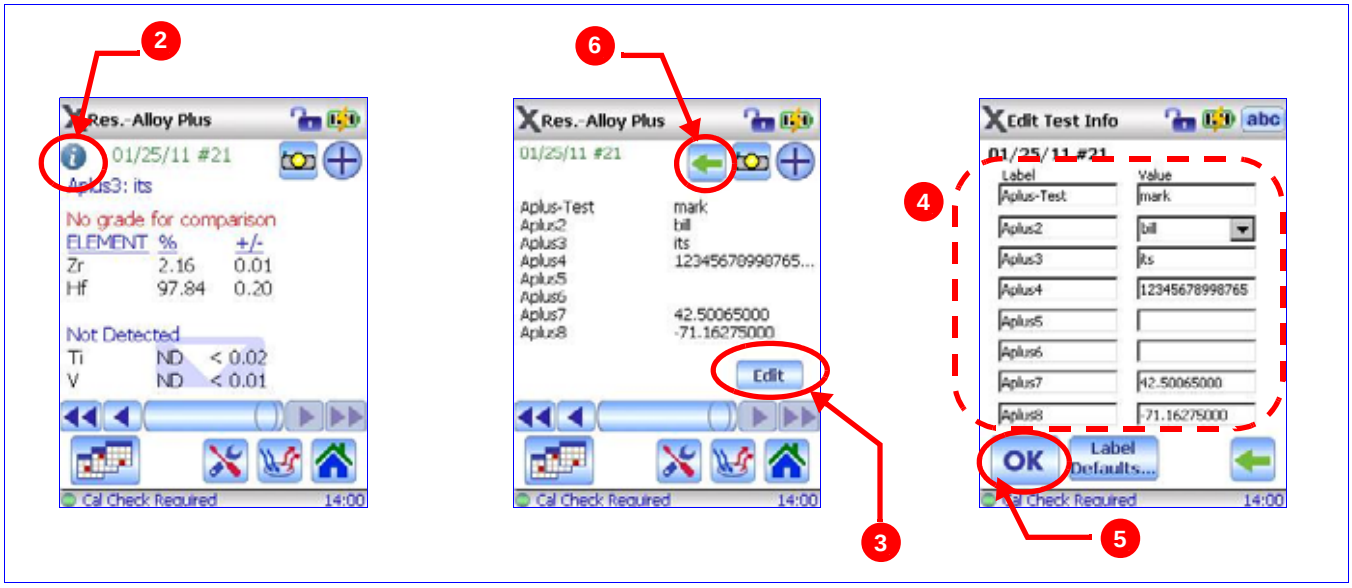
When a Delta instrument is Factory configured to allow “after test edits,” employ this procedure to use this option:

1. In Results mode, scroll to the desired record; the function is available for all test results.
2. Tap the **Info** icon to access the record’s current Label information.
   A special **Edit** button is present in the lower right corner.
3. Select **Edit** to call the Edit Test Info data entry screen
   See *Section 2, Page 30* for a general discussion of the Test Label features and fields.
4. Make desired changes.

IMPORTANT

Modifications can be made in both the Label and Value fields for this individual record. However, the original parameters remain in place for subsequent tests.

5. Tap **OK** to return to Label information screen, now displaying the changes.
6. Select the **Back Arrow** to return to the original test record.



OLYMPUS

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APPENDIX D
NRA GUN SAFETY RULES

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NRA Gun Safety Rules

The fundamental NRA rules for safe gun handling are:

1. Always keep the gun pointed in a safe direction.
This is the primary rule of gun safety. A safe direction means that the gun is pointed so that even if it were to go off it would not cause injury or damage. The key to this rule is to control where the muzzle or front of the barrel is pointed at all times. Common sense dictates the safest direction, depending on different circumstances.

2. Always keep your finger off the trigger until ready to shoot.
When holding a gun, rest your finger on the trigger guard or along the side of the gun. Until you are actually ready to fire, do not touch the trigger.

3. Always keep the gun unloaded until ready to use.
Whenever you pick up a gun, immediately engage the safety device if possible, and, if the gun has a magazine, remove it before opening the action and looking into the chamber(s) which should be clear of ammunition. If you do not know how to open the action or inspect the chamber(s), leave the gun alone and get help from someone who does.

When using or storing a gun, always follow these NRA rules:

- **Know your target and what is beyond.**
  Be absolutely sure you have identified your target beyond any doubt. Equally important, be aware of the area beyond your target. This means observing your prospective area of fire before you shoot. Never fire in a direction in which there are people or any other potential for mishap. Think first. Shoot second.

- **Know how to use the gun safely.**
  Before handling a gun, learn how it operates. Know its basic parts, how to safety open and close the action and remove any ammunition from the gun or magazine. Remember, a gun's mechanical safety device is never foolproof. Nothing can ever replace safe gun handling.

- **Be sure the gun is safe to operate.**
  Just like other tools, guns need regular maintenance to remain operable. Regular cleaning and proper storage are a part of the gun's general upkeep. If there is any question concerning a gun's ability to function, a knowledgeable gunsmith should look at it.

- **Use only the correct ammunition for your gun.**
  Only BBs, pellets, cartridges, or shells designed for a particular gun can be fired safely in that gun. Most guns have the ammunition type stamped on the barrel. Ammunition can be identified by information printed on the box and sometimes stamped on the cartridge. Do not shoot the gun unless you know you have the proper ammunition.

- **Wear eye and ear protection as appropriate.**
  Guns are loud and the noise can cause hearing damage. They can also emit debris and hot gas that could cause eye injury. For these reasons shooting glasses and hearing protectors should be worn by shooters and spectators.

- **Never use alcohol or over-the-counter, prescription, or other drugs before or while shooting.**
  Alcohol, as well as any other substance likely to impair normal mental or physical bodily functions, must not be used before or while handling or shooting guns.

- **Store guns so they are not accessible to unauthorized persons.**
  Many factors must be considered when deciding where and how to store guns. A person's particular situation will be a major part of the consideration. Dozens of gun storage devices, as well as locking devices that attach directly to the gun, are available. However, mechanical locking devices, like the mechanical safeties built into guns, can fail and should not be used as a substitute for safe gun handling and the observance of all gun safety rules.

- **Be aware that certain types of guns and many shooting activities require additional safety precautions.**

- **Cleaning.**
  Regular cleaning is important in order for your gun to operate correctly and safely. Taking proper care of it will also maintain its value and extend its life. Your gun should be cleaned every time that it is used.

  A gun brought out of prolonged storage should also be cleaned before shooting. Accumulated moisture and dirt, or solidified grease and oil, can prevent the gun from operating properly.

  Before cleaning your gun, **make absolutely sure that it is unloaded.** The gun's action should be open during the cleaning process. Also, be sure that no ammunition is present in the cleaning area.