

APPENDIX F

RISK ASSESSMENT WORK PLAN REVISION 1

1. Baseline Human Health Risk Assessment (BHHRA)

A BHHRA will be prepared to address the detected analytes found to be present at the Site in accordance with the Risk Assessment Guidance for Superfund (RAGS) series published by USEPA (as interpreted by Region 1), CERCLA and USACE risk assessment guidance contained in EM 200-1-4 (Volume I), and the Maine Department of Environmental Protection (MEDEP, 2018). The BHHRA will assess the risk to the human receptors associated with the complete or potentially complete current or reasonably anticipated future exposure pathways involving soil and groundwater and, where applicable, local biota that may be important to people's food chains.

The BHHRA will consider the range of concentrations of detected analytes measured in the surface soil (0 – 0.5 feet bgs) and shallow soil (0.5 – 2 feet bgs), where soil 0 – 2 feet bgs is considered to be accessible soil, subsurface soil (2 – 15 feet bgs), which is considered to be potentially accessible soil, sediment, surface water, and groundwater, and the extent of the constituents relative to the potential points of exposure of the current and future Site users. The BHHRA will be presented using the RAGS Part D standardized tables (USEPA, 2001). In addition, outputs from USEPA's RSL Calculator will be included to facilitate and streamline the review of this assessment. If potential risks to human receptors are determined to be present at the Site based on the BHHRA, corresponding preliminary risk-based soil remedial goals may be developed for the identified chemicals of concern (COCs) that were shown to contribute the most to the projected risks. These preliminary remediation goals would be used in the FS to evaluate human health protectiveness. These preliminary remedial goals would identify the levels of constituents in the impacted media that would reduce the projected risks to levels deemed to be acceptable by the risk managers and stakeholders.

1.1 Data Summary and Selection of Chemicals of Potential Concern

Upon completion of the RI field program, the results of the characterization activities will be compiled. A description of the environmental features observed within the Site will be presented. The pre-RI field program CSM for the Former Salvage Yard will be updated, as necessary, to reflect any new data collected during the field investigation effort relative to environmental transport and migration pathways or Site usage. The information collected during the RI will be used to develop the risk assessment databases required for the human health and ecological risk assessments.

The BHHRA will make use of the site characterization data that were compiled for the screening level human health risk assessment (i.e., the combined Phase I and II ESA [qualitative] and validated RI sampling results). This data will be grouped by appropriate exposure point or area according to the indicated land use patterns.

Chemicals of potential concern (COPCs) will be identified on a Site-wide basis, followed by a more detailed assessment of potential risk within each decision unit (DU) associated with the selected COPCs. COPCs will be identified by comparing the maximum detected concentrations of each constituent in the surface soil, subsurface soil, sediment, surface water and groundwater to established conservative human health risk-based screening values developed for those exposure pathways identified in the CSM to be complete and potentially complete. The justification for

retaining a constituent as a COPC or screening it out will be clearly documented in the risk assessment report.

Selected COPCs will be those constituents present at concentrations above background levels, detected in more than one sample, not present as a result of trip or method blank contamination, and exceeding one or more conservative risk-based screening criteria. These risk-based screening criteria will include USEPA Regional Screening Levels (RSLs) for residential soil and tapwater at conservative risk/hazard levels [i.e., an Excess Lifetime Cancer Risk (ELCR) of 10^{-6} or a non-carcinogenic hazard index (HI) of 0.1], and for constituents without a USEPA RSL, Maine DEP Remedial Action Guidelines (RAG) for soil (residential, commercial, construction), and RAGs groundwater (residential and construction) will be multiplied by 0.1 to achieve the equivalent risk/hazard level (i.e., 10^{-6} cancer risk or 0.1 hazard index). Screening values based on these risk/hazard levels were selected for use in the BHHRA to consider a potential unlimited use and unrestricted exposure (UU/UE) future land use. These screening values are intended to be inclusive such that the selection of COPCs does not exclude a constituent that may be a significant contributor to the overall risk or hazard at the Site. All detected constituents will be evaluated in the COPC selection process and the rationale for exclusion of any detected constituent as a COPC will be identified. A summary of the fate and transport characteristics of each COPC will also be provided.

For the background comparison, statistical hypothesis testing is the preferred method (USEPA, 2002). Discrete samples collected onsite will be compared to discrete background samples, and ISM samples collected onsite will be compared to ISM background samples. The most appropriate hypothesis testing technique is expected to be a two-sample test of the means, such as the Welch's t-test or the Student's t-test. If the data do not appear to be normally distributed, non-parametric tests (such as Mann-Whitney) will be performed. The selection of the technique to be applied will ultimately be based on the characteristics of the data collected. If the collected data is such that statistical testing methods would not be sufficiently powerful to support the required site management decision-making, graphical evaluation techniques for comparing the subarea data to background will be employed, as recommended by Interstate Technology & Regulatory Council (ITRC, 2012) and DoD guidance.

The hypothesis testing will be set up to match the current CSM. Site history and limited prior Phase II ESA data suggest that little or no contamination will be found in DUs 5. As such, the most appropriate hypothesis to be tested is that the concentrations of candidate COPCs are not statistically different from (greater than) background (i.e., Test Form 1). The use of Test Form 1 is consistent with Section A.2 of USEPA's Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites, which suggests that in the characterization stage, Background Test Form 1 is useful for determining if the difference between the Site mean and background mean is significantly greater than zero (USEPA, 2002). If the comparisons (including statistical testing, graphical evaluation, and consideration of other lines of evidence) indicate candidate COPC concentrations are not greater than background, NFA relative to these constituents would be warranted as MEDEP will not require a clean-up of site soil to be more stringent than the local background concentration (MEDEP, 2018). If the comparisons indicate the concentrations of one or more of the selected COPCs in a DU are greater than background, further risk evaluation will be required.

Although MEDEP recommends calculating the 90% Upper Prediction Limit (UPL) for background, it is unlikely that the ISM and discrete background data sets collected during the RI will be sufficiently large enough for this calculation. ISM background data will be collected from three DUs (i.e., BGDU1-BGDU3). The ISM background dataset will consist of three replicates collected from across BGDU1, where the DU is one sampling unit (SU) and one replicate collected from each of three SUs from both BGDU2 and BGDU3 (7 total SUs, and 9 ISM samples). The discrete background dataset will consist of five soil boring samples from the observed onsite granular fill interval at the surface (approximately 0-4 feet bgs) and five from the layer of clay located beneath the fill layer. An additional five soil boring samples will be collected from the 0.5 to 2-foot exposure interval within offsite native surface soil. It should be noted that the UPL is particularly useful for calculating a single background threshold value for comparison to individual discrete sample results rather than comparing a DU to background. Comparison of Site ISM data to background discrete data using either hypothesis testing or a background threshold value (e.g., a UPL) is not recommended because the variance is represented differently in ISM and discrete sampling. If it becomes necessary to compute background UPLs for ISM results, the ProUCL Monte Carlo Background Incremental Sample Simulator (BISS) module can be used although in general use of simulation requires a large discrete sample background data set. If the quantity of discrete data is not sufficient for statistical hypothesis testing, the maximum concentration from each subarea will be used for comparison to background.

1.2 Exposure Assessment

Based on the planned reuse of the Site for commercial use, receptors at the Site would include construction workers during redevelopment and employees of any future commercial business. However, to assess potential future uses, the Screening Level HHRA will assume unrestricted future Site uses including residential use (child and adult) and recreational. Assessment of these receptors will identify whether any future use should be prohibited or if Site conditions are acceptable for unrestricted future uses.

1.2.1 Calculating Exposure Point Concentrations

Reasonable Maximum Exposure (RME) exposure point concentrations (EPCs) to be calculated for use in a BHHRA will be the 95 percent UCL of the mean concentration (UCL95) of the constituent in the soil at the exposure area or point of interest. The EPC will be calculated for each COPC using the most current version of the ProUCL software (currently Version 5.1) or the maximum detected concentration of the COPC in that medium, whichever is lower. ProUCL's functionality for handling non-detects (i.e., not applying the $\frac{1}{2}$ detection limit substitution for non-detect results) will be used in the calculation of the EPCs (USEPA, 2015). If there is not a sufficient number of samples for an exposure area to use ProUCL (which may occur with incremental sampling), then guidance provided in the ITRC Technical and Regulatory Guidance Incremental Sampling Methodology (ITRC, 2012) will be used to compute appropriate estimates for the EPC. Fortunately, ProUCL has been modified to facilitate the computation of UCLs from ISM based samples; such that the minimum sample size requirement has been lowered to three, so that one can compute the UCL95 based upon ISM datasets of sizes three or more samples. If there is not a sufficient number of discrete samples for an exposure area to calculate a 95UCL, then the maximum detected concentration will be used as the EPC.

The use of ProUCL is recommended by USEPA for the evaluation of the UCLs. The ProUCL software uses an internal decision scheme to select the “optimal” UCL calculation method in consideration of: the number of detected and non-detected sampling results; the shape of the probability distribution of the chemical concentration data set as determined by distributional fit tests (e.g., normal, lognormal, gamma, or nonparametric); the estimated standard deviation of the log-transformed data set; and the estimated gamma distribution shape parameter (that is related to the skewness of the data set). Based on these parameters, ProUCL recommends the best UCL estimation method from 15 computational algorithms (including five parametric methods and 10 nonparametric methods) and calculates the parameter.

Simple modeling using a suitable Particulate Emission Factor (PEF) will be used to estimate the EPCs for airborne dust from soil.

1.2.2 Exposure Parameters and Chemical-Intake Estimation

Default exposure parameters published by the USEPA (2008, 2011a) and OSWER Directive 9200.1-120 (USEPA, 2014), MEDEP (MEDEP, 2018), or DoD will be used, when appropriate, in the evaluation of the exposure pathways indicated to be complete or potentially complete in the updated Conceptual Site Exposure Model (CSEM). Preference will be given to the use of exposure parameters from USEPA sources, such as the Exposure Factors Handbook. However, consideration will be given to MEDEP exposure factors that reflect modifications of USEPA exposure factors to reflect Maine’s climate and other Site-specific observations of activity patterns and professional judgment will be used to specify the other exposure parameters needed to complete the exposure assessment.

Estimates of intake or dose will be calculated using current USEPA risk assessment guidance. Intake parameters for each combination of media and receptor will be presented in RAGS Part D format tables. Non-carcinogenic hazards will be assessed by estimating a total annual exposure, then converting the dose to an average daily projected intake. Carcinogenic risks will be estimated as an incremental lifetime exposure and then converting the does to an average daily projected intake.

1.2.3 Exposure Pathways and Potential Receptors

The future land use of the Site is anticipated to be redeveloped into a commercial/industrial facility and the Site is located within the Airport Development District. According to the City of Bangor Codes of Ordinances (Bangor, 2017), this use suggests Site use would be, “*aviation uses as well as certain manufacturing, retail and service uses which generally would be considered compatible with an airport complex.*” However, discussion on the anticipated land use with the City on January 7, 2021, indicated they would entertain any zoning change and would not restrict any use, including residential or childcare, as long as the proposed development and construction plans complied with airport and FAA runway proximity requirements.

As the Site is to be assessed for the need for remedial actions under a UU/UE scenario, potential receptors are conservatively assumed to be future hypothetical residents and recreational users, potential future commercial and industrial workers, trespassers, outdoor maintenance workers, utility workers, and construction workers, as well as terrestrial and aquatic (wetland) biota.

Exposure pathways to these receptors given the current CSM would be through direct exposures including dermal absorption, incidental ingestion of contaminated soil, inhalation of volatile compounds and particulates, or ingestion through drinking contaminated water or indirect exposures such as consuming contaminated biota.

Attachment A reflects the assessment of the “completeness” of each exposure pathway considering the current Site conditions. A “complete” exposure pathway exists only when the following four elements are present:

1. A source and mechanism of chemical constituent release to the environment
2. An environmental transport pathway or secondary media for the released chemical constituent or mechanism of transfer of the chemical from one environmental medium to another
3. An exposure point (or area) for potential contact by human or ecological receptors with the environmental medium of interest
4. A route of exposure (i.e., ingestion, dermal absorption, inhalation, or uptake) for that receptor to contact the chemical constituent of interest

Prior to the performance of the RI, exposure pathways were evaluated as being either “potentially complete” or “incomplete”. The potentially complete exposure pathways are shown with a black circle with a dot in the column beneath the receptor. Exposure pathways that are known to be incomplete (i.e., known to not have all four of the required elements) are shown with an open black circle. A more detailed, refined human health CSM will be developed based on updated information and observations collected during the RI field activities. The following reflects the preliminary assumptions that will be verified or revised for the updated CSM. At this time, the potentially complete pathways are considered to be:

- Each of the identified human receptors could be exposed to the ambient air that could contain impacted surface soil particulates from unvegetated or disturbed areas that could be entrained by the wind or resuspended by future construction activities or vehicle traffic, or from limited emitted volatiles.
- Each of the identified human receptors could be exposed to the accessible surface soil via incidental ingestion and/or dermal absorption.
- Possible future construction workers, utility workers, outdoor maintenance workers and hypothetical future residents could be exposed via incidental ingestion or dermal absorption to the subsurface soil during excavation or following Site regrading.
- A hypothetical future resident could ingest plants or wildlife that have lived or foraged in the area of contamination.
- Possible future construction workers, utility workers, outdoor maintenance workers, recreational users, trespassers and hypothetical residents could be exposed to the sediment present onsite via incidental ingestion or dermal absorption.

- Possible future construction workers, utility workers, outdoor maintenance workers, recreational users, trespassers and hypothetical residents could be exposed to the surface water present onsite via ingestion (either incidentally or by intentional consumption) or dermal absorption.
- Each of the identified human receptors could be exposed to the groundwater via ingestion (either incidentally or by intentional consumption), dermal absorption and/or inhalation of volatiles in the groundwater.
- A hypothetical future resident, possible future commercial/industrial worker and current nearby commercial/industrial workers could be exposed to volatiles in groundwater or soil vapor via indoor air through the vapor intrusion pathway. Possible future construction workers, and utility workers could be exposed to volatiles in groundwater or soil vapor via inhalation in an excavation/trench scenario.
- There is no documented MEC associated with the Site.

1.3 Toxicity Assessment

Consistent with USEPA (1989, 2004) and MEDEP (2018), the most current published toxicity values from the preferred approved sources will be used to evaluate the significance of the potential exposures of people to the COPCs in the soil or air at the Site. Toxicological information and toxicity values will be drawn from the following hierarchy of sources and using the preferential order of selection specified by USEPA (USEPA, 2003):

1. Tier 1: USEPA's Integrated Risk Information System (IRIS), which is an on-line database containing current toxicity values for many chemicals that have gone through a peer review and USEPA consensus review process [<http://www.epa.gov/ncea/iris>];
2. Tier 2: USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) developed by the Office of Research and Development/National Center for Environmental Assessment/ Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by USEPA's Superfund Program; and
3. Tier 3: Other Toxicity Values - Additional USEPA and non-USEPA sources of toxicity information, including (but not limited to) the California Environmental Protection Agency toxicity criteria, the Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels, and toxicity criteria published in the USEPA Health Effects Assessment Summary Tables (HEAST). Priority will be given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed.

The reference dose (RfD) is the toxicity value used to evaluate non-cancer health effects for ingestion and dermal exposures. The reference concentration (RfC) is used to evaluate non-cancer health effects for inhalation exposures. The RfD and RfC represent a daily exposure level for a human population that is unlikely to pose an appreciable risk during a portion or all of a human lifetime. Non-cancer RfDs and RfCs are based on a review of animal and/or human toxicity studies, including laboratory or epidemiological studies. Carcinogenic effects are quantified using

the cancer slope factor (CSF) for ingestion and dermal exposures, and inhalation unit risks (IUR) for inhalation exposure. CSFs and IURs are developed as a plausible upper bound estimate of the probability of developing cancer on the basis of a per unit intake of the chemical over a lifetime. CSFs are appropriate for estimating the lifetime probability (assumed 70-year lifespan) of human receptors developing cancer as a result of exposure to known or potential carcinogens.

RfDs and CSFs are typically expressed as “administered” (i.e., not “absorbed”) doses based on estimating toxicity via the oral route of exposure. As such, these values are considered to be potentially inappropriate for estimating risks associated with dermal exposures. Therefore, oral dose response parameters based on administered doses will be adjusted to absorbed doses as per standard protocols before they are compared to estimated dermal exposure intakes. The adjustment from administered to absorbed dose will be made using chemical-specific gastrointestinal (GI) absorption efficiencies published in numerous sources of guidance (e.g., USEPA, 2004 (which will be the primary reference), IRIS, and ATSDR toxicological profiles).

USEPA’s Supplemental Guidance of Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA, 2005) recommends adjustments to the toxicity of carcinogenic chemicals that act via the mutagenic mode of action when evaluating early-life exposures. The guidance recommends using age-dependent adjustment factors (ADAFs) combined with age-specific exposure estimates when assessing cancer risks to receptors exposed at an early age. In the absence of chemical-specific data, the supplemental guidance recommends the following default adjustments, which reflect the fact that cancer risks are generally higher from early-life exposures than from similar exposures later in life:

- For exposures before 2 years of age (i.e., spanning a 2-year interval from the day of birth until a child’s second birthday), a 10-fold adjustment.
- For exposures between 2 and 16 years of age (i.e., spanning a 14-year time interval from a child’s second birthday until their sixteenth birthday), a three-fold adjustment.
- For exposures after turning 16 years of age, no adjustment.

The adjustments will be applied using the same method that was used by USEPA in the development of the screening level RSLs. Children will be evaluated as two age groups, ages 0 to 2 years and ages 2 to 6 years, and older children / adults will be evaluated as two age groups, ages 6 to 16, and ages greater than 16 years old.

If lead is selected as a COPC, the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) and the Adult Lead Model (ALM) will be used to estimate the blood lead concentration as appropriate for the identified receptors.

1.4 Risk Characterization

Non-cancer hazards will be assessed using the concept of Hazard Quotients (HQs) and HIs. The HQ for a COPC is defined for ingestion and dermal exposures as the ratio of the estimated intake (expressed in units of milligrams per kilogram per day [mg/kg/day]) to the RfD, while for inhalation exposures, the HQ is the ratio of the exposure concentration (expressed in units of milligrams per cubic meter [mg/m³]) to the RfC. HIs will be generated by summing individual HQs for all of the COPCs for that exposure medium (e.g., soil). If the value of the total HI exceeds unity (1.0), the potential for non-carcinogenic health hazards associated with exposure to a

particular chemical mixture cannot be ruled out (USEPA, 1989). In that case, a review of the target organ(s) affected by each COPC will be performed. This further assessment reveals the most sensitive toxic endpoints that were used to develop the associated RfDs for each COPC. Target organ-specific HIs will be evaluated for a receptor by summing the HQs for all COPCs with the same target organs or systems. USEPA's goal of protection for non-cancer hazards is an HI less than or equal to one for a target organ or system.

ELCR estimates will be generated for each complete or potentially complete exposure pathway in the updated CSM using the estimated intakes and published cancer toxicity factors. An ELCR is defined as a unitless expression of an individual's increased likelihood of developing cancer over a lifetime as a result of a specific period and amount of exposure to carcinogenic chemicals. An ELCR of 10^{-6} indicates that the exposed receptor has a one in one million chance of developing cancer under the defined exposure scenario.

Risks will be estimated for each of the identified receptors of interest. The ELCRs and HIs will be summed across the full set of complete exposure pathways and across the full set of identified soil COPCs. The results will be tabulated and evaluated to determine if there is an excess risk in accordance with CERCLA guidelines. As part of this determination, HIs will be evaluated relative to a target threshold HI of 1 and the excess cancer risk estimates for the receptors will be evaluated relative to the NCP risk management range (10^{-4} to 10^{-6} excess cancer probability). This risk management range defines a range of excess cancer risk estimates considered to be acceptable under CERCLA. If the total HI for a receptor exceeds one (1), the target organ or system-specific HI also will be considered.

1.5 Vapor Intrusion

A data gap analysis was performed by reviewing the available RI investigation data, having PDT meeting discussions, identifying areas of concern, and then assessing the need for additional field data to perform the remaining required analyses. This data gap analysis highlighted TCE in groundwater in two overburden/hybrid wells (i.e., SY-OBMW11 and SY-OBMW12). A data gap was identified for the assessment of the bedrock aquifer for TCE and other potential CVOCs based on the presence of TCE in two overburden/hybrid wells.

The migration of TCE vapors to nearby commercial receptors along Odlin Road is considered unlikely based on the dense clay and till overburden geology that would limit the migration of TCE, depth of the overburden groundwater (that is below the till layer at the top of bedrock greater than 15 to 30 feet bgs in most wells), and volatile contaminants currently just detected in two wells located a significant distance from the receptors at relatively low concentrations. However, since the source of the TCE detected in the two monitoring wells has not been identified and data gap related to the bedrock aquifer CVOC concentrations, the soil vapor concentrations in proximity to the nearby Odlin Road commercial receptors remains a data gap. The potential for vapor intrusion (VI) into the nearby Odlin Road commercial structures was considered to be a potentially complete exposure route under current site conditions as indicated in the Conceptual Site Exposure Model (see **Attachment A**).

The Site is expected to be redeveloped into a commercial/industrial facility as the Site is located within the Airport Development District. According to the City of Bangor Codes of Ordinances

(Bangor, 2017), this use suggests the future land use would be “aviation uses as well as certain manufacturing, retail and service uses which generally would be considered compatible with an airport complex.” However, discussion about the anticipated land use with the City of Bangor on January 7, 2021, indicated they would entertain any zoning change and would not restrict any use, including residential or childcare as long as the proposed development and construction plans complied with airport and FAA runway proximity requirements. In the future, new occupiable buildings may be associated with additional residential housing (rental or single-family) or new commercial or industrial operations. People living or working indoors in one of these future buildings could be chronically exposed to infiltrating soil vapors if they were to be present, and a construction worker working in a trench associated with building a new structure or installing a new utility also could be exposed to VOCs emitted from the soil and fugitive particulates for a short exposure period during excavation. As such, the potential for exposure of these receptors to volatile groundwater contaminants via VI also was considered to be a potentially complete exposure route under future use scenarios.

No VI screening criteria for either soil or groundwater have been developed by MEDEP (“Supplemental Guidance for Vapor Intrusion of Chlorinated Solvents and Other Persistent Chemicals”, February 5, 2016). MEDEP recognizes in this guidance that USEPA’s VI guidance (USEPA, June 2015) provides enhanced approaches and methods for modeling VI fate and transport, along with conservative default VI attenuation factors for soil and groundwater. The guidance further states that MEDEP believes models cannot accurately predict vapor intrusion in most cases for Maine sites due to the complex and varied subsurface conditions in Maine and the numerous factors that influence VI. Furthermore, they state that they have found that contaminant levels in soil or groundwater divided by an attenuation factor are not reliable indicators of VI potential in Maine. Therefore, MEDEP recommends against using soil or groundwater attenuation factors or modeling protocols to predict VI potential. Lacking state specific criteria, the groundwater and soil vapor data collected during the RI will be initially screened using the USEPA VI screening levels (VISLs) to determine if a potential VI related exposure may be significant. The screening will consider both measured concentrations and the physical characteristics of the Site relative to the potential migration of VOCs.

Detected concentrations of VOCs in groundwater and soil vapor from all data collected during the RI will be screened using USEPA VISLs (EPA, 2021) to assess potential risk to a hypothetical future resident and the current nearby commercial/industrial workers. The VISLs will be associated with either an ELCR of 10^{-6} or a HI of 0.1. If the concentration of a VOC in groundwater or soil vapor is found to exceed its respective groundwater or soil vapor VISL, it will be identified as a COPC. If groundwater or soil vapor COPCs are identified, a VI risk assessment will be performed. For carcinogenic VOCs, the detected concentration of the VOC will be divided by its respective groundwater or soil vapor VISL and multiplied by 10^{-6} to calculate the individual constituent risk. For non-carcinogenic VOCs, the detected concentration of the VOC will be divided by its VISL to calculate the HQ. Cumulative risks for each VI media will be calculated following the risk characterization rules outlined in Section 1.4.

To assess the possible future risks to construction workers and/or utility workers associated with the VI pathway and an excavation, site-specific soil vapor risk-based screening values will be developed for a construction worker in a trench exposure scenario for comparison to soil vapor concentrations measured on-site. USEPA does not have published default soil vapor screening values for the protection of these workers to vapors that may migrate up into a trench or excavation from contamination beneath. However, these receptors and exposure scenarios may be evaluated using the Virginia Department of Environmental Quality (VDEQ) trench model.

1.6 Uncertainty Analysis

The uncertainty analysis discusses the general and Site-specific uncertainties associated with the estimated risks, exposure models, and assumptions utilized in the human health risk assessment. The goal of the uncertainty analysis is to identify important uncertainties and limitations that are associated with the risk assessment and its results.

Uncertainty in the selection of COPCs is related to the current status of the toxicity databases; the grouping of samples; the numbers, types, and distributions of samples; and the procedures used to include or exclude constituents as COPCs. Uncertainty associated with the exposure assessment includes the values used as input variables for a given intake route or scenario, the assumptions made to determine EPCs, and the predictions regarding future land use and population characteristics. Uncertainty in the toxicity assessment includes the quality of the existing toxicity data needed to support dose-response relationships and the weight of evidence used to determine the carcinogenicity of COPCs. Uncertainty in risk characterization includes that associated with exposure to multiple chemicals and the cumulative uncertainty from combining conservative assumptions made in earlier steps of the risk assessment process.

Typically, risk assessments carry two types of uncertainty: measurement and informational uncertainty. Measurement uncertainty refers to the usual variance that accompanies scientific measurements. For example, this type of uncertainty is associated with the analytical data that will be collected. The risk assessment reflects the accumulated variances of the individual values used. Informational uncertainty stems from inadequate availability of information needed to complete the toxicity and exposure assessments. Often, this gap is significant, such as the absence of information on the effects of human exposure to low doses of a chemical, on the biological mechanism of action of a chemical, or the behavior of a chemical in soil.

Once the risk assessment is complete, the results must be reviewed and evaluated to identify the type and magnitude of uncertainty involved. Both the results of the risk assessment and the uncertainties associated with those results must be considered when making risk management decisions that rely on those results. Uncertainty interpretation is especially relevant when the risks exceed the point of departure for defining “acceptable” risk.

2 Ecological Risk Assessment

This section describes the approach and methodology for the ecological risk assessment (ERA) to be conducted for the Former Salvage Yard. The ERA will determine whether any constituent of interest released at the Site contributes an excess risk from exposure of potential ecological

receptors present in the habitats associated with the Yard area. The ERA will consist of: a SLERA and, if warranted, a baseline ecological risk assessment (BERA). A focused BERA will be conducted only if potential exposures to contaminants of concern are identified as posing potential hazards in the SLERA. The ERA will be conducted in accordance with the USACE (2010) and Ecological Risk Assessment Guidance for Superfund (ERAGS) (USEPA, 1997, 1998).

2.1 Screening Level Ecological Risk Assessment

The SLERA for the Site will identify and evaluate potentially complete exposure pathways and exposure routes between Site related constituents and potential ecological receptors present and determine whether or not these constituents pose significant risks to the ecological receptors identified in the habitat areas present.

The three key components of the SLERA will be:

- Preliminary Problem Formulation;
- Exposure and Effects Analysis; and
- Risk Characterization.

Each component will be conducted in accordance with technical risk assessment approaches in the CERCLA process and other guidance as developed by the USACE (2010) and USEPA (1997, 1998).

2.1.1 Preliminary Problem Formulation

The preliminary Problem Formulation in the SLERA will describe the Site history, describe the ecological setting and habitats and receptors of concern, identify potentially complete exposure pathways/routes, identify chemicals of potential ecological concern (COPECs), and determine if the ERA process should continue to the BERA stage for the Site. Initial evaluation of these components is provided in the following sections.

2.1.1.1 Preliminary Assessment and Measurement Endpoints

Assessment endpoints are explicit expressions of the environmental value that are to be protected. Assessment endpoints are operationally defined by an ecological entity and its response (USEPA, 1998). Measures of effect are measurable changes in an attribute of an assessment endpoint or its surrogate in response to a stressor to which it is exposed (USEPA, 1998). These responses were selected such that they are sensitive and ecologically relevant to the Site based on existing information.

Preliminary assessment endpoints for ecological receptors (i.e., plants and animals) will consist of: (1) protection of terrestrial and wetland plant and invertebrate communities from adverse impacts, including reduced productivity and species diversity; and (2) protection of avian and mammalian wildlife populations from adverse impacts, including reduction in survival, growth or reproductive success and mortality. These endpoints will be assessed using appropriate measures of effect as selected in the Exposure and Effects Assessment.

2.1.1.2 Identification of Site-Related Chemical Constituents

Historic use of the Site indicates the potential for contamination to exist at the Site. As described in Worksheet #17, sampling is planned to characterize and screen the Site related constituents of concern for identification as COPECs present in soils, sediments and surface water. Ground water will be qualitatively assessed based on ground water flow and evidence of discharge to a surface waterbody based on pore water analysis. Ground water at the Site was interpolated to flow to the southeast towards an unnamed tributary of the Penobscot River.

Site-related chemical constituents in environmental media will be identified from the data collected at the Site as part of the remedial investigation phase. Site data will consist of the characterization results meeting appropriate QA/QC criteria. The data set containing the qualitative Phase I and II ESA data and validated RI data will be drawn on for the SLERA. As part of the SLERA process, all detected chemical constituents in environmental media of concern will be evaluated.

2.1.1.3 Ecological Habitats and Receptors of Concern

The Former Dow Salvage is not located within a national wildlife refuge, national park, or state park. Areas within the boundary of the Site consist primarily of formerly developed or unused open land, fallow field or fragment deciduous forest. The Site is approximately 14 acres in size and is located at 233 Odlin Road in the City of Bangor, ME. The topography at the Site is relatively flat and the terrain at the Site consists of formerly developed areas now leveled, open fallow field and forested areas that include areas of palustrine forested (PFO) wetlands. Surrounding land use in the area consists of developed areas of commercial development to the south and east, the Bangor International Airport to the north and fragmented forested areas with mixed commercial development to the west. The Maine Department of Environmental Protection's (MEDEP) Environmental and Geographic Analysis Database (EGAD) was consulted for occurrence of specific natural resource attribute occurrences at the Site. Results of this review revealed:

- No intermittent streams or open water habitats have been identified within the Site boundary;
- No significant vernal pools were identified from the Site;
- No significant inland wading bird/waterfowl habitats were identified from the Site;

Sucker Brook is located to the southeast of the Site and ground water from the Site is suspected to potentially discharge to this waterbody though this remains to be fully verified.

Based on initial field inspections and wetland delineation confirmation, PFO and emergent wetlands are present in fragmented forested areas and a meadow area in the eastern edge of the Site.

2.1.1.4 Ecological Exposure Pathways and Routes

A CSM is a description of a site and its environment that can be used to identify and summarize potential contamination and the possible human and environmental receptors potentially present, and also to focus the investigation and guide the selection of appropriate and effective

characterization methods. The CSM will be refined based on site specific characteristics observed during investigation process. The preliminary CSM for the Site is presented in Worksheet #10. Associated potential ecological exposure pathways are described below.

Attachment A shows the preliminary CSM as a flow chart with the potential Site-related contamination and receptor groups that may come into contact with potential chemical constituents in environmental media, media specific transport and migration pathways and associated exposure routes. All migration and exposure pathways will initially be evaluated for completeness based on Site characteristics and habitats present. As mentioned above, complete exposure pathway includes all of the following elements:

1. A source and mechanism of chemical constituent release to the environment
2. An environmental transport pathway or secondary media for the released chemical constituent or mechanisms of transfer of the chemical from one environmental medium to another
3. An exposure point for potential contact by human or ecological receptors with the environmental medium of interest
4. A complete route of exposure (i.e., ingestion, dermal absorption, inhalation, or uptake) for that receptor to contact the chemical constituent of interest

The potential exposure pathways reflected in the preliminary CSM are discussed in general in Worksheet #10. A more detailed, refined ecological CSM will be developed based on updated information and observations collected during the RI field activities. The following sections reflect preliminary assumptions that will be verified or revised for the updated CSMs.

2.1.1.5 Incomplete Exposure Pathways

Direct contact of ground water with ecological receptors is considered an incomplete pathway and will be assessed by collection of pore water data. Therefore, the direct contact pathway with ground water will not be evaluated. However, discharge of ground water to surface waterbodies whether intermittent or perennial is considered a complete migration pathway for chemical constituents in ground water to come in contact with ecological receptors. Ephemeral surface waterbodies such as vernal pools and springs are dependent upon ground water resources as part of their hydrologic cycles.

Exposure pathways associated with subsurface soils generally considered to be incomplete for most ecological receptors. While some tree and shrub species have tap roots extend into subsurface soils and some burrowing mammals can have burrows extend into depths beyond 2 feet below ground surface (bgs), exposure for most ecological receptors is generally confined to the first 1.0 foot bgs. Therefore, as part of the exposure assessment, exposure to subsurface soils > 1 foot bgs will not be considered a complete pathway in the exposure assessment.

2.1.1.6 Potentially Complete Exposure Pathways

Only those pathways that are considered to be potentially complete (i.e., where all four exposure pathway elements are known to be present) provide the potential for exposure and potential risk. The following exposure pathways were judged to be potentially complete for the project Site:

- The identified ecological receptors could be exposed to the accessible terrestrial surface soils, wetland sediments or ponded surface water either via incidental ingestion (i.e., the birds, and mammals) or via direct contact/absorption/uptake (i.e., the plants and soil and benthic invertebrates). As such, these potential exposures to Site related constituents in impacted environmental media are considered potentially complete pathways.
- Higher trophic level ecological receptors (i.e., intermediate and higher trophic level receptors) are expected to come into contact with Site related constituents that can be accumulated through uptake in terrestrial and wetland plants and fauna (i.e., soil invertebrates and small mammals) through the dietary ingestion exposure route.
- Wildlife (i.e., birds and mammals) could be exposed to the surface soils, wetland soils/sediment and surface water (seasonally when present) in the upland and wetland habitats present. The degree to which chemical constituent levels in these media (especially the surface soils and sediment) are attributable to historic operations at the Site.
- Birds and mammals could be exposed to the ambient air that could contain Site related constituents soil particulates from un-vegetated or disturbed areas of surface soil that may be entrained by the wind or re-suspended by vehicle traffic. However, this exposure route is expected to be insignificant relative to other exposure routes being evaluated.

2.1.1.7 Potentially Complete Not Quantitatively Assessed Exposure Pathways

Some exposure pathways cannot currently be designated as complete or incomplete due to certain unknowns associated with the Site. The following exposure pathways are considered potentially complete not quantitatively assessed for the Site:

- Dermal contact with surface soil and inhalation of particulates for ecological receptors are considered potentially complete exposure pathways. These exposure pathways have no standard methods for assessment in ERAs. Dermal absorption may be a relatively minor exposure pathway for birds and mammals in certain circumstances because results of exposure studies indicate that exposures to various chemicals such as metals due to dermal absorption are insignificant compared to ingestion (Peterle, 1991). Incidental soil ingestion also incorporates exposures from grooming of particulates on skin, feathers, and fur. Inhalation of airborne particulates is believed to be a relatively insignificant portion of the total risk in most circumstances (Carlsen, 1996). The discussion of these pathways will be qualitative.
- The maximum depth of a surface soil accessible to most receptors is 12 inches bgs (i.e., 1 foot bgs). The roots of terrestrial plants (e.g., shrubs and trees) and excavations by

some burrowing mammals may extend into the subsurface soil below 1 foot bgs. As such, exposure to the subsurface soil is considered to be potentially complete but not quantitatively assessed for these receptors.

2.1.2 Analysis Phase

The Analysis phase bridges the Problem Formulation (including the CSEM) with the Risk Characterization by providing the information necessary to determine or predict ecological responses to the presence of chemical constituents through exposure routes of interest. The Analysis phase refines the CSM developed during problem formulation to provide focus and structure for the analyses (USEPA, 1998). The analysis phase consists of two individual components: Exposure Assessment and Effects Assessment. These components provide the basis for estimating and describing hazards in the risk characterization.

2.1.2.1 Exposure Assessment

The exposure assessment for the SLERA will consist of calculating EPCs for each chemical constituent. An EPC is the representative concentration of a chemical constituent in a contaminated environmental medium (e.g., soil, sediments, surface water) at the point of contact with a receptor. Pore water exposure will be evaluated as part of the benthic invertebrate assessment endpoint only. EPCs for each detected chemical constituent will be calculated for the surface interval of soils and sediments (defined as the 0-0.5 feet bgs depth interval) and shallow interval soils (0.5-2 feet bgs).

The maximum detected concentrations of a chemical constituent in an exposure unit area will be initially compared to the most stringent applicable ecological benchmarks in the SLERA. Only if a chemical constituent is identified in this manner would other EPCs be calculated. If there is a potential for ecological exposures to terrestrial plants/soil invertebrates or benthic macroinvertebrates in wetland sediments (i.e., spatially fixed receptors), a sample-by-sample comparison to the appropriate screening values will be conducted.

If there is a potential for ecological exposures to mobile avian or mammalian wildlife, the exposure area average (over an Site area) and reasonable maximum exposure concentrations will both be used in the screening to span the likely exposure concentrations for constituents of concern. The RME concentrations will be assumed to be the maximum detected concentration if there were fewer than 8 samples collected in the exposure unit areas. If 8 or more samples were collected, a 95% UCL on the mean will be calculated using ProUCL and appropriately accounting for the number/percentage of non-detects in the exposure area database. Where the 95% UCL exceeds the maximum detected concentration, the maximum concentration will be used as the RME term in the assessment.

2.1.2.2 Effects Assessment

Measures of effects will be based on ecological soil screening levels that will be selected for each receptor group (i.e., plants, soil invertebrates, birds, and mammals). Screening levels are typically based on toxicity studies that indicate the potential for adverse impacts on populations due to decreased reproductive success, decreased survival, or other appropriate endpoints. Ecological screening levels will be selected from the following sources in the preferential order shown:

Surface Soils:

1. Eco-SSLs for plants, soil invertebrates, mammals and birds developed by the USEPA;
2. Soil-based toxicity benchmarks for plants and soil invertebrates developed by the DOE (Sample et al. 1996, 1998a, 1998b);
3. Other sources based on contaminants present.

Screening levels for plants and soil invertebrates will be preferentially based on the USEPA Eco-SSLs where applicable.

Sediments:

1. Consensus based Threshold Effects Concentrations (TECs) and Probable Effects Concentrations (PECs) (MacDonald et al. 2000);
2. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment Associated Biota: 1997 Revision. Oak Ridge National Laboratories, Office of Environmental Management. November 1997 (Jones et al. 1997);
3. Other sources based on contaminants present.

TECs will be used as the conservative screening value as part of the SLERA and PECs where no TEC or equivalent value is identified.

Surface Water/Pore Water

1. USEPA National Recommended Ambient Water Quality Criteria (<https://www.epa.gov/wqc/national-recommended-water-quality-criteria>);
2. Tier II Secondary Surface Water Screening Values (<https://rais.ornl.gov/documents/tm96r2.pdf>);
3. Other sources based on contaminants present.

The chronic ambient water quality or Tier II value will be used as the preferred initial screening value and acute values will be applied where no chronic or equivalent value is identified.

2.1.3 Risk Characterization

The Risk Characterization portion of the SLERA will evaluate the potential for adverse impacts to receptors considered to have potentially complete exposure pathways. This process will consist of comparisons of chemical constituent concentrations in soil to the protective ecological screening levels selected for each receptor group. The screening comparisons will be calculated as HQs, the ratios of the EPC to the identified screening level:

$$HQ = EPC / \text{Ecological Screening Level}$$

An HQ less than or equal to 1 is considered to represent a negligible potential for adverse ecological effects. An HQ greater than 1 is considered indicative of a potential for adverse ecological impacts. The Risk Characterization will describe the results of the screening

comparisons and their associated uncertainties. Those chemical constituents with HQs greater than 1 for a given receptor group will be identified as chemicals of potential ecological concern (COPECs). Consistent with the ERA process, a Scientific Management Decision Point (SMDP) will be used to evaluate the findings of the SLERA process and determine if the Site will need to proceed to a BERA.

2.2 Baseline Ecological Risk Assessment

A BERA will be conducted for the Site if current or potential future exposures to contaminants in soils are identified as COPECs in the SLERA. The BERA will focus only on the identified COPECs, exposure pathways, and receptors for which potential risks are identified based on the screening comparisons and other lines of evidence. The BERA will provide a more site-specific, refined assessment of potential exposures and hazards. The BERA will consist of Problem Formulation, Analysis, and Risk Characterization components (USEPA, 1998).

2.2.1 Refined Problem Formulation

The refined Problem Formulation describes the Site, identified COPECs, ecological habitats and receptors of concern, representative species selected for receptors of concern, potentially complete exposure pathways, and assessment endpoints and measures of effects.

To make the BERA more Site-specific, wildlife receptor groups, such as herbivorous birds, insectivorous birds, carnivorous birds (e.g., red-tailed hawk, American kestrel), herbivorous small mammals, insectivorous small mammals, and carnivorous mammals will be evaluated using representative receptor species. A representative species represents a functional group of organisms present at a site identified for evaluation of assessment endpoints. Representative species will be selected for each functional receptor group based on:

- Similar function/role in the ecosystem;
- Taxonomic relatedness to receptors of concern;
- Known or presumed similarities in physiology and life history;
- Availability of wildlife exposure factor data;
- Biological characteristics that would tend to maximize estimates of exposure (e.g., small body weight, small home range or foraging area, forages on the ground surface); and
- Species known to occur or potentially present at the site.

Whenever possible, representative species will be selected to maximize estimates of exposure to ensure a conservative assessment of risk. For example, this approach may entail selecting a raptor species with a small foraging range instead of a raptor species with a large foraging range in order to ensure that the estimate of exposure to Site-related contaminants is maximized. Risks to representative species will be used to infer the potential for adverse impacts to taxonomically and functionally related receptors of concern. For example, the vole has a small foraging range and a high food ingestion rate and could be used to conservatively represent other small herbivorous mammals, and thus the risks to the vole could be considered an upper estimate of exposure and risk for the other species in this functional group.

As described for the SLERA (see Section 2.1.1.1), assessment endpoints are explicit expressions of the environmental values that are to be protected. Assessment endpoints are operationally defined by an ecological entity and its response (USEPA, 1998). If the assessment endpoint is found to be significantly impacted, it may indicate the need for remediation or other management action (USEPA, 1992). Measures of effect are measurable changes in an attribute of an assessment endpoint or its surrogate in response to a stressor to which it is exposed (USEPA, 1998). These responses will be selected such that they are sensitive and ecologically relevant.

Assessment endpoints for plants will consist of reduction in productivity or reproduction at the level of the community. Assessment endpoints for soil invertebrates will consist of adverse impacts to the community, including reduced biomass and species diversity. Assessment endpoints for bird and mammal receptors of ecological concern will be evaluated at the level of the population. Corresponding responses include reduction in reproductive success or abundance of the population.

Measures of effects for plants and soil invertebrates will be based on reproductive, survival, and growth effects that provide protection at the level of the community. Measures of effects to representative bird and mammal species will be chronic no observed adverse effect levels (NOAELs) corresponding to the selected assessment endpoints (i.e., protective of population-level effects). These measures are the basis for the TRVs.

2.2.2 Analysis Phase

The Analysis Phase links Problem Formulation with Risk Characterization by providing the information necessary to determine or predict ecological responses to COPECs under exposure conditions of interest. The Analysis Phase builds upon the CSEM and assessment endpoints developed during Problem Formulation to provide focus and structure for the analyses (USEPA, 1998). The Analysis Phase consists of two assessments: Exposure Assessment and Effects Assessment. These components provide the basis for estimating hazards in the Risk Characterization.

2.2.3 Exposure Assessment

The Exposure Assessment provides a quantitative profile summarizing the magnitude and spatial and temporal patterns of exposure of representative species to COPECs. To estimate exposures of representative bird and mammal species to COPECs at the Site, four essential inputs are required:

- Exposure equations;
- Exposure factors;
- Bioaccumulation models; and
- EPCs.

2.2.3.1 Exposure Equations

Exposure equations used in the baseline ERA will be consistent with USEPA's Wildlife Exposure Factors Handbook (1993) and other federal and state guidance (USEPA, 1998). COPEC exposures will be calculated using the following equations:

$$\text{Total Dose} = \text{Dose}_{\text{Soil}} + \text{Dose}_{\text{Food}}$$

Human Health and Screening Level Ecological Risk Assessment Methodology
Former Dow Air Force Base Salvage Yard
233 Odlin Road, Bangor, Maine

$$\text{Dose}_{\text{Soil}} = \text{IR} \cdot \text{Diet Fraction}_{\text{Soil}} \cdot C_{\text{Soil}} \cdot \text{SPI} \cdot \text{BW}^{-1}$$
$$\text{Dose}_{\text{Food}} = \text{IR} \cdot \text{Diet Fraction}_{\text{Plant, Invert.}} \cdot C_{\text{Diet}_{\text{Plant, Invert.}}} \cdot \text{SPI} / (\text{BW})$$

where:

IR	=	Ingestion rate (kg/day)
Diet Fraction _{Soil, Food}	=	Soil or food diet fraction (proportion)
C _{Soil}	=	Concentration of COPEC in soil (mg/kg)
Diet Fraction _{Soil}	=	Incidental ingestion of soil as a fraction of total ingestion rate
Diet Fraction _{Plant, Invert}	=	Ingestion of plant and invertebrate diet items as fraction of total ingestion rate
C _{Diet_{Plant, Invert.}}	=	Concentration of COPEC in plant and invertebrate diet (mg/kg)
SPI	=	Site presence index (SPI; i.e., the site area divided by the foraging area with a maximum value of 1.0)
BW	=	Body weight of the animal (kg)

The concentrations C_{Diet_{Plant, Invertebrate}} will be determined from bioaccumulation models described below. Diet concentrations will be generally calculated by applying soil-to-tissue regressions (see below) or multiplying soil concentrations by bioaccumulation factors (BAFs).

2.2.3.2 Exposure Factors

Wildlife exposure factors to be used in the exposure equations for identified representative wildlife species will be consistent with those developed in USEPA (1993, 2007). Ingestion rates will be estimated using body weights and allometric equations (Nagy, 2001; USEPA, 1993).

Chemical doses from ingested items will be estimated based on receptor information on diet and incidental ingestion of soil. Plant and invertebrate diet proportions will be 100 percent for herbivores and insectivores, respectively. Soil diet proportions will be selected based on available data for similar species (Beyer et al. 1994; USEPA 2007). Foraging areas will be used to estimate the fraction of the total area used by a representative species in which it may be exposed to contaminated media at the Site. The Site presence index (SPI), or area use factor, is the Site area (in acres) divided by the foraging area (in acres) with a maximum value of 1.0 or 100 percent site-area usage. When the foraging area is less than the Site area, the animal is assumed to forage only within the Site (i.e., SPI = 1). Conversely, if a given foraging area is greater than the area of the Site, then the SPI is the fraction of the Site area divided by the species-specific foraging area.

2.2.3.3 Bioaccumulation Models

Bioaccumulation models will be used to estimate COPEC concentrations in food items of representative species (i.e., plants, soil invertebrates). The order of preference of these models for bioaccumulation estimates will be:

Literature-based bioaccumulation regression models and uptake factors incorporating empirical data and recommended in recent publications (e.g., Sample et al., 1998a, b; Bechtel Jacobs Company LLC, 1998; USEPA 2007),

Bioconcentration factors (BCFs) for plants (Baes et al., 1984), and

If no applicable models are available for a chemical, a default BAF of one will be assumed (i.e., the tissue concentration equals the soil concentration for a given plant or animal).

Regression models will be preferred because they more realistically describe the relationships between concentrations in soils and plant and invertebrate tissues.

2.2.3.4 Exposure Point Concentrations

The EPCs for COPECs in soil will be based on the 95% UCL as described in the SLERA (see Section 2.1.2.1). Only those COPECs found in the SLERA to have HQs greater than 1 for a given receptor group and exceed background will be evaluated in the BERA.

2.2.4 Effects Assessment

The Effects Assessment evaluates the potential for identified COPECs to cause adverse ecological effects by establishing TRVs. TRVs are doses to an animal that are protective of representative species and may consist of no-effect level or effect level doses. The primary TRVs for birds and mammals will be based on NOAELs. NOAELs indicate the highest tested doses at which no adverse effects occurred in a study. Estimated doses above the TRV indicate a potential for adverse effects. However, exceedance of a NOAEL does not necessarily indicate an adverse effect will occur, particularly if the HQ based on the corresponding lowest observed adverse effect level (LOAEL) is less than 1. The LOAEL indicates the lowest tested dose at which adverse effects were identified.

The TRVs for birds and mammals will be developed from the following sources: USEPA Eco-SSL documents (USEPA 2003-2008), Sample et al. (1996b), U.S. Navy/USEPA Region 9 Biological Technical Advisory Group (BTAG) (U.S. Navy 1997), and LANL (2015). In addition to these references, other references will be consulted if necessary to develop TRVs, particularly if the TRVs available in the secondary sources are lacking in ecological relevance. To be protective of receptors of ecological concern at the population level, TRVs will be preferentially based on test endpoints of reproduction, development, growth, and survival. TRVs protective of individuals of special status species known or likely to occur at the Site may also include sub-lethal test endpoints. The TRVs will be based on chronic exposures whenever possible or based on conversions to chronic equivalent exposures using an acute-to-chronic uncertainty factor of 10. If a NOAEL was not identified for a particular chemical, NOAEL equivalent doses will be calculated using a LOAEL-to-NOAEL uncertainty factor of 10. The following criteria will be considered when selecting toxicity studies and developing TRVs:

- Doses administered during critical and sensitive periods (e.g., during gestation) and/or effects on sensitive life stage (e.g., effects on fetuses, embryos);
- Chronic exposures (greater than 50% of the life span) or doses administered throughout most of the reproductive period;
- Use of a serial dosing regimen, especially a serial dosing regimen in which both a NOAEL and LOAEL were reported;
- Large per-treatment sample sizes;

- Phylogenetic similarity between the receptor and test species (i.e., taxonomically related);
- Methods and results of statistical analyses clearly described; and
- Wildlife species examined in the study.

The TRVs will not be adjusted for body weight differences between laboratory test species and representative species due to the considerable uncertainty in developing and applying scaling factors.

2.2.5 Risk Characterization

The goal of the Risk Characterization is to identify chemicals of ecological concern (COECs), media, and areas impacted that may need to have remedies evaluated through the FS. The Risk Characterization step will include the following evaluation.

The quantitative results of the BERA are intended to indicate the potential for impacts resulting from the presence of specifically identified COPECs. Similar to the screening comparisons in the SLERA, the Risk Characterization portion of the BERA will present calculated HQs, the ratios of the exposure dose to the TRV, both expressed in mg/kg-day:

$$HQ = \text{Exposure Dose}/\text{TRV}$$

An HQ less than 1 is considered to represent a negligible potential for adverse ecological impacts due to exposure to a particular COPEC, whereas an HQ greater than or equal to 1 is considered indicative of a potential for adverse ecological impacts.

The relevance of the HQs will be evaluated within a weight of evidence (WOE) approach to provide a qualitative assessment of the magnitude of impact using multiple lines of evidence to support the identification of COECs posing a significant hazard to the identified assessment endpoints. Potential hazards will be discussed within the context of the uncertainties identified in the Exposure and Effects Assessments. These considerations may include the magnitudes of HQs; frequency of detection; size of the affected area; habitat quality; potential presence of special status species; confidence in exposure factors, bioaccumulation models, and TRVs; and consideration of LOAEL-based HQs. The Risk Characterization will also describe key uncertainties relevant to the conclusions of the BERA. The intent is to provide risk managers with an accurate and concise analysis upon which decisions on the necessity of remediation and restoration can be made. This analysis will be presented as a narrative within the Risk Characterization section and will provide the basis for the BERA conclusions.