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APPENDIX H
METHODOLOGY FOR DEVELOPMENT OF CLEANUP GOALS FOR NEW CONSTITUENTS OF POTENTIAL CONCERN

for

Laboratory for Energy-related Health Research/ Old Campus Landfill Superfund Site University of California, Davis

prepared for

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ACRONYMS AND ABBREVIATIONS

ANL	Argonne National Laboratory
bgs	below ground surface
CHHSL	California Human Health Screening Level
CNL	California Notification Level
COC	constituent of concern
CVRWQCB	Central Valley Regional Water Quality Control Board
DL	designated level
FS – Volume 1	*Final Feasibility Study for the University of California, Davis Areas Volume 1: Soil/Solid Waste and Soil Gas*
HHRA – Part A	*Site-Wide Risk Assessment, Volume I Human Health Risk Assessment (Part A – Risk Estimate), LEHR/SCDS Environmental Restoration*
HHRA – Part C	*Site-Wide Risk Assessment, Volume I Human Health Risk Assessment (Part C – Risk Characterization for UC Davis Areas)*
K_d	soil/water partitioning coefficient
K_{oc}	organic carbon/water partitioning coefficient

K_{ow}	octanol/water partitioning coefficient
LCL	lower confidence limit
LEHR	Laboratory for Energy-related Health Research
MCL	Maximum Contaminant Level
MWH	Montgomery Watson Harza
ml/g	milliliters per gram
NCOPC	new constituent of potential concern
NUFT	Non-isothermal Unsaturated Flow and Transport
OCL	Old Campus Landfill
OEHHA	Office of Environmental Health Hazard Assessment
PCG	preliminary cleanup goal
PRG	Preliminary Remediation Goal
RD/RA	remedial design/remedial action
ROD	Record of Decision
RSL	Regional Screening Level
Site	Laboratory for Energy-related Health Research/Old Campus Landfill Superfund Site
UC Davis	University of California, Davis
US EPA	United States Environmental Protection Agency
Weiss	Weiss Associates

H1. Introduction and Background

Preliminary cleanup goals (PCGs) were developed for constituents of concern (COCs) identified in the *Draft Final Feasibility Study for the UC Davis Areas Volume 1: Soil/Solid Waste and Soil Gas* (FS – Volume 1) for the Laboratory for Energy-related Health Research (LEHR)/Old Campus Landfill (OCL) Superfund Site (Site). These COCs and PCGs were based upon consideration of a constituent's potential to impact groundwater resources and human health (Appendices A and C). Final cleanup goals will be established by the United States Environmental Protection Agency (US EPA) in the Record of Decision (ROD). This appendix provides the basis for the development of cleanup goals for constituents that have not been identified as COCs in FS – Volume 1, but may be identified during implementation of the selected remedy, herein referred to as new constituents of potential concern (NCOPCs).

The Remedial Design/Remedial Action (RD/RA) Work Plan will detail the confirmation sampling protocol and subsequent analysis phase. It is anticipated that the screening and analysis of detected constituents will follow the methodologies outlined in Appendices A and C for soil-to-groundwater and human health risks, respectively.

H2. Site Data Sets

Only data considered representative of Site conditions at the time of evaluation will be used. These include confirmation sampling analytical results and results from previous investigations for samples that are remaining subsequent to remedial action. Data sets for each of the six land disposal units will be evaluated separately and further divided into two depth intervals. Consistent with the *Site-Wide Risk Assessment Volume I Human Health Risk Assessment (Part A – Risk Estimate) LEHR/SCDS Environmental Restoration* (HHRA – Part A) (MWH, 2004), soil/solid waste from zero to 10 feet below ground surface (bgs) will be considered the depth to which humans might be directly exposed under future use scenarios. Under the conservative assumption that deeper material could be brought to shallower depths during future construction activities, soil/solid waste data from 10 to 20 feet bgs will also be compared to human health-based PCGs.

The soil background values for inorganic constituents to be used in this evaluation will be those used in Appendix C of the FS – Volume 1 (Weiss, 1998; Weiss, 2000), unless additional background data are collected between the time of the publication of FS – Volume 1 and implementation of the remedial action. If additional data are obtained, the updated background values would follow the existing procedure and would be calculated as the 80 percent lower confidence limit (LCL) on the 95th percentile of the updated background data set. Organic constituents will be assumed not to be present in background (i.e., background is "zero").

H3. Human Health Constituent of Concern Preliminary Cleanup Goals

This section describes the methodology used to identify PCGs for NCOPCs that may pose a risk to human health. The methodology follows that used in Appendix C of the FS – Volume 1, which is based on the soil/solid waste portion of the *Site-Wide Risk Assessment Volume I Human Health Risk Assessment (Part C – Risk Characterization for UC Davis Areas)* (Brown and Caldwell, 2006) (HHRA – Part C).

In Appendix C of the FS – Volume 1, the November 2011 US EPA residential soil Regional Screening Levels (RSLs) (US EPA, 2011) were used as the screening values for the human health

COC screening evaluation. For radionuclides, the August 2010 residential soil Preliminary Remediation Goals (PRGs) (US EPA, 2010) were used. Lead was compared with 2010 California Human Health Screening Levels (CHHSLs) obtained from the Office of Environmental Health Hazard Assessment (OEHHA, 2010). At the time of this updated COC evaluation, a new set of screening values will reflect the most current screening levels published by EPA or OEHHA.

A comparison will be undertaken between the residential soil screening levels and background. For each NCOPC detected during the confirmation sampling, the PCG will be selected as the greater of the screening level or background; the PCG for organic constituents will be the corresponding screening level, since it is assumed that organic constituents have a background value of zero.

H4. Soil-to-Groundwater Impact Constituents of Concern and Preliminary Cleanup Goals

The groundwater impact evaluation methodology used in the 2010 *Feasibility Study Data Gaps Technical Report* (Appendix A of the FS – Volume 1) will be modified to screen the list of constituents identified for sampling in the RD/RA Work Plan. First, the constituent list will be screened to consider the physical and chemical properties that determine their fate and transport mechanisms in the environment and to predict the potential impact to groundwater. NCOPCs that would not pose a threat to groundwater would be eliminated. Second, for constituents that could pose a potential threat to groundwater, designated levels (DLs) will be calculated with the numerical Non-isothermal Unsaturated Flow and Transport (NUFT) model (Nitao, 1996).

The soil-to-groundwater PCGs for NCOPCs detected during confirmation sampling will be set at the higher of the calculated screening DLs or the Site background value.

H4.1 Preliminary Screening Analysis

A preliminary screening analysis will be conducted to identify those constituents that potentially could pose a threat to groundwater. This process will be adopted from the screening procedure previously approved for use at the LEHR Site (see Appendix C of the *Feasibility Study Data Gaps Work Plan* [Weiss, 2008]). This step will compare the physical and chemical properties that would determine the fate and transport mechanisms of the analytes in the environment and predict their potential impact to groundwater.

To assess the potential mobility of a constituent from soil to groundwater, soil/water partitioning coefficient (K_d) values will be reviewed. The K_d value measures the relative capacity for a compound to sorb to the surface of a soil particle when compared with water; K_d values are inversely related to compound mobility in the subsurface. The lowest chemical-specific K_d value reported in the literature for an analogous soil type will be selected as a conservative value; for organic compounds, the K_d value can also be estimated from the fraction of organic content and either the organic carbon/water partitioning coefficient (K_{oc}) or the octanol/water partitioning coefficient (K_{ow}). The K_d values were compiled and reported previously in the *Feasibility Study Data Gaps Work Plan* for constituents designated at the time of that report's publication (Weiss, 2008). Tritium and carbon-14 will be assumed to partition completely into water in the form of tritiated water or methanol, respectively ($K_d = 0$), rather than using literature values.

Previous Site-specific vadose zone modeling with NUFT suggested that the K_d value can be used as a proxy for the time for the peak concentration to occur at the water table (time-to-peak) for organic compounds. It will be assumed that constituents with sufficiently high K_d values would remain sorbed and would not pose a risk to groundwater. For pesticides, semi-volatile organic compounds, and volatile organic compounds, the K_d value of each constituent will be compared to a K_d of 10 milliliters per gram (ml/g); this screening value indicates that a constituent with this K_d would reach groundwater after approximately 2,000 years (Weiss, 2008). Pesticides, semi-volatile organic compounds, and organic compounds with a K_d value greater than 10 ml/g will be eliminated from further evaluation. The K_d values for inorganics, including metals and radionuclides, will be compared to a K_d of 1,000 ml/g, which corresponds to a vadose zone travel time of 100,000 years (Weiss, 2008). Inorganic constituents with a K_d value greater than 1,000 ml/g will be eliminated from further evaluation. The discrepancy in screening values reflects the fact that organic compounds generally degrade while most inorganic compounds do not.

For radioactive constituents, the decay half-lives will be compared to a screening half-life of one year. The decay half-lives for radionuclides will be compiled from the online US EPA database "Superfund Chemical Data Matrix", the *User's Manual for RESRAD Version 6, Environmental Assessment Division, Argonne National Laboratory* (ANL, 2001) or, if necessary, from other reliable literature-based sources. Since land disposal activity at the Site ceased over 20 years ago, and given that the maximum activities of radionuclides at LEHR would be on the order of milliCuries or less, it is assumed that radionuclides with half-lives less than one year would not significantly impact groundwater; any constituent with a decay half-life less than one year will be eliminated from further evaluation.

H4.2 Designated Level Modeling

For soil constituents that pass through the screening process, designated levels will be calculated with the numerical modeling approach used in the 2010 *Feasibility Study Data Gaps Technical Report* (Appendix A of the FS – Volume 1), which follows the EPA-approved established modeling approach for United States Department of Energy areas. DLs are concentrations of constituents in waste, soil, or soil gas that are protective of water quality while accounting for environmental attenuation. The DL methodology evaluates environmental attenuation between the location of contaminated waste and nearby receiving waters. Environmental attenuation at the Site is expected to occur in vadose zone soil. DLs will be determined following the *Designated Level Methodology for Waste Classification and Cleanup Level Determination* (CVRWQCB, 1986).

Contaminant migration and attenuation will be analyzed with the numerical NUFT model (Nitao, 1996), which would be run iteratively to determine DLs. Developed at Lawrence Livermore National Laboratory, NUFT simulates multiphase flow and contaminant transport in one-, two-, or three-dimensions. The vadose zone modeling will be used to estimate the time required for remaining constituents to migrate through the vadose zone and to determine soil cleanup levels protective of groundwater quality (DLs). Model parameters and procedures (including vertical soil profiling) will follow the approach taken in Appendix A.

Simulated concentration data from the NUFT model would indicate the peak constituent concentration at the water table. These simulated peak concentrations will be compared to groundwater goals in order to predict DLs for the contaminated zone. The model will be run iteratively until convergence of peak concentrations within one percent of the groundwater goals. The federal or California Maximum Contaminant Levels (MCLs) for drinking water will be the

primary source of groundwater cleanup goals. If MCLs are unavailable, the United States Environmental Protection Agency RSLs for tap water or California Notification Levels (CNLs) would be used as goal concentrations, unless other screening values would be more appropriate for use at the time of this evaluation. Background levels for inorganic constituents and sample detection limits for organic constituents will be used to provide baseline goals.

In addition to calculating DLs, the NUFT model would estimate the time to peak groundwater impact for each constituent. Constituents whose peak impact is predicted to occur in more than 500 years will be eliminated from the screening list.

H5. **Final Cleanup Goal Selection**

Cleanup goals will be selected based on the results of the soil-to-groundwater impact assessment and human health screening evaluation performed for soil media. For soil constituents, the lower value between the human health screening level and groundwater impact designated level will be selected. This conservative value will be compared with the background value. If the selected value is below background, the background value will be retained as the final cleanup goal. Final cleanup goals for the NCOPCs will be documented in the remedial action report.

H6. **References**

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