APPENDIX F

Proposed Approach for Site-Specific Selenium Criterion and Fish Population Monitoring

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LIST OF ACRONYMS

AOC – Administrative Order on Consent

ASTM - American Society for Testing and Materials

BURP - Beneficial Use Reconnaissance Plan

EECA – Engineering Evaluation/Cost Analysis

ELS – Early Life Stage

FSP – Field Sampling Plan

HQI - Habitat Quality Index

HSI - Habitat Suitability Index Models

IDEQ – Idaho Department of Environmental Quality

MATC-Maximum Acceptable Toxic Concentration

SI – Site Investigation

SFI - Stream Fish Index

SHI - Stream Habitat Index

SMI - Stream Macroinvertebrate Index

SRI/SCE - Stream Reach Inventory and Channel Stability Evaluation

TMDL –Total Maximum Daily Load

USFS – United States Forest Service

USEPA – United States Environmental Protection Agency

WBAG - Water Body Assessment Guidance

WCR - WRRI Cover Rating Method

1.0 PURPOSE AND OBJECTIVES

Selenium concentrations in surface waters and fish tissues at Hoopes Spring and Lower Sage Creek exceed current numeric thresholds of effects, based on State of Idaho Water Quality Standards and the USEPA 2004 draft tissue based criterion. However, biological data collected in the field suggests that while concentrations of selenium may exceed current regulatory thresholds in surface waters and fish tissues, the apparent biological community structure and function may not be impaired, at least in Lower Sage Creek. Many factors likely influence this observation including, potential changes in the chemical state of selenium present which affects bioavailability, binding and/or complexation of selenium which may reduce bioavailability, increased tolerance of resident species, and a combination of these and other factors.

Because the community conditions may contradict the chemistry-based effects values and because it may take several years for the benefits of source control to become evident at Hoopes Spring, an investigation is being developed to document and evaluate the current biological effects of elevated selenium concentrations in Hoopes Spring and downstream receiving waters.

The purpose of this Work Plan is two fold:

(1) to provide an approach for data collection that yields results that can be used to document the toxicological, biological, chemical, and physical conditions of Hoopes Spring and the downstream receiving waters; and

(2) to characterize the existing fish population and communities in Crow Creek upstream and downstream of the Sage Creek confluence.

The resulting documentation and characterization of these conditions will be used to evaluate current biological effects in these stream settings. Based on the documentation provided from these efforts, as well as the analyses of site-specific data, a site-specific selenium criterion will be developed. In addition, the fish population and community conditions will be evaluated to assess expected fish carrying capacity based on habitat quantity and quality.

Data derived from this investigation are expected to be of suitable and acceptable quality to modify the current State of Idaho selenium criterion and the Draft Aquatic Life Water Quality Criteria for Selenium – 2004 (USEPA 2004). A modified selenium criterion is expected to be applicable to Hoopes Spring, as well as downstream Sage Creek receiving waters.

The approach described herein would be presented to State and Federal Agencies for concurrence. Idaho's Administrative Code IDAPA 58.01.02 - Water Quality Standards and

Department of Environmental Quality Wastewater Treatment Requirements indicates, "[t]o insure that the approach to be used in developing site-specific criteria is scientifically valid, the Department shall be involved early in the planning of any site-specific analyses so that an agreement can be reached concerning the availability of existing data, additional data needs, methods to be used in generating new data, testing procedures to be used, schedules to be followed and quality control and assurance provisions to be used."

The following sections of this proposed approach present several phases of combined field and laboratory monitoring and testing designed to document existing biological conditions, existing chemical conditions in water, sediment, and biota, and toxicological conditions based on exposure to site conditions, both through the aqueous and dietary exposure pathways.

2.0 REGULATORY BASIS FOR MODIFICATION AND/OR DEVELOPMENT OF A SITE-SPECIFIC CRITERION

Both Federal and State laws permit the development and or modification of water quality criteria or standards. The Federal water quality standards regulation at Section 131.1 l(b)(l)(ii) provides States with the opportunity to adopt water quality criteria that are " . . .modified to reflect site-specific conditions." IDAPA 58.01.02 - Section 275 of Idaho's Standards indicates, "[t]he water quality criteria adopted in these standards may not always reflect the toxicity of a pollutant in a specific water body. These criteria also represent a limited number of the natural and human-made chemicals that exist in the environment which may pose a threat to designated or existing beneficial uses. Thus, it may be possible in some water bodies to develop new water quality criteria or modify existing criteria through site-specific analyses which will effectively protect designated and existing beneficial uses."

According to IDAPA 58.01.02 - Section 275 of the Standards, the following are acceptable conditions for developing site-specific criteria:

- Resident species of a water body are more or less sensitive than those species used to develop a water quality criterion.
- Natural adaptive processes have enabled a viable, balanced aquatic community to exist in waters where natural background levels of a pollutant exceed the water quality criterion (i.e., resident species have evolved a greater resistance to higher concentrations of a pollutant).
- The composition of aquatic species in a water body is different from those used to derive a water quality criterion (i.e., more or less sensitive species to a pollutant are present or representative of a water body than have been used to derive a criterion).
- Biological availability and/or toxicity of a pollutant may be altered due to differences between the physicochemical characteristics of the water in a water body and the laboratory water used in developing a water quality criterion (e.g., alkalinity, hardness, pH, salinity, total organic carbon, suspended solids, turbidity, natural complexing, fate and transport water, or temperature).
- The affect of seasonality on the physicochemical characteristics of a water body and subsequent effects on biological availability and/or toxicity of a pollutant may justify seasonally dependent site-specific criteria.
- Water quality criteria may be derived to protect and maintain existing ambient water quality.
- Other factors or combinations of factors that upon review of the Department may warrant modifications to the criteria.

Acceptable procedures for the modification or development of a site-specific criterion, as defined in IDAPA 58.01.02 - Section 275 of the Standards, include:

1) Recalculation Procedure
2) Indicator Species Approach
3) Resident Species Approach
4) Water Effects Ratio
5) Other scientifically defensible procedures such as relevant aquatic field studies, laboratory tests, biological translators, fate and distribution models, risk analyses or available scientific literature.

USEPA guidance on developing site-specific criteria is summarized in the Water Quality Standards Handbook (USEPA 1994). Procedures one through four above are those provided by USEPA as acceptable approaches. Indicator Species and Water Effects Ratio approaches have been combined and are now simply referred to as the Water Effects Ratio. Procedures identified under item five above are identified as additional acceptable procedures by IDEQ.

The approaches identified in numbers one through four above are based on modifying criteria due to aqueous exposures, thus these approaches are largely ineffective for modifying a criterion for selenium. USEPA's recent Draft Aquatic Life Water Quality Criteria for Selenium – 2004 indicates, "[s]tudies have shown that diet is the primary route of exposure that controls chronic toxicity to fish, the group considered to be the most sensitive to chronic selenium exposure (Coyle et al. 1993; Hamilton et al. 1990; Hermanutz et al. 1996)." Because diet is the primary exposure pathway, procedures identified in number five will be used to modify the selenium criterion. The proposed approach described below will use lines of evidence based on the data collected to modify the criterion.

3.0 RECOMMENDED PHASES

Several lines of evidence are proposed as part of the process of modifying the State of Idaho's and USEPA's selenium criterion. The project is outlined in phases and an approximate sequence of implementation is proposed. Five phases of the proposed approach are briefly described below:

- Phase 1 - Develop a Monitoring Plan
    - Plan will provide approach to (1) evaluate spatial and temporal trends of selenium in biotic and abiotic media; (2) assess fish population and community health. Monitoring will include physical habitat assessments for quality and quantity as well as availability of spawning habitat; and (3) provide the details for fish reproduction assessment as well as the early life stage (ELS) fish toxicity testing.
- Phase 2 – Implement the Monitoring Plan
    - Conduct field investigations described in the Monitoring Plan
- Phase 3 – Fish Reproduction
    - Assess wild fish reproduction in the laboratory
- Phase 4 –ELS fish toxicity testing
    - Conduct laboratory-based toxicity testing for survival and growth of swim-up fry (post alevins).
- Phase 5 - Reporting
    - Develop a report that documents that data used to derive the selenium criterion relative to reproduction, growth, and mortality endpoints. Relate biological and ambient chemical conditions to these endpoints.
    - Document the fish population and community conditions including habitat quality assessments.

3.1 Phase 1 and 2 – Develop and Implement a Detailed Monitoring Plan

A Monitoring Plan will be developed that details when, where, and the frequency of sample collection proposed to meet the objectives of the investigation. Table F-1 summarizes when and where components of the plan will be implemented. The monitoring plan will also include the details of the experimental design for assessing fish reproduction and ELS fish toxicity testing. For much of the proposed plan, methods implemented as part of the field sampling plan (FSP) for the SI will be utilized (MFG, 2003). American Society for Testing and Materials (ASTM) methods will be used as the protocol for conducting ELS fish toxicity testing.

IDEQ protocols identified either as part of the Beneficial Use Reconnaissance Plan (BURP), and/or the Water Body Assessment Guidance (WBAG) (Grafe et al., 2002) will be used to supplement the existing FSP protocols as needed. Fish populations and community assessments will be conducted in such a manner that both the WBAG and BURP data collection requirements are met but which also satisfy the needs of specific indices such as the Stream Reach Inventory and Channel Stability Evaluation (SRI/SCE), Habitat Quality Index (HQI), WRRI Cover Rating (WCR) Method, and/or Habitat Suitability Index Models (HSIs). The following subsections describe the components of the Monitoring Plan.

3.1.1 Location of Upstream Reference Sites

Idaho DEQ has developed a reference stream ranking process by which to rate the quality of potential reference streams used as a comparative condition for streams being evaluated for various impacts or use attainment. The document *Selection of Reference Condition for Small Streams in Idaho: a Systematic Approach* (Grafe, 2004) provides a protocol to evaluate specific criteria for candidate reference streams. IDEQ uses the first two of the three operational definitions from Larson (2003), presented below, to define the reference condition for bioassessment purposes:

- **Minimally Disturbed Condition–**this condition occurs in the absence of significant human disturbance (e.g., “natural,” “pristine,” or “undisturbed”). Some regions may have no sites that meet minimal disturbance criteria. It is understood that even minimally disturbed areas (e.g., wilderness areas) receive some disturbance through atmospheric deposition and other widespread impacts.
- **Least Disturbed Condition–**this condition is found in combination with the best available physical, chemical, and biological characteristics given the current state of the landscape. The least disturbed condition is relative. Regardless of the level of disturbance in a region, some sites are relatively less disturbed than others. For the least disturbed condition, it is possible to use a “proportion of the resource” criterion such as “the upper one percent of the resource that is least disturbed.”
- **Best Attainable Condition–**this condition is equivalent to the ecological condition of (hypothetical) least disturbed sites where the best possible management practices are in use. In some cases, this condition could be better than the least disturbed condition. This condition can be determined using techniques such as historical reconstruction, best ecological judgment with modeling, restoration experiments, and/or inference from data distributions.

Grafe (2004) indicates that the definition of best attainable condition is not currently used in reference condition for bioassessment index development. However, best attainable conditions may be used for other purposes, such as total maximum daily load (TMDL) or site-specific criteria development. At the time Grafe (2004) was published, IDEQ had 165 candidate areas and ranked and rated 140 of these areas. Only 22 were selected as reference sites for trend analysis. While one of the reference streams identified for this assessment (i.e., Crow Creek) was on the candidate list, it was not evaluated. Crow Creek is likely representative of a Least

Disturbed Condition. In addition to using these reference sites, additional in-basin reference sites will also likely be considered, either for sampling or for review of literature to evaluate the availability of fish population monitoring data. For example, Tincup Creek, listed as a candidate reference stream in Grafe (2004) could be an appropriate reference stream. Stump Creek, which is even closer to Sage Valley, could also be an appropriate reference stream. Similar to those creeks listed above, the State's guidance would be used to rate and rank these streams for use as reference streams. Certain areas monitored as part of the Panels F and G Environmental Impact Assessment (EIA), such as Crow Creek near Wells Canyon and or South Fork Deer Creek may also serve as upgradient reference locations for this investigation. The advantage of using sites evaluated for the F and G EIA is that existing data for water quality, fisheries, and habitat currently exists.

For the purpose of this assessment, two to three reference sites will be used as the comparative basis for Hoopes Spring and its downstream receiving waters. Locations of the proposed reference sites include the following:

- **CC-2** – Crow Creek upstream of Sage Creek Confluence (reference)
- **CC-4** – Crow Creek upstream of CC-2 to serve as additional reference location – likely downstream of Manning Creek
- **US or US-3** - Sage Creek upstream of the haul road culvert (reference).

Using the protocol described by Grafe (2004), each of these streams will be scored according to the criteria to determine how they rank relative to other candidate reference streams assessed by IDEQ. These reference sites are identified on Figure F-1.

3.1.2 Location of Downstream Sampling Sites

A number of locations, including Hoopes Spring and downstream receiving waters, have been selected to evaluate biotic and abiotic conditions for the purposes of this assessment. These sites are identified below and on Figure F-1:

- **Hoopes Spring (near discharge) and discharge channel (HS-3)** – (Note: HS is a routine monitoring location [fall and spring monitoring])
- **LSV-2** – Sage Creek downstream of Hoopes Spring and upstream of South Fork Sage Creek (Note: LSV-3 is a routine monitoring location [fall and spring monitoring])
- **LSV-4** – Sage Creek upstream of the confluence with Crow Creek
- **CC-1** – Crow Creek downstream of Sage Creek Confluence
- **CC-3** - Crow Creek downstream of CC-1 and upstream of the unnamed tributary that confluences Crow Creek near the Idaho and Wyoming state line.

These locations have been selected because existing water quality data indicate that there is a decreasing trend in selenium concentrations from Hoopes Spring to downstream receiving

waters. These locations represent relatively high, moderate, and low selenium concentrations based on the existing data. Decreasing trends in selenium concentrations provide the opportunity to evaluate what concentration of selenium in the aquatic environment poses a potential risk.

Previously collected water quality data indicates that concentrations of selenium in Crow Creek surface waters are below current standards. Crow Creek sites downstream of Sage Creek will be evaluated to quantify if selenium from upgradient sources is adversely affecting fish and other biological resources downstream of the Sage Creek confluence. Upstream Crow Creek reference sites will be used to establish baseline fish population, community, and habitat quality.

3.1.3 Monitoring Periods and Frequency

Two monitoring periods, spring and fall, are proposed at each site described above for each year of this investigation. As part of the Environmental Program Monitoring Plan for the Mine (MFG, 2002), sampling will be conducted twice annually, in spring and fall, at a number of locations including lower South Fork Sage Creek (LSS), lower Sage Creek (LS), lower Pole Creek (LP), Lower Sage Valley (LSV3), and Hoopes Spring (HS).

Spring monitoring prior to high flows in March or April is proposed in order to coincide with the collection of spring-spawning cutthroat trout. Water, sediment, and biota sampling will be conducted at this time. Likewise, fall low-flow monitoring, which is likely to be conducted in late October, is proposed to coincide with collection of fall-spawning brown trout. These spawning periods are approximate, and specific time periods will need to be determined based on available data and water temperatures. IDEQ's Waterbody Assessment Guidance (2002) provides some data on the spawning periods for several salmonid species in several of Idaho's rivers.

Monitoring for the fish population and community analysis will be conducted at all locations for an additional year beyond Year 2 (during 2 seasons, spring and fall) to assure that adequate temporal data are collected.

3.1.4 Parameters for Chemical Analysis

A number of chemical and physical parameters are proposed for sampling during each of the monitoring events, including water chemistry, sediment chemistry, and tissue residues. To evaluate water quality, the following chemical parameters are proposed:

- Total and dissolved selenium concentrations;
- Hardness, alkalinity, sulfate, phosphate; and
- Temperature, dissolved oxygen, pH and conductivity.

Water quality samples, whether collected for laboratory analyses or collected in-situ using electronic instrumentation, will be collected according to the FSP (MFG 2003). Selenium speciation will be conducted at one or more locations for Hoopes Spring near the discharge point, and one or more locations in downstream receiving waters. The purpose of water quality sampling is to determine the concentrations of selenium at various locations in the study area and verify the predominant form of selenium present. In the flowing surface waters, selenate is expected to be the predominant aqueous species. In tissues, organoselenium is expected to predominate. These expectations will be verified.

Sediment chemistry analyses will focus on measuring total selenium in bulk sediment samples sieved to the 2 millimeter fraction which will best represent the sands and finer substrate size particles. Percent moisture and organic carbon concentrations will also be measured for each sediment sample. Sediment samples will be collected according to the FSP (MFG, 2003). Sediment data are collected to understand if there are differences in how selenium may compartmentalize in the environment and if that compartmentalization changes at different locations in the downstream receiving waters.

Biological tissue residues for benthic macroinvertebrates and periphyton will be sampled and analyzed for selenium content during each field sampling effort (spring and fall of Year 1 and Year 2). Because selenium effects in fish are suspected to be due in large part to dietary exposure, understanding how selenium compartmentalizes in the food web is important to the understanding of the exposure pathways.

Periphyton, which represents the primary producers, will be sampled by scraping or brushing rocks to dislodge attached algae. A uniform number of rocks and area scrubbed from each location helps to maintain consistency in the sampling protocol. Both the FSP (MFG, 2003) and the WBAG (Grafe et al., 2002) provide similar protocols which will be the basis for collecting a composite periphyton sample from each site. Selenium concentrations, including total and organic fractions, will be analyzed for periphyton samples.

Selenium concentrations in benthic invertebrates, the primary consumers, will also be analyzed. Benthic invertebrate samples, three per location, will be collected and composited for each location in order to evaluate how selenium behaves in this second trophic level. Data from other studies have indicated that while algal communities may concentrate selenium in their tissues from an aqueous exposure, the same observations are not seen in benthic invertebrates. Residues of selenium in benthic tissues tend to be lower than that measured in algae.

Fish tissue residues, particularly for trout, will only be collected from the adult fish used for the reproduction assessment. The streams to be evaluated in this system are small, and excessive sampling pressure is not warranted. When fish community data are collected, a few representative sculpins from each location, if present, will be retained for tissue residue analysis

as well. Sculpin are a prey item for adult piscivorous fish, thus they are an important part of the food web.

3.1.5 Aquatic Community Health

In addition to collecting water and sediment quality data and chemical data for tissue residues, in-situ measurement data will be collected to quantify fish population and communities, benthic invertebrate communities, and physical habitat quality. An independent fisheries expert will conduct the fishery population and community monitoring and assessment of the fishery and habitat data. This independent analysis will be included in the assessment of aquatic community health.

These data combined with the chemical data will be used collectively to evaluate the aquatic community health at each of the locations. The objectives of this assessment are to:

- Document fish abundance, species compositions, and age classes at each of the sampling locations;
- Document benthic invertebrate community composition, structure, and function at each of the sampling locations;
- Compare indices of fish populations and communities between reference sites and downstream receiving waters; and
- Compare indices of benthic community characteristics between reference sites and downstream receiving water sites.

During each sampling event, fish and benthic community data will be collected according to the FSP (MFG, 2003) and consistent with WBAG protocols (Grafe et al., 2002). Fish data collected will be used to evaluate abundance, composition, diversity, and biomass. Electrofishing and/or seining methods will be used to collect fish during spring and fall periods.

Benthic invertebrate samples will be collected at each location using either a modified Surber or Hess sampler. Three benthic invertebrate samples for benthic community composition, diversity, and biomass from each reach will be collected. Taxonomy will be conducted on a composite sample for each reach. Samples will be collected using methods identified for the FSP (MFG, 2003) and the SI (NewFields, 2005). Taxonomy and enumeration will be conducted in the laboratory.

Idaho DEQ's *Small Stream Ecological Assessment Framework: An Integrated Approach* (2002) provides documentation and methods for deriving a Stream Macroinvertebrate Index (SMI), Stream Fish Index (SFI), and Stream Habitat Index (SHI). These methods will be evaluated to assess how they relate to achieving the objectives of this investigation. In other words, while these methods may provide an adequate assessment tool for use-attainability analysis, they may not answer the questions which need to be addressed for this investigation. Additional

methods will also be used to assess fish-carrying capacity based on habitat quality and quantity. The analysis of fish population and habitat data will also need to consider in Year 3 the impacts of the previous year's sampling and its effect on Year 3 results. Recall that in Year 2, it is proposed that several adult pre-spawn fish be collected from several locations. Removal of these adults, as well as the eggs they will produce, from the system will affect the following year class which will need to be considered in the assessment and comparison of fish population data and habitat based carrying capacity. These methods are described below.

3.1.6 Physical Habitat Quality and Carrying Capacity

Physical habitat quality and quantity data will be collected at each site during each field visit. The purpose of quantifying habitat is that trout populations and carrying capacity of streams are directly related to availability of quality habitat as well as water quality conditions. If water quality is not having an adverse affect on trout in for example, Crow Creek, and habitat quality is equally high at all locations, then one would expect that trout populations would also be relatively equal at all locations as well. Potential barriers to fish migration, such as beaver ponds, or culverts will be considered in the evaluation of fish populations and communities. Consideration will likely include if these structures are potential impediments, affect abundance and distribution, hydraulics, and/or habitat structures and quality.

The objectives of this assessment are to:

- Document physical habitat quality and quantity at each sample location;
- Develop predictions of fish-carrying capacity based on physical habitat quality and relate measured fisheries data to predicted data; and
- Compare physical habitat quality, predicted carrying capacity and actual carrying capacity between reference sites identified for this assessment and reported data for other high quality streams of similar size and ecoregion to the data collected from the downstream receiving water locations.

IDEQ's WBAG and BURP protocols provide methods for the assessment of habitat and ranking quality based on ocular evaluations. Habitat data to be collected can be used for these assessment strategies, such as the SHI identified above, however, other strategies will be utilized for the purpose of this investigation. Physical habitat composition and structure will be evaluated at each of the study sites. Field sampling will focus on collecting data necessary to assess the physical habitat at each study site by means of (1) temporal and spatial comparison of hydraulic conditions; (2) the Stream Reach Inventory and Channel Stability Evaluation (SRI/CSE) system; (3) the WRRI Cover Rating (WCR) method; (4) the Habitat Quality Index (HQI) procedure; and (5) Habitat suitability index models (HSIs).

3.1.6.1 Assessment of Hydraulic Conditions

To assess hydraulic conditions at each study site, five cross-channel transects (spaced at two channel width intervals) will be selected, permanently marked with survey stakes, and monitored. Discharge data will be collected consistent with the FSP (MFG, 2003) using a Marsh-McBirney current meter. Substrate composition will also be determined at 10 to 20 locations along each transect using the ocular technique and classification system described by Wesche (1980). The overall reach velocity will be determined using Rhodamine dye. The dye will be discharged at the upper limit of each study site and time of travel is recorded to the nearest second by observing when the leading edge of the dye crosses the lower limit of the reach.

The water-surface slope through each study site will be determined by measuring the drop in water-surface elevation from the upstream reach limit to the downstream limit using a standard surveyors level and rod. The change in elevation (feet) divided by the length of the site (feet) yields slope, expressed as a percent. The sinuosity ratio will be determined by dividing the length of the thalweg line (feet) through the study site by the length of the valley floor.

3.1.6.2 Stream Reach Inventory and Channel Stability Evaluation (SRI/CSE)

The stability of each study site will be assessed using the SRI/CSE procedure developed by Pfankuch (1975). This ocular system involves the numerical evaluation of 15 hydraulic indicators found within three major stream zones: upper banks, lower banks, and channel bottom. Basically designed for application on second to fourth order streams, the procedure is flexible in that it can be used in the physical evaluation of stream reaches of various lengths. Scoring is based on four stability categories, excellent, good, fair, and poor, with a numerical value assigned to each of the 15 indicators within each category. The total reach score is found by summing the values recorded under each category. The reach score is then compared to a series of numerical intervals, thereby determining the reach to either be excellent, good, fair, or poor, in terms of hydraulic stability.

3.1.6.3 WRRI Cover Rating (WCR) Method

The WCR method will be used to assess the availability of instream cover, an important component of trout-rearing habitat. Based upon the field measurement of water depth, substrate composition, stream width, study site length, and the amount of overhead bank cover present, cover ratings were developed that allow comparison of available physical habitat among study sites. Wesche (1980) presents a thorough description of the background and application of this method. Cover ratings will be made for each of the study sites. Data

collection will be closely tied to the methods described above for the assessment of hydraulic conditions.

3.1.6.4 Habitat Quality Index (HQI)

The HQI procedure will be applied to each of the study sites during each sampling period in accordance with the guidelines given by Binns (1982). Developed by the Wyoming Game and Fish Department, the HQI is designed specifically to quantify aquatic stream habitat and predict trout standing crop potential. Two models are available and the attributes from each will be characterized.

3.1.6.5 Habitat Suitability Index Models (HSIs)

Individual Habitat Suitability Index Models (HSIs) for brown trout and cutthroat trout are available and each model is comprised of several habitat variables. Similar to models discussed above, HSIs can be used as an index by which habitat quality can be compared. Many of the variables needed for these HSIs will also overlap with the variables needed for the above described models, thus the use of the HSI provides an alternative mechanism by which to compare trout populations, habitat quality, and habitat quantity.

3.1.6.6 Availability of Potential Spawning Habitat

A reconnaissance level survey of several locations will be conducted to determine where potential spawning habitats may exist for brown trout and cutthroat trout. The survey will identify locations and/or reaches of streams where trout might likely spawn. Potential spawning habitat is based on water velocity, suitability of gravels (i.e. size), and water depth. Water temperature is a key determinant in timing when fish will spawn. Local fisheries experts will be contacted to assist in determining when the appropriate period for this survey would commence.

3.2 Phase 3 – Fish Reproduction Evaluation

Phase 3 examines two very important linkages in the life cycle of trout exposed to selenium. The overall objective of the proposed reproduction test is to evaluate in-situ selenium exposures via diet and water and how those exposures at different locations may affect successful reproduction and viability of the young produced. These tests will not expose eggs to selenium concentrations in water, rather adult wild fish ready to spawn will be captured at various locations from the study area. Although young will not be exposed to aqueous selenium, they will have consumed any protein bound organic selenium that was present in the yolk and passed on to the egg via parental exposure.

The objectives of this testing approach are as follows:

- Document the selenium concentrations in parental fish due to in-situ integrated exposure of diet and water that may adversely affect successful reproduction.
- Document the selenium concentrations in parental fish due to in-situ integrated exposure of diet and water that may aversely affect the viability of young.
- Document the selenium concentrations in eggs produced by adults from different locations in the study area.
- Develop relationships between selenium concentrations in parental whole body tissues to egg tissues.
- Develop relationships between selenium concentrations in parental whole body tissues to ambient exposure media (i.e., water and diet).
- Define a selenium concentration for each species evaluated where an acceptable level of effects to reproductive success and viability of young occur.

The approach for this phase of the investigation is similar to that presented in the following published works:

- Kennedy et al. (2000). The effect of bioaccumulated selenium on mortalities and deformities in the eggs, larvae, and fry of a wild population of cutthroat trout (*Oncorhynchus clarki lewisi*).
- Holm (2002). Sublethal effects of selenium on rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*)
- Holm et al. (2003). An assessment of the development and survival of rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*) exposed to elevated selenium in an area of active coal mining.

Gravid females and males in pre-spawn condition will be collected from each location. Collection locations will be at those sites described previously in this Work Plan. Ideally, fish will be collected at a number of sites that represented a range of selenium exposures, ranging from very low (i.e., reference) low to moderate, moderate to high, and high. However, it is unknown at this time, if spawning fish will be collected at each location due to water quality limitations or habitat limitations. The number of males and females used for this phase from each site will be dependent upon the number of fish collected from each site. Fish for the reproduction assessment will be collected during spring and fall in Year 2. The spawning habitat survey will be used to target specific areas where suitable spawning habitats are found.

Adult fish will be transported to an appropriately qualified laboratory for conduct of the reproduction test. Females from each location will be stripped of eggs which will be fertilized with milt from one or more males from the same stream reach or location. A subsample of eggs will be collected for tissue analysis. Adult fish will also be sacrificed for tissue residue analysis. Four conditions will be evaluated, including the following: low, moderate, and high selenium concentrations and a reference condition. It is expected that fish collected, if available, from

Hoopes Spring will be placed in the high exposure condition, fish from Lower Sage Valley will be placed in the moderate exposure condition, and fish from Crow Creek downstream of the Sage Creek confluence will be placed in the low exposure condition. The reference condition will include fish from upstream Crow Creek sites and/or Upper Sage Creek.

This test will rear fertilized eggs to the swim-up stage (that point at which young fish would begin to feed ~60 days) in separate treatment tanks. Counts on successfully fertilized eggs will be made and non-viable eggs will be removed. Fertilized eggs for each treatment will be reared in the laboratory and examined for time to hatch, deformities (craniofacial, finfold, skeletal and yolk sac malformations, among others), and mortality or survival.

Test endpoints will be evaluated for their relationship to parental selenium tissue residues as well as surface water selenium concentrations from where the parents were captured.

These relationships will aid in determining effect and/or no effect concentrations of selenium that result in adverse effects on reproduction endpoints. Comparisons of the incidence of deformities or other physical abnormalities of fish, survival, and numbers of successfully fertilized eggs will also be made among each of the treatments for fish from downstream areas to upstream reference areas to evaluate if the observations are significantly different.

3.3 Phase 4 - Laboratory Toxicity Testing

Phase 4 testing is designed to evaluate the concentrations of selenium in diet and aqueous exposures that may adversely affect young developing trout. For most chemicals, testing for ELSs would be commenced with fertilized eggs and continue to a period of 60 days post hatch (~90 days total test duration). However, these testing regimes are primarily designed to evaluate aqueous contaminant exposures, not dietary exposures.

Currently, only a few studies have evaluated salmonid egg exposures via aqueous pathways with no pre-parental exposure. Those that were conducted and summarized briefly in the USEPA's 2004 Draft Criteria document (USEPA, 2004) were for acute exposures. The lowest LC50 reported was > 550,000 ug/l. These concentrations are well above those observed in the study area. The concentrations of selenium observed in surface water and fish tissues of Hoopes Spring and Sage Creek are not acutely toxic, but are in the range of literature defined chronic toxicity.

Chronic effects of selenium exposure to fish are due primarily to diet. Chronic toxicity is manifested slowly in fish, and is based on magnitude and duration of exposure, as well as biouptake in the food web. The USEPA 2004 draft criteria document for selenium did not consider or use tests in which aqueous-only exposures were tested in its consideration of acceptable data for developing a chronic criterion. It states, "[b]ecause diet controls selenium chronic toxicity in the environment and water-only exposures require unrealistic aqueous

concentrations in order to elicit a chronic response, only studies in which test organisms were exposed to selenium in their diet alone or in their diet and water were considered in the derivation of a chronic value." Because ELS trout toxicity testing beginning with fertilized eggs would consume approximately one-third of the test period with only aqueous exposures, and because chronic selenium toxicity is primarily related to dietary and aqueous exposures, testing proposed under Phase 4 will commence using swim-up fry (post alevins) once young fish begin to feed.

The objective of this testing approach will be to evaluate the combined effects of dietary and aqueous exposure concentrations of selenium that affect growth and survival of young trout. Dietary and aqueous selenium concentrations will approximate those concentrations observed to be present in Hoopes Spring and downstream receiving waters.

ELS trout toxicity tests will be conducted using diet and aqueous exposures with trout that are considered to be swim up fry (approximate time when fry begin to feed). Aqueous exposure would be from inorganic selenium (sodium selenate) dosing of treatment tanks that represent a low, moderate, and high exposure similar to the ambient concentrations measured in the field. An additional high selenium concentration which is approximately 2 times the highest treatment will also be included to evaluate potential effects due to selenium concentration spikes that may occur in the field.

Dietary exposure to young trout will be from bioaccumulated selenium in invertebrate feedstocks. Lumbriculus or other aquatic invertebrates suitable for trout feed will be exposed to selenium spiked water. Exposure concentrations of selenium to the feedstock will be dependent upon the analysis of data from Year 1 field monitoring at various locations. These measurement data will provide information about concentration as well as speciation. These two components of exposure will be replicated as close as possible in the laboratory exposures. For example, if organic selenium is the primary selenium species found in the analysis of benthic invertebrate and water analyses, then an appropriately proportioned mixture of organic selenium will be dosed to the feedstock organisms. Exposed feedstock would then be fed live to young trout.

Overall, these ELS tests will be conducted according to ASTM standards. Feeding regimes, water dosing, water exchange, and associated details of the exposure will be provided in the Monitoring Plan. The test duration will be approximately 30 days. Test endpoints will be growth and survival. The goal will be to establish the Maximum Acceptable Toxic Concentration (MATC) for growth and survival in tissues and water based on diet and water exposures. Selenium concentrations will be measured in fish tissue, diet feedstock, and water at the beginning, middle, and end of the test.

3.4 Implementation Sequence

Staged implementation is needed in order to gather data. Important data will be collected in Year 1 about surface water and biotic tissue concentrations of selenium as well as species of selenium that predominate in different environmental media. In-situ monitoring prior to initiation of reproductive and ELS tests is planned for this purpose. Phases 1 and 2 will be developed and implemented during Year 1. Prior to implementing any field or laboratory studies, the Monitoring Plan will be submitted to appropriate agencies for review and concurrence on the proposed approach. The Monitoring Plan will continue to be implemented in Year 2 together with the collection of data to evaluate aquatic community health.

Phases 3 and 4 will also be implemented during Year 2. The fish reproduction assessment will be conducted in Year 2 using adult cutthroat trout collected in the spring and brown trout collected in the fall. By the time this portion of the plan is implemented, it is expected that there will be a reasonable understanding of habitat and where potential spawning areas may be located, as well as the selenium concentrations in biotic and abiotic media.

In between monitoring events, data will be continually compiled and organized. Following the completion of fall monitoring in Year 2, as well as the completion of laboratory studies, the full compendium of data will be analyzed. A draft report will be developed for submittal to Simplot. Comments from Simplot will be integrated into an Agency Review Draft Report. The Agencies will be involved to gain concurrence on the approach and data analysis early on in the process. It is expected that Agency review of the draft report will focus on interpretation of the data collected and the conclusions drawn from that analysis. Table 3-2 summarizes the implementation sequence of the proposed project phases.

3.5 Phase 5 - Report Preparation

This Work Plan is designed to provide data for the following:

- Modifying the existing fish tissue and/or surface water standard for selenium; and
- Assessing if fish populations in Crow Creek and other downstream receiving waters are similar or different from reference sites.

The report prepared from the results of this investigation will document all data collected including data for surface water and sediment chemistry, biological tissue residues, fish and benthic community characteristics, toxicological data for reproduction, survival, and growth, and physical habitat quality. These results will provide the lines of evidence to be used in a targeted risk assessment to define the concentrations of selenium in water and diet that pose a risk to aquatic receptors, primarily fish.

As with any risk assessment, ambient concentrations of selenium will define the exposure concentrations. Key exposure concentrations to be evaluated will include aqueous and diet pathways. Laboratory toxicity data will define the effects due to exposure. The biological community data will define the characteristics of the aquatic community that occur under different exposure conditions. Furthermore, because the aquatic community can also be affected due to factors other than chemical conditions, physical habitat quality will also be evaluated to assess what influence it may have on the aquatic community integrity.

Relationships between selenium concentrations in water and diet will be investigated relative to fish abundance, biomass, community composition, reproductive success, and ELS fish growth and survival. Biological community characteristics for fish and benthic macroinvertebrates will be evaluated to assess if differences exist between downstream receiving water sites and reference sites, as well as among downstream receiving water sites. In addition, data collected to evaluate fish population and community characteristics will yield sufficient information to assess whether or not there are differences in these characteristics in Crow Creek as well as other sites identified in the study area.

It is expected that concentrations of selenium that pose acceptable risks, as well as unacceptable risks, will be defined. One or both of these concentrations will then be used to modify the selenium criterion.

Because continued fish tissue sampling is particularly destructive to the fish populations and communities, it may be prudent to derive relationships of effects to concentrations that cause effects. For example, if practical, developing a model to predict tissue concentrations based on aqueous concentrations may be a logical step in order to reduce the quantity of fish tissue samples that would be needed to evaluate future potential risks.

Brix et al. (2005) developed a model to derive site-specific water quality criteria based on co-located tissue residues and water quality data. As part of developing the report, the applicability of the Brix et al. (2005) model and other models to predict selenium-tissue residues based on water quality conditions will be investigated.

Once the draft report is prepared, and reviewed by Simplot, an Agency Review Draft Report will be submitted to the appropriate agencies for review and comment. One or more meetings may be necessary to present the details of the modified criterion and how it is derived.

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TABLES

Table F-1
Proposed Locations for Sampling in Support of Deriving a Site-Specific Selenium Criterion

Drainage/Station Name	Reach	Sampling Activity													
		Water and Sediment Quality		Benthic and Periphyton Tissues		Fish Tissue		Fish Population		Benthic Community		Fish Reproduction		Habitat Quality	
	Sampling Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Sage Creek															
LSV-3 and/or LSV-2	Lower Sage Valley (Sage Creek)	X	X	X	X	X	X	X	X	NS	X	X	X	X	X
LSV-4	Lower Sage Valley (Sage Creek)	X	X	X	X	X	X	X	X	NS	X	X	X	X	X
Hoopes Spring															
HS	Hoopes Spring	X	X	X	X	X	X	X	X	NS	X	X	X	X	X
HS-3	Hoopes Spring (Discharge Channel)	X	X	X	X	X	X	X	X	NS	X	X	X	X	X
Crow Creek															
CC-1	Crow Creek d/s Sage Creek	X	X	X	X	X	X	X	X	NS	X	X	X	X	X
CC-2	Crow Creek u/s Sage Creek	X	X	X	X	X	X	X	X	NS	X	X	X	X	X
CC-3	Crow Creek d/s of CC-1	X	X	X	X	X	X	X	X	NS	X	X	X	X	X
CC-4	Crow Creek u/s of CC-2	X	X	X	X	X	X	X	X	NS	X	X	X	X	X

Notes:

N/S - Not Sampled.

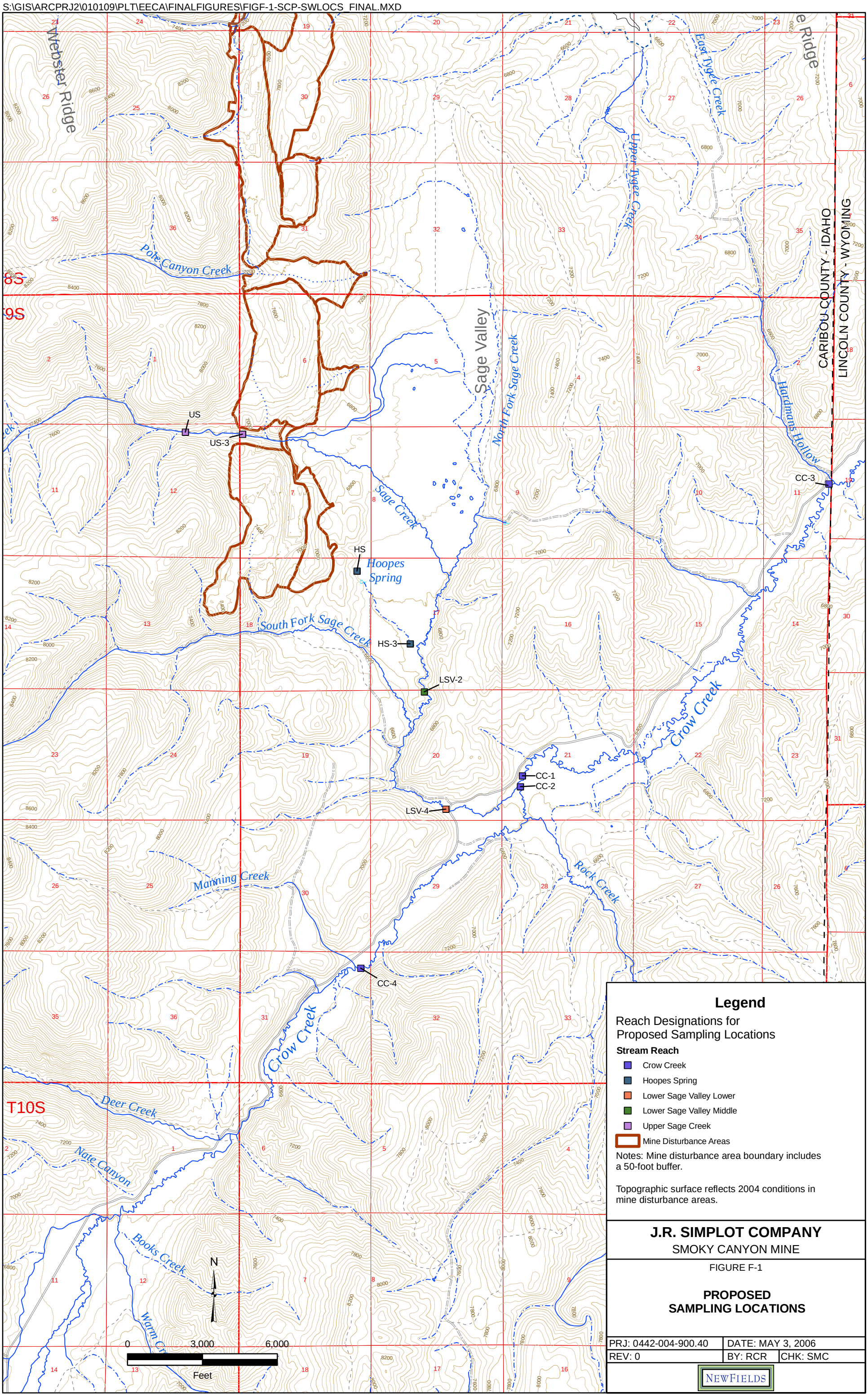
Yellow highlighted cells - activities that will only be conducted during Year 2.

Green highlighted cells - Fish tissues during Year 1 will only be collected for cottids. Tissue data for Year 2 will be derived from parent fish used in the reproduction study, additional cottids may be used to supplement fish tissue data.

Orange Cells - activity to be continued into Year 3.

Table F-2
Summary of Phases and Implementation Sequence

Phase Number	Phase Description	Tasks	Implementation Period
1	Develop a Monitoring Plan	Provide approach to evaluate spatial and temporal trends of selenium in biotic and abiotic media.	Year 1
		Provide approach to assess fish population and community health.	
		Physical habitat assessments for quality and quantity as well as availability of spawning habitat.	
		Provide details for Phase 3 and Phase 4.	
2	Implement the Monitoring Plan	Conduct field investigations described in the Monitoring Plan.	Year 1,Year 2 and Year 3
3	Fish Reproduction Evaluation	Assess wild fish reproduction in laboratory.	Year 2, with fish collected in spring and fall
4	Early Life Stage Fish Toxicity Testing	Conduct laboratory-based toxicity testing for survival and growth of swim up fry.	Year 2
5	Report Preparation	Document the fish population and community conditions including habitat quality assessments.	Following completion of Phases 1-4
		Document the data used to derive the selenium criterion.	

FIGURES

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