Work Plan for
Supplemental Feasibility Study
Radiological-Impacted Material
Excavation Alternatives Analysis
West Lake Landfill Operable Unit-1

Prepared for

The United States Environmental Protection Agency Region VII

Prepared on behalf of

The West Lake Landfill OU-1 Respondents

Prepared by

Engineering Management Support, Inc.
7220 West Jefferson Avenue, Suite 406
Lakewood, Colorado 80235

In association with

Feezor Engineering, Inc.
406 E. Walnut Street
Chatham, Illinois 62629

and

Auxier & Associates
9821 Cogdill Road, Suite 1
Knoxville, Tennessee 37932

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List of Acronyms

ACM	asbestos containing materials
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Recovery, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
cm/sec	centimeter per second
CSR	Code of State Regulations
DCGL	Derived concentration guideline
DOT	United States Department of Transportation
EMSI	Engineering Management Support, Inc.
ENR CCI	Engineering News Record Construction Cost Index
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
FS	Feasibility Study
ft	feet
gm	gram
GM	Geiger Mueller
HHRA	Human Health Risk Assessment
HI	Hazard Index
IC	Institutional Control
kg	kilogram
L	liter
LEL	lower explosive limit
LLRW	Low level radioactive waste
m	meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCA	Multi-channel analyzer
MDA	Minimum detectable activity
MDNR	Missouri Department of Natural Resources
mg	milligram
mm	millimeter
MTG	Migration to Groundwater
NCP	National Contingency Plan
NRC	Nuclear Regulatory Commission
O&M	operation and maintenance
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response

List of Acronyms (continued)

OU	Operable Unit
pCi	pico Curie
PID	Photoionization Detector
PPE	personal protective equipment
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDWP	Remedial Design Work Plan
RI	Remedial Investigation
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SFS	Supplemental Feasibility Study
SLAPS	St. Louis Airport Site
SLDS	St. Louis Downtown Site
SOW	Statement of Work
SWMP	Solid Waste Management Program
TS	Transfer Station
TSDF	Treatment, storage, and disposal facility
ug	microgram
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACOE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USCS	United States soil classification system
VOCs	Volatile Organic Compounds
VCA	Verification of current acceptability

1 INTRODUCTION

This Work Plan describes the work to be performed and the methods to be used to conduct a Supplemental Feasibility Study (SFS) of a select group of potential remedial alternatives for Operable Unit 1 (OU-1) at the West Lake Landfill Site. This Work Plan has been developed pursuant to EPA's January 11, 2010 letter to the OU-1 Respondents, the attached Statement of Work (EPA, 2010b) and in response to comments provided by EPA and MDNR on an initial draft version of this Work Plan (EPA, 2010c and 2010d and MDNR, 2010).

1.1 Site Background

The West Lake Landfill Superfund Site is located in Bridgeton, Missouri approximately four miles to the west of Lambert-St. Louis International Airport and approximately 17.5 miles from downtown St. Louis (Figure 1). The West Lake Landfill Superfund Site is a former solid waste landfill facility that consists of various contiguous and discrete areas historically used for disposal of municipal solid wastes and construction and demolition debris.

EPA has divided the site into two Operable Units. Operable Unit 1 (OU-1) consists of two areas where radiologically-impacted soil is present within the landfill mass in two portions of the waste disposal areas at the site. These two areas are referred to as Radiological Area 1 and Radiological Area 2 (Figure 2). OU-1 also includes adjacent property that has previously been referred to as the Ford property as it was previously owned by Ford Motor Credit but has since been divided into two parcels that include Crossroads Lot 2A-2 which is part of the Crossroads development and the landfill Buffer Zone (Figure 2). OU-2 consists of other areas of historic solid waste disposal including a former construction and demolition landfill and an inactive solid waste landfill (Figure 2).

1.2 Prior Remedial Investigation/Feasibility Study

Remedial Investigations (RI) and Feasibility Studies (FS) were previously completed for both OU-1 (EMSI, 2000 and 2006) and OU-2 (Herst & Associates, 2000 and 2006). Based on the results of the OU-1 RI, six potential remedial alternatives were identified and evaluated in the FS for theOU-1 portion of the landfill. The six remedial alternatives evaluated for OU-1 included the following:

1. No action;

2. Landfill cover repair, maintenance, additional access restrictions, additional institutional control restrictions, and monitoring;

3. Additional soil cover;

4. Regrading of Areas 1 and 2 (2% minimum slope) and installation of a RCRA Subtitle D landfill cover system;

5. Regrading of Areas 1 and 2 (5% minimum slope) and installation of a RCRA Subtitle D landfill cover system; and

6. Partial excavation and off-site disposal and regrading and installation of a RCRA Subtitle D landfill cover system.

Four remedial alternatives, including no action; institutional and access controls; capping and institutional and access controls; and excavation were identified and evaluated for the former Ford property (Buffer Zone/Crossroads properties).

Based on the results of the RI/FS, EPA developed a Proposed Plan for OU-1 and OU-2 (EPA, 2006), held three public meetings, and provided for an extended period for public comment on the Proposed Plan.

1.3 EPA-Selected Remedy

Based on the above documents and activities, EPA selected a containment remedy for OU-1 to protect human health and the environment by providing source control for the landfilled waste materials. The source control methods prevent human receptors from contacting the waste material and control contaminant migration to air or groundwater.

The description and basis for the selected remedy was documented in the Record of Decision (ROD) [EPA, 2008b]. The components of the selected remedy include the following:

1. Landfill Cap: Install landfill cover system to control and minimize the migration of contaminants from the OU-1 source areas and prevent direct contact with landfilled wastes.
2. Buffer Zone/Crossroads Property: Consolidate radiologically contaminated soil within the area of source control prior to installation of the cap.
3. Groundwater Monitoring: Implement long-term groundwater monitoring program to demonstrate groundwater protection.
4. Institutional Controls: Implement land use restrictions to ensure future uses do not impact the effectiveness or the integrity of the remedy.
5. Surveillance and Maintenance: Implement periodic inspection and maintenance program for all components of the remedy.

Performance standards for each of the selected remedy components are specified in the ROD. Additional performance standards were identified and will be incorporated into the remedial design as a result of subsequent discussions between EPA Region 7 and EPA's Office of Superfund Remediation and Technology Innovation.

1.4 Scope of Supplemental FS

EPA has recently determined that additional work is necessary to accomplish the objectives of the RI/FS for OU-1. Specifically, EPA has requested that the OU-1 Respondents to perform an SFS consisting of an engineering and cost analysis of remedial alternatives that would remove all radiologically-impacted materials from the radiologically-contaminated areas (Areas 1 and 2 and the Buffer Zone/Crossroads properties) in OU-1; referred to by EPA as "complete rad removal".

EPA has indicated (EPA, 2010a) that "complete rad removal" is defined to mean attainment of risk-based radiological cleanup levels specified in OSWER Directives 9200.4-25 and 9200.4-18. Although it has been termed "complete rad removal", it must be recognized that the remedial alternatives identified by EPA would not result in complete removal of all radionuclides from the landfill but instead are intended to remove radionuclides from Areas 1 and 2 to the degree feasible such that additional engineering and institutional controls would not be required due to the radiological content of these areas. As these areas may still contain solid wastes after removal of the radiologically-impacted materials, regrading, capping and establishment of institutional controls related to the presence of solid wastes would still be required for these areas.

In its January 11, 2010 letter (EPA, 2010a) and the attached SOW (EPA, 2010b) EPA identified two "complete rad removal" alternatives that should be developed and evaluated:

1. Excavation of radioactive materials with off-site commercial disposal of the excavated materials; and

2. Excavation of radioactive materials with on-site disposal of the excavated materials in an on-site engineered disposal cell with a liner and cap if a suitable location outside the geomorphic flood plain can be identified.

Once developed, these alternatives will be evaluated using the threshold and primary balancing criteria provided in the National Contingency Plan (NCP) at 40 CFR § 300.430 (EPA, 2009a). The SOW also required the "complete rad removal" alternatives be compared against the remedy selected in the OU-1 ROD using these same threshold and primary balancing criteria.

The engineering and cost analyses of the "complete rad removal" alternatives and the ROD-selected remedy will be performed based on existing information provided in the Remedial Investigation (EMSI, 2000), Baseline Risk Assessment (Auxier, 2000), Feasibility Study (EMSI, 2006), and the ROD for OU-1. These analyses will also consider the results of supplemental evaluations prepared by EPA subsequent to the ROD (TetraTech, 2009). Additional information may also be obtained from various vendors of equipment, materials and services as necessary to evaluate the potential effectiveness, implementability and cost of the "complete rad removal" alternatives. Additional field investigations or laboratory testing are not included in the scope of this effort and will not be performed.

The OU-1 Respondents have tasked Engineering Management Support, Inc. (EMSI) to conduct the SFS. This Work Plan describes the engineering analyses and other evaluations necessary to develop and evaluate the "complete rad removal" alternatives; the evaluations of the alternatives using the threshold and primary balancing criteria specified in the NCP; and the preparation of a SFS Report documenting the results of these evaluations. A project schedule for completion of the SFS for the "complete rad removal" alternatives and a description of the project personnel that will perform these analyses are also included in this Work Plan.

As with any FS or engineering evaluation, uncertainty exists with respect to site and subsurface conditions; material conditions and distribution; the nature and extent of contamination; engineering constraints; the implementability, performance and effectiveness of various actions and equipment; unit costs, cost scaling, and other economic considerations; and other factors. In performing the work necessary to complete the SFS, it is EPA's and EMSI's intent to develop and consider a reasonable range of assumptions as necessary to address potential uncertainties that could have a material impact on the effectiveness, implementability, short-term impacts, costs or duration of each alternative. Sufficient explanations of scientific and engineering concepts and technical rationales that may not be familiar to or readily recognized by the general public will be provided in the SFS.

2 ENGINEERING EVALUATIONS

Various additional engineering evaluations need to be performed prior to evaluation of the “complete rad removal” alternatives pursuant to the threshold and balancing criteria specified in the NCP. The nature and scope of the additional engineering evaluations are described below.

2.1 Identification of Soil for Removal Evaluation

Per EPA’s January 11, 2010 letter, the SFS will examine remedial alternatives for “complete rad removal” from the radiologically contaminated areas (Areas 1 and 2 and the Buffer Zone/Crossroads properties). For purposes of this analysis, EPA (EPA, 2010b) has defined “complete rad removal” to mean attainment of the risk-based radiological cleanup levels specified in OSWER directives 9200.4-25 and 9200.4-18 (EPA, 1998a and 1997a).

2.1.1 OSWER Directives

As indicated above, EPA has defined “complete rad removal” to mean attainment of the risk-based radiological cleanup levels specified in OSWER directives 9200.4-25 and 9200.4-18 (EPA, 1998a and 1997a). The following subsections discuss the potential applicability or relevance and appropriateness of the specific regulations and procedures addressed by these guidance documents.

OSWER Directive 9200.4-25, titled “Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites” (EPA, 1998a) discusses the applicability, relevance and appropriateness, and use of the soil cleanup standards established pursuant to the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 at CERCLA sites. As set forth in this guidance, EPA has determined that the surface soil standard for cleanup of soil at UMTRCA sites (5 pCi/g plus background) would only be applicable to cleanup of uranium mill tailings at the 24 uranium mill tailing sites designated under Section 102(a)(1) of UMTRCA (Title I sites). West Lake Landfill is not a Title I site and therefore these standards are not applicable to any remedial actions for the West Lake Landfill.

This guidance indicates that these standards may be relevant and appropriate to CERCLA sites that contain soil contaminated with radium-226, radium-228 and/or thorium isotopes. Although the radiologically-impacted materials in waste materials within OU-1 contain radium-226, radium-228 and thorium, these standards are not considered to be relevant and appropriate as they do not address conditions that are sufficiently similar to the West Lake Landfill. The standards established pursuant to 40 CFR 192 Subpart B were not developed or intended to address conditions at solid waste disposal units. Furthermore, as indicated in the guidance, “The purpose of these standards was to limit the risk from inhalation of radon decay products in houses built on land contaminated with tailings, and to limit gamma radiation exposure of people using contaminated land." The West Landfill is a solid waste landfill that is subject to controls on future land use that would prevent construction of houses over the waste materials regardless of whether radiologically-impacted materials were present or not. Institutional controls to restrict residential use of the property have previously been developed and implemented by the owners of the West Lake Landfill properties, including OU-1, OU-2 and other portions of the landfill properties. In addition, implementation of institutional controls to restrict future use of solid waste disposal sites is required by the Missouri Solid Waste Regulations (10 CSR 80-3.010(20)(C)2.C.II). Furthermore, EPA has indicated in the Statement of Work that even if a "complete rad removal" alternative were to be implemented, waste materials would still remain on site thereby requiring institutional controls. Consequently, construction of houses or future use of the landfill area for residential or other unrestricted uses is prohibited. Therefore, the standards established pursuant to 40 CFR 192 Subpart B do not address situations sufficiently similar to those present within the solid waste management units at the West Lake Landfill.

It should be noted that as stated in the guidance, the standards established pursuant to 40 CFR 192 Subpart B do address cleanup of so-called "vicinity" sites at which cleanup of specified off-site properties for unrestricted use is authorized. As these areas are related solely to the 24 Title I sites, they are not applicable to any remedial actions at the West Lake Landfill. Previous overland gamma surveys and surface soil sampling have indicated that soil containing radionuclides has been eroded from the surface of Area 2 at West Lake Landfill and was deposited on the surface of the adjacent Buffer Zone and a portion of the Crossroad property. As site development at the Crossroad property has resulted in regrading and placement of surface soil previously located on the Crossroad property onto the Buffer Zone, current conditions relative to occurrences of radionuclides at these properties are unknown but will be the subject of additional investigation and sampling as part of the selected remedy for OU-1. Remaining occurrences of radionuclides, if present, on the Crossroads property would represent a condition that may be sufficiently similar to the conditions associated with the "vicinity" properties addressed by the UMTRCA regulations. As such, the standards established pursuant to 40 CFR 192 Subpart B may be relevant and appropriate to any remedial actions taken to address radionuclides in soil at the Crossroads property.

Although the standards established under 40 CFR 192 Subpart B are neither applicable nor relevant and appropriate to the solid waste landfill areas at the West Lake site, they do represent standards that have been established by EPA for cleaning up radionuclide occurrences so as to allow for unrestricted use. EPA (2010d) has indicated that "One intent of the 'complete rad removal' alternatives, if implemented, would be to leave disposal areas 1 and 2 in a condition that would not require additional engineering and institutional controls due to their radiological content, if feasible." The standards established pursuant to 40 CFR 192 Subpart B are intended to allow for unrestricted use of land relative to radionuclide occurrences. Therefore, although these regulations and standards are neither applicable nor relevant and appropriate to the conditions at West Lake Landfill, they will be considered in the SFS as part of the development and evaluation of "complete rad removal" alternatives. For purposes of the SFS, these criteria will be referred to as cleanup levels for the evaluation of the "complete rad removal" alternatives.

OSWER Directive 9200.4-25 further determined that for CERCLA sites where subsurface contamination exists at a level between 5 pCi/g and 15 pCi/g averaged over areas of 100 square meters, conditions would not be sufficiently similar to an UMTRCA site to consider the subsurface soil standard of 15 pCi/g over background as a relevant and appropriate requirement. Under these instances, EPA recommends 5 pCi/g as a suitable cleanup standard for subsurface contamination, if a site-specific risk assessment demonstrates that 5 pCi/g is protective. EPA goes on to further state that when the UMTRCA standards are found to be relevant and appropriate requirements for a CERCLA site, the 5 pCi/g standard should be applied to the combined levels of radium-226 and radium-228. EPA also determined that in order to provide reasonable assurance that the preceding radionuclides in the series will not be left behind at levels that will permit the combined radium activity to build-up to levels exceeding 5 pCi/g after completion of the response action, the 5 pCi/g standards should also be used as a relevant and appropriate requirement for cleanup of the combined level of thorium-230 and thorium-232.

OSWER Directive 9200.4-18 titled "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA, 1997a) provides clarifying guidance regarding protection of human health at CERCLA sites containing radionuclides. This guidance identifies potential applicable or relevant and appropriate requirements (ARARs) of other regulations relative to radionuclide occurrences at CERCLA sites. In particular this guidance indicates that where ARARs are not available or are not sufficiently protective, EPA generally sets site-specific remediation levels for: (1) carcinogens at a level that represents an exceedance of upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}; and, (2) non-carcinogens such that the cumulative risks from exposure will not result in adverse effects to human populations (including sensitive sub-populations) that may be exposed during a lifetime or part of a lifetime, incorporating an adequate margin of safety. Since all radionuclides are carcinogens, this guidance addresses carcinogenic risk.

The sum of the ratios method for computation of radiological cleanup levels detailed in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) [EPA et al., 1997] is not being used for the SFS because it is not consistent with the OSWER directives discussed in this section.

2.1.2 Evaluation of Soil Cleanup Levels for "complete rad removal"

The method to be used to identify the cleanup levels for development and evaluation of the "complete rad removal" alternatives were specified by EPA in the SOW. As specified in the SOW, these cleanup levels were not developed from risk-based preliminary remediation goals, but rather were developed consistent with the OSWER directives discussed in Section 2.1.1. Although the cleanup levels were not developed from risk-based preliminary remediation goals, as discussed further below, the cleanup levels developed using the OSWER directives are protective of human health.

OU-1 at the West Lake Landfill addresses contamination in a former solid waste landfill that includes layers, lenses or other bodies of soil that contain radium, thorium, and uranium isotopes and their radioactive decay products. EPA previously determined that the UMTRCA soil cleanup standards established under 40 CFR 192 Subpart B were not applicable but were relevant and appropriate to cleanup of soil containing radionuclides at the Buffer Zone/Crossroads properties adjacent to Area 2.

As indicated above, radium and thorium isotopes are present in soil contained within the overall mass of solid waste materials located within OU-1. As the intent of the SFS is to evaluate alternatives for “complete rad removal”, engineering measures and institutional controls will not be required to address the remaining levels of radionuclides in OU-1 if one of the supplemental alternatives were to be implemented. Specifically, the intent of the “complete rad removal” alternatives is to remove radiologically-impacted materials from OU-1 to the degree necessary to allow for unrestricted use of the OU-1 areas relative to the presence of radionuclides. Therefore, although the cleanup standards established under the UMTRCA regulations, as modified and clarified by the two EPA guidance documents referenced above, are not considered relevant and appropriate requirements for the West Lake Landfill, they will be considered as cleanup levels for purpose of evaluation of the “complete rad removal” alternatives that are the subject of the SFS.

A Baseline Risk Assessment (BRA) [Auxier & Associates, 2000] was completed as part of the RI (EMSI, 2000). The highest level of potential risk to human health identified in the BRA was a 2×10^{-4} future risk for a groundskeeper working in Radiological Area 2. This risk was based on an expected future average activity level for radium-226 plus its eight daughter products of 1,524 pCi/g. Under the “complete rad removal” alternatives, the combined levels of radium-226 plus radium-228 that would remain at the site if one of the “complete rad removal” alternatives were to be implemented would be 5 pCi/g plus background. This represents an approximately 300 fold reduction from the projected future average level of radium-226 which should result in an approximately 300-fold reduction in the projected risk level, reducing the maximum projected risk level identified in the BRA to approximately 1×10^{-6}. As a result, use of the 5 pCi/g plus background cleanup level set forth in UMTRCA regulations, as modified by the referenced EPA guidance documents, should result in a cleanup level that is protective of public health.

The radiological cleanup levels specified in OSWER directive 9200.4-25 are total radium 226 + 228 greater than 5 pCi/g (above background) and total thorium 230 + 232 greater than 5 pCi/g (above background). As a result, it must be noted that the so-called “complete rad removal” alternatives would not result in complete removal of all radionuclides from the landfill but would only result in removal of radionuclides to a level such that engineering measures and institutional controls intended to address radionuclide occurrences at the site would no longer be required. EPA's policies pursuant to CERCLA and the NCP do not require removal of all radionuclides. The radionuclide levels that would remain with Radiological Areas 1 and 2 under the "complete rad removal" alternatives would be protective of human health for reasonably expected future exposure scenarios.

There are no ARARs or established cleanup levels for uranium. The ROD for the St. Louis Downtown Site (SLDS) [EPA, 1998b] and the 2005 ROD for the St. Louis Airport Site (SLAPs) [EPA, 2005] were reviewed relative to the uranium cleanup level established by EPA for other sites in St. Louis area that contained uranium and other radionuclides in soil. The SLDS ROD indicated that the point of departure (10^{-6}) remediation goal for U-238 would be 2.6 pCi/g using standard Risk Assessment Guidance for Superfund (RAGs) methodology (EPA, 1989, 1991c and 1991d) and site-specific exposure factors. The value of 2.6 pCi/g however, was determined by EPA to be within the range of site background concentrations (0.159 to 3.78 pCi/g for 32 sample detects). EPA also concluded that the point of departure concentration would present significant issues with respect to implementability. Therefore, so as to enable field measurement of U-238, preclude the cost for over-excavation of clean soils, and facilitate statistical confirmation of the cleanup, EPA adjusted the remediation goal upward to 50 pCi/g. EPA determined that this level would be protective of human health in that it corresponds to a risk of less than 2×10^{-5} without regard to the presence of clean soil cover that would be placed over the excavation areas. EPA further concluded that this value is a valid, supportable remediation criterion for the SLDS Site given that actual residual concentrations are generally substantially less than the applicable criterion, and is further appropriate given the need to minimize over-excavation of soils and the associated costs.

For SLAPS, a site-specific remediation goal for U-238 was derived based on the approach described in 10 CFR 40, Appendix A, Criterion 6(6), also referred to as the benchmark dose approach. The U-238 remediation goal was established using U-238 as a surrogate for all of the uranium isotopes (including U-234 and U-235) and certain uranium decay products. The SLAPS ROD indicates that the remediation goal for U-238 was calculated to be 81 pCi/g when used as a surrogate for total uranium. The U-238 remediation goal was revised downward to 50 pCi/g to account for Pa-231 and Ac-227 concentrations that are present above their expected natural abundance.

Based on the uranium remediation goal of 50 pCi/g established for the SLDS and SLAPs, for purposes of performing the SFS for "complete rad removal" alternatives, a cleanup level of 50 pCi/g plus background will be used. The risk calculations used to derive and that support this cleanup level were presented in the SLDS and SLAPs RODs (EPA, 1998 and 2005).

Although the site-specific Baseline Risk Assessment (BRA) is not being used to justify the cleanup values presented above, comparisons between the BRA results and the cleanup levels derived from the UMTRCA regulations as described above, do provide an additional qualitative line of evidence that the cleanup levels will be protective of human health. The highest risk level calculated in the BRA for uranium-238 and its daughter products was 5 x 10^{-8} for a future storage yard worker working in Area 2. This risk estimate was based on a projected average uranium activity level of 15.7 pCi/g which is approximately one-third of the proposed cleanup criteria of 50 pCi/g plus background. Therefore, the risk level associated with the proposed cleanup level would be approximately three times higher than the risk level calculated in the BRA, which would still be less than the 1 x 10^{-6} point of departure established by EPA for carcinogenic risk.

2.1.3 Soil Cleanup Levels

EPA has defined the "complete rad removal" alternatives to mean attainment of the risk-based radiological cleanup levels specified in OSWER directives 9200.4-25 and 9200.4-25. These directives provide guidance for establishing protective cleanup levels for radioactive contamination at CERCLA (Superfund) sites. In particular, these directives provide clarification as to the use of the UMTRCA soil cleanup criteria as remediation goals at CERCLA sites. The UMTRCA soil cleanup criteria are based on concentrations above background levels. Similarly, EPA has stated elsewhere that CERCLA cleanup levels are not set at concentrations below natural background levels (EPA, 2002). As a result, the cleanup standards to be used for the development and evaluation of the "complete rad removal" alternatives are background-based standards. Determination of background levels therefore is an important part of the development of the soil cleanup levels for the "complete rad removal" alternatives.

As with any set of data, background values are subject to variability. By definition, the mean background value represents the central tendency of the background data set but does not incorporate any measure of the variability of the background data set. Consequently, values greater than the mean value may nonetheless be representative of background conditions. Therefore, some measure of the variability of the background data is necessary to define the uncertainty associated with the mean of the background values. A common type of value for the interval around an estimate is a confidence interval. A confidence interval may be regarded as combining an interval around an estimate with a probabilistic statement about the unknown parameter. Confidence intervals are based on the standard deviation of the data set and published statistical values defining population distributions.

Background concentrations of the various isotopes of radium, thorium and uranium are presented in Section 6.2 of the RI report (EMSI, 2000). These background concentrations were determined using analytical results from samples collected at four background locations. In order to account for the variability in the background results, the representative background values used in the RI are the mean values of the four results plus two standard deviations. Use of two standard deviations reflects the critical value of 1.96 used to calculate the 95% confidence limit for a normally distributed population with a large number (greater than 30) of sample results. Specifically, through repeated sampling, the true mean value is expected to fall within a range defined by two times the standard deviation 95% of the time. For smaller sample sizes, the critical values are larger. In the case of a sample set consisting of four data values, the critical value would be 2.35. Therefore, use of a value of two is a reasonable, yet slightly conservative (more protective) method of estimating the variability of the background values.

The mean background concentrations and the mean background concentrations plus two standard deviations were presented in the RI report (EMSI, 2000) and are listed below:

Parameter	Mean of the background sample results	Standard deviation of the background sample results	Mean value plus two standard deviations
Radium-226	1.06	0.12	1.30
Radium-228	1.65	0.36	2.37
Thorium-230	1.51	0.47	2.45
Thorium-232	0.90	0.33	1.55
Uranium-238	1.33	0.46	2.24
Uranium-235	0.39	0.38	1.15
Uranium-234	1.47	0.63	2.73

Note: All values reported as pCi/g

Collection of additional background samples to provide a larger data set for use in estimating background values or incorporation or use of background values obtained from other studies conducted in the general area of the site (such as SLAPS) may need to be performed if one of the “complete rad removal” alternatives were selected for implementation at the site.

Each of the above-identified radionuclides are members of either the uranium-238 or the thorium-232 decay chains. In theory, the short lived members of these chains should be in equilibrium with longer-lived progenitors in the same chain. For example, thorium-232 and radium-228 are members of the thorium-232 decay series and should be in equilibrium with each other. Examining the results listed above, it can be seen that they are noticeably different. These differences likely result from variations in the analytical results obtained from the four samples combined with the effects of averaging the results and incorporation of two standard deviations about the results to address the overall variability of the sample results.

In order to address the difference in activity levels of the parent and daughter radionuclides in the SFS, the representative background concentration for all short-lived members of a decay chain will be set to the lowest value calculated for any member in the chain. This is a small adjustment that results in a slightly lower derived concentration guideline (DCGL). In the case of the thorium-232 series, the background concentration of all members of the thorium-232 series will be set to1.55 pCi/g in this SFS. Applying this same logic to the remaining radionuclides, the background values to be used for series nuclides in this evaluation are as follows:

- Radium-226 = 1.3 pCi/g
- Radium-228 = 1.55 pCi/g
- Thorium 232 = 1.55 pCi/g (parent of Ra-228)
- Thorium-230 = 1.3 pCi/g (parent of Ra-226)
- Uranium-238 = 2.24 pCi/g (parent of U-234)
- Uranium 234 = 2.24 pCi/g (parent of Th-230)

These values are comparable to the following background values identified for SLAPS (EPA, 1998b):

- Radium-226 = 2.8 pCi/g
- Radium-228 = not identified
- Thorium 232 = not identified
- Thorium-230 = 1.9 pCi/g
- Uranium-238 = 1.4 pCi/g
- Uranium 234 = not identified

The resultant cleanup values to be used to identify the site soils that will be the subject of the evaluation of the "complete rad removal" alternatives will be the sum of the representative background concentrations and the appropriate risk-based remediation concentrations listed in the OSWER directives; that is 5 pCi/g plus background. Based on the site background values presented in the RI (EMSI, 2000) the site cleanup values would be as follows:

- Radium-226+228 = 7.9 pCi/g[1]
- Thorium-230+232 = 7.9 pCi/g

[1] Total radium DCGL = 1.3 pCi/g radium-226 + 1.6 pCi/g radium-228 + 5 pCi/g radium cleanup level = 7.9 pCi/g total radium

- Total uranium = 54.5 pCi/g

The RI (EMSI, 2000) and pre-RI (RMC, 1982 and NRC, 1988) data will be reviewed to identify those soil borings and depth intervals that contain radium, thorium, and/or total uranium activity levels greater than these cleanup values. In the event that the results for one or more of the isotopes were reported as being less than the minimum detectable activity (MDA) value, a surrogate value of one-half the MDA value will be used for the particular isotope.

In addition to review of the soil sample results, the results of the downhole gamma logging will also be used to define areas and depth intervals that likely contain soil with radionuclide levels above the cleanup levels. As there is not a direct correlation between the downhole gamma results and the results of soil sample analyses, the downhole gamma logs will be visually reviewed and qualitatively evaluated to identify locations and depth intervals where soil containing radionuclides above the cleanup levels are expected to be present.

As only graphical portrayals of the overland gamma survey results are available, these results will be qualitatively reviewed to insure that areas with elevated overland gamma results that may reflect occurrences of soils with radionuclide levels greater than the cleanup levels are also included in the delineation of the areas with soil above the cleanup levels.

The results of these evaluations will consist of tabulation of the locations and depth intervals that contain, or are likely to contain radionuclide occurrences above the stated cleanup levels. The survey data for these locations and the depth intervals will be tabulated to identify the location and elevation of the intervals that contain, or are likely to contain radionuclides above the cleanup levels. These locations and depth intervals will then be correlated to identify general zones where radionuclides are expected to be present at activities greater than the cleanup levels (see discussion in Section 2.3 below).

2.2 Identification of Volumes of Soil to be Excavated and Disposed

The volume of soil to be excavated from the Buffer Zone/Crossroads properties will be estimated based on the results of the design-phase field investigations discussed above.

For Areas 1 and 2, the Project Team will use the results of the evaluations described in Section 2.1 to identify the waste materials containing radionuclides above the cleanup levels. Intervals containing or suspected to contain radionuclide activities above the cleanup levels will be plotted in three-dimensions and located within the overall waste mass. By using computer-assisted volumetric calculating software, a volume projection will be estimated for both the waste materials containing radionuclides above the cleanup levels and the overburden waste which must be removed in order to excavate the underlying radiologically-impacted materials.

The Project Team will use the AutoCAD Civil 3D 2010 software (AutoCAD, 2010) to portray the lateral and vertical extent of the radiologically-impacted materials and estimate the volumes of radiologically-impacted materials and overlying waste materials. This program generates surfaces of a layer of interest, and then uses a volume calculation algorithm to estimate the in-place volume between two defined surfaces. A surface is the three-dimensional geometric representation of an area of land. Surfaces are developed by triangles or grids, which are created by either three-dimensional contours (from an aerial topography), or from a series of three dimensional points (x,y,z).

The AutoCAD Civil 3D 2010 software uses the defined surfaces to calculate a volume by subtracting the difference in elevations within the specific grid, and multiplying the difference in elevation by a grid area. The surface is broken into several smaller grid areas, and the total volume adds the incremental volume calculated from each sub-grid area. Evaluation of the "complete rad removal" will include development of estimates of the volumes of soils and wastes projected to be excavated as overburden and the volumes of soils and wastes (radiologically-impacted materials) to be excavated for off-site disposal or disposal in a new on-site disposal cell for both Areas 1 and 2 of OU-1.

In addition, a surface will be created based upon the starting and ending elevations of the waste materials containing radionuclides above the cleanup levels as estimated by the analysis described in Section 2.1 of this Work Plan. From the soil boring data, a beginning surface and an ending surface will be generated by connecting the three-dimensional point data between borings. Assumptions relative to layer termination will be discussed in detail. In addition, if there are multiple layers within a vertical column of a boring, multiple volumes may be required. These calculations will be presented in the SFS Report.

For both Area 1 and Area 2 of OU-1, the volume of the overburden waste materials (not containing radionuclides) will be calculated by creating a surface from the latest aerial topography, and comparing that surface to the top of the waste materials containing radionuclides above the cleanup levels. This volume would be removed to access the waste materials containing radionuclides above the cleanup levels. Allowable excavation slopes in accordance with applicable Occupational Safety and Health Administration (OSHA) regulations to minimize waste excavation will also be investigated in the SFS.

As discussed in Section 2.3.2.2, the required overburden removal volume to exhume the waste materials containing radionuclides above the cleanup levels may consist of waste materials that do not include radiologically-impacted materials or in some instances native soil located adjacent to the waste materials. Excavation of the radiologically-impacted materials would likely not only entail excavation of overlying soil and waste materials, but could also require excavation of waste materials or native soils located adjacent to the radiologically-impacted materials in order to provide suitable side-slopes for the waste excavation activities. The configuration and volume of any waste materials/native soil that would need to be excavated or laid-back in conjunction with the excavation of the radiologically-impacted materials will be calculated.

All generated overburden material and related material needed to be excavated to safely access the waste materials containing radionuclides above the cleanup levels would need to be properly managed. For purposes of the SFS it is assumed that the most cost-effective method for management of the non-radiologically impacted waste materials would be to stockpile these materials near the excavation areas and replace them into the excavation after the waste materials containing radionuclides above cleanup levels have been removed. Evaluation of MDNR requirements and possible waivers necessary to allow for temporary stockpiling of excavated waste materials will be evaluated as part of the SFS. Double-handling of the overburden materials would occur as a result of initial excavation, stockpiling, temporary covering, and control of runon, runoff and leachate, followed by replacement, regrading and capping these overburden materials. This doubling handling would result in additional costs. Therefore, the cost of disposing of the overburden wastes, either in the newly-constructed disposal cell as part of the on-site disposal option, or alternatively at an off-site solid waste disposal facility or off-site radiological waste disposal facility will also be evaluated as part of this SFS. Evaluation of the two options for the disposition of the overburden material and related material (i.e., [1] stockpiling and replacement into the excavation, and [2] disposal in the newly-constructed on-site disposal cell or in an off-site waste disposal facility) will require the preparation of two final grading plans and cover designs.

Regardless of the approaches taken in performing the SFS evaluations, there will be a large degree of uncertainty associated with the volume estimates. This uncertainty arises from the limits on the accuracy of the existing site topographic mapping, which is based on aerial photogrammetry without ground control producing, at best, a topographic surface with a tolerance of approximately one foot. In addition, past subsurface investigations of the site were focused on providing information on the general nature and extent of occurrences of radiologically-impacted materials. The current understanding of the lateral and vertical extent of the radiologically-impacted materials is based on data density derived from approximately one soil boring per acre. This information was determined to be sufficient to characterize the potential risks posed by the site and to identify and evaluate potential remedial alternatives for the site. For purposes of the SFS evaluation, the volume of radiologically-impacted materials is the single largest factor affecting the potential costs of the “complete rad removal” alternatives.

2.3 Excavation Plan

A conceptual excavation plan would be developed for the exhumation of the waste materials containing radionuclides above the cleanup levels within Area 1 and Area 2 of OU-1. The excavation plan should be similar for both the off-site and on-site disposal alternatives. The excavation plan would provide details pertaining to the methodology of exhumation of the waste materials containing radionuclides above the cleanup levels, temporary storage of the overburden waste and soils, and the reclamation plan once the radiologically-impacted materials have been removed. These plans would be presented in the SFS Report.

2.3.1 Excavation Phasing and Staging

Based upon the estimated defined horizontal and vertical limits of the waste materials containing radionuclides above the cleanup levels and the calculated allowable slopes and overburden depths, estimated lines of projection or “daylight” lines would be surveyed. The SFS will identify the location of these daylight lines based upon the three-dimensional projections of the waste relocation limits. Details will be provided discussing how the affected areas would be cleared of vegetation, how the overburden waste would be excavated and stockpiled in pre-defined areas, and how the waste materials containing radionuclides above the cleanup levels would be identified, removed, processed, and ultimately transported out of the Area 1 and Area 2 boundaries of OU-1.

A general description of how radiologically-impacted materials have been successfully removed at conventional (non-landfill) sites follows:

1) An experienced radiological technician would survey and sample the working face to determine the extent of any radiologically-impacted material present. The technician would clearly mark any impacted areas with paint or flagging.

2) The excavator would remove a layer of waste materials from the marked area and transfer the waste materials to haul trucks.

3) The surveyor and the excavator would repeat steps one and two until the technician determines that the area may meet release criteria.

4) The area is then sampled and scanned as part of the final status survey for that area.

5) If the scanning and analytical data indicate the area meets release criteria, the excavations would be backfilled in accordance with the approved remedial design documents. If the final status survey finds that radiologically-impacted materials still remain, the process returns to Step 1 until the area does pass.

A conceptual strategy will be developed in the SFS to transition the waste materials containing radionuclides above the cleanup levels from off-road haul trucks to on-road transfer vehicles and then to long-distance transport vehicles for the off-site commercial disposal alternative.

2.3.2 Equipment Requirements

"Complete rad removal" would be expected to entail exhumation of waste materials using a hydraulic excavator(s) and off road haul trucks to remove the overburden, exhume the waste, and reclaim the excavated areas. Dozers would be used to clear the affected areas and provide grading during the construction project. On road trucks (and if rail is used, a rail transfer facility) would be used for any off-site disposal option. A design for the truck to rail transfer facility would be required if this option is selected. In order to control any potential emissions during transfer activities, it is envisioned that this facility would be an enclosed structure complete with climate controls.

Other equipment would be used to process the waste and reclaim Area 1 and Area 2 of OU-1. The types of equipment that would be used for this exhumation and reclamation effort and the analytical equipment needed to control the excavation will be identified in the SFS. This would aid with the project scheduling requirements, project costs, and assessing the exposure of the construction workers and oversight staff for use in evaluation of the "complete rad removal" alternatives.

2.3.3 Production Rates

The types of equipment that would be used for this exhumation and reclamation effort (as discussed in Section 2.4.1.1) will be identified in the SFS. The equipment production rates will be investigated by exploring typical manufacturer data and published construction cost estimating software to estimate the number and type of pieces of equipment needed, the time frame for construction, and for cost estimating purposes.

2.3.4 Material Volumes

The material volumes as discussed in Section 2.3.2 would consist of waste materials containing radionuclides above the cleanup levels, the waste overburden, and soil overburden. The in-place soils and wastes would have a certain compaction level, or density. This is often referred to as "Bank Cubic Yards". Once the soils and waste materials are loaded using excavation equipment, the volume of the excavated materials will expand. This volume is often referred to as "Loose Cubic Yards". Upon placement and compaction, the volume of the excavated materials would be reduced but the final in-place density is likely to differ from the original in-place density. The literature will be reviewed and historical project experience used to attempt to approximate these bulking and compaction factors, as they will affect project schedules, costs, and quantities. This phenomenon would apply to both the on-site disposal and off-site disposal options as well as to the various material handling and transport activities.

2.3.5 Material Handling

Material handling procedures will be discussed in the SFS. This will include the methods used to identify material for removal, preferred methods of excavation, the labor involved, and daily procedures that would be followed to provide for effective removal and reclamation including procedures to identify the radiologically-impacted material during the excavation and to determine when the radiologically-impacted materials have all been removed.

The material handling plan will also discuss requirements for temporary stockpiles including staging, temporary covering at the end of shifts, diversion of surface water runoff around any piles, and management of any leachate generated from the piles. MDNR restrictions on temporary stock-piling of wastes will be evaluated and if determined to be ARARs, a basis for a waiver, if needed, will be presented. Alternatively, the materials handling plan may include requirements associated with off-site disposal of the excavated non-radiologically impacted waste materials that lie over or adjacent to the radiologically-impacted materials.

The material handling plan will also address handling of any special wastes such as liquid wastes, hazardous waste, or asbestos-containing material (ACM) if such wastes are encountered during excavation of the radiologically-impacted materials. The material handling plan would aid with the project scheduling requirements, project costs, and assessing the exposure of construction workers and oversight staff.

2.3.6 Personnel and Equipment Monitoring and Decontamination

Access to areas containing radiologically-impacted materials would be limited. Equipment and personnel entering and leaving these controlled areas would be surveyed and, if necessary, decontaminated before moving outside the areas where radiologically-impacted materials are present. Prior to leaving the site, vehicle monitoring and decontamination would be required for highway trucks used to transport excavated material for off-site disposal and for any other vehicles that may enter areas containing radiologically-impacted materials. The costs associated with the monitoring and personnel and equipment decontamination efforts and the necessary production delays will be evaluated for each alternative.

2.3.7 Dust/Odor Control

Waste relocation and exhumation can generate excessive dust and nuisance odors. The SFS will discuss potential concerns and impacts associated with dust and odor emissions and evaluate the anticipated effectiveness of commonly accepted industry standard procedures to address these issues. Procedures to be evaluated include, but will not necessarily be limited to, application of a daily soil cover or alternative daily covers, odor mitigation products, as well as moisture conditioning and other dust suppression techniques/products.

Perimeter and work site air monitoring as part of the radiological monitoring program for worker and public safety are discussed in Section 2.11. A monitoring program and parameters to assess the effectiveness of dust and odor mitigation measures in conjunction with the radiological monitoring program will be developed in the SFS.

2.3.8 Surface Water/Leachate Control

Conceptual design phase surface water management and leachate control plans will be developed for the SFS. Since the exhumation process of waste materials containing radionuclides above the cleanup levels would involve excavated depressions, storm water would collect within these temporarily created depressions. The surface water management plan will discuss techniques for diverting storm water around the work area. In addition, the leachate management plan will discuss methods to handle and dispose of leachate that may be encountered during the exhumation process, or could be generated by storm water commingling with the exposed refuse. Leachate removal techniques, management practices, and treatment and disposal options will be discussed in the SFS.

2.3.9 Impacts to Airport Operations/Mitigation Approaches

The SFS will investigate the waste exhumation process as it affects local airport operations, specifically the Lambert-St. Louis International Airport. Missouri Solid Waste Regulations (10 CSR 80-3.010 (4)(B)1) restrict landfill siting and operations located within 10,000 ft of runways used for jet aircraft. Radiological Area 1 at the West Lake Landfill is located just inside of 10,000 feet of the west end of the recently completed western-most runway at the airport, while Radiological Area 2 is located just inside of approximately 12,000 feet of the west end of the western-most runway. Available techniques to reduce bird hazards to aircraft during the waste exhumation process will be identified and their anticipated effectiveness will be evaluated in the SFS.

2.3.10 Coordination/Impacts to other Site Uses/Activities

The SFS will also discuss how the on-site disposal in an engineered disposal cell alternative or the off-site commercial disposal alternative would affect the other operations within the defined facility boundary (owned property). For example, transport of excavated waste to an on-site engineered disposal cell or to an off-site commercial facility could impact the internal site truck traffic associated with the existing solid waste transfer station, concrete plant and asphalt batch plant as well as traffic along St. Charles Rock Road at the point of ingress and egress to the site. Possible limitations with basic site services (e.g., electrical service, water supply) that could affect implementation of the "complete rad removal" alternatives or other site business will be identified in the SFS. Use of an on-site engineered disposal cell or trucking of wastes off-site could require additional health and safety monitoring and precautions for other site workers not involved in the remedial actions. For the off-site commercial disposal alternative, decontamination of trucks prior to leaving the site may be required. The need for, requirements, and impacts to other site activities will be evaluated in the SFS.

2.3.11 Methane Gas Emergency Action Plan

A Methane Gas Emergency Action Plan will be developed as part of the SFS. Such a plan would be necessary as in-place waste would potentially be disturbed. The project Health and Safety Officer would be responsible for excavation and perimeter monitoring for methane and hydrogen sulfide gases. On-site monitors would be established and maintained for the duration of the excavation activities. Applicable local, State, and federal regulations would be adhered to. Additional details on the Methane Gas Emergency Action Plan will be included in the SFS and would be included in the Site Safety Plan for remedy implementation.

2.4 Sampling and Analysis Plan

As part of the SFS, a conceptual sampling plan will be developed to provide details about the sampling and survey techniques to be used to identify radiologically-impacted materials during excavation and upon completion of the excavation activities in a given area, to document that all of the materials that exceed the cleanup levels have been removed.

2.4.1 Excavation Control Surveys and Sampling

It is expected that any excavation of radiologically-impacted materials would be controlled by qualified technicians using a combination of walkover field survey equipment and solids sampling to identify impacted materials above the cleanup levels established for the radiologically-impacted materials. The SFS will evaluate available equipment and methods to determine the most cost-efficient way to perform real-time monitoring of the radiological status of materials on the working face.

2.4.2 Final Status Survey and Sampling

It is anticipated that a final walkover survey, including radiological scans of exposed areas and sampling of soil/trash at the base of the excavation, would need to be performed as part of the "complete rad removal" alternatives to document that soils and materials containing radionuclides above the cleanup levels have been removed. Verification sampling would need to demonstrate compliance with the UMTRCA standards (40 CFR 192.12) relative to radium-226 in surface soil, as modified to reflect the cleanup levels established by EPA in the Statement of Work (EPA, 2010b). Specifically, post-excavation soil samples would need to be collected to demonstrate that at the completion of the excavation activities, the remaining soil does not contain total radium (radium-226 and radium-228) or total thorium (thorium-230 and thorium-232) at concentrations greater than the cleanup levels discussed above. These samples may be analyzed in the on-site lab with a percentage sent to an independent off-site laboratory for verification of the results. Alternatively, all of the samples may be sent to an off-site laboratory, if a laboratory capable of providing quick analytical turn-around can be located. The excavation plan will include actions necessary to keep excavated areas open until the verification sample results are available in the event that the sample results indicate that additional excavation is required to achieve the cleanup goals.

Normally, the approach described in MARSSIM would be chosen for this task without further consideration of other methods. However this particular application poses some conceptual problems for a MARSSIM-based final status survey methodology[2]. MARSSIM and other methods will be evaluated in the SFS and a scientifically-sound method will be selected and described. It is expected that the final survey method would integrate scanning and sampling activities. The costs and scheduling concerns associated with this survey method will then be evaluated in the SFS.

2.4.3 Establishment and Maintenance of On-site Laboratory

It is anticipated that the majority of the samples collected would be analyzed in an on-site laboratory but that a percentage of the samples (perhaps 10% to 20%) would be submitted to an off-site analytical laboratory for quality assurance purposes. An on-site laboratory would be equipped with the most up-to-date analytical equipment available. The intention of the on-site laboratory would be to identify Th-230 at the 5 pCi/g level with a high degree of confidence. In practice, no excavated area where the final survey has been completed would be backfilled until the off-site analytical results for Th-230 are reported and found to be at or below cleanup levels. The costs associated with establishing and maintaining an on-site laboratory will be evaluated in the SFS. The on-site laboratory would also be used to conduct real- or near real-time monitoring and for preparation of samples for off-site laboratory analyses to assist in evaluation of environmental conditions such as dust emissions during the excavation activities. Additional discussion of environmental and health and safety monitoring is presented in Section 2.11 below.

2.5 Soil/Waste Segregation Evaluation

An evaluation will be performed in the SFS to assess whether the radiologically-impacted soil that is interspersed with landfilled waste materials in Areas 1 and 2 could be

[2] MARSSIM is specifically designed for surface soil, and most of the areas to be remediated are subsurface. In addition, the cleanup criteria contained in UMTRCA are stated as pCi averaged over a 100 square meter area and 15 cm depth. MARSSIM does not use averaging criteria. Instead, it uses a non-parametric statistical test to compare groups of samples from areas to a similar number of samples from a "reference area" to test if the area contains soil above a certain activity level. Given the degree of industrial and other development in the area (i.e., building coverage, pavement and landscaping), locating and obtaining access to suitable "reference area(s)" near the site may not be possible.

separated from the waste materials. Based upon the evaluation of the radionuclide materials above cleanup levels described in Section 2.1, the three dimensional distribution of the materials to be removed may vary in Area 1 and Area 2 of OU-1. In Area 1, the radionuclide materials above cleanup levels are located in a contiguous horizontal area between 0 and 17 feet below the surface, represented by elevations between 438 and 470 feet amsl. The radionuclide materials above cleanup levels in Area 2 are distributed in a more complex spatial orientation. Horizontally, the radionuclide materials above cleanup levels are distributed throughout approximately 60-70% of the Area 1 boundary. Vertically, the radionuclide materials above cleanup levels are between 0 and 49 feet below the surface, represented by elevations between 427 and 480 feet amsl. The SFS will quantify the three dimensional distribution of these materials and associated volumes in greater detail.

As the cost of any of the excavation alternatives will primarily be driven by the cost of disposal of the excavated materials, methods that may potentially be effective in segregating the overall radiologically-impacted materials from non-radiologically impacted wastes will be identified. These methods could include more precise identification and excavation of the radiologically-impacted materials (large-scale separation) as well as possible separation of radiologically-impacted soil from non-radiologically impacted solid wastes or construction and demolition debris (small-scale separation). The potential effectiveness, implementability, impacts, and costs of monitoring, identifying and verifying the differences between radiologically- and non-radiologically impacted waste materials during the excavation activities (large-scale segregation) will be evaluated as part of the SFS. These factors will be compared against the anticipated impacts and cost of excavation without field segregation of the radiologically- and non-radiologically-impacted materials and resultant disposal (in an on-site cell or at an off-site facility) of a larger volume of waste material.

The goal of separating the radiologically-impacted soil from the landfilled waste materials (small-scale segregation) would be to further reduce the volume of radiologically-impacted material that would need to be transported and disposed off-site at a commercial facility or disposed in a new on-site engineered disposal cell. The following information will be analyzed as part of the evaluation of the potential effectiveness, implementability, impacts, benefits, and costs of performing soil-waste segregation:

- The type, number, size, capacity, materials of construction, footprint, labor and analytical requirements, and costs of equipment needed to separate the radiologically-impacted soil from the landfilled waste materials;

- Production rates for the separation equipment;

- Type, number, size, capacity, production rates, labor requirements, materials of construction, footprint, and costs of equipment needed to support the separation equipment (e.g., track hoes, front-end loaders, bin surge hoppers, conveyors, off-road and highway trucks, temporary enclosed structures);

- Percentage of segregation expected;
- Any limitations/constraints to segregation;
- Additional labor requirements;
- Operation, maintenance, and monitoring costs for separation and supporting equipment; and
- Potential for exposure to radiologically-impacted material by equipment operators and any laborers, type of exposure, and any personal protective equipment required.

If the results of the evaluation conclude that separating the radiologically-impacted soil from the landfilled waste materials is feasible, an estimate of the volume of separated soil will be prepared to be used in the off-site transportation/commercial disposal alternatives analysis as well as the conceptual design of an on-site engineered disposal cell.

2.6 Applicable or Relevant and Appropriate Requirements

As part of the engineering evaluations for the SFS, potentially applicable or relevant and appropriate requirements (ARARs) of other environmental regulations, standards or criteria will be identified and evaluated. This task will include evaluation of the ARARs identified in the FS report for the site (EMSI, 2006) and in the ROD previously prepared by EPA. The criteria identified in these prior evaluations will be evaluated with respect to their potential applicability or relevance and appropriateness relative to the “complete rad removal” alternatives. Additional requirements that may potentially be applicable or relevant and appropriate to the “complete rad removal” alternatives, such as criteria or requirements related to the design, operation or closure of an on-site engineered cell or relative to off-site transport and disposal of the excavated radiologically-impacted materials will also be evaluated.

2.7 Off-site Commercial Disposal Alternatives

An analysis of the potential off-site commercial disposal alternatives will be conducted for the SFS. The analysis will involve identifying potential disposal facilities and any limitations/constraints on use of the facilities, assessing transportation methods and constraints, and evaluating transportation and off-site disposal cost information.

Based on a preliminary search, potential off-site commercial disposal locations for radiologically-impacted material might include the Clean Harbors (Colorado), American Ecology (Idaho), Energy Solutions (Utah), and Waste Specialists (Texas) facilities. These and other potential facilities will be contacted and waste acceptance information will be gathered including waste type limitations, the ability of the facility to accept mixed soil and garbage, radionuclide activity level limitations, volume limitations, limitations regarding other waste characteristics, and whether the facility has direct rail access.

Transportation of radiologically-impacted material to each potential off-site disposal facility will be evaluated, including truck, rail and truck/rail combination methods. The feasibility of constructing a rail link to the West Lake Landfill site and constructing an on-site transfer facility will be assessed. Alternatively, the feasibility of upgrading and using the existing rail transport facility established by the U.S. Army Corps of Engineers (USACE) at the airport site will be evaluated. Potential location(s), design requirements, worker exposure assessment, and estimated capital and operation costs for an off-site truck-to-rail transfer facility will be reviewed. Any truck and rail transportation special requirements and/or limitations; (e.g., routing limitations on rail hauling, railroad-specific rules/regulations, special Department of Transportation (DOT) packaging requirements for rail shipments, or other requirements) will be identified and associated costs will be included in the alternatives evaluation.

Procedures for planning and implementing off-site response actions under CERCLA are specified in 40 CFR 300.440, known as "The Off-Site Rule". The regulation applies to off-site treatment and disposal of "hazardous wastes" that cannot be managed on-site. The Off-Site Rule specifies that USEPA would determine the acceptability of any off-site facility that has been selected for treatment, storage, or disposal of CERCLA wastes. The proposed receiving facility must be operating in compliance with all applicable federal, state, and local regulations, and there must be no relevant violations affecting the receiving unit. Also, there must be no releases from the receiving unit, and contamination from prior releases at the receiving unit as well as any releases from other units located within the receiving facility must be addressed as appropriate. USEPA verifies the acceptability of off-site treatment, storage, and disposal facilities ("TSDFs") on a frequent basis. Consequently, before any off-site shipment occurs, a verification of current acceptability ("VCA") must be obtained from USEPA certifying that the proposed receiving facility is operating in compliance with the requirements of CERCLA Section 121(d)(3), 42 USC § 9621(d)(3), and 40 CFR 300.440. Site wastes could only be sent to an off-site facility that complies with the requirements of the statutory provision and regulations cited in the preceding sentence. The provisions of The Off-Site Rule will be considered in the analysis of the potential off-site commercial disposal alternatives.

Transportation and off-site disposal cost information will be collected for inclusion in the cost estimates for each of the "complete rad removal" alternatives. It is anticipated that this information would include rates for soil, soil/garbage (if applicable), and debris disposal; any disposal fees and taxes; and estimates for truck and rail transportation. Waste acceptance information will obtained from potential disposal facilities.

There is a potential that liquid wastes, RCRA hazardous wastes and/or ACM may be encountered during excavation of solid waste materials contained in Areas 1 and 2. As part of the evaluation of potential off-site disposal facilities, waste acceptance criteria or constraints related to acceptance of these types of wastes will be identified. Additional costs that may be incurred related to identification, characterization, profiling and disposal of these types of wastes (i.e., radiological wastes containing liquids or mixed with hazardous waste or ACM) will be identified and considered in the NCP evaluation (see Section 3 below) of the off-site disposal alternative. In the event that no off-site disposal facilities are identified that can accept any or all of these types of mixed wastes (i.e., radiological wastes containing liquids or mixed with hazardous waste or ACM), this condition will be identified as a potential factor affecting the implementability of the off-site disposal alternative.

Off-site disposal of radiologically-impacted materials via trucks would potentially have a significant effect to the local traffic patterns, roads, and highway infrastructure in and around the St. Louis metropolitan area. The potential impacts to traffic and highway structure that may arise if an off-site disposal alternative were to be implemented will be evaluated in the SFS. A qualified, local traffic engineering firm, familiar with the St. Louis metropolitan area, will be retained to evaluate and quantify the potential impacts, including consideration of applicable local and State regulations and permitting restrictions, if any, that could affect the traffic flow patterns associated with the project.

2.8 On-Site Engineered Disposal Cell

One of the alternatives required by EPA in the January 11, 2010 Statement of Work is to evaluate the alternative of on-site disposal in an engineered cell of the radiologically-impacted materials if a suitable location outside the geomorphic flood plain can be identified. For this alternative, multiple steps, described below, will be required in order to properly complete this alternative evaluation. These steps will be identified and evaluated in detail in the SFS.

2.8.1 Cell Siting/Location

The Project Team will review applicable local, State and federal regulatory-specified criteria and regulations, evaluate existing aerial photography/imagery/mapping, conduct site reconnaissance, use site knowledge, and/or interview site personnel to aid in locating an on-site engineered disposal cell. The entire property owned by Rock Road Industries, Inc. is approximately 216 acres. OU-1 and OU-2 are both included in this area. Of the 216 acres, approximately 52 acres are associated with the formerly active sanitary landfill. The remainder of the site is generally divided into the two OU-1 areas, the closed demolition landfill, inactive sanitary landfill borrow area, former leachate pond, and the area currently used/leased predominantly by the Bridgeton Transfer Station ("TS"), Red Bird Concrete, and Simpson Asphalt (Figure 2).

There are three on-site areas which could possibly serve as the site for a new on-site engineered disposal cell. These included the following:

- Area in the northern portion of Radiological Area 2 that could be cleared during the soil excavation effort, and potentially used for construction of a new on-site engineered disposal cell;

- Existing OU-2 soil stockpile area; and

- Existing concrete/asphalt batch plant area and/or existing transfer station area.

The locations of these three areas are provided on Figure 2.

Of these three areas, only the existing OU-2 soil stockpile area appears to be located outside of the geomorphic floodplain (Figure 3). Therefore, only this area will be evaluated in the SFS as a potential site for a new disposal cell.

The existing OU-2 soil stockpile area is located to the south of OU-1 Area 1 and the formerly active sanitary landfill. It currently is an open field containing natural in-situ soil and previously stockpiled soil. The soil material is the borrow source for the formerly active sanitary landfill. It is also envisioned for potential use as cover soils for OU-2. The location of this area will be evaluated for proximity to receptors, whether the location would violate any MDNR landfill buffer zone or geologic constraints, and whether an on-site engineered cell for containment of radiologically-impacted materials would require a new permit from MDNR.

The soil stockpile area contains stockpiled soil for use in post-closure care of the formerly active sanitary landfill and as potential cover soils for remedial actions for OU-2. Use of this area would require the excavation and relocation of the stockpile soil prior to construction of a new on-site engineered disposal cell. Alternatively, implementation of the OU-1 remedy could be delayed until after completion of the OU-2 remedy so that a portion of the stockpiled soils could be removed prior to possible use of this area for construction of a new on-site cell. Other constraints are associated with this area including use of this area would entail construction and operation of a new on-site engineered disposal cell in close proximity to other property owners and businesses located along St. Charles Rock Road. This location is also the portion of the site property located closest to the residential properties in the Spanish Village area. As shown on Figure 3, of the three sites that could possibly serve as a site for a new on-site engineered disposal cell, the soil stockpile area is the only site that is not located within the Missouri River geomorphic floodplain.

2.8.2 Floodplain Evaluation

As stated in the USEPA January 11, 2010 Statement of Work, if feasible, the on-site engineered disposal cell should be located outside of the historical Missouri River geomorphic floodplain. The Project Team has evaluated existing publicly-available literature, mapping, imagery, as well as project-related documents. As stated in Section 2.8.1, the soil stockpile area represents the only area located outside of the Missouri River geomorphic floodplain. For this reason, the SFS will assume this location as the only practical location for an on-site engineered disposal cell.

The potential effects of an Earth City levee-breach and ensuing flood event on both the existing wastes in Areas 1 and 2, over which a new cover will be installed pursuant to the ROD-selected remedy, or a new on-site engineered disposal cell that may be considered for the "complete rad removal" alternative will be evaluated in the SFS. This evaluation will include identification of the expected elevation of the flood waters at the site in the event that the Earth City levee is breached during a 500-year flood event. Estimates will also be made of the anticipated velocity of water flow near the site and the potential for the flood waters to erode or otherwise impact the integrity of the waste containment structures and waste materials on site.

2.8.3 On-Site Engineered Disposal Cell Conceptual Design

As stated above, the soil stockpile area is the location that would be evaluated for placement of an on-site engineered disposal cell. In support of the SFS, a conceptual design of an on-site engineered disposal cell will be prepared by the Project Team in accordance with applicable federal, State, and local regulations.

2.8.3.1 Regulatory Requirements for On-Site Engineered Disposal Cell Design

Both the MDNR solid waste regulations and UMTRCA requirements would need to be considered during conceptual design of an on-site engineered cell disposal alternative. Site selection and suitability requirements established under both of these regulations will be reviewed and evaluated relative to the potential location (existing OU-2 soil borrow area) for construction of an on-site disposal cell. As the new cell would be constructed on-site, no permits would be required; however, in accordance with the NCP, the substantive requirements of the siting and permitting portions of these regulations will be considered during the evaluation of the feasibility of building an new on-site disposal cell.

The conceptual design for a new on-site engineered disposal cell will primarily be based the UMTRCA requirements (40 CFR 192.02). The design will also consider the requirements of the MDNR Solid Waste Regulations (10 CSR 80-3.010) to the extent that such additional requirements do not compromise or diminish the performance of the relevant and appropriate requirements by the UMTRCA regulations. A conceptual cross section of the on-site engineered disposal cell liner and final cover configuration will be prepared for the SFS. In addition, the size of the cell footprint necessary to contain the volume of radiologically-impacted materials will be evaluated.

As indicated previously, there is a potential that that liquid wastes, RCRA hazardous wastes and/or ACM may be encountered during excavation of solid waste materials contained in Areas 1 and 2. As part of the evaluation of the design for an on-site engineered disposal cell, regulatory requirements and restrictions related to siting and design of a waste disposal cell for these types of wastes will be identified. In the event that these types of wastes are encountered during excavation, design of the new on-site cell may need to be modified to incorporate any additional requirements or design components. Impacts to the project schedule and additional costs that may be incurred to meet such requirements will be identified and considered as part of the NCP evaluation (see Section 3 below) of the on-site disposal alternative. In the event that regulatory requirements prevent or limit disposal of these types of wastes on-site, this condition will be identified as a potential factor affecting the implementability of the off-site disposal alternative.

2.8.3.2 Hydrogeologic Setting of On-Site Engineered Disposal Cell

In accordance with the MDNR Solid Waste Management Program (SWMP) regulation 10 CSR 80.2.015, the geologic and hydrologic (hydrogeologic) setting of the on-site engineered disposal cell will be described in sufficient detail to allow a thorough evaluation of such. The end result would be compliance with the above regulations and, in the process, confirming the suitability of the soil stockpile site's geologic and hydrologic setting of the existing OU-2 soil stockpile site and the use of the site for the on-site engineered disposal cell.

2.8.3.3 Cover System - On-Site Engineered Disposal Cell

In accordance with the MDNR SWMP regulation 10 CSR 80-3.010 (17)(C)(4)(B) and UMTRCA, the envisioned final cover for the on-site engineered disposal cell would consist of the following layers (from top to bottom):

- 2-ft vegetative soil
- Drainage Layer
- Synthetic liner
- 1-ft (subject to radon emanation evaluation over the projected 1,000 years of risk calculations for the cell) compacted clay liner (10^{-5} cm/sec) The final thickness would be determined by the method described in "Radon Attenuation Handbook for Uranium-Mill Tailing Cover Design, NUREG/CR-

3533" in conjunction with the multi-pathway environmental transport model RESRAD – Offsite.

- 2-foot rock/concrete rubble bio-intrusion layer

The properties and requirements for each of these layers are described briefly below.

<u>2-ft vegetative soil layer</u>

This soil layer must be capable of sustaining vegetative growth. It is typically a soil with sufficient organic content and permeability allowing such growth. Soil types such as OH and OL (per the USCS classification system), are often found suitable for this end use. The USDA soil taxonomy system will also be referenced and used to aid in identifying suitable vegetative layer soils. The properties of this layer will be identified and potential sources, testing requirements, and construction techniques will be discussed in the SFS.

<u>Synthetic liner</u>

This liner is a flexible geomembrane material that meets the requirements of 10 CSR 80-3.010 (10)(B)(1)(G). The properties of this liner would be identified and potential vendors, testing requirements, and installation techniques will be discussed in the SFS.

<u>2-ft compacted clay liner</u>

This layer would likely consist of a clay soil material, typically a CL or CH soil-type (per the USCS classification system), and would need to produce a compacted permeability of 1×10^{-7} cm/sec or less. Although the thickness of this layer would be a minimum of two-feet as required by the solid waste regulations, the thickness of this layer could be increased if necessary to provide sufficient radon attenuation to reduce the predicted radon emanation rates below those specified by UMTRCA and to take into account increased radon generation resulting from in-growth of radium over the design life of the cell. The properties of this layer will be identified and potential sources, testing requirements, and construction techniques will be discussed in the SFS.

<u>2-foot rock/concrete rubble bio-intrusion layer</u>

As part of the "complete rad removal" alternative, this layer is included to address UMTRCA requirements pertaining to the long term disposal and landfilling of the waste materials containing radionuclides above the cleanup levels. It would be used to prevent bio-intrusion as well as limit potential erosion of the underlying waste mass. The properties of this layer will be identified and potential sources, testing requirements, and construction techniques will be discussed in the SFS.

2.8.3.4 Liner System - On-Site Engineered Disposal Cell

In accordance with the MDNR SWMP regulation 10 CSR 80-3.010 (9 and 10), the envisioned liner for the on-site engineered disposal cell would consist of the following layers (from top to bottom):

- Leachate collection system
- Synthetic liner
- 2-ft compacted clay liner (10^{-7} cm/sec)

<u>Leachate collection system</u>

Leachate generated from the relocated materials would be collected via the leachate collection system. The properties of this layer will be identified and potential sources, testing requirements, and construction techniques will be discussed in the SFS. This system would be designed to maintain a leachate liquid layer head of one (1) foot or less over the underlying layers (described below in more detail). This would require installation of riser pipes that extend from the leachate collection system, up the side-slope of the cell to the ground surface. Submersible pumps would need to be installed in the riser pipes to remove any leachate that may accumulate such that the leachate head over the liner would be maintained at one foot or less. Options for treatment and disposal of leachate will be evaluated as part of the SFS. The leachate collection system would include a drainage layer that would be designed to protect a synthetic liner to the extent that such a liner is included in the conceptual design of a new engineered waste disposal cell.

<u>Synthetic liner</u>

This liner would consist of a flexible geomembrane material that meets the requirements of 10 CSR 80-3.010 (10)(B)(1). The properties of this layer will be identified and potential sources, testing requirements, and construction techniques will be discussed in the SFS.

<u>2-ft compacted clay liner</u>

This layer would likely consist of a clay soil material, typically a CL or CH soil-type (per the USCS classification system), and would need to produce a compacted permeability 1 x 10^{-7} cm/sec or less. The properties of this layer will be identified and potential sources, testing requirements, and construction techniques will be discussed in the SFS.

2.8.4 On-Site Engineered Disposal Cell Construction and Operation

Construction of the on-site engineered disposal cell would involve the components as described above in Section 2.8.2.2, and 2.8.2.3. The methods of construction envisioned for the on-site engineered disposal cell will be described in detail within the SFS. This will include describing the borrow source(s) of on-site soil/raw materials, identifying potential third-party sources, means to move and handle the materials, as well as the proper placement and survey of the various project-required materials. The operation of the cell (after completion of construction) will also be discussed in detail. Since the on-site engineered disposal cell would be located in the non-geomorphic floodplain areas, the only option with respect to tying-into existing cells on the Site would be a discrete non-contiguous cell from OU-1 and OU-2. Therefore, no transition liner considerations are required.

2.8.5 Construction QA/QC - On-Site Engineered Disposal Cell

The QA/QC for construction of an on-site engineered disposal cell would meet the requirements of 10 CSR 80-3.010 (6). The methods of QA/QC that would pertain to the construction of the liner and final cover for the on-site engineered disposal cell will be described in the SFS. During construction of any on-site engineered disposal cell, a project-specific QA/QC plan, developed during remedial design, would be followed.

2.8.6 On-Site Engineered Disposal Cell Closure

Closure of the on-site engineered disposal cell described in the SFS would comply with the requirements referenced in Section 2.8.2.1.

2.8.7 Post-Closure Maintenance and Monitoring - On-Site Engineered Disposal Cell

Maintenance and monitoring costs will be estimated and used in preparing the operation and maintenance cost estimates in the SFS for the on-site engineered disposal cell alternative. Since the on-site engineered disposal cell would be located in the non-geomorphic floodplain areas, the only option with respect to tying-into existing cells on the Site would be a discrete non-contiguous cell from OU-1 and OU-2. Therefore, no transition liner considerations would be required. Groundwater and other environmental monitoring necessary to verify long-term containment or otherwise required by ARARs will be identified and a preliminary scope for such monitoring will be developed.

2.9 Closure of Remaining OU-1 Solid Waste Areas Conceptual Design

If waste materials containing radionuclides above the cleanup levels are removed from Areas 1 and 2, only non radiologically-impacted waste materials would remain in these areas. The presence of these wastes would require a final RCRA Subtitle D cap to be constructed over these areas. As the cleanup criteria would have been met, it is assumed that the cover would comply with 10 CSR 80-3.010 (17)(C)(4)(A).

For the ROD-selected remedy, and in the event that the SFS determines that it is not feasible to remove all of the radiologically-impacted materials, a RCRA Subtitle D cap including additional components such as the biointrusion/marker layer to address the requirements of UMTRCA would be required in areas that may still contain radiologically-impacted materials. The needed final cover configuration for the closure of the remaining OU-1 solid waste areas will be investigated in the SFS. Regardless of which type of cover is determined to be necessary, the design of the final cover for Areas 1 and 2 will also address the transition into the OU-2 solid waste final cover system.

2.9.1 Final Grading Plan - Remaining OU-1 Solid Waste Areas

In order to safely access and remove waste materials containing radionuclides above the cleanup levels described earlier in this Work Plan, it may be necessary to temporarily handle (excavate and stockpile) solid wastes that currently lie on top of the radiologically-impacted materials (overburden wastes). This overburden waste material would be returned to the excavated areas after removal of all of the radiologically-impacted materials had been verified. These wastes would then be graded and new Subtitle D landfill cover would be installed over the remaining solid wastes. A conceptual design-level reclamation plan will be developed in the SFS that would allow the proper long-term placement of the overburden waste material. It is envisioned that this material would be suitable for backfilling into the excavations of Areas 1 and/or 2, which would aid in the proper regrading of the two excavations and promote positive drainage from the two areas. It is assumed that the design criteria specified for the ROD-selected remedy (e.g., minimum 2% slopes) would also apply to design of the final grades for any waste materials that would remain after excavation of the radiologically-impacted materials. AutoCAD Civil 3D 2010 software will be used during preparation of the SFS to develop conceptual design-level drawings.

Additional conceptual design-level drawings will then be developed and presented in the SFS for the closure of the two areas, with the goals of restoring positive grades off of the areas and establishing sufficient drainage patterns and outfalls/controls.

2.9.2 Capping Plan - Remaining OU-1 Solid Waste Areas

As discussed above in Section 2.8, a conceptual design for a final cover/cap that would cover both OU-1 Areas 1 and 2 will be included in the SFS. The final cover/cap would serve to effectively cover the remaining solid wastes in both areas. Per MDNR regulations for existing solid waste landfills without liners (per 10 CSR 80-3.010 (17)(C)(4)(A)), the cap envisioned for Areas 1 and 2 would consist of the following layers (from top to bottom):

- 1-ft vegetative soil; and

- 2-ft compacted clay layer (10^{-5} cm/sec).

The uppermost, one (1) foot soil layer must be capable of sustaining vegetative growth. It is typically comprised of a soil with sufficient organic content and permeability allowing such growth. Soil types such as OH and OL (per the USCS classification system) are often found suitable for this end use.

The two (2) foot compacted clay layer would likely consist of a clay soil material, typically a CL or CH soil-type (per the USCS classification system) with characteristics such that a compacted permeability 1 x 10^{-5} cm/sec or less can be achieved during construction.

The properties of these cover materials will be identified and potential sources, testing requirements, and construction techniques will be discussed in the SFS Report.

2.9.3 Drainage Plan - Remaining OU-1 Solid Waste Areas

Conceptual design for regrading of the final caps for Areas 1 and 2 so positive drainage/grades would be established was described previously in Section 2.9.1. Conceptual design-level AutoCAD drawings presenting the drainage plan to promote long term erosion protection and detailing terraces, letdowns, and related outfalls/controls will be developed during preparation of the SFS.

2.10 Post-Closure Maintenance and Monitoring - Remaining OU-1 Solid Waste Areas

Groundwater and other environmental monitoring necessary to verify long-term containment or otherwise required by ARARs will be identified and a preliminary scope for such monitoring will be developed. An estimate of the duration for post-closure maintenance and monitoring for the remaining solid waste areas will be quantified in the SFS. The typical time period for post-closure for a Municipal Solid Waste landfill is 30 years. Maintenance and monitoring costs will be estimated and used in preparing the operation and maintenance cost estimates included in the SFS for closure of the remaining OU-1 solid waste areas. This monitoring program will be compared to the monitoring program envisioned under the ROD-selected remedy. Any changes to the long-term monitoring program that may result if one of the “complete rad removal” alternatives were implemented will be identified. For example if one of the “complete rad removal” alternatives were implemented, this could reduce the need for long-term monitoring of radionuclides in groundwater or radon gas.

2.11 Assessment of Potential Risks

In the SFS, long-term and short-term risks will be evaluated for the selected remedy in the OU-1 ROD, as well as for the on-site disposal in an engineered cell and off-site commercial disposal "complete rad removal" alternatives. Short-term risks refer to potential risks that may occur during the period of remedy construction and implementation. Long-term risks refer to potential risks that may arise during the post-closure or operations and maintenance period after remedy construction and implementation has been completed.

A conceptual model of each alternative will be constructed. This model will provide the basis for the risks and receptors featured in the assessment of potential short-term and long-term risks associated with each remedial alternative. Where appropriate and/or where site-specific data are not available, the risk assessment will be performed using methods and exposure factors set for in EPA's Risk Assessment Guidance (EPA, 1989, 1991c, 1991d, 2001b, 2004, and 2009b).

The risk assessment will include evaluation of risks associated with occurrences of radionuclides and non-radiological constituents to the extent that such chemical constituents are anticipated to be encountered during remedy implementation. Both carcinogenic and non-carcinogenic risks will be evaluated. As no toxicity information is currently available from EPA for natural uranium, non-carcinogenic risks will be evaluated using the toxicity data for soluble uranium salts although this form of uranium is not expected to be found at the site. This is the same procedure that was previously used to develop a chemical reference dose to evaluate the chemical toxicity of uranium in the BRA. Risk posed by off-site exposure to radon gas will also be evaluated, including the effects of migration of thorium and radium parent isotopes in groundwater to the extent that potential migration of these radionuclides is determined to be a significant pathway.

For the purposes of this Work Plan, Table 1 lists the sources of the risks to be investigated during this evaluation. Risks may be added or removed as the evaluation progresses. To the extent possible, information on the radionuclides and likely exposure pathways and receptors will be drawn from the existing OU-1 RI, Baseline Risk Assessment, and FS documents. Any updates to toxicity or exposure factors that may have occurred since the Baseline Risk Assessment (Auxier & Associates, 2000) was completed, will be identified and considered in the risk assessment conducted during the SFS.

The risk assessment team intends to use RESRAD-Offsite with the latest slope factors to evaluate radiological risks from the radiologically-impacted materials under each of the different remedial alternatives. RESRAD-Offsite is an industry-standard computer program developed by the Department of Energy Argonne National Laboratory (ANL) that evaluates doses and radiological risks from multiple transport and exposure pathways. Information about RESRAD Offsite and the RESRAD family of computer codes can be obtained from the ANL website (http://web.ead.anl.gov/resrad/home2/index.cfm).

RESRAD Offsite uses the equations presented in HEAST to calculate intakes and risks. Available site-specific data will be used to quantify the physical dimensions of the waste, select the potential receptors, and identify the exposure pathways featured in the modeled simulations. When site-specific data is not available, EPA default parameters will be used to fill the data gaps in the exposure assessment. RESRAD-Offsite default parameters will be used to describe the transport of radionuclides, including radon, through the environment unless well-documented site-specific information is available.

The original risk assessment screened out risks from groundwater, primarily due to the extremely low solubility typical for thorium and radium compounds. A review of the decision to exclude groundwater pathways will be made in the SFS. If the review finds a reasonable expectation of a complete groundwater exposure pathway, requests will be made for the resources and time necessary to characterize subsurface geochemical conditions and model the flow of contaminants from the radiologically impacted material to off-site locations. If groundwater modeling is necessary, appropriate stand-alone groundwater models such as HYDRUS, MODFLOW or their equivalent will be used to evaluate the fate and transport of contaminants of concern down gradient from the Site.

The risk assessment team will provide a supplementary set of calculations using EPA's soil PRG calculator for risks associated with air and soil exposure pathways to critical receptors. These calculations will be presented in the uncertainty assessment section of the SFS's risk assessment to allow a side-by-side comparison of risk values for individual pathways calculated by both the multi-pathway RESRAD-Offsite simulations and the EPA's risk calculator.

To quantify the short-term radiological risks, information related to the actual work process, the number of hours of work, the number of workers, and data quantifying local environmental factors such as meteorological data (likely obtained from Lambert Airport) are necessary. Once this information is available, it will be used to select the representative receptor(s) considered in this risk assessment. This selection process first identifies the group of generic receptor types typically associated with construction tasks of the type anticipated to be implemented for the "complete rad removal" alternatives. After this initial pool of generic receptors is established, a combination of criteria will be used to focus the assessment on those receptor scenarios that combine reasonable work assumptions with the greatest potential for exposure during the construction activities. These criteria will consider the use of safety procedures and the potential for a receptor to be exposed to materials or radiation during the construction activities. Exposure times and worker proximity to the radiologically-impacted materials will be estimated from the analysis of the work process.

Microshield® will be used to calculate exposure rates from radiologically-impacted materials to the selected short-term receptors. Microshield® is a comprehensive photon/gamma ray shielding and dose assessment program published by Grove Software, Inc. (http://www.radiationsoftware.com/mshield.html) that is widely used for designing shields, estimating source strength from radiation measurements, minimizing exposure to people, and teaching shielding principles. These calculated exposure rates will be used in conjunction with the exposure times, distances and shielding information from the work process evaluation to estimate maximum credible doses that that may be received by the receptors. These doses will be compared to dose-based exposure limits or radiation standards that are determined to be ARARs (EPA, 1999b). The calculated doses will also be converted to risks using the dose to risk conversion factor of 0.0575 Gy^{-1} in Table 7.3 of Federal Guidance Document 13 (EPA, 1999a) when necessary. Radon emanation will be estimated from soil concentrations of radium-226 using the method described in NUREG/CR-3533 (NRC, 1984).

The construction risks, information related to estimated work process, the number of hours of work by each equipment type, and the number of workers involved will be quantified. Each of the activities performed by workers during construction, maintenance, and monitoring of the various components of the selected remedy in the OU-1 ROD, as well as for the on-site disposal in an engineered cell and off-site commercial disposal "complete rad removal" alternatives, would have certain hazards associated with them. The risks associated with these hazards are quantified in Department of Labor publications and insurance statistics. These risks will be used in conjunction with the labor estimates to calculate the risk of fatality and injury for each activity through the life of each of the remedy alternatives evaluated in the SFS.

Toxic chemical risks would also be evaluated, drawing information from the existing OU-1 RI, Baseline Risk Assessment and FS documents. Any updates to toxicity factors or other factors that may affect risks since the date of the Baseline Risk Assessment will be incorporated.

A post-remediation dose/risk assessment could be prepared, if necessary or required by EPA, after any remedy completion using techniques and data that are consistent with the risk assessments performed for each remedial alternative. The latest data would be used whenever possible. For example, risks from radon and radon daughters would be based on actual measured radon-fluxes in the post-remediation risk assessment. This final risk assessment would be submitted after the remedial action construction activities are complete

2.12 Health and Safety Requirements

A conceptual comprehensive site radiological environmental monitoring program will be described and costs will be estimated for each of the "complete rad removal" alternatives developed as part of the SFS. The program would focus on three objectives:

1. Monitor doses at the fence line to determine that the public is protected from releases, if any, during construction and operation of the remedy;

2. Assure that other on-site (non-remediation) workers present in other portions of the landfill site are not exposed to any increased levels of radiation; and

3. Insure that on-site remediation workers are not exposed to unnecessary radiation exposure.

Radiological conditions in adjacent, publicly accessible areas would be monitored by establishing a series of perimeter monitoring locations along the fence line. The conceptual monitoring program would include programmatic details of these monitoring stations such as selection of monitoring locations, the equipment to be housed in each station, and the sampling and reporting frequencies. For example, it is anticipated that perimeter air sampling stations for airborne radioactive particulates and radon would be located at down-wind locations along the fence line. These stations may also house environmental radiation dosimeters. Other potentially harmful particulates may be included in the sampling program.

Worker safety would be a priority during implementation and maintenance/monitoring of the selected remedy for OU-1. Most of the requirements below would apply to work associated with the "complete rad removal" alternatives (i.e., excavating the radiologically-impacted material, loading it into transport vehicles, and placing it in an on-site engineered disposal cell). Differences in potential exposures and risks to workers associated with the various alternatives will be identified and considered in the NCP evaluation of the alternatives (see additional discussion in Section 3). For example, it is anticipated that less material handling and placement and consequently less short-term exposure to site workers would be associated with an off-site disposal option compared to an on-site disposal option. Similarly, it is anticipated that a lesser level of exposure would occur and therefore lower level of personal protective equipment would be required for the landfill regrading option included in the ROD-selected remedy compared to that required for either of the "complete rad removal" alternatives.

As indicated previously, there is a potential that liquid wastes, RCRA hazardous wastes and/or ACM may be encountered during excavation of solid waste materials contained in Areas 1 and 2. Procedures for identifying the presence of such wastes such as provisions for pre-excavation testing and evaluation, ongoing visual inspection of the wastes that are encountered, and real-time monitoring will be identified and discussed as part of the health and safety requirements. As part of the evaluation of the health and safety requirements for the waste excavation and handling activities, additional requirements that may be necessary in the event that these types of waste materials are encountered will be identified. Impacts to the anticipated waste excavation, handling and disposal procedures, changes to the overall project schedule and additional costs that may be incurred to address worker health and safety and regulatory requirements in the event that such mixed wastes are encountered will be identified and considered as part of the NCP evaluation (see Section 3 below) of the various alternatives.

2.12.1 Worker Training and Monitoring

All workers would be trained for work in a radiological work site. Training would be conducted by qualified trainers. Workers would need to be able to ascertain their training qualification before being allowed to work in a radiological-controlled area. Workers would be qualified to wear respiratory protection.

All site workers would be required to participate in a dosimetry monitoring program. As part of the SFS, the scope and costs for personnel dosimetry monitoring will be estimated including per person monthly operations requirements costs as well as costs to set up a dosimetry monitoring program. Some workers in close-by locations could potentially be affected by the on-site activities. This will be evaluated in the SFS and, if necessary, these workers would be integrated into the dosimetry monitoring program. Some training may be required for those personnel. The training may include discussion of the overall activity and the protective actions put in place for the remediation workers and the potential for any risk to the existing landfill site workers. As a minimum, air sampling stations would be positioned to monitor off site locations and to monitor potential airborne emission in the areas where local workers frequent.

Air sampling stations would be established in the work site to monitor airborne particulates and radon. Breathing zone samplers would be assigned to selected workers to evaluate potential intake of airborne particulates, radon, and possibly toxic chemicals.

All site workers would be required to participate in a medical monitoring program. Estimated scope and costs for establishment and maintenance of a medical monitoring program will also be developed as part of the SFS. Medical monitoring would be expected to include the following:

- Respiratory qualification physical;
- Baseline bioassay screening; and
- Potential monthly fecal analysis for thorium. (Note that while fecal analysis is not the norm for bioassay, it is an appropriate method for evaluation of potential thorium exposures. An undiscovered intake would lead to a potential radiation overexposure. The decision to implement fecal analysis would be based on the overall individual protective equipment policy that would be implemented during implementation of any remedial action.)

Area and personnel air sampling programs would be established that would be capable of detecting both radiological and non-radiological chemical hazards. Frequent real time survey for radiological and non-radiological hazards would be conducted. As a minimum, all individuals would be surveyed as they leave a radiological-controlled area.

2.12.2 Personal Protective Equipment and Decontamination

Personnel in an area where radiologically-impacted materials are known or suspected to exist would wear anti-contamination clothing (Tyvek® disposable outer garments or equivalent). This would consist of protective outer garments, head cover, shoe covers and gloves. Based on results of air sampling performed in the breathing zone of the various work areas (i.e., excavation area, stockpile and materials handling areas, waste segregation equipment, etc.), it may be necessary to use respiratory protection.

The goal of any decontamination effort would be to have no detectable contamination on personnel or equipment that leave the radiologically-controlled area. A decontamination station would be established at the radiation controlled exit point. Personnel would be surveyed when leaving a radiologically-controlled area after they discard their anti-contamination clothing. Unless site monitoring indicates the presence of chemical wastes or ACM, it would be reasonable to assume that if personnel are not contaminated by radiological contaminants, they would not be contaminated by toxic chemicals. If contamination is found, the individual would be decontaminated before being allowed to proceed. Any such incidents would be investigated to limit other such occurrences.

Any equipment leaving the radiologically-controlled area would be cleaned and surveyed. Hand tools and other smaller items of equipment may be brought through the personal exit point after they are cleaned. The decision to have a large equipment decontamination station would be dependent on the conditions at the site. It may be easier to establish such a station on an as-needed basis. All equipment and vehicles that enter the site that have a potential to traverse an area where radiologically-impacted materials may be present (a controlled area) would be surveyed and decontaminated before leaving the controlled area.

2.12.3 Health and Safety Staffing and Equipment Requirements

A team of professional health and safety personnel would be required while work progresses at the site. These personnel would include, but would not be limited to, industrial hygienists, safety personnel, and health physicists.

A qualified radiation safety professional, such as a Certified Health Physicist, would be required to lead the radiation safety team. Radiation control technicians would be required in sufficient number to perform the required tasks of monitoring, survey, and sample collection. If an on-site laboratory would be used, at least one qualified laboratory technician would be required. Unless the radiation safety specialist is qualified in industrial hygiene and industrial safety (not very likely) qualified personnel in these areas would be required. Construction safety personnel and possibly industrial hygiene personnel (unless others are cross-trained to performed industrial hygiene monitoring) may also be required in addition to health physicist personnel. The total personnel estimated to be required to implement, monitor and manage health and safety requirements will be estimated during preparation of the SFS.

Radiation survey and laboratory equipment requirements that would be necessary to support the "complete rad removal" alternatives will also be developed in the SFS. Equipment requirements would be dependent on the number of personnel required during implementation of any remedial action. Until the number and type of personnel are identified for each alternative evaluated during the SFS, the following tentative equipment list cannot be finalized but provides a general listing of the radiation survey and other sampling equipment that could be included:

- Rad Survey Instruments:
  - 6 α/β survey instruments;
  - 2 dose rate instruments (MicroR);
  - 4 scintillation survey instruments;
  - 3 pancake Geiger Mueller (GM) survey instruments;
  - 1 or more GM survey instruments;
  - Radon detection monitor(s);
  - Radon daughter detectors; and
  - Radiation Survey Equipment for Final Survey (rent as needed).

- Toxic Gas Monitors (e.g., ammonia, carbon monoxide, chlorine gas, hydrogen sulfide, sulphur dioxide, methane, and lower explosive limit)
- Organic vapor analyzers (photoionization detectors and/or flame ionization detectors)

- Air Sampling Equipment:
  - Air Pumps and filter holders for fixed position samplers in the work site(s);
  - Air Pumps and filter holders for fixed position samplers for perimeter monitoring with enclosures as needed.;
  - Breathing zone air samplers; and
  - Air sample calibrator(s).

- Soil sampling equipment:

The estimated requirements and costs for establishing an on-site laboratory that would provide real-time results for use in controlling excavation and providing feedback on radiological conditions at the site will also be developed in the SFS and may include the following:

- Building or office type trailer with power and air-conditioning
- Multi-channel analyzer (MCA) with analytical software
- Low background alpha/beta counter

- Source Standard for MCA
- Standard source for the low background counter
- Drying oven
- Scales
- Computer and printer

2.12.4 Respirator, PPE and Consumable Requirements

The nature and anticipated cost of the respiratory protection equipment, personal protective equipment (PPE) and consumable items that would be necessary to support a health and safety monitoring program will be developed as part of the SFS. It is anticipated that each person working in a radiologically-controlled area would require a respirator and that all personnel would use Tyvek suits and/or other anti-contamination clothing that would be changed-out and discarded several times daily. Each person would be required to have waterproof steel-toed safety boots and a hard hat. Each person would also be provided with safety glasses and work gloves that would likely need to be replaced at some frequency due to loss, breakage, or wear.

Several hundred sample containers would be needed for collection and analysis of health and safety related samples. Smears, placards and other warning signs and yellow radioactive waste bags would also be required. Materials estimated to be necessary for personnel decontamination such as wash basins, brushes, soaps, and paper towels, among other items will be identified in the SFS and the costs for such materials will be estimated based on the anticipated project duration. Similarly, miscellaneous office supplies that would be necessary to support operation of the on-site laboratory will also be estimated in the SFS along with additional and spare equipment and supplies necessary to operate and maintain the analytical laboratory and field monitoring equipment.

2.12.5 Reduction of Worker Efficiency

For purposes of preparing cost estimates for the SFS, it is anticipated that dressing and undressing from the personnel protective equipment and performing personnel decontamination for breaks and at the end of each shift would require approximately one hour per day. Wearing of anti-contamination clothing would necessitate longer rest periods during periods of hot weather. Longer rest periods may account for an extra one/half to one hour according to the magnitude of the temperature. If respiratory protection would be required, additional rest periods would be required if the weather is hot. The protective equipment would likely reduce productive time by at least one hour on cool days and two hours on hot days.

2.13 Institutional Controls/Site Re-use Evaluation

Evaluation in the SFS of the "complete rad removal" alternatives will include identification of additional institutional controls that may be necessary to insure the protectiveness and long-term effectiveness of the alternatives. For example, construction of an on-site engineered disposal cell may require implementation of additional institutional controls or modification and/or expansion of some or all of the existing institutional controls or the institutional controls currently anticipated to be implemented as part of the remedy selected in the ROD for OU-1. Evaluation of the "complete rad removal" alternatives will also include identification of institutional controls, if any, that are currently anticipated for Areas 1 and 2 but that may not be necessary if "complete rad removal" were to be implemented.

Evaluation of the "complete rad removal" alternatives will also include identification of potential site re-use alternatives that may be allowable if a "complete rad removal" alternative were implemented for Areas 1 and 2. Specifically, site owner Rock Road Industries, Inc. will provide information on land uses that it considers acceptable and that are typically implemented at closed landfill sites. EPA guidance on re-use of landfill sites will also be consulted (EPA, 2002b and EPA, 2001a). Additional land uses that may be appropriate for Areas 1 and 2, assuming that "complete rad removal" were implemented, and that would not otherwise interfere with the protectiveness and effectiveness of the various components of the "complete rad removal" alternatives, will be identified. To the extent that any additional allowable land uses are identified, the potential value, if any, of such site re-use options will be identified. If additional site re-use options are identified and if such options may allow for site income that would not otherwise be achieved if the remedy selected in the ROD for OU-1 were implemented, the value of such options will be identified as potential positive income and considered as a potential offset to the costs of implementation of the "complete rad removal" alternatives.

2.14 Construction Project Schedules

Project schedules including critical path schedules will be prepared for the construction phase activities and included in the SFS. Project schedules will be prepared for both the excavation and off-site commercial disposal alternative and the excavation and on-site disposal in an engineered disposal cell alternative. The SFS will also include a critical path schedule for the ROD-selected remedy for comparative purposes. These schedules will reflect both optimal construction schedules as well as budget-constrained schedules (as described further in Section 2.15). The critical path schedules will display the various tasks and subtasks that would be necessary to design, construct, operate and maintain the various components of the alternatives. Along with the estimated durations necessary to complete each of these tasks and subtasks, these schedules will also display the relationships among the various tasks and subtasks that together would act to constrain the overall project schedules. The schedules and critical path diagrams will be prepared using Microsoft Project or equivalent software. The project schedules will be summarized in narrative text of the SFS report and the project schedule diagrams will be included in an appendix to the SFS report.

2.15 Estimation of Probable Costs

Estimates of probable costs will be developed for each of the two "complete rad removal" alternatives. The cost estimates previously prepared for the remedy selected in the ROD for OU-1 will also be updated to 2010 costs using the Engineering News Record Construction Cost Index (ENR CCI). In accordance with the NCP as well as the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988) and A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (EPA, 2000b), estimated capital costs, annual operation and maintenance (O&M) costs, periodic costs, and present worth costs will be prepared.

Capital costs will include (1) direct costs for labor, equipment, materials, subcontractors, contractor markups such as overhead and profit, and professional/technical services that are necessary to support construction of the remedial action, and (2) indirect capital costs that are not part of the actual construction but are necessary to implement the remedial action (e.g., engineering, legal, construction management, and other technical and professional services). O&M costs will include annual post-construction costs for labor, equipment, materials, subcontractors, and contractor markups such as overhead and profit associated with activities such as monitoring and maintaining the components of the remedial action. Annual O&M costs will also include expenditures for professional/technical services necessary to support O&M activities. Periodic costs are those that occur only once every few years (e.g., five-year reviews and equipment replacement) or expenditures that would occur only once during the entire O&M period or remedial timeframe (e.g., well abandonment, update of ICs Plan, and site closeout). In accordance with the above-referenced guidance documents, costs estimates are expected to be prepared to provide an accuracy of +50 to -30 percent.

In preparing the cost estimates used in this SFS, quantities for labor, equipment, and materials will be developed as discussed in Sections 2.1 through 2.14 above. Cost data will be selected from a variety of sources including cost estimating guides and references such as unit prices in the latest RS Means Heavy Construction and Sitework & Landscaping Cost Data, RS Means CostWorks 2010 digital cost data, site-specific vendor and contractor quotes, experience with actual costs from similar projects, other historical project costs updated to 2010 costs using the ENR CCI, and engineering judgment.

Estimates for professional/technical services cost elements (project management, remedial design, construction management, and technical support) will be based on the example percentages in Exhibit 5-8 of A Guide to Developing and Documenting Cost

Estimates During the Feasibility Study (EPA, 2000b) for construction of remedies greater than $10 million. These percentages of total construction cost are 5, 6, and 6 percent, respectively for project management, remedial design, and construction management. These percentages may be adjusted up or down based on engineering judgment.

A contingency will be added as a percentage of the total capital, annual O&M, and periodic costs to cover unknowns, unforeseen circumstances, or unanticipated conditions that are not possible to evaluate from the data on hand at the time the estimates are prepared. The contingency will be comprised of two elements: scope and bid. Scope contingency covers unknown costs due to scope changes that may occur during detailed remedial design, since design concepts are not typically developed enough during preparation of the FS to identify all project components or quantities. Bid contingency represents costs, unforeseeable at the time of estimate preparation, which are likely to become known as the remedial action construction or O&M proceeds. Bid contingency accounts for changes that occur after a construction or O&M contract is awarded and represents a reserve for quantity overruns, modifications, change orders, and/or claims during construction or O&M. Examples include changes due to adverse weather, material or supply shortages, or new regulations.

A present worth analysis will also be prepared to allow the estimated costs of each alternative to be compared on the basis of a single figure; i.e., a single dollar amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. While the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988) recommends the general use of a 30-year period of analysis for estimating present worth costs during the FS, the more recent A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (EPA, 2000b) recommends that for projects with durations exceeding 30-years, both a present worth analysis using the project duration and a non-discounted constant dollar cash flow over time scenario be prepared. Both the present worth and non-discounted constant dollar cash flow analyses will be presented for each alternative. It should be noted that the 2000 guidance states “Non-discounted constant dollar costs are presented for comparison purposes only and should not be used in place of present value costs in the Superfund remedy selection process.” USEPA policy on the use of discount rates for RI/FS present worth cost analyses is stated in the preamble to the NCP (55 FR 8722) and in Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-20 entitled “Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis” (EPA, 1993C). The latest (December 2, 2008) OMB Circular A-94 Appendix C 30-year Real Discount Rate for 2009 is 2.7 percent. This rate will be used for the present worth analysis.

In addition to the present worth evaluations, cash flow analyses for each of the two “complete rad removal” alternatives as well as the remedy selected in the ROD for OU-1 will be prepared assuming optimal construction schedules to minimize remedy construction costs and including St. Louis area construction season considerations. A second set of cash flow analyses (and associated construction schedules) will also be provided assuming capital expenditures of only $10 million per year. Under the scenarios subject to a $10 million per year expenditure limitation, the duration of construction and total capital costs will be higher than those where the construction schedules and associated construction costs are optimized.

3 NCP EVALUATIONS

USEPA's correspondence of January 11, 2010 directing the Respondents to prepare a SFS specifies that the two "complete rad removal" alternatives be analyzed using the threshold and primary balancing criteria provided in the NCP at 40 CFR § 300.430. A comparative analysis of the "complete rad removal" alternatives against the remedy selected in the ROD for OU-1 is also to be conducted.

3.1 Detailed Evaluation of "Complete Rad Removal" Alternatives

In accordance with the NCP, the relative performance of each alternative is evaluated in the FS using the nine evaluation criteria [Section 300.430 (e)(9)(iii)] in the NCP as a basis for comparison. The purpose of the detailed evaluation process is to determine which alternative: (a) meets the threshold criteria of overall protection of human health and the environment and attainment of ARARs, (b) provides the "best balance" with respect to the five balancing criteria of 40 CFR § 300.430(e)(9)(iii)(C)-(G), and (c) takes into consideration the acceptance of the support regulatory agency and the community. USEPA's correspondence of January 11, 2010 specifies that only the two threshold criteria and five primary balancing criteria are to be used in the detailed analysis of the two "complete rad removal" alternatives in the SFS. Specific strengths and weaknesses relative to these statutory requirements and technical criteria will be highlighted during the detailed analysis.

Threshold criteria are requirements that each alternative must meet to be eligible for selection as the preferred alternative, and include overall protection of human health and the environment and compliance with ARARs (unless a waiver is obtained). Primary balancing criteria are used to weigh effectiveness and cost tradeoffs among alternatives that meet the threshold criteria. The primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The primary balancing criteria represent the main technical criteria upon which the alternative evaluation is based. The criteria are described in more detail as follows:

Threshold Criteria:

- Overall Protection of Human Health and the Environment addresses whether a remedy provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering, or institutional controls.

- Compliance with ARARs addresses whether a remedy meets ARARs set forth in federal and state environmental laws and/or justifies a waiver from such requirements.

Primary Balancing Criteria:

- Long-term Effectiveness and Permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

- Reduction of Toxicity, Mobility, or Volume through Treatment addresses the statutory preference for selection of a remedial action that employs treatment technologies that permanently and significantly reduce toxicity, mobility, or volume through treatment of the hazardous substance as a principal element.

- Short-term Effectiveness considers the time to reach cleanup objectives and the risks an alternative may pose to site workers, the community, and the environment during remedy implementation. This criterion also considers the reliability and effectiveness of any mitigative measures taken during remedy implementation to control those short -term risks.

- Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular alternative.

- The “Costs” criterion includes estimated direct and indirect capital costs associated with construction of a remedy as well as estimated post-construction annual operation, maintenance, and monitoring costs and periodic costs. Cost estimating that will be conducted for the SFS was previously discussed in Section 2.15.

The SFS will also include an evaluation of potential occurrences of principal threat wastes in accordance with EPA’s “A Guide to Principal Threat and Low-Level Threat Wastes (EPA, 1991B). This evaluation will be included as part of the evaluation of the long-term effectiveness and permanence and/or the reduction in toxicity, mobility or volume through treatment of each alternative. This evaluation will reflect the results of the engineering evaluations performed as part of the SFS.

Although not required by the SOW for SFS (EPA, 2010b), the NCP requires remedial alternatives to be evaluated in terms of Modifying Criteria which include State and community acceptance. State acceptance will be evaluated based on comments provided by MDNR on the SFS. State and community acceptance will be evaluated by EPA as part of any decision process that may be undertaken by EPA after completion of the SFS.

3.2 Comparative Analysis of “Complete Rad Removal” Alternatives

The relative performance of each of the two “complete rad removal” alternatives and the remedy selected in the ROD for OU-1 will be evaluated against the performance of the other alternatives for each of the threshold and primary balancing criteria during the comparative analysis. This comparative analysis will identify the advantages and disadvantages of each alternative.

Prior to conducting the comparative analysis, components of remedy selected in the ROD may require updating. In particular, unit costs for labor, equipment, materials, and monitoring included in the cost estimates for the remedy selected in the ROD will need to be updated to the current unit costs that will be used in the cost estimates for the two “complete rad removal” alternatives.

The volume of disturbed material (inclusive of both waste materials containing radionuclides above the cleanup levels, and the non-impacted materials) generated under both of these two alternatives will also be compared to those volumes associated with the grading design incorporated in the Remedial Design Work Plan (RDWP) dated November, 25, 2008. The RDWP was prepared pursuant to the May 1, 2008 ROD for the project. This will allow for a thorough comparative analysis of all of the alternatives under consideration.

4 REPORT PREPARATION

Upon completion of the engineering and NCP evaluations, a draft SFS Report will be prepared. A potential outline for the SFS Report is as follows:

1. Introduction, Purpose, and Scope of SFS
2. Engineering Evaluations (as described in Section 2 of this Work Plan)
3. Development of Alternatives
4. Detailed Analysis of Alternatives
5. Comparative Analysis of Alternatives
6. References

Appendices

A. Applicable or relevant and appropriate requirements
B. Identification of radiologically-impacted material
C. Extent and volume of radiologically-impacted material
D. Excavation plan
E. Off-site disposal facility requirements
F. On-site disposal cell conceptual design
G. Conceptual grading plans for excavation and regrading alternatives
H. Waste segregation evaluation
I. Sampling and Analysis Plan outline
J. Risk Assessment
K. Health and Safety Plan outline
L. Institutional controls/site reuse evaluations
M. Preliminary construction schedules
N. Estimated costs for remedial alternatives

Activities necessary for completion of the draft SFS Report include the following:

- Prepare draft report;
- Internal project team review of draft report;
- Prepare revised draft report; and
- Submit Draft SFS Report to EPA.

Upon completion of EPA review of the Draft SFS Report, it is assumed that EPA will provide written or verbal comments on the Draft SFS Report. A meeting to discuss EPA's comments is also anticipated. Responses to EPA's comments may be prepared and a Final SFS Report will be prepared subsequent to this meeting. The activities necessary for preparation of the Final SFS Report are anticipated to be similar to those listed above for preparation of the Draft SFS Report.

The status of the work performed to complete the SFS will be tracked and reported to EPA in monthly status reports, as required by the Administrative Order on Consent, as amended (EPA, 1993a, 1997b and 2008a).

5 SCHEDULE TO COMPLETE SUPPLEMENTAL FS

A critical path schedule for the various activities to be conducted to complete the SFS is presented on Figure 4. This schedule meets the requirement set forth in the Statement of Work that the SFS Report be submitted within 60 days of EPA approval of the Work Plan. In order to meet this requirement, the duration of many of the task activities have been reduced to the minimum amount necessary to complete the activity. In addition, work on the SFS will be initiated prior to EPA approval of the Work Plan.

As shown on Figure 4, it is anticipated that a meeting will be held among EPA representatives, MDNR representatives, and the EMSI project team early-on in the SFS preparation process for purposes of reaching an agreement with respect to the identification, configuration, and extent/distribution (location, depth interval[s], and three-dimensional configuration) of radiologically-impacted materials prior to developing the “complete rad removal” alternatives and conducting the SFS evaluations. A subsequent meeting(s) may also be held among EPA, MDNR, and EMSI to reach agreement on volume estimates for radiologically-impacted materials, discuss the waste segregation and cleanup level evaluations, and review the first draft of the engineering evaluations sections of the SFS Report.

6 PROJECT TEAM/ORGANIZATION

The Project Team that will prepare the SFS is composed of three engineering and environmental firms consisting of:

- Engineering Management Support, Inc. (EMSI)
- Feezor Engineering, Inc. (Feezor)
- Auxier & Associates, Inc. (Auxier)

EMSI will serve as the Supervising Contractor and will provide overall project management and technical direction to the project. Mr. Paul V. Rosasco, P.E., of EMSI will serve as the Project Coordinator. Having previously been responsible for the RI and FS for OU-1, EMSI personnel are familiar with the various aspects of the project. EMSI is currently in the process of preparing the remedial design (RD) for the remedy selected in the ROD for OU-1. EMSI will be responsible for the following activities for the SFS:

- Identification of the various technical requirements of the project, assignment of project tasks to the various members of the project team, development and tracking of the project schedule and budget, and review and approval of project deliverables and overall Quality Assurance;
- Identifying soil volumes to be considered for removal or relocation;
- Developing pre-excavation waste characterization/surveying/sampling needs;
- Soil/waste segregation evaluation;
- Evaluation of off-site commercial disposal alternatives;
- Institutional Controls/Site reuse evaluations;
- Preparing schedules for alternatives implementation;
- Preparing cost estimates for alternatives;
- Conducting NCP criteria evaluations of alternatives; and
- Preparation of monthly project status reports to EPA and for scheduling and coordination of meetings and interactions with EPA and MDNR.

Feezor Engineering, Inc. specializes in solid waste and landfill facility-related planning, design, and construction projects and will conduct the activities associated landfill cell and cover conceptual design and earthwork quantity determinations for the alternatives considered for the SFS. Feezor will also be responsible for preparing drawings and illustrations using AutoCAD software. Feezor has extensive experience designing and permitting solid waste landfill cells and covers with components similar to those required for the alternatives to be evaluated in the SFS. Feezor is currently serving with EMSI in preparing the RD for the landfill design component of the remedy selected in the OU-1 ROD and has previously worked at the Bridgeton Landfill on closure of the former leachate lagoon. For the SFS, Feezor will conduct the following activities:

- Calculation of volumes to be excavated and disposed or relocated;
- Preparation of excavation plans;
- Conceptual design of the on-site engineered disposal cell alternative;
- Conceptual design of the closure of the remaining OU-1 solid waste areas;
- Assisting EMSI in preparing schedules for alternatives implementation; and
- Preparing cost estimates for alternatives.

Auxier & Associates, Inc. specializes in health physics and radiation safety and is familiar with the OU-1 project site, having prepared the Baseline Risk Assessment (Auxier, 2000) associated with the RI/FS for OU-1. Auxier will be responsible for the following SFS activities:

- Preparing an excavation verification sampling plan;
- Conducting assessments of potential risks to workers and the community associated with the various activities for each alternative;
- Determining the health and safety requirements for the alternatives including monitoring, decontamination, and effects on production; and
- Developing cost estimates for health and safety and monitoring.

Figure 5 presents an organization chart for the project team that will prepare the SFS. Specific personnel to be involved and the generalized lines of communication and responsibility are indicated on Figure 5. Resumes for the various project team members are provided in Appendix A.

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Table

Table 1 Risk Overview

ROD Remedy

Time Period	Source of Hazard or Risk		Potential Receptors
Short-term(During Construction Phase)	Construction	Operating heavy equipment	Workers
		General heavy labor	Workers
	Transportation	Physical hazards from Mob & Demob of equipment	Workers and the Community
		Physical hazards from importation of material for cell construction.	Workers and the Community
		Physical hazards from importation of material to restore grade in excavated areas.	Workers and the Community
	Radiological & Toxic Material Excavated	Exposure to direct radiation	Workers
		Inhalation of particulates and radon	Workers & Off-site community
		Inadvertent ingestion	Workers
	Other Hazards	Environmental: Punctures to PPE, biological hazards in municipal waste, heat.	Workers
Long-term (Post Closure)	On-Property Use	Transient exposures for future visitors	Future On-site Property Users
		Occupational exposures for future workers using reclaimed land	Future On-site Property Users
	Use of Adjacent Property	Well water	Future Off-site Property Users
		Airborne radon and particulates	Future Off-site Property Users
	Ecological	Disruption of habitat	Flora and Fauna
		Potential radiological exposure	Flora and Fauna

Excavate and Move to On-site Engineered Disposal Facility

Time Period	Source of Hazard or Risk		Potential Receptors
Short-term(During Construction Phase)	Construction	Operating heavy equipment	Workers
		General heavy labor	Workers
	Transportation	Physical hazards from Mob & Demob of equipment	Workers and the Community
		Physical hazards from importation of material for cell construction.	Workers and the Community
		Physical hazards from cell construction.	Workers
		Physical hazards from moving contaminated material to new cell	Workers and the Community
		Physical hazards from importation of material to restore grade in excavated areas.	Workers and the Community
	Radiological & Toxic Material Excavated	Exposure to direct radiation	Workers
		Inhalation of particulates and radon	Workers & Off-site community
		Inadvertent ingestion	Workers
	Other Hazards	Environmental: Punctures to PPE, biological hazards in municipal waste, heat.	Workers
Long-term (Post Closure)	On-Property Use	Transient exposures for future visitors	Future On-site Property Users
		Occupational exposures for future workers using	Future On-site Property Users
	Use of Adjacent Property	Well water	Future Off-site Property Users
		Airborne radon and particulates	Future Off-site Property Users
	Ecological	Disruption of habitat	Flora and Fauna
		Potential radiological exposure	Flora and Fauna

Excavate and Move to Off-site Engineered Disposal Facility

Time Period	Source of Hazard or Risk		Potential Receptors
Short-term(During Construction Phase)	Construction	Operating heavy equipment	Workers
		General heavy labor	Workers
	Transportation	Physical hazards from Mob & Demob of equipment	Workers and the Community
		Physical hazards from transport of excavated materials on Public Roads.	Workers and the Community
		Physical hazards from importation of material for cell construction.	Workers and the Community
		Physical hazards from importation of material to restore grade in excavated areas.	Workers and the Community
	Radiological & Toxic Material Excavated	Exposure to direct radiation	Workers
		Inhalation of particulates and radon	Workers & Off-site community
		Inadvertent ingestion	Workers
	Other Hazards	Environmental: Punctures to PPE, biological hazards in municipal waste, heat.	Workers
Long-term (Post Closure)	On-Property Use	Transient exposures for future visitors	Future On-site Property Users
		Occupational exposures for future workers using reclaimed land	Future On-site Property Users
	Use of Adjacent Property	Well water	Future Off-site Property Users
		Airborne radon and particulates	Future Off-site Property Users
	Ecological	Disruption of habitat	Flora and Fauna
		Potential radiological exposure	Flora and Fauna

Figures

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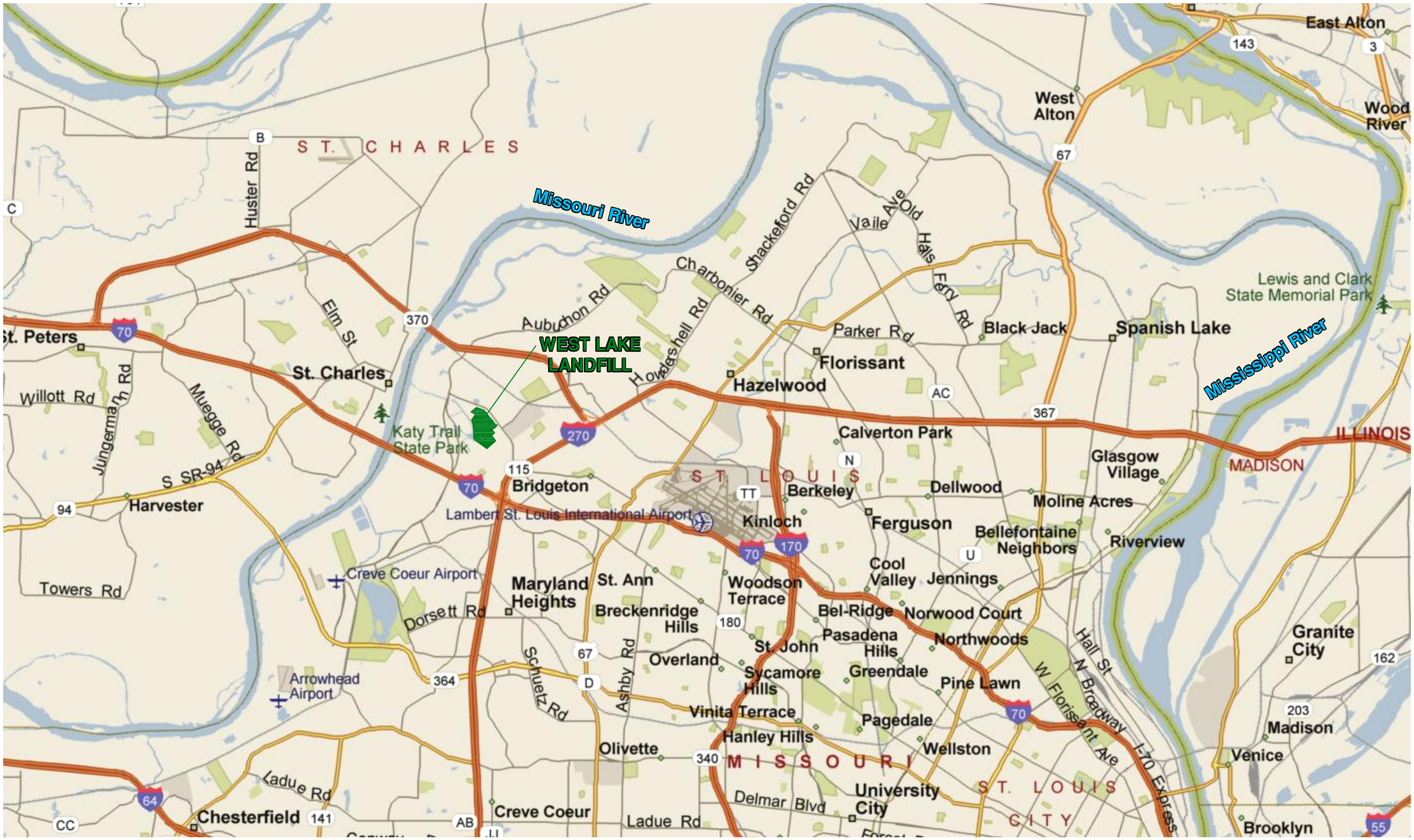

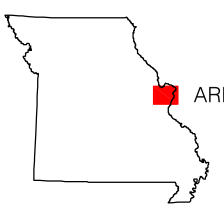

0 3
SCALE IN MILES

N

Figure 1

General Location Map

West Lake Landfill OU-1 Supplemental Feasibility Study

EMSI Engineering Management Support, Inc.

Source: MyTopo.com Date of Photograph 8/9/2007

0 600
SCALE IN FEET

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Figure 2

Site Features

West Lake Landfill OU-1 Supplemental Feasibility Study

EMSI Engineering Management Support, Inc.

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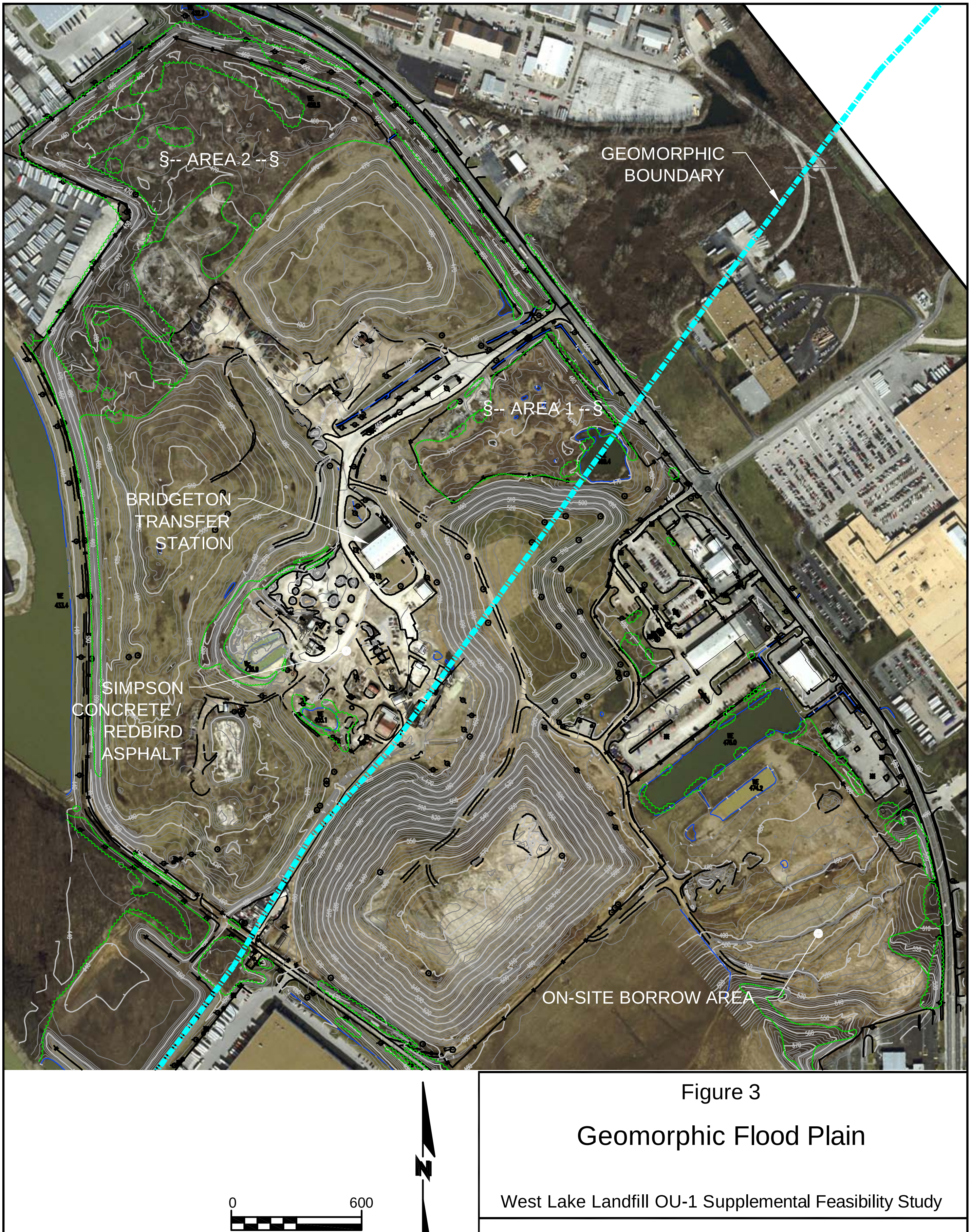


Figure 3

Geomorphic Flood Plain

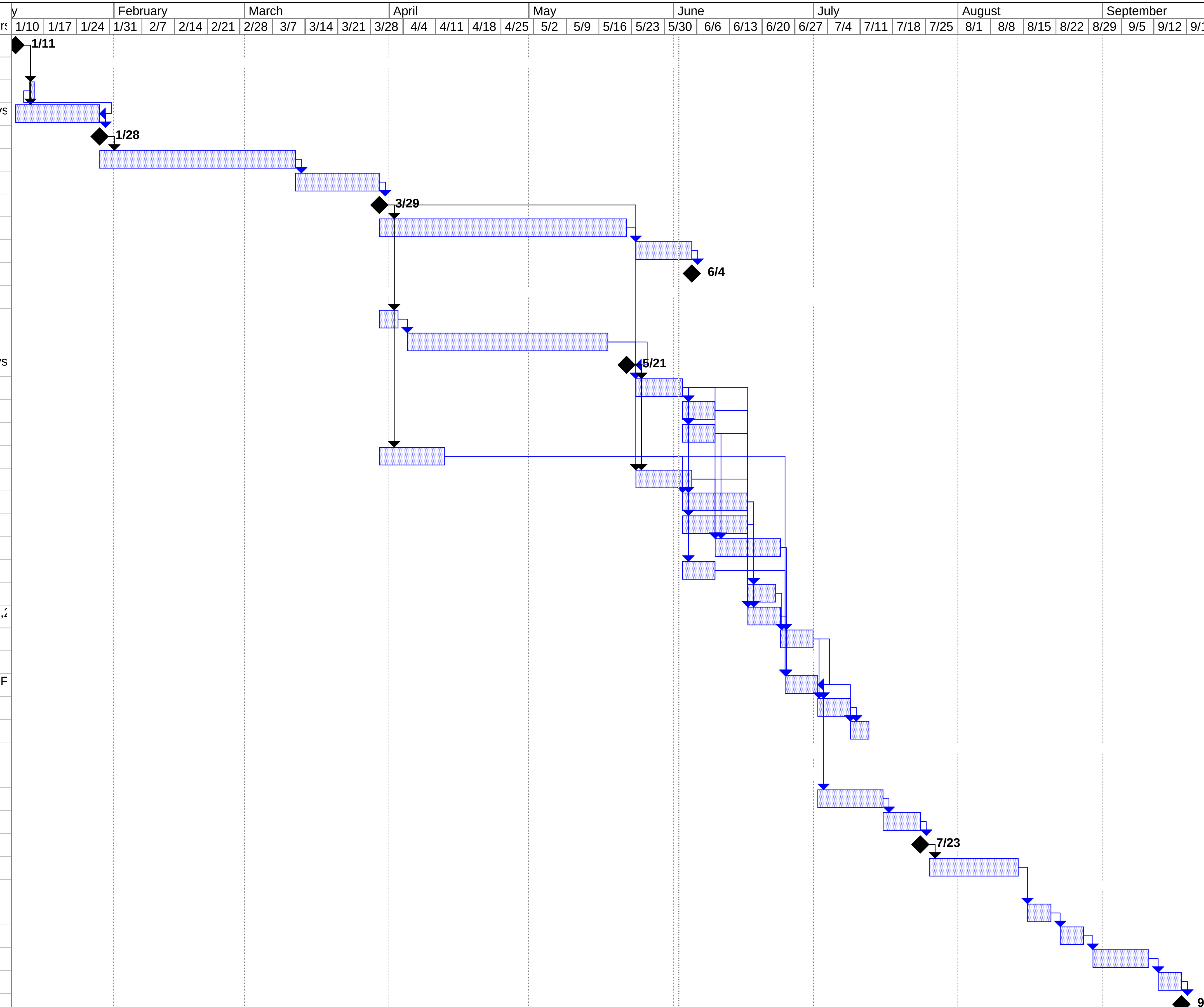
West Lake Landfill OU-1 Supplemental Feasibility Study

EMSI Engineering Management Support, Inc.

M:\clients\EMSI\westlake\2010\BT-005-001 Floodplain Drawing – 2007 Format\Flood-Plain-Fig.dwg plotted: 03/23/2010

Figure 4: Supplemental FS Schedule - West Lake Landfill OU-1

ID	Task Name	Duration	Start	Finish	Predecessors
1	**EPA Statement of Work**	0 days	1/11/10	1/11/10	
2	**Work Plan**	**105 days**	**1/11/10**	**6/4/10**	
3	Scoping meeting (conf call)	1 day	1/14/10	1/14/10	1
4	Work Plan preparation	14 days	1/11/10	1/28/10	3SF+11 days
5	Work Plan Submittal	0 days	1/28/10	1/28/10	4
6	EPA Review	30 days	1/29/10	3/11/10	5
7	Work Plan Revision	12 days	3/12/10	3/29/10	6
8	Revised Work Plan Submittal	0 days	3/29/10	3/29/10	7
9	EPA Review	39 days	3/30/10	5/21/10	8
10	Work Plan Revision	10 days	5/24/10	6/4/10	9
11	Final Work Plan Submittal	0 days	6/4/10	6/4/10	10
12	**Engineering Evaluations**	**67 days**	**3/30/10**	**6/30/10**	
13	Delineation of Rad soil	4 days	3/30/10	4/2/10	8
14	Define extent & volume of rad soil	31 days	4/5/10	5/17/10	13
15	Meeting re: delineation & extent	0 days	5/21/10	5/21/10	14FF+4 days
16	Prepare excavation plan	8 days	5/24/10	6/2/10	14,15
17	Scope verification sampling	5 days	6/3/10	6/9/10	16
18	Evaluate waste segregation	5 days	6/3/10	6/9/10	16
19	ARARs Evaluation	10 days	3/30/10	4/12/10	8
20	Identify off-site disposal facilities	10 days	5/24/10	6/4/10	15,8
21	Site & design on-site disposal cell	10 days	6/3/10	6/16/10	16,19
22	Design solid waste closure	10 days	6/3/10	6/16/10	16
23	Assess potential risks	10 days	6/10/10	6/23/10	16,20,18
24	Define health & safety rquirements	5 days	6/3/10	6/9/10	16
25	Evaluate Institutional Controls	4 days	6/17/10	6/22/10	22,21
26	Prepare project schedules	5 days	6/17/10	6/23/10	16,17,18,20,2
27	Assemble cost data	5 days	6/24/10	6/30/10	26,25
28	**NCP Evaluations**	**12 days**	**6/25/10**	**7/12/10**	
29	Evaluation of excavation alternative	5 days	6/25/10	7/1/10	23,24,26,27F
30	Updates to ROD remedy	5 days	7/2/10	7/8/10	27,29
31	Comparative analysis	2 days	7/9/10	7/12/10	29,30
32	**Report Preparation**	**56 days**	**7/2/10**	**9/17/10**	
33	**Draft Supplemental FS Report**	**16 days**	**7/2/10**	**7/23/10**	
34	Prepare draft supplemental FS	10 days	7/2/10	7/15/10	29
35	Internal review/revision	6 days	7/16/10	7/23/10	34
36	Submit Draft Supplemental FS	0 days	7/23/10	7/23/10	35
37	EPA review	15 days	7/26/10	8/13/10	36
38	**Final Supplemental FS Report**	**25 days**	**8/16/10**	**9/17/10**	
39	Meeting to discuss comments	5 days	8/16/10	8/20/10	37
40	Prepare responses	5 days	8/23/10	8/27/10	39
41	Prepare revised draft	10 days	8/30/10	9/10/10	40
42	Internal review/revision	5 days	9/13/10	9/17/10	41
43	Submit Final Report to EPA	0 days	9/17/10	9/17/10	42



Project: Supplemental FS Rev 2
Date: 6/2/10

Task	Progress	Summary	External Tasks	Deadline	
Split	Milestone	Project Summary	External Milestone		

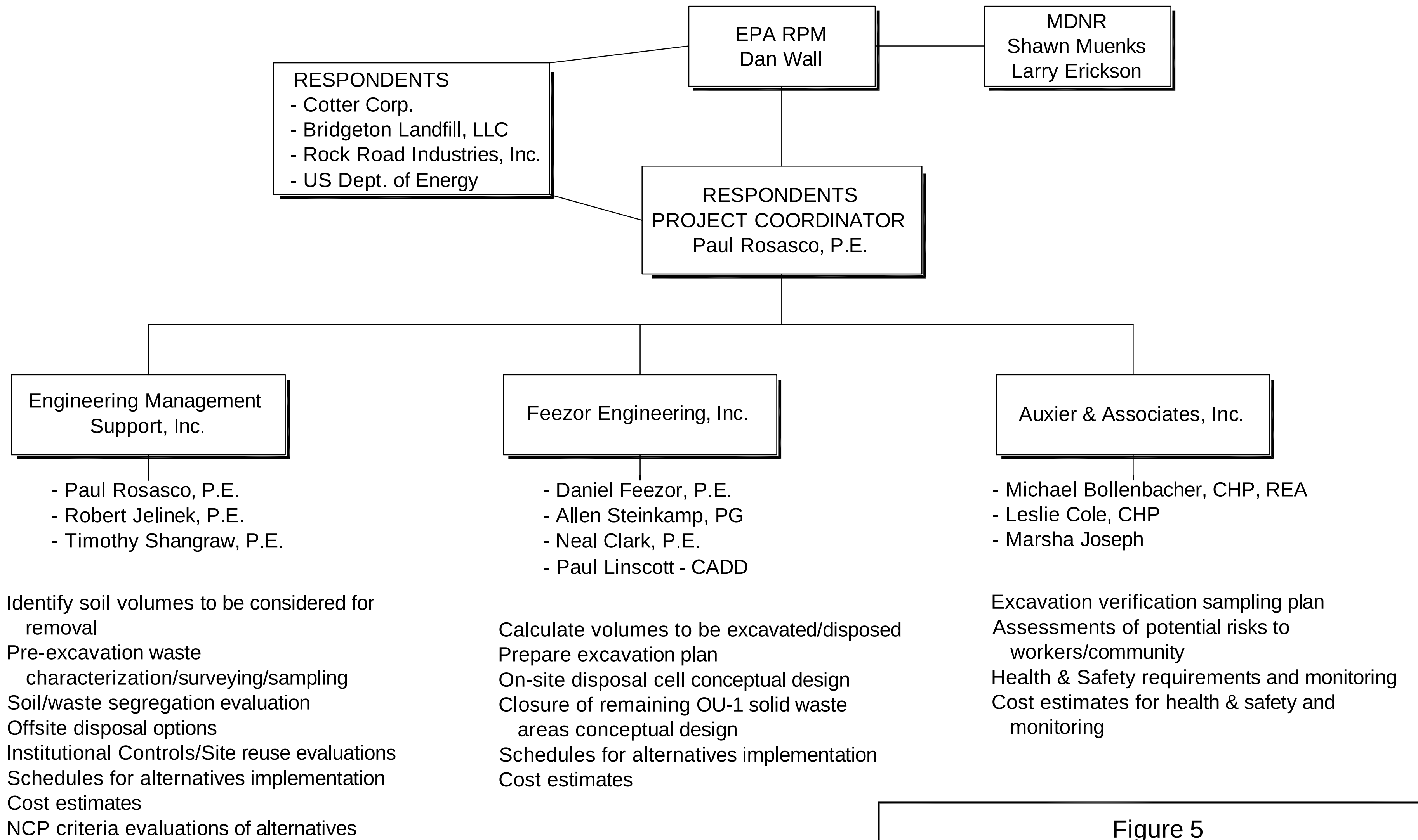


Figure 5

Project Team Organization

West Lake Landfill OU-1 Supplemental Feasibility Study

EMSI Engineering Management Support, Inc.

Appendix A:

Resumes of Project Team Members

Engineering Management Support, Inc.

PAUL V. ROSASCO, P.E.

Mr. Rosasco has over 29 years experience in providing supervision, management, and technical review for geological, hydrogeological, and engineering projects. He has designed and implemented geological, hydrogeological and geophysical investigations and environmental monitoring programs for sites ranging from 0.5 acres to over 300 square miles. Mr. Rosasco has extensive project management and technical experience in a wide variety of waste disposal and environmental contamination projects. He has provided design, site engineering, and construction management services and acted as owner's representative for surface and subsurface remediation projects. He has also been involved in a variety of geotechnical, geologic hazard, and water supply evaluation projects.

Mr. Rosasco has 25 years of experience with all aspects of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and National Priorities List (NPL) site projects. His experience includes evaluation of existing data and development of scopes of work, negotiation of scopes of work, administrative orders and consent decrees, implementation and supervision of remedial investigations, feasibility studies, remedial designs, remedial actions, removal actions and performance and effectiveness evaluations of operation and maintenance of removal and remedial actions. He has been qualified by several federal courts as an expert in the areas of hydrogeology, contaminant occurrence, fate and transport, remedial actions, cost allocation and National Contingency Plan (NCP) consistency. He has worked at over 30 Superfund Sites. A list of these sites and a brief description of his work related to these sites is attached to this resume.

Mr. Rosasco has performed characterizations of waste disposal sites, assessed contamination, and designed remedial measures for Resource Conservation and Recovery Act (RCRA) facilities, CERCLA solid and hazardous waste disposal sites as well as other waste management and industrial/commercial facilities. He has participated in the development and review of RCRA Part B applications, ground-water monitoring and corrective measure programs and closure plans. Mr. Rosasco has developed operations plans and designed and facilitated permitting for solid and liquid waste disposal sites.

Mr. Rosasco has provided expert testimony related to groundwater occurrence, flow and chemical transport, the nature, extent and sources of environmental contamination, the necessity and appropriateness of various remedial actions, consistency of response actions with the National Contingency Plan (NCP) and other environmental regulations, and allocation of response costs. He has also provided expert assistance related to construction claims and disputes. He has provided expert testimony on the role of environmental issues and site remediation related to property valuation and condemnation proceedings. He has testified at numerous regulatory hearings and public meetings on issues ranging from site selection and the design and operations of waste disposal facilities, environmental contamination and remediation, and water quality standards.

EDUCATION

M.E., Engineering Geology, Colorado School of Mines, 1985
B.S., Geology, University of Oregon, 1976

REGISTRATION

Professional Engineer - Colorado, Illinois

EMPLOYMENT HISTORY

1994 - Present	Engineering Management Support Inc. President Principal Engineer
1985 - 1994	Harding Lawson Associates Member of Board of Directors Senior Vice President Director of Program Development Consulting Vice President Director of RCRA and CERCLA Services Northeast Regional Manager Mid-continent Operating Officer Rocky Mountain Regional Manager Principal in Charge - Denver Office Associate in Charge - Denver Office
1981 - 1985:	Fox Consultants, Inc. Hydrogeology group manager Project geological engineer Rock mechanics supervisor
1979 - 1981:	Department of Energy/Office of Nuclear Waste Isolation, Colorado School of Mines Project geologist Assistant project manager
1978 - 1979:	Colorado School of Mines Research assistant
1977 - 1978:	Kennicott Copper Co./Bear Creek Mining Co.

Assistant geologist

1976 - 1977 Lane County Community College
Mathematics Instructor

COMMUNITY SERVICE

Former Member - Jefferson County, Colorado Planning Commission (member and former Chairman [twice] and Vice-Chairman [twice] 1994 - 2004)

MEMBERSHIPS

American Society of Civil Engineers
Association of Groundwater Scientist and Engineers

PUBLICATIONS

1995 Weaver, Jeffrey, D., Digel, Robert, K., and Rosasco, Paul V., Performance of a Post-audit of Groundwater Flow Models Used in Design of a Groundwater Capture/Containment System, in Symposium on Subsurface Fluid Flow (Ground-Water) Model, American Society for Testing and Materials.

1985 Rosasco, Paul, V., Geometric Continuity of Structural Discontinuities, CSM-ONWI Test Site, Idaho Springs, Colorado. Masters of Engineering report, Colorado School of Mines, Golden, Colorado.

1984 Rosasco, Paul, V. and Curry, John, A Cooperative Agreement to Investigate and Remedy Chemical Contamination at the Boulder/Marshall Landfills, Colorado. Prepared for the 5th National Conference on Management of Uncontrolled Hazardous Waste Sites.

1981 Mining Technology Development in Crystalline Rock. "Advances in the Science and Technology of the Management of High Level Nuclear Waste," U.S. Department of Energy.

1980 Mining technology development for hard rock excavation. "Rockstore."

SELECTED EXPERIENCE

West Lake Landfill Operable Unit 1, Bridgeton, MO – Project manager and lead hydrogeologist/engineer for Remedial Investigation/Feasibility Study of radiologically impacted materials disposed in a solid waste landfill. Subsequently, project manager/project coordinator for the Remedial Design consisting of a new landfill cover, stormwater collection and diversion system, erosion control systems, landfill gas control and monitoring systems, and groundwater monitoring systems.

Marshall/Boulder Landfills, CO - Project manager/Project engineer/Project consultant for RI, FS, RD and RA of CERCLA municipal landfill site. Assisted in scoping and negotiation of Administrative Order for the RI/FS and Consent Decree for the RD/RA. Also provide expert testimony on landfill design and operations, gravel recovery, groundwater conditions and contaminant occurrences.

Lowry Landfill, CO - Project manager/principal investigator for RI/FS of waste pit liquids and ground-water operable unit RI/FS. Expert testimony related to NCP consistency, cost allocation and cost recovery litigation. Consultant to owner/operator on groundwater conditions and issues during remedial design and remedial action. Consultant and technical director for groundwater investigations and evaluations to address issues raised by EPA in the Five Year Review Reports. Prepared comprehensive groundwater monitoring plan and supervised implementation of groundwater monitoring plan and associated statistical evaluations to demonstrate compliance with groundwater performance standards and effectiveness of remedial action components.

Vasquez Boulevard/Interstate-70 Superfund Site Operable Unit 2 – Project manager and lead engineer for Remedial Investigation/Feasibility Study of smelter wastes and municipal solid waste landfill.

Denver Radium Sites OU-2, DuWald Steel Site – On behalf of prospective purchaser, prepared and negotiated scope of Materials Management Plan (MMP) to address residual radium-contaminated soils that would be excavated during re-development of the property. Assisted purchaser with implementation of the MMP including health and safety monitoring, soil screening, sampling, analysis and disposal. Also performed routine groundwater, indoor air and radon monitoring in support of owners maintenance of bona fide prospective purchaser status.

BNSF Livingston Shop Complex, Livingston, MT – Provided expert assistance and expert testimony relative to toxic tort claims. Also consulted on application of in situ chemical oxidation to reduce source area concentrations.

Bunker Hill Mine, Wallace ID – Consultant for cost allocation and evaluation of hydrologic conditions including interconnection of mine drainage for the Crescent and Bunker Hill Mines.

California Gulch, CO - Project consultant for Lake County Board of Commissioners regarding local issues associated with RI/FS and removal actions at this NPL site. Provided technical review of EPA and PRP documents, participated in public meetings, performed site inspections to assess effectiveness of anticipated or recently implemented removal actions and developed and evaluated alternative approaches and designs to proposed removal actions to preserve historic mining character/scenic aspects of area.

Rocky Mountain Arsenal, CO - Principal investigator for ground-water monitoring and ground-water characterization task for CERCLA RI/FS and RCRA groundwater monitoring program.

Midnite Mine, Spokane, WA – Expert witness regarding scoping and data needs for the RI/FS and cost recovery.

Sand Creek Industrial Area, CO - Project manager/project hydrogeologist for hydrogeologic and geochemical evaluation related to source identification/ source segregation effort. Provide technical assistance during negotiations of Administrative Order for RI/FS.

Woodbury Chemical Site, CO - Principal investigator for RI/FS of former wood treating and chemical distribution site.

Galley Road Dump Site, Colorado Springs, CO – Provided expert testimony regarding NCP consistency and cost allocation.

Rocky Flats Industrial Park Site, CO – Project manager for Engineering Evaluation/Cost Analysis for chlorinated and aromatic solvent, trace metal and PCB contamination investigations and evaluations. Project manager for design and implementation of air sparge/soil vapor extraction system for source removal/reduction of chlorinated solvents/DNAPLs.

Cotter Corporation Canon City Mill/Lincoln Park Subdivision – Evaluated soil sampling data, developed cleanup levels and prepared a Feasibility Study for area of former tailings impoundments that contributed to downgradient occurrences of molybdenum and uranium in groundwater. Prepare work plan, negotiated scope of work with agencies, provided technical assistance to field investigations for characterization of subsurface conditions at toe of lined tailing impoundments. Prepared a comprehensive groundwater monitoring plan to detect potential leakage from impoundments.

Denver Radium Sites OU-8, S.W. Shattuck Site - Owner's representative during remedial action consisting of stabilization./solidification of radioactive contaminated soils. Technical consultant to owner during EPA Five Year Review of implemented remedy. Participant in EPA Headquarters review and public dialogue related to the implemented remedy and Five Year Review Report. Also performed routine onsite and offsite groundwater monitoring, data evaluation and reporting.

Smeltertown Site, Salida, CO – Provided technical assistance with scoping of remedial action and institutional controls and negotiations for Consent Decree and Scope of Work for Remedial Design/Remedial Action.

Edmunds Street Operable Unit, South Valley of Albuquerque, NM - Project consultant for ground-water investigation, modeling and risk assessment.

San Gabriel Valley, Suburban Operable Unit, Azusa, CA – Expert assistance for mediation between U.S. EPA and a potentially responsible party relative to recovery of past cost claims asserted by EPA.

Mystery Bridge Site, WY – Expert assistance regarding NCP consistency, cost recovery and cost allocation issues.

Wasatch Chemical Site, UT - Principal investigator for RI/FS and project consultant for Remedial Design at former chemical manufacturing and distribution facility. Provided technical support for negotiation of Consent Decree for RD/RA.

Talache Mining District, ID – Expert testimony regarding cost allocation for CERCLA remediation of tailings dam failure.

Milltown Reservoir, MT - Project manager/Project engineer for site characterization and feasibility study of CERCLA reservoir site containing arsenic and other trace metal bearing mill tailings/sediments and associated arsenic impacted groundwater.

Whitewood Creek, SD – Provided technical support and performed quality control for Remedial Investigation.

Operable Unit 1, Westlake Landfill, MO. - Project management for RI/FS for multi-party group performing RI/FS of radioactive-contaminated soils at CERCLA municipal landfill site.

Bartlesville, OK - Expert testimony related to NCP consistency, cost recovery and cost allocation and technical representative for one PRP for the Corrective Measures Study including ground-water modeling evaluations and risk assessment.

Commerce, TX - Expert testimony related to proposed class action certification and subsequent toxic tort claims at a former pesticide manufacturing facility subject of a CERCLA Removal Action. Expert assistance with groundwater conditions, water supply well operations and reported arsenic occurrences in Ridgeway, TX.

Bailey Site, TX - Project consultant for remedial design investigations at chemical disposal site.

Aerojet General Facility, Rancho Cordova, CA – Technical assistance in preparation of Feasibility Study for Western groundwater OU. Provided independent technical review of aquifer characterization, properties, nature and extent of chemical occurrences and proposed groundwater extraction and treatment alternatives. Analyzed potentially applicable or relevant and appropriate requirements of federal and state regulations and prepared text and summaries for FS report. Provided technical assistance with development of scope of work for perimeter groundwater OU.

International Business Machines, San Jose, CA – Provided technical support and quality control review of Feasibility Study.

Baldwin Park Operable Unit, San Gabriel Valley, CA - Consultation and development of a numerical allocation model for multi-party regional ground-water contamination site. Consultant on groundwater and contaminant sources and migration. Developed Geographic Information System database of facilities, facility operations, water supply and monitoring wells and water quality data for approximately 15 square mile area.

Tulalip Landfill, WA - Project manger / consultant to multi-party group performing the RI/FS of CERCLA municipal landfill site. Consultant during remedial design/remedial action related to landfill regarding, cover design and construction and construction dewatering.

Southeast Rockford, IL - Project consultant for ground-water investigation, source identification and site-segregation evaluation at this regional ground-water contamination site. Also provided technical review of EPA Record of Decision, RI/FS and EPA cost estimate for source control and ground-water remediation on behalf of potentially responsible party.

Acme Solvents reclaiming Site, IL - Principal investigator/Project consultant to multi-party group for RI/FS and Remedial Design of former solvent recycling disposal site.

Joliet Landfill, IL - Project consultant for negotiation of Administrative Order and scope of work for the RI/FS for industrial landfill site.

Pollution Control Inc., IL - Project consultant for negotiation of Administrative Order and scope of work for the RI/FS for former chemical disposal site.

Fisher-Calo Site, IN – Provided expert testimony related to cost allocation and divisibility of harm at a multi-facility NPL site.

Waste Inc. Site, IN - Review of remedial design/ remedial action cost estimates and contract documents for capping and ground-water remediation on behalf of multi-party group.

Pine Bend Sanitary Landfill, MN - Project consultant for RI/FS of CERCLA municipal landfill site.

Michigan Ave Site, Kalamazoo, MI – Provide expert testimony related to NCP consistency in conjunction with cost recovery action.

Woodlands, NJ - Project consultant related to remedial technologies and remedial alternatives for ground-water contamination evaluation by multi-party group.

Mr. Rosasco also has other experience at the sites listed above, at various State "Superfund" sites as well as RI/FS and RD/RA experience at non-NPL sites and in performance of RCRA RFI/CMS.

ROBERT T. JELINEK, P.E.

Mr. Jelinek has over 29 years of experience specializing in engineering alternatives evaluations, cost estimating, and designs for groundwater and soil remediation and water/wastewater treatment systems projects. He has been involved both in technical and managerial positions on a wide range of engineering projects. Mr. Jelinek formerly managed the corporate-wide Remedial Design Center for a major consulting firm. In this role, he provided oversite, design review, value engineering review, and quality control (QC) review of all remedial design projects world-wide. In addition, he served as a lead author for their Design Procedures Manual and prepared the company's standard technical specifications and standard drawings.

Mr. Jelinek has prepared CERCLA feasibility studies (FS) and Engineering Evaluation/Cost Analyses (EE/CAs) as well as RCRA corrective measures studies (CMS). He has prepared engineering design evaluations; remedial action plans; drawings and specifications for construction of remedial actions and removal actions as well as water and wastewater treatment facilities for industrial and municipal application; construction quality assurance plans; facilities plans; construction cost estimates, and scheduling. He is also experienced in bench- and pilot-scale treatability studies, water and sewer utility rate studies, plans of operation, operation and maintenance (O&M) manuals, industrial pretreatment evaluations and program development, sewer use ordinances, water quality evaluations, and infiltration/inflow analyses.

Mr. Jelinek has conducted process, civil, and mechanical design and design review for metals and other inorganics, VOC, semivolatile organic compound (SVOC), and radionuclide removal, as well as side-stream and sludge treatment facilities at industrial, military, and municipal sites. He has experience at 38 hazardous waste sites and on 24 industrial or municipal water/wastewater-related projects and has provided regulatory interface, management of multiple-client relationships, project management, engineering services during construction at both contaminated and uncontaminated sites, and onsite inspection/ construction management.

With respect to uranium mining, he recently he prepared the preliminary design for two in-situ leach (ISL) uranium mining projects in support of permitting and Life of Mine (LOM) costing efforts. His design efforts included aboveground uranium recovery, yellowcake production, surface impoundment, land application, and mining unit header house equipment, facilities, and buildings, as well as supporting utilities and infrastructure. He has also designed and operated several point of use systems for uranium removal from drinking water.

EDUCATION

M.S., Environmental Engineering, University of Colorado - Boulder, 1979
B.S., Civil Engineering, Lehigh University, Pennsylvania, 1978

REGISTRATIONS

Registered Professional Engineer in New Jersey, Pennsylvania, Illinois, Texas, and Colorado

EMPLOYMENT HISTORY

1996-Present — Engineering Management Support, Inc.

Vice President, Principal Engineer

1989-1996 — Harding Lawson Associates

Vice President

Manager of the corporate-wide remedial design center and chief engineer. Responsible for preparation and QC review of all drawings and specifications for construction of ground water and soil remedies at contaminated sites. Also preparation of O&M manuals. Responsible for coordination of designs of three internal Remedial Construction Divisions.

Principal Engineer

Project manager for large remedial action projects. Deputy Program Manager for 40-million-dollars of remedial investigation, endangerment assessment, feasibility study, remedial design, and remedial action programs at the Rocky Mountain Arsenal. Company-wide resource for remedy conceptualization and implementation.

Associate Engineer

Manager of engineering group. Prepared CERCLA feasibility studies and RCRA Corrective Measures Studies, bench and pilot-scale hazardous waste treatability studies, and remedial designs. Project Manager for several design and design/build projects. Also provided engineering services during construction.

1983-1989 — Project Manager, Richard P. Arber Associates, Inc.

Managed industrial and municipal water and wastewater conveyance, treatment and residuals disposal engineering projects, including facility audits, evaluations, design, and engineering services during construction . Designed water and wastewater treatment, distribution, and storage facilities. Also served as Town Engineer.

1980-1983 — Project Engineer, Henningson, Durham & Richardson (HDR)

Prepared drawings and specifications for construction of expansions to numerous municipal wastewater treatment facilities in Colorado and Wyoming. Also developed industrial pretreatment programs and prepared utility rate studies.

1978-1979 Research Associate, Union Carbide Corporation
Operated pilot-scale ion exchange tertiary treatment systems for conversion of municipal wastewater to potable water (through the University of Colorado at Boulder).

1974-1978 Field Engineer, Stearns & Wheler Engineers
Conducted several sanitary and combined sewer system infiltration/inflow and sewer system evaluation surveys. Prepared 201 Facilities Plans under the Clean Water Act.

AFFILIATIONS AND MEMBERSHIPS

American Water Works Association
Water Environment Federation (formerly Water Pollution Control Federation), Rocky Mountain Section (Colorado, New Mexico, and Wyoming)-President, 1990-91

PUBLICATIONS AND PRESENTATIONS

1994. Field optimization of groundwater extraction and recharge: Design reevaluation during system construction and startup, Rocky Mountain Arsenal. Presented at the National Groundwater Association Forum on Remediation of Groundwater Contamination, February 2.

1993. Groundwater treatment plant design under CERCLA versus the Record of Decision design concept: The paradox. Poster presentation at the Hazardous Materials Control Research Institute SUPERFUND Conference, November 30.

1993. Evaluation of soil vapor extraction for mass removal of organic and odor-causing compounds and characterization of odorants by tandem mass spectrometry in Basin F solids, Rocky Mountain Arsenal. In *proceedings* of Hazardous Materials Control Research Institute SUPERFUND Conference, November 30.

1991. Development of optimal processes and operational procedures for treatment of hydrazine wastewater. In *proceedings* of and presented at the Hazardous Materials Control Research Institute, Research and Development conference, February 22.

1990. Selecting a chemical oxidation/ultraviolet treatment system and successful treatment of hydrazine wastewater at Rocky Mountain Arsenal. In *proceedings* of and presented at the Hazardous Materials Control Research Institute SUPERFUND conference, November 28.

1990. UV/Chemical Oxidation of Hydrazine Wastewater at the Rocky Mountain Arsenal. Presented at the Hazardous Waste Treatment Technologies and

Applications Seminar to the Rocky Mountain Water Pollution Control Association and American Water Works Association.

1989. Uranium removal from drinking water using a small full-scale system. U.S. EPA Risk Reduction Engineering Laboratory Research and Development Report, EPA/600/52-89/012.

1988. Operating a small full-scale ion exchange system for uranium removal. *Journal of American Water Works Association*, vol. 80, no. 7.

1987. Radioactivity in drinking water. Presented to Colorado Water Quality Analysts Association.

1987. Occurrence and treatment of uranium in point of use systems in Colorado. In *Radon and Groundwater,* edited by Barbara Graves, Lewis Publishers (with others).

1987. Operation of small-scale uranium removal systems. In *proceedings* of and presented at the American Water Works Association annual conference, Kansas City, Missouri, June.

1979. Comparative evaluation of clinoptilolite minerals for wastewater renovation application. M.S. thesis, University of Colorado, Boulder.

SELECTED PROJECT EXPERIENCE

Groundwater and Soil Remediation Projects:

Aerojet General Corp. CERCLA Site – Sacramento, CA:

- Prepared draft of the Boundary Operable Unit (BOU) CERCLA FS. Institutional controls, containment/operational controls, and source removal/reduction alternatives were developed and analyzed for addressing TCE, NDMA, perchlorate, PCBs, and metals in soil, soil vapor, and groundwater media at 42 source areas within the 8500 acre site. The BOU is the first of five source area OUs undergoing the CERCLA RI/FS process. Agency comments on the draft are currently being addressed.

- Currently preparing draft of the Island OU CERCLA FS. This OU is addressing 66 source areas within the Aerojet Sacramento site, some of which contain potential NAPL concentrations of organics in groundwater and soil.

- Prepared Perimeter Groundwater OU CERCLA FS that involved development and analysis of alternatives for addressing TCE, NDMA, and perchlorate in groundwater along four on-site and off-site areas of the 8,500 acre site. No action, containment, and mass removal alternatives were evaluated for each area.

- Prepared Western Groundwater operable unit CERCLA FS (six major alternatives were evaluated) which addressed solvents and rocket fuel constituents of concern in groundwater in the western portion of the site and offsite to the west. Also prepared a construction and O&M cost estimate for a seventh alternative that would have involved in-situ treatment of perchlorate associated with the western plume.

- Prepared Groundwater Cleanup and Abatement Plan (CAP) and remedial design for the former White Rock North Dump (WRND) south-central plume. The CAP included an alternatives analysis for addressing chlorinated solvents in groundwater. Also prepared an alternatives analysis for the western plume. The analysis included both in-situ and ex-situ treatment alternatives for perchlorate and solvents.

- In 1994, for purposes of reporting environmental liability to the Securities and Exchange Commission (SEC), conducted expedited evaluation of 300 individual sites at the 8500-acre Sacramento facility with respect to whether soil and groundwater remedial action may be required, screened and evaluated remedial alternatives, and provided construction and O&M costs and schedules for proposed remedial action at 101 of the 300 sites. Contaminants included chlorinated solvents, propellants, petroleum hydrocarbons, heavy metals, and other inorganics. Provided master planning consulting and cost estimating activities associated with centralizing existing and planned future boundary groundwater extraction and treatment systems. Also provided independent technical review of treatability study results and recommendation to use a biological treatment process to remove perchlorate from groundwater. In 1997, provided update to 1994 SEC study that involved extensive cost estimating using the ENVEST environmental cost estimating system. In addition, in 2002 through 2009, provided annual and quarterly updates to 1994/1997 cost estimates based on current potential site, technology, and cost information.

- In 2006, assisted in preparing the report that documents the initial survey/assessment of the nature and extent of Conditional Asset Retirement Obligations at each of the Aerojet facilities in the U.S, as required by the Financial Accounting Standards Board (FASB) Interpretation No. 47 (FIN 47), Accounting for (CAROs).

Rocky Mountain Arsenal CERCLA Site, Commerce City, CO

- o Abandoned Hydrazine Bending and Storage Facility. Project manager for a $4.2M interim response action (IRA) for decommissioning facility. Design and construction activities associated with this project were awarded a 1991 "Engineering Excellence" award by the Consulting Engineers Council of Colorado. This design/build project involved bench- and pilot-scale testing of three vendors' UV/chemical oxidation treatment systems, design and construction of a state-of-the-art full-scale treatment system to treat 360,000 gallons of hydrazine wastewater containing NDMA to levels acceptable for discharge to a sanitary sewer system, preparation of O&M manual, operation of treatment system, and preparation of an implementation document for decommissioning.

- o Offpost Rocky Mountain Arsenal groundwater extraction, treatment, and recharge system. Technical reviewer for CERCLA FS and design manager for $11M 720 gpm system, which extracts groundwater from two pathways using 35 extraction wells, removes diisopropylmethylphosphonate (DIMP) and chloroform via upflow GAC columns, and recharges treated groundwater via 18 wells and 6 trenches. This design won a 1994 Engineering Excellence Award from the American Consulting Engineers Council.

- Confidential Wholesale Distributor, Denver, CO – Prepared alternatives evaluation to address perchloroethene (PCE) in groundwater. Implemented in-situ oxidation (ISCO) full-scale pilot test where solution containing 15,000 pounds of sodium permanganate was injected via 12 injection wells over a 6,000 sq ft area to oxidize PCE concentrations in groundwater ranging from 1,200 to 15,000 ug/L.

- Former Plummer Precision Optics/Redfield Rifle Scope Facility (Current La Plata County Detention Center), Durango, CO – Previous investigations have demonstrated TCE and 1,1,1-TCA in indoor air, soil vapor, subsurface soil, and groundwater, and the solvent stabilizer 1,4-dioxane in groundwater at the 8-acre site exceed federal and/or state standards or risk-based levels. Conducting additional site investigation and ISCO treatability study using persulfate to address 1,4-dioxane and preparing investigation report, risk assessment, and feasibility study in accordance with the substantive requirements of RCRA and CERCLA.

- West Lake Landfill CERCLA Site (OU-1), Bridgeton, MO - Prepared CERCLA FS for this municipal landfill that contains disposed uranium processing materials. Five alternatives were evaluated in the FS. Effected area ranges from 17 to 55 acres. Also conducted alternatives evaluation for removal of “hot spots” and fieldwork/data reduction associated with a radon flux determination using large area activated carbon canisters (LAACC). Currently preparing the RD for the $30M soil cover remedy selected in the ROD.

- Rocky Flats Industrial Park CERCLA Site, Jefferson County, CO – Prepared an EE/CA for two former solvents recycling facilities. This alternatives evaluation included both in-situ and ex-situ groundwater remediation technologies. Conducted pilot-scale treatability studies of the air sparging/soil vapor extraction (AS/SVE) and SVE technologies at three locations and prepared remedial design/removal action Work Plan. Prepared design documents and constructed two AS/SVE systems located on adjacent sites, one of which includes regenerative thermal oxidation and a dry scrubbing system for treatment of offgas. EMSI is currently operating the $2M systems.

- Confidential client, sites being considered for acquisition - Conducted evaluation of 69 individual sites at three RCRA- or CERCLA-regulated facilities located in three different states with respect to whether soil and groundwater remedial action may be required, screened and evaluated remedial alternatives, and provided construction and O&M costs for proposed remedial action at the individual sites. Contaminants included chlorinated solvents, heavy metals, and other inorganics and petroleum hydrocarbons.

- Woodland Township Route 532 and Route 72 CERCLA sites - Burlington County, NJ. Provided technical input with respect to alternate remedies considered in the Remedial Alternatives Analysis (RAA) and treatability studies.

- Denver Radium CERCLA site, Denver, CO – Designed and constructed bioremediation system consisting of air sparge wells to remediate soils containing oily materials. Served as a construction QA engineer representing the owner during construction of on-site monolith/capping remedy. Also prepared Construction Completion Report. Remedy included onsite solidification/stabilization (S/S) of approximately 70,000 cubic yards of above-action level soils contaminated with radionuclides, construction of an onsite monolith with the S/S soils, and capping of the monolith with a 1,000 year RCRA cap.

- Lowry Landfill CERCLA site, Arapahoe County, CO – Currently serve as QA Officer for all RD/RA projects. Participated on expert panel in developing and reviewing biological and physical/chemical process alternatives for removal of 1,4-dioxane from groundwater associated with a boundary containment system and waste pit source removal system. Also conducted bench-scale treatability studies of several technologies for pretreatment removal of 1,4-dioxane. Participated in preparing 5-year review document.

- Marshall/Boulder Landfill CERCLA Site, Boulder County, CO - Project manager for the leachate treatment phase and design manager for remedial measures. Treatment processes included equalization, pH adjustment, breakpoint chlorination, air stripping, metals precipitation, both liquid- and vapor-phase granular activated carbon (GAC) adsorption, chemical oxidation, and sludge concentration to remove iron and metals, VOCs, ammonia, and phenols. Several no-discharge options were considered to minimize concern relative to future changes regarding stream classifications and discharge standards. The treatment system is used to collect groundwater and leachate via a 1,500-foot collection trench (bio-polymer slurry construction), 35 extraction wells (pneumatic ejector pumps), and a French drain. 80 acres of the site were capped with a soil cover. Remedy construction costs were $5.2M. Prepared an O&M manual and provided engineering services during construction.

- Acme Solvents Reclaiming Inc. CERCLA Site, Rockford, IL - Named as Project Coordinator per EPA Region V CD in contract with client for RD/RA at 120-acre chlorinated solvents-contaminated site. Remedy components implemented included institutional controls, fence construction, and removal/incineration of contents of two partially buried tanks, treatability testing of three vendors of low temperature thermal desorption (LTTD) equipment for removal of PCBs from soil and sludge, EPA approval of 100 percent design of LTTD process, proof-of-process testing of LTTD at the site using infrared LTTD process, onsite treatment of 10,000 tons of soil via LTTD, solidification/ stabilization of lead-contaminated soil treated by LTTD, alternate water-supply system design and construction, SVE and groundwater extraction/treatment systems design and construction, including air modeling of off-gas emissions and preparing O&M manuals. The groundwater extraction system was constructed in fractured bedrock. Provided engineering services during construction of the RA.

- 48th and Holly (Sand Creek) CERCLA site, Commerce City, CO - Project manager for engineering services during construction of a 75-well landfill gas (LFG) extraction and thermal treatment/LFG condensate collection system. Regulatory-driven 3 month construction schedule presented significant challenge with respect to scheduling and coordination. Construction cost totaled $2M. Also provided technical and QC review for the EE/CA for OU 6 that addressed LFG.

- A.O. Polymer CERCLA Site, Sparta, NJ - Technical reviewer and QC reviewer for RD/RA design/build project involving chlorinated solvents contamination at former polymer manufacturing facility. Provided QC review for design of a 12 well SVE system to address the unsaturated zone at the former pond area where Freon 113; 1,1,1-TCA; and TCE are the primary contaminants. Offgas from the SVE system is treated via a resin sorption/desorption process. Resin sorption/desorption was proposed to USEPA as an alternative to the ROD remedy of vapor phase GAC to effectively remove Freon 113. Also provided QC review of the groundwater extraction and treatment system design and provided construction QC review. Groundwater treatment includes air stripping with offgas treatment via resin sorption/desorption.

- Wasatch Chemical Site, Salt Lake City, UT - Design manager for CERCLA RD/RA design/build project at this former pesticide and chemical manufacturing facility. Remedial activities associated with treating contaminated soil included excavating contaminated soil and piping trenches, removing chemical sludge from buried chemical sewers, and consolidating these materials and drummed dioxin-contaminated materials in an engineered cell for subsequent in situ vitrification. Soil remedial activities also included design, construction, and operation of a dewatering water treatment facility (storage, LPGAC, plate-and-frame filter press). The groundwater remedy included extraction wells, sequestering agent addition, air stripping, LPGAC polishing, and discharge under a NPDES permit. Construction costs associated with these remedial activities totaled $2M.

- Olympic View Sanitary Landfill Site – Port Orchard, WA. Prepared cost estimates for seven alternatives considered in the FS for covering the leachate lagoon. Prepared design/build documents for alternatives and assisted Waste Management, Inc. during construction of flexible membrane floating cover and lagoon mixing system.

- TRW TAPCO site - Cleveland, OH. Existing groundwater extraction trenches and treatment/discharge system. Served on Value Engineering (VE) team for Camp, Dresser & McKee in evaluation of existing systems designed by others. Provided recommendations to client for modifications to save O&M costs.

- Confidential Client, Lakewood, CO – Conducted soil vapor and groundwater field investigation and prepared alternatives analysis for removal of PCE from soil and groundwater. Alternatives analysis included both in-situ and ex-situ remediation technologies.

- Offsite Area – Former Redfield Facility, Denver, CO – Prepared preliminary construction and O&M cost estimates for remediation of groundwater contaminated with solvents. Also prepared conceptual remedial design drawings.

- Woodland Container, Aitken, MN - Conducted design QC of a land treatment unit that was used to bioremediate pentachlorophenal and diesel-contaminated soil.

- Remedial design projects throughout the US: Served as either the project manager, design task manager, principal-in-charge, technical reviewer, or QC reviewer on the following remedial design projects. These projects all involved preparing detailed design drawings and technical specifications for construction under either the design/build or design/bid scenarios, preparing O&M manuals, and providing engineering services during construction:

- TRW - Hawthorne, CA groundwater extraction and treatment early action. Air stripping with regenerable vapor phase GAC and fluidized-bed biological treatment are used to address chlorinated solvents and ketones, respectively, in groundwater.

- TRW - Colorado Crystal site - Loveland, CO soil and ground water State cleanup site. Provided technical and QC review with respect to soil removal and ground water/seeps conceptual model, remedy alternatives, and design.

- Teledyne Rodney Metals - Scottdale, PA groundwater hydraulic control system and soils remediation. Groundwater contaminated with chlorinated solvents, including DNAPLs, was collected in a trench with an HDPE liner located on the downgradient side and treated via air stripping. Resin sorption/desorption was used for offgas treatment and treated groundwater was recycled to an inplant boiler for cooling. Soils excavated from a downgradient stream channel improvements project were treated via SVE in a constructed treatment cell.

- Honeywell - Ft. Washington, PA groundwater treatment system. A UV/chemical oxidation reactor was installed in an existing building to treat chlorinated solvents.

- GE Plastics - Ottawa, IL soil treatment. Specifications and bidding documents were prepared and construction management provided for treatment of soil contaminated with benzylbutylphthalate, bis(2-ethylhexyl) phthalate and phenol via low temperature thermal desorption.

- Sundstrand - Denver, CO groundwater and seeps remediation. A 400 gpm groundwater and free product recovery system and offsite seeps collection and treatment facility were constructed. Treatment consists of air stripping and liquid phase carbon polishing for VOC removal with ultrafiltration for addressing emulsions.

- Rodale Manufacturing CERCLA site - Emmaus, PA groundwater extraction and treatment. Resin sorption/desorption is used to treat offgas from the air stripping process which is used to remove VOCs from groundwater. A sequestering agent is added to prevent iron and manganese precipitation.

- Green River Disposal CERCLA Site - Daviess County, KY RCRA Subtitle C cap. A leachate collection trench and 20 acre cap were designed at a former landfill.

- Munoz Pits State Superfund site - Mission, TX - QC reviewer for design and construction oversight for removal of soil contaminated with pesticides and arsenic.

- City of San Francisco 24th and Utah former municipal railway yard - QC reviewer for design of in situ bioremediation system for soil and groundwater contaminated with diesel and other petroleum hydrocarbons.

- National Semiconductor Corporation and Matsushita Semiconductor Corp. of America - diesel fuel-contaminated loading dock area, Puyallup, WA - Technical and QC review for design of in situ bioremediation of soil and groundwater using extraction wells, recharge trenches, an aboveground oil/water separator and submerged fixed film bioreactor, nutrient and hydrogen peroxide addition, and liquid-phase LPGAC polishing facilities. An O&M manual was prepared for the treatment facilities. Construction costs associated with the remedy were $0.5M.

- Monsanto Chemical Co. - stormwater wastewater treatment system revisions, Carson, CA - Provided design services involving repiping and providing power/controls to convert a decommissioned industrial wastewater treatment facility (pump stations, oil/water separator, LPGAC units, and tanks) to a storm-water treatment facility at a demolished chemical manufacturing plant. Design also included incorporating client's process and instrumentation diagram (P&ID) and technical specifications into design package.

- Methode Electronics East - electronics manufacturing site cleanup regulated under New Jersey Industrial Site Recovery Act (ISRA), Willingboro, NJ - Chlorinated solvent-contaminated groundwater and soil vadose zone concerns are being remediated under a design/build scenario using the air sparging/SVE processes. Construction costs were $1.4M.

- Caloric, Inc. - former appliance manufacturing site, near Allentown, PA - Remedial action included excavation and disposal of soil from seven paint sludge, porcelain impoundment, and plating sludge impoundment sites contaminated with TCA, xylenes, barium, cadmium, nickel, chromium, and cyanide.

- Ashland Chemical/Western Forge - metal hand tool manufacturing facility, Colorado Springs, CO - assisted in excavating, aerating, and bioremediating 1,500 cubic yards of acetone-contaminated soil with concentrations up to 15,000 parts per million at a RCRA-compliant treatment system. The excavation adjacent to an operating facility was backfilled with recycled concrete. A state-of-the-art buried concrete vault was designed to contain two steel tanks of acetone and isobutyl acetate, including transfer pumps, level controls, and a ventilation system. Performed a full-scale evaluation of pressure grouting into the recycled concrete as a foundation for the vault. A caisson foundation was eventually constructed. Of particular concern during construction was preventing movement of the existing building foundation.

- Gasoline station, Westminster, CO - Reviewed a remedial action plan involving drawdown and skimming of free product from a recovery well with discharge of drawdown water to the municipal sewer.

Contaminated Site Investigation/Remediation:

- Rocky Mountain Arsenal, Denver, CO - Served as Deputy Program Manager for delivery order projects completed under former employer's 1988 prime contract ($23.4M of work completed) and projects completed while I served under former employer's 1992 prime contract ($14.3M awarded under my service). Duties as Deputy Program Manager included providing technical and administrative direction and guidance to task managers and program support staff, preparing and defining scopes of work, cost estimates, and schedules, negotiating delivery orders and modifications with the Contracting Officer, conducting monthly technical and performance review meetings with the Army, reviewing monthly cost/schedule status reports, conducting technical and QC reviews, auditing former employer's performance, and conducting presentations to parties involved in the RMA program. Specific delivery order projects included (1) Offpost OU remedial investigation (RI), endangerment assessment (EA), FS, and ROD preparation; (2) Offpost OU IRA groundwater extraction/treatment/recharge system treatability studies, design, and engineering services during construction; (3) Offpost OU monitoring well installation, sampling, and analytical program; (4) treatability studies program in support of the Onpost OU FS (treatability studies included evaluating subsurface drains, 12 aquifer pumping tests, UV/chemical oxidation treatment of contaminated groundwater, and SVE for removal of mass and odor-causing chemicals from near the Basin F waste pile); (5) Emerging Technologies Evaluation Program where bench-scale treatability studies were performed using aqueous soil washing and solvent extraction processes to provide input to the onpost FS with respect to reducing the potential 3,000,000 cubic yards of organochlorine pesticide-contaminated soil requiring remediation; in addition, 14 soil, groundwater, and contaminated building emerging technologies were evaluated under a similar format to the EPA Superfund Innovative Technology Evaluation (SITE) program; (6) installation-wide onpost and offpost comprehensive (1,800 wells) groundwater monitoring program; (7) installation-wide data quality assessment including review of well construction, water quality, and water levels to support a vertical extent of contamination assessment; (8) in accordance with RCRA, management of soil, water, used personal protective equipment, and laboratory wastes from RMA sampling activities, including collection, transport, and storage; solidifying wastes; and operating, maintaining, and inspecting the Basin F IRA waste pile, tank farm, and surface impoundment structures; (9) implementation of Section 36 complex disposal trenches IRA including monitoring and annual reevaluation report; (10) Hydrazine Blending and Storage Facility IRA including treatability testing, design, construction, and operation of UV/chemical oxidation treatment process for removal of hydrazine rocket fuels and NDMA from rinsewater; (11) evaluation of the 19.5-acre three cell Basin F waste pile, including assessments of the cover, leachate collection and removal systems, secondary liner, and response action plan; (12) pilot-scale evaluation of solvent extraction process for removal of pesticides from soil; (13) pilot-scale evaluation of SVE technology at 16 locations in Basin A, Basin F, and South Plants; (14) geotechnical soil boring program (98 soil borings, 340 geotechnical analyses) to evaluate the use of onsite low permeability soil for landfill cap, landfill liner, and structural borrow materials for construction of an onsite landfill; and (15) preparation of closure plans for Basin F IRA structures, including Pond A, Pond B, the tank farm, and the submerged quench incinerator. The standardized closure process included the decontamination, removal, restoration, and certification phases.

Industrial and Municipal Water and Wastewater Treatment Facility Design:

- Reviewed designs, identified deficiencies, and provided improvement recommendations for three package water treatment plants and a domestic wastewater treatment facility. For the Town of Nederland, CO, Blue River Water District in Summit County, CO, Genessee Water and Sewer (W&S) District, CO, and Pinebrook Water District, near Boulder, CO.

- Conducted wastewater treatment facility audits for three aluminum can manufacturing facilities in North America. Included on-site review of treatment system unit operations; review of operating, maintenance, monitoring, cost, and regulatory requirement data; and provision of recommendations report.

- Dutchman’s Hill Water Company, Cedar Hill, NM - designed improvements to water system including addition of a sequestering agent for control of iron and manganese precipitation, hypochlorite for disinfection, aeration for methane removal, treated water storage capacity, and a radio telemetry system to control pumping of water among the three water storage facilities in the system.

- Warrior's Mark water treatment facility, Blue River Water District, Summit County, CO - designed a 200-gpm adsorption clarifier and pretreatment modifications to eliminate giardia concerns.

- Colorado and Wyoming - Prepared design drawings and specifications for construction, plans of operation, and O&M manuals for various municipal water and wastewater treatment facilities. Also served as resident engineer during construction or provided office engineering services during construction. Unit processes included chemical feed, residuals thickening and dewatering, sidestream treatment, biological treatment and digestion, filtration, mechanical conveyance, flocculation, filtration, chlorine disinfection, pumping, and instrumentation. Facilities included:

  - City of Sheridan, Wyoming (4.4-million gallons per day [mgd] wastewater treatment)
  - Cities of Littleton and Englewood, Colorado (33-mgd wastewater treatment)
  - City of Brighton, Colorado (2.63-mgd wastewater treatment)
  - City of Highlands Ranch, Colorado (16-mgd water treatment)
  - City of Laramie, Wyoming (7-mgd water treatment)
  - City of Westminster, Colorado (5-mgd wastewater treatment)
  - Town of Nederland, Colorado (0.2-mgd wastewater treatment)

- Water distribution system - Nederland, CO - prepared a potable water system distribution analysis using computer modeling, identified prioritized list of system deficiencies and construction costs, and designed piping and fire flow booster pump station improvements.

- Prepared water and sanitary sewer utility rate studies for customers served by the City of Sheridan, WY.

- Manville Corporation - fiberglass manufacturing facilities, Innisfail, Alberta, and Parkersburg, WV - Served as project manager and process engineer for eliminating high concentrations of pathogenic organisms in recycled multiple-source process water containing phenols and formaldehyde. Program involved onsite sampling and analysis, participation in onsite cleanup of process piping and equipment, pilot plant evaluation of alternative technologies, recommending short-term solution, and implementing long-term process facilities.

- Industrial wastewater pretreatment programs for cities of Boulder, Westminster, Littleton, Englewood, and Grand Junction, CO - As project manager, prepared methodology and developed specific pollutant discharge limitations for industry, inventoried multiple pollutant sources at several industries, reviewed the designs of industrial wastewater pretreatment systems, and implemented compliance monitoring programs and enforcement activities.

- City of Boulder, CO - wastewater sludge processing and headworks facilities - Project manager for FSs, preliminary and final design of wastewater residuals processing, and ultimate disposal program for a 16.8-mgd municipal wastewater treatment facility. Included operational-related improvements to existing facilities. Equipment sized for 120 gpm included gravity thickeners, polymer and ferric chloride chemical feed systems, solid-bowl centrifuges, associated feed pumps and flow measurement, mechanical conveyance equipment, storage, and hauling and application vehicles. New headworks equipment included pneumatic conveyance of screenings and grit and mechanical bar screen. Provided construction management, grant funding assistance, and regulatory interface, and prepared the startup plan, plan of operation, and O&M manual. Led to the publication of two articles by the City of Boulder Utilities staff: "Innovation in Boulder, Getting Operators and Designers to Talk" and "Involvement of Operations Staff in Facility Planning, Design and Construction." Construction costs associated with the remedy totaled $3.9 million.

- Union Carbide Corp. and Denver Water Dept. - ammonia removal from wastewater, Commerce City, CO - Performed bench- and pilot-scale evaluations using ion exchange media for ammonium removal from wastewater. Wastewater was treated to potable water quality as part of the Potable Reuse Demonstration Project.

- Cities of Gloversville and Johnstown, NY - treatment of leather tanning industrial and domestic wastewater - Prepared sections of 201 Facility Plan and computer modeling to determine plant effluent limitations.

- City of Westminster, CO - 5 mgd municipal wastewater treatment facility - evaluated the effects of high pH industrial discharge on biological treatment processes.

- Watershed survey of industrial, municipal, and RCRA facilities in Clear Creek watershed, Colorado - for the Cities of Thornton and Westminster, CO, identified point source discharges, industries reporting under RCRA, and landfills in watershed.

Uranium Removal Design:

- Uranium removal from drinking water, West Jefferson County, CO - Project manager and design engineer for design, construction, and operation of an ion exchange process for several locations. Provided construction inspection services. Uranium, radon, and gamma radiation levels were monitored for one year under an EPA grant.

- Confidential In-Situ Leach (ISL) Mining Company: ISL uranium mining projects in Colorado and South Dakota. Prepared preliminary design and construction/operating cost estimating in support of permitting and Life of Mine (LOM) costing efforts. Design included aboveground uranium recovery, yellowcake production, surface impoundment, land application, and mining unit header house equipment, facilities, and buildings, as well as supporting utilities and infrastructure.

TIMOTHY C. SHANGRAW, P.E.

Mr. Shangraw has over 29 years of technical and management experience relevant to hazardous waste investigations, feasibility studies, remedial design (RD) and construction, operations and maintenance (O&M), and permitting, as well as water and wastewater treatment, mine dewatering, mine permitting, stormwater planning; and environmental studies. His expertise is particularly strong in conceptual and detailed design and implementation of hazardous waste removal, treatment and stabilization programs; groundwater pump and treat systems; landfill gas collection and treatment; RCRA compliance; and performance and compliance monitoring.

For the past 14 years, Mr. Shangraw has managed RD, remedial action, and O&M of the Lowry Landfill Superfund Site near Denver, Colorado. This has been a $100M+ project involving bentonite slurry walls, biopolymer slurry trenches, groundwater pump and treatment systems, waste pit excavation and treatment, landfill gas collection and treatment, landfill capping, wetlands restoration, and extensive environmental monitoring. Unique challenges included development of a new technology to biodegrade 1,4-dioxane and tetrahydrofuran in groundwater and application of emerging technologies to thermally treat waste pit material *insitu*, biotreat excavated waste material *exsitu*, optimize landfill gas extraction to fuel a gas-to-energy plant, and optimize subsurface conditions to enhance natural attenuation of organic compounds. Many of these activities were published in technical journals and/or presented to national technology-transfer organizations.

Throughout his career, Mr. Shangraw has managed and technically directed regulatory closures for Superfund, RCRA, and radioactive mixed-waste sites for Fortune 500 companies throughout the United States, for DOD sites, and for US DOE sites. He has also assisted clients with estimating present and future environmental liabilities for current assets and pending acquisitions and divestitures.

EDUCATION

M.S., Civil/Environmental Engineering, University of Colorado, Boulder, 1979
B.S., Civil Engineering, Southeastern Massachusetts University, 1977

REGISTRATION

Registered Professional Engineer (Colorado, 1981, No. 19853)

EMPLOYMENT HISTORY

1998-Present Engineering Management Support, Inc. Littleton, Colorado

Vice President and Principal Engineer. Managing and directing cleanup of Superfund and RCRA sites nationwide (see Selected Experience)

1984-1998 PARSONS Corporation. Denver, Colorado

Senior Associate and Program Manager. Directed, managed, or performed hazardous waste studies, design, and construction projects performed from the Denver, Salt Lake City, and Richland, Washington offices. Projects included restoration programs under RCRA and CERCLA for industry, PRP groups, Department of Defense, and Department of Energy. Also responsible for staff recruiting/retention, business development, quality control, P&L, and intra-company coordination of Denver's operations.

1983-1984 Law Engineering Testing Company. Englewood, Colorado.

Project Engineer. Performed RCRA compliance studies for wood preserving sites throughout the United States. Conducted field investigations, prepared landfill siting studies, and designed lagoon closures. Also prepared drainage reports for land development projects utilizing HEC-2 flood plain model.

1980-1983 D'Appolonia Consulting Engineers. Englewood, Colorado.

Staff Engineer. Conducted remedial evaluations of abandoned mine reclamation sites, prepared environmental baseline studies for coal gasification plants and underground mines, and participated in cleanup of Enterprise Avenue Superfund Site in Philadelphia, Pennsylvania. Also participated in geotechnical studies for surface water impoundments and mine subsidence evaluations.

1979-1980 Cyprus Mines Corporation - Hansen Project, Canon City, Colorado.

Staff Engineer/Hydrologist. Responsible for design of dewatering systems for large open pit uranium mine. Performed aquifer tests, supervised computer modeling study, and integrated dewatering system into mine development plans. Also provided conceptual designs for treatment of radioactive mine water.

AFFILIATIONS AND MEMBERSHIPS

Willowbrook Water and Sanitation District – Director
Water Environment Federation
DOE "Q" Clearance (Rocky Flats Plant)

PUBLICATIONS AND PRESENTATIONS

T.C. Shangraw, W. Plaehn, S. Richtel, D. Bollmann, 2003. “Biological Treatment Option for 1,4-Dioxane in Landfill Leachate.” Presented at the 9th Symposium in the

Series on Groundwater Contaminants for the California Groundwater Resources Association, San Jose, California, December 10.

W.A. Plaehn, T.C. Shangraw, M.F. Steiner, M. Murphy, L.T. Tagawa, and D.D Bollmann. 2000. “Case Study in the Constructability Testing and Operation of an Ex-Situ Soil Treatment Cell.” Presented at the Second International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California. May 22-25.

W.A. Plaehn, P.R. Guest, T.C. Shangraw, K.A.Friesen, L.T.Tagawa, and D.D. Bollmann. 1998. “ROD Amendment for On-Site Treatment of Hazardous Waste Pit Materials.” Presented at the 14th Annual Conference on Contaminated Soils, University of Massachusetts at Amherst. October 19-22.

Yu, J.K., C. Stoltz, T.C. Shangraw, M. Stofford, and G.A. Jones. 1990. "Surface Water and Ground Water TCE Interactions of Air Force Installations at Foothills, Denver Basin, Colorado and Suisan - Fairfield Basin, California." Presented at the Annual Meeting of the Association of Ground Water Scientists and Engineers, NWWA, Anaheim, California, September 25-27.

Hicks, J.R., T.M. Murphy, L.A. Korner, T.C. Shangraw, and J.K. Yu. 1990. "Hydrogeologic Characterization Supporting a Ground Water Contaminant Pathway Evaluation at Air Force Plant PJKS, Waterton, Colorado." Presented at Groundwater Engineering and Management Conference, Denver, Colorado, February 28-March 1.

Shangraw, T.C., T.S. Mustard, and D.P. Michaud. 1988. "Remote Detection of Ground Water Contamination Using Soil Gas Surveys." Presented at the AICHE Summer National Meeting. Denver, Colorado, August 21-24.

Shangraw, T.C., D. P. Michaud, T.M. Murphy, and J.K Yu. 1988. "Verification of the Utility of a Photovac Gas Chromatograph for Conduct of Soil Gas Surveys." Second National Outdoor Action Conference, NWWA, Las Vegas, Nevada, May 23-26.

Shangraw, T.C. 1987. "Application of Soil Gas Surveys for Remote Detection of Ground Water Contamination." Presented at the AWWA/WPCA Clean Water Conference, Denver, Colorado, May.

SELECTED EXPERIENCE

Currently supervising contractor/project coordinator for RD/RA, and O&M of the sitewide remedy for Lowry Landfill Superfund Site near Denver, CO. Remedial components include: collection and treatment of landfill gas involving 50 extraction wells, 20 perimeter monitoring probes, three miles of buried laterals/headers, a 2,000 scfm enclosed flare, automatic condensate traps, and automated operations; an 8,800 LF perimeter bentonite slurry wall; two groundwater extraction systems; two water treatment plants; excavation and onsite treatment of 20,000 CY of waste pit material; five miles of buried waterlines; wetlands reconstruction; and two landfill covers. Geotechnical, hydrogeologic, and bench scale treatability studies were performed in support of RD. Site groundwaters are pretreated onsite, then pumped offsite to a POTW. Issuance of a POTW industrial discharge permit necessitated extensive negotiations with two municipalities, USEPA Region VIII, and CDPHE. O&M manuals and Performance and Compliance Monitoring Plans were also prepared for all remedial components/environmental media. Throughout the project, regulatory liaison with USEPA Region VIII and CDPHE has been provided, including negotiating several ROD modifications and Explanation of Significant Differences, negotiating a new Statement of Work under a new Consent Decree, speaking at public meetings, leading design review meetings, and preparing quarterly O&M status reports. Budgeting, cost control, schedule control, and presentations to the PRP Steering Committee are also required.

Also currently participating in RD/RA, O&M, and monitoring of a DNAPL cleanup program at a drum recycling facility, an *in-situ* chemical oxidation (ISCO) cleanup program at a chemical distribution facility, an ISCO treatability study for 1,4-dioxane remediation at a former rifle scope manufacturing plant, and reclosure of a municipal solid waste landfill.

Project manager for RI/FS, and natural resources damage assessment for the Eagle Mine Superfund Site in Eagle County, Colorado. Heavy metals and acid mine drainage were the contaminants of concern. Recommended alternatives of capping mine wastes in place, implementing runon and runoff controls, stabilizing mine tailings and waste rock piles, and treatment of mine discharges were all incorporated into the ROD.

Task manager for engineering studies for an RI/FS, and natural resources damage assessment for the Yak Tunnel/California Gulch Superfund Site near Leadville, Colorado. Sources of heavy metals contamination included tailings ponds, waste rock, and roaster piles from the mining and processing of ore.

Project manager for programmatic RCRA corrective measures studies and CERCLA feasibility studies (CMS/FSs) for three operable units at the DOE's Rocky Flats Plant Superfund Site near Golden, Colorado. Supported development and negotiations of regulatory requirements and land use limitations to focus remedial alternatives development and evaluation. Supported DOE throughout remedy selection and ROD negotiations. Project manager for design, construction management, startup, and O&M support for the Lowry Landfill Superfund Site Surface Water Removal Action (SWRA). Project involved collecting contaminated groundwater and seepage via separate systems, treating them in a single treatment facility, then reinjecting downgradient of a subsurface barrier wall. Project was completed in half the time and at a 20 percent cost savings.

Technical director for CERCLA RI/FS for approximately 60 hazardous waste sites at the Air Force Plant PJKS Superfund Site near Waterton, Colorado. Soil, groundwater, and landfill contamination were assessed, a risk assessment was performed, and a plant-wide FS was prepared.

Technical director for an RI/FS and remedial design for soil and groundwater contamination at the Nebraska Air National Guard Base in Lincoln, Nebraska.

Technical director for an RI/FS and pilot-scale vapor extraction testing at the Chemical Sales Company Superfund Site in Denver where soils and groundwater contamination had resulted from spills and leaks at a bulk chemical storage facility. ROD included recommended remedial action.

Technical director for RCRA Part B permitting, waste minimization, and characterization of contamination at a Utah explosives manufacturing plant.

Technical director for an RI and implementation of soils remediation at a Phoenix, Arizona pesticide formulating facility.

Project manager and technical director for feasibility studies associated with remediation of hazardous, radioactive, and mixed wastes at the DOE's Hanford Superfund Site in Washington.

Technical director for underground storage tank management planning for 71 tanks at the DOE Rocky Flats Plant Superfund Site. Follow-on work included removal and replacement or abandonment of six USTs.

Technical director for identification and preliminary characterization of more than 1,000 process tanks at the Rocky Mountain Arsenal Superfund Site in Colorado. Many tanks were used in the production of pesticides and nerve agents and are highly hazardous. Also supervised preparation of a contingency plan for all on-post activities.

Project manager for RI for five hazardous waste sites at Edwards AFB Superfund Site in California.

Project manager for a CERCLA site inspection at Air Force Plant PJKS Superfund Site in Colorado.

Project manager for a groundwater assessment and RCRA Part B permitting, design of lagoon closure, and remedial action oversight at hazardous waste sites associated with a Wyoming coking facility.

Feezor Engineering, Inc.

DANIEL R. FEEZOR, P.E.

President

Education

B.S., Agricultural Engineering, University of Illinois at Urbana-Champaign, 1989

M.S., Agricultural-Environmental Engineering University of Illinois at Urbana-Champaign, 1994

Licensing

Registered Professional Engineer
- Illinois
- Missouri
- Indiana

Illinois Certified Landfill Operator

Expertise

Landfill Siting

Landfill Permitting

Landfill Design and Remediation

Landfill Gas Systems

Landfill Construction

Work History

Feezor Engineering, Inc. President 2000-Present

EMCON, Office Manager 1996-2000

Andrews Environmental Engineering, Inc. Project Manager 1990-1996

Professional Experience

Mr. Feezor is the President and Owner of Feezor Engineering, Inc. He has extensive solid waste management experience, including designing waste management facilities and hydraulic structures; securing NPDES permits; and permitting new landfill units in accordance with Illinois regulations. He has also designed three material recovery facilities and provided construction observation for landfills in Missouri and Illinois, including serving as a construction quality assurance officer for several landfill facilities in accordance with the 35 Illinois Administrative Code 811 regulations.

Project Experience

Landfill Siting

- **Prepared design, site plan drawings, calculations, and narratives for the S.B. 172 local siting application for lateral expansion at the Pagel Landfill in Rockford, Illinois. Participated in the preparation of the significant modification permit application and prepared the CERCLA final cover work plan. Prepared design, site plan drawings, calculations, and narratives for an application for a material recovery facility.**
- **Project Manager for the Deer Track Landfill Expansion in Johnson City, Wisconsin, for Sanifill, Inc.**
- **Project Manager for the 28 million cubic yard expansion of the Roxana, Illinois landfill. Prepared design, site plans, calculations and narratives for the S.B.172 local siting application.**
- **Prepared design drawings, calculations, and narratives for the 25 million cubic yard expansion of the Envirite/American Disposal Services' Livingston Landfill in Pontiac, Illinois for the S.B. 172 local siting application.**
- **Project Manager for the Roxana, Landfill siting for an additional 29 million cubic yard expansion. Included developing plans and specifications, coordinating geotechnical studies, developing needs and solid waste management plan assessment reports, and operational plans.**

Landfill Permitting

- **Managed the preparation of the significant modification permit application for Envirite/American Disposal Service's Livingston Landfill**

in Pontiac, Illinois, including a lateral expansion for a total landfill area of 250 acres.

- **Served as Project Engineer for the preparation of a permit application for the lateral expansion of an existing Part 807 facility under RCRA Subtitle D Regulations.**

- **Managed the preparation of a significant modification permit application at the Brickyard Disposal and Recycling facility in Danville, Illinois. Prepared drawings and calculations and assembled pretreatment permit applications for discharges to the local treatment system.**

- **Project Manager for the significant modification permit application for the Pagel Landfill in Rockford, Illinois, Northern Unit.**

- **Project manager for the Danville General Motors foundry sand landfill stormwater drainage revisions. Included securing Part 807 permit for revised stormwater letdowns, and a total revision of the stormwater conveyance system.**

- **Project Manager for the South Unit Expansion for the Pagel Landfill in Rockford, Illinois. Prepared drawings and specifications, reports and calculations in support for the permit application.**

- **Project Manager for the Rockford Airport final cover IEPA permit design in Rockford, Illinois. Included balancing the waste to allow relocation to accommodate future runway expansions. Prepared drawings and specifications, reports and calculations in support for the permit application.**

- **Project Manager for Waste Management, Five Oaks Landfill in Taylorville, Illinois gas design revision and leachate forcemain design. Prepared drawings and specifications, reports and calculations in support for the permit application.**

- **Project Manager for the Roxana Landfill gas system upgrade and leachate system upgrade for 125 acre facility. Included the design of a gas control and collection system to process up to 5,000 cubic feet per minute landfill flow rate.**

Landfill Construction

- **Served as Construction Quality Assurance Officer for Wayne County Landfill Area IIA liner, 7.2-acre landfill construction, Fairfield, Illinois.**

- **Served as Construction Quality Assurance Officer for Wayne County Landfill Area IIIA liner, 5-acre landfill construction, Fairfield, Illinois.**

- **Served as Construction Quality Assurance Officer for the Pagel Landfill, North Unit, Western Landfill Closure. Included 16.5 acres of synthetic final cover, with a dual leachate and gas collection system.**

- **Served as Construction Quality Assurance Officer for the Southern Illinois Regional Landfill, Baseliner Construction, 8 acres, Desoto, Illinois.**

- **Served as the Missouri Certifying Engineer for the Prairie Valley Landfill Cuba, Missouri, Baseliner (New Greenfield Site). Included test liner analysis, construction of 3.2-acre liner, and all necessary infrastructures.**

- **Served as Construction Quality Assurance Officer at the R.C.S. Inc., Landfill in Jerseyville, Illinois, including construction and testing of an earthen test liner, construction staking for the excavation of 1 million cubic yards of soil, oversight and testing of full-scale liner construction, and the development of leachate drainage, collection, and management systems.**

- **Provided construction oversight and documentation for the closure of the McHenry County Landfill in Crystal Lake, Illinois, including passive gas vent installation and the placement, testing, and documentation for the recompacted earthen layer.**

- **Installed field testing apparatus and analyzed the field permeability of a test liner for the Pagel Landfill, in Rockford, Illinois; RCS Landfill, in Jerseyville, Illinois; Saline County Landfill, In Harrisburg, Illinois; Brickyard Landfill in Danville, Illinois; Roxana Landfill, in Roxana, Illinois; the Envirofil Landfill in Macomb, Illinois, and the Ameran Duck Creek Gypsum Stack in Canton, Illinois.**

- **Served as the Construction Quality Assurance Officer at the Wayne County Landfill 5-acre cell 3B baseliner, Fairfield, Illinois. Project included constructing a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at Pagel Landfill, 27-acre final cover system, eastern half, of the North Unit, in Rockford, Illinois. Project included a composite cap, and a dual leachate/gas collection system.**

- **Served as the Construction Quality Assurance Officer for the 62-acre Danville, Illinois General Motors Foundry Sand Landfill, final cover construction. In addition, served as the Construction Quality Assurance Officer for the new foundry sand landfill (in accordance with 35 Illinois Administrative Code 817) at the Danville, Illinois General Motors Facility.**

- **Served as the Construction Quality Assurance Officer for the 9-acre Cell 3 of the South Unit at Pagel Landfill in Rockford, Illinois. Project included constructing a clay and geosynthetic liner, a leachate collection and drainage system and leachate forcemain connection.**

- **Served as the Construction Quality Assurance Officer at the Wayne County Landfill, 5-acre cell 2B baseliner, Fairfield, Illinois. Project included constructing clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served and the Construction Quality Assurance Officer at the Rockford Airport Landfill No 1 in Rockford, Illinois. Project involved closing an old landfill associated with World War 1 Camp Grant landfill with varying runways, taxiways, and hangers overlying the old landfill. Project included investigating the existing earthen cover, supplementing cover with additional engineered materials, and permitting with the IEPA several alternative covers including building foundations and runway paving. Total project encompassed 16 acres.**

- **Served as the Construction Quality Assurance Officer at the Wayne County Landfill, 4-acre cell 2C baseliner, Fairfield, Illinois. Project included constructing a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 5-acre Module 5 baseliner, Roxana, Illinois. Project included constructing a dewatering system, a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 5-acre Module 7A baseliner, Roxana, Illinois. Project included constructing a dewatering system, a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Waste Management Peoria City / County Landfill No. 2 at Peoria, Illinois. Project included 6 acres of Cell 10 baseliner which included a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer for the 9-acre Cell 4 of the South Unit at Pagel Landfill in Rockford, Illinois. Project included constructing a clay and geosynthetic liner, a leachate collection and drainage system. Project also included the installation of gas collection wells, a header system, and utility flare.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 5-acre Module 8A baseliner, Roxana, Illinois. Project included constructing a dewatering system, a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 5-acre Module 9A baseliner, Roxana, Illinois. Project included constructing a dewatering system, a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 1.8-acre Module 10A – South baseliner, Roxana, Illinois. Project included constructing a dewatering system, a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Brickyard Landfill, Danville Illinois, 3.2-acre Cell 5A baseliner. Project included constructing a clay and geosynthetic liner, a leachate collection and drainage system, including a sump and leachate forcemain connection.**

- **Served as the Construction Quality Assurance Officer at the 62-acre Foundry Sand Landfill, Danville, Illinois. Project included overseeing the final cover and stormwater revisions, terraces and linkmat articulated concrete block chute installation for a stormwater letdown.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 5.2-acre Module 10A – South and 11A baseliner, Roxana, Illinois. Project included constructing a dewatering system, a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Wayne County Landfill, Fairfield, Illinois leachate extraction system. Design included an innovative telescoping riser design to replace a failed sideslope riser.**

- **Served as the Construction Quality Assurance Officer at the Waste Management Peoria City / County Landfill No. 2 at Peoria, Illinois. Project included 6 acres of Cell 9 baseliner which included a clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer the gas system expansion, South Unit at Pagel Landfill in Rockford, Illinois. Project included the installation of gas collection wells, a header system, and an additional utility flare.**

- **Served as the Construction Quality Assurance Officer at the Brickyard Landfill, Danville, Illinois, 5-acre Cell 5B baseliner. Project included constructing clay and geosynthetic liner, and a leachate collection and drainage system.**

- **Served as a Missouri Certifying Engineer for the Bridgeton Landfill, Bridgeton, Missouri, Operable Unit Number 1 Lagoon Closure. Project involved draining the lagoon to a Sewage Treatment Plant, removing the sludge to a special waste landfill, and grading the remaining lagoon using the perimeter berms to promote positive drainage. Project also included testing the residual soils to ensure the remaining soils were devoid of contamination.**

- **Served as the Construction Quality Assurance Office at the RCS, Inc. Landfill in Jerseyville, Illinois, 3.2-acre Cell 2A Sideslope and Cell 3A baseliner construction. Project included constructing clay liner, and a leachate collection and drainage system, and an underground leachate storage tank and forcemain connections. The project also included installing 6 passive gas flares with solar igniters.**

- **Served as the Construction Quality Assurance Officer for the Coles County Landfill, Charleston, Illinois, 7-acre Western Slope Closure. Project included a final cover consisting of a low permeability earthen liner, a geosynthetic liner, and a protective layer. Also included was a vegetation layer and stormwater controls.**

- **Served as the Construction Quality Assurance Officer at the Coles County Landfill, Charleston, Illinois, 1.5-acre Cell 10B baseliner. Project included constructing clay and geosynthetic liner, and a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Wayne County Landfill, 2.68-acre cell 2D baseliner, Fairfield, Illinois. Project included constructing clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Brickyard Landfill, Danville, Illinois, 3.7-acre Cell 4D and 5C baseliner. Project included constructing clay and geosynthetic liner, and a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Illinois Landfill, Hoopeston, Illinois, 2.05-acre Cell 2B baseliner. Project included constructing clay and geosynthetic liner, and a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 10-acre Expansion Cell 2A and 3A baseliner, Roxana, Illinois. Project included constructing a clay and geosynthetic liner, a leachate collection and drainage system. Project also included developing a sump with leachate forcemain connection.**

- **Served as the Construction Quality Assurance Officer at the Sangamon Valley Landfill, Springfield, Illinois, 6.0-acre Cell 2A and 3A baseliner. Project included constructing clay and geosynthetic liner, and a leachate collection and drainage system. Project also included developing stormwater controls, ponds, and leachate forcemain connections.**

- **Served as the Construction Quality Assurance Officer at the Waste Management Five Oaks Landfill Taylorville, Illinois. Project included the installation of a vertical gas collection well system and associates laterals and headers to convey the gas to a gas to energy facility. Project also included running over 1 mile of HDPE forcemain and airline to power the pneumatic system.**

- **Served as the Construction Quality Assurance Officer for the Coles County Landfill, Charleston, Illinois, 7-acre Northern Slope Closure. Project included a final cover consisting of a low permeability earthen liner, a geosynthetic liner, and a protective layer. Also included was a vegetation layer.**

- **Served as the Construction Quality Assurance Officer for the Brickyard Landfill, Danville, Illinois, 17-acre Eastern Slope Closure. Project included a final cover consisting of a low permeability earthen liner, a geosynthetic liner, and a protective layer. Also included was a vegetation layer and stormwater controls.**

- **Served as the Construction Quality Assurance Officer for the Saline County Landfill, Harrisburg, Illinois, 20.5-acre Unit 1 Closure. Project included a final cover consisting of a low permeability earthen liner, a geosynthetic liner, and a protective layer. Also included was a vegetation layer and stormwater controls, and with leachate and gas collection revisions.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 4.5-acre Expansion Cell 2B and 3B baseliner, Roxana, Illinois. Project included constructing clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Office at the Waste Management Envirofil Landfill, Macomb, Illinois. Project included developing 2.3 acres of baseliner for Phase 2A-1, which involved constructing clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Missouri Certifying Engineer at the Missouri City, Missouri closed landfill. Project included overseeing the construction of a 10,000 leachate storage tank and pumping system for under hazardous waste definitions.**

- **Served as the Construction Quality Assurance Officer at the Roxana Landfill, 12.8-acre Expansion Cell 2C and 3C baseliner, Roxana, Illinois. Project included constructing clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Office at the Waste Management Five Oaks Landfill, Taylorville, Illinois. Project included developing 8.5 acres of baseliner for Unit 7-III, which involved constructing a temporary dewatering system, clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Office at the Waste Management Five Oaks Landfill, Taylorville, Illinois. Project included developing a 5.0 Megawatt Gas to Energy Facility, which involved materials and soils testing, building construction observation, and gas collection header system installation and flare relocation.**

- **Served as the Construction Quality Assurance Officer for the 10.93-acre North Expansion Cells 1A and 2A of the North Expansion Unit at Winnebago Landfill in Rockford, Illinois. Project included constructing a dewatering system, clay and geosynthetic liner, a leachate collection and drainage system. Project also included the installation of a 30,000 gallon leachate storage tank and forcemain connection.**

- **Served as the Construction Quality Assurance Office at the Pagel Landfill in Rockford, Illinois Project included developing a 6.8 Megawatt Gas to Energy Facility, which involved gas collection header system installation and flare relocation, and lateral gas collector installation.**

- **Served as the Certifying Engineer for the geosynthetic portions of the Gypsum Stack and Fly Ash Landfill for the Ameren Duck Creek Power Generating Facility – Included 125 acres of geosynthetic installation.**

- **Served as the Construction Quality Assurance Officer for the 12.80-acre North Expansion Cells 1B and 2B (Phase 2) of the North Expansion Unit at Winnebago Landfill. Project included constructing a dewatering system, clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer for the 11.52-acre North Expansion Cells 1C and 2C (Phase 3) of the North Expansion Unit at Winnebago Landfill. Project included constructing a dewatering system, clay and geosynthetic liner, a leachate collection and drainage system.**

- **Served as the Construction Quality Assurance Officer at the Republic Services, Inc. Roxana Landfill Roxana, Illinois. Project included the installation a vertical gas collection well system (over 70 new wells) and associates laterals and headers to convey the gas to a gas to energy facility. In addition, over 4,000 linear feet of gas header piping was installed. Project also included running over 1 mile of HDPE forcemain and airline to power the pneumatic system.**

- **Served as the Construction Quality Assurance Officer for the Republic Services, Inc. Roxana Landfill Roxana, Illinois, 15-acre portion Final Cover Closure. Project included a final cover consisting of a low permeability earthen liner, a geosynthetic liner, and a protective layer. Also included a vegetation layer and stormwater controls, and with leachate and gas collection revisions.**

Material Recovery Facilities

- **Prepared design, site plan drawings, calculations, and narratives for the S.B. 172 local siting application for the material recovery facility in Lake-in-the-Hills, Illinois, including a double-lined, 50-**

acre balefill and a mixed-waste material recovery facility. Provided expert witness testimony to Criteria 2, 4, 5, 7, and 9 of Section 39.2 of the Illinois Environmental Protection Act within a hostile public hearing.

- **Prepared design, site plan drawings, calculations, and narratives for a mixed-waste material recovery facility, Madison County, Illinois.**

Geotechnical Engineering

Prepared calculations and drawings of critical surfaces, using the STABL5 slope stability model, for a States Land Improvement Landfill in Owatta, Illinois

ALLEN L. STEINKAMP, R.G.

Senior Engineering Geologist

Education

B.S., Geology,
Missouri State University – Springfield, Missouri, 1984

M.S., Resource Planning-Environmental emphasis ,
Missouri State University – Springfield, Missouri, 1987

Licensing

Registered Professional Geologist

- Missouri
- Wisconsin
- Arkansas

Certified Professional Geologist

- American Institute of Professional Geologists

Expertise

Landfill Siting, Design/Permitting, Construction, and Closure

Remediation

CERCLA/RCRA

Hydrogeological Investigations

UST/AST

Professional Experience

Mr. Steinkamp is a Senior Engineering Geologist in Feezor Engineering, Inc.'s St. Charles, Missouri office. He has over 22 years experience within both environmental consulting and environmental compliance within private industry, primarily across the Midwest, with projects in Missouri, Illinois, Indiana, Kansas, Kentucky, Tennessee, Wisconsin, Michigan, Ohio, Arkansas, and Colorado.

He spent seven (7) years working for a large solid waste hauling and disposal company, managing compliance, engineering issues, capital improvements, construction, contractors, and consultants at numerous active and closed landfills, transfer stations, and hauling companies.

He has been responsible for managing/completing numerous projects involving solid waste, hazardous waste, petroleum, chemical, NPDES/stormwater, health & safety compliance, due diligence, and EHS auditing.

Mr. Steinkamp has been involved with numerous solid waste and chemical manufacturing facility permit applications and modifications, pollution control equipment permitting/upgrades, landfill/manufacturing facility expansions, landfill cell construction/CQA, closure plans, and preparation of contractor/consultant bid documents. He has been involved with projects subject to CERLCA, RCRA, VCP, UST/AST, and DOT regulations, managing such through the investigatory phase (RI), remedial design/analysis (FS), report development, and installation/operation/maintenance of remediation work phases. Mr. Steinkamp has experience interfacing/negotiating with regulatory agencies, at the local, state and federal levels.

FEEZOR ENGINEERING, INC.
Engineering for a Better World

Project Experience

Work History

Feezor Engineering, Inc. - Senior Eng. Geologist – 2009-present

Allied Waste - Environmental Manager - 2002-2009

General Chemical - Regional EHS Supervisor - 1997-2002

Schreiber, Yonley & Associates - Senior. Hydrogeologist - 1993-1997

Foth & Van Dyke – Project Hydrogeologist - 1991-1993

Technical Training

OHSA

- 40 Hour Hazardous Waste Operation and Emergency Response certification

National Safety Council – Advanced Safety Certificate

Landfill Permitting/Engineering

- **Owner Project Manager for a total of 5 active and 6 closed landfill facilities.**
  - **Responsible for the development of new landfill cells, capacity calculations, scheduling of third party CQA, and contractors, and resource & material coordination.**
  - **Responsible for budgeting and maintaining capital for construction/cell development, closure/post-closure, engineering, and operations.**
  - **Responsible for permitting, siting, and designing issues, and new technology evaluation.**
  - **Responsible for potential acquisitions, including Phase I assessment /property survey coordination, engineering review of design and operations, landfill accruals and amortization calculations, pro-forma modeling assistance.**
  - **Responsible for ensuring environmental compliance by coordinating air, water, and other environmental media as such relates to individual landfill permits, required reporting and recordkeeping, and responses to regulatory inspections.**
  - **Provided appropriate interfacing with corporate office, regulatory agencies, public relations, and due diligence through regulatory interface, site audits, monthly reports, and status reports.**
- **Served as Owner Project Manager for the preparation and submittal of a permit application for a horizontal expansion of Lemons East Landfill in Dexter, Missouri. It encompassed approximately 34.8 acres and 9,900,000 cubic yards. This project involved both the hydrogeological (Detailed Site Investigation) work phase, and the engineering design, complete with design provisions to account for seismic stability issues.**
- **Project Manager responsible for developing construction, landfill gas, closure, post-closure, and capital improvement budget quantities, as well as related engineering justification for numerous landfill sites.**

Project Experience (Continued)

- Prepared permit application for a horizontal and vertical expansion of Roxana Landfill in Roxana, Illinois. It encompassed approximately 73 acres and 28,457,452 cubic yards.
- Served as Project Manager for Roxana Landfill, conducting an ~ 100+ acres soil borrow study involving 20 soil borings, installation of groundwater piezometers, development of soil logs, cross sections, fence diagrams, and soil balance calculations.
- Served as Owner Project Manager/Local for both Operable Unit 1 and Operable Unit 2 CERLCA/Superfund actions at Bridgeton Landfill, Bridgeton, MO.
- Served as Owner Project Manager/Local for both Operable Unit 1 and Operable Unit 2 CERLCA/Superfund actions at Bridgeton Landfill, Bridgeton, MO.
- Project Manager responsible for developing construction, landfill gas, closure, post-closure, and capital improvement budget quantities, as well as related engineering justification for numerous landfill sites.

Landfill Construction

- Served as Owner Project Manager for Wayne County Landfill, Fairfield, IL, Area IID liner, 2.7-acre landfill construction, Fairfield, Illinois. Project included waste relocation, constructing clay and geosynthetic liner, a leachate collection and drainage system. Responsible for contractor and consultant selection, management of construction, and budget, and communications between the regulatory agencies, 3rd parties and owner management.
- Served as Owner Project Manager for Laubscher Meadows Landfill, Evansville, IN, Cell 4E, 6-acre landfill construction, Evansville, Indiana. Project included constructing a dewatering system, a clay and geosynthetic liner, a leachate collection and drainage system. Responsible for contractor and consultant selection, management of construction, and budget, and communications between the regulatory agencies, 3rd parties and owner management.
- Served as Owner Project Manager for Butler County Landfill, Poplar Bluff, MO, Cell 3C, 2.3 acre landfill construction, Poplar Bluff, Missouri. Project included constructing a clay and geosynthetic liner, a leachate collection and drainage system. Responsible for contractor and consultant selection, management of construction, and budget, and communications between the regulatory agencies, 3rd parties and owner management.
- Served as Owner Project Manager for Lemons Landfill, Dexter, MO, Cell 7W, 2.8 acre landfill construction, Dexter, Missouri. Project included constructing a clay and geosynthetic liner, a leachate collection and drainage system. Responsible for contractor and consultant selection, management of construction, and budget, and communications between the regulatory agencies, 3rd parties and owner management.

- **Served as Owner Project Manager for Lemons Landfill, Dexter, MO, Cell 8/9A, 5.0 acre landfill construction, Dexter, Missouri. Project included constructing subgrade improvements (to stabilize prior slope failure issues noted within such), a clay and geosynthetic liner, a leachate collection and drainage system. Responsible for contractor and consultant selection, management of construction, and budget, and communications between the regulatory agencies, 3rd parties and owner management.**

- **Served as the Owner Project Manager at the Wayne County Landfill, Fairfield, IL leachate extraction system. Design included an innovative telescoping riser design to replace a failed sideslope riser**

- **Served as Owner Project Manager for the closure of a leachate storage lagoon associated with Operable Unit 2 at Bridgeton Landfill, Bridgeton, MO. Project involved draining the lagoon liquids to an approved POTW, removing the sludge to a special waste landfill, and grading the remaining lagoon using the perimeter berms to promote positive drainage. Project also included testing the residual soils to ensure the remaining soils were devoid of contamination.**

- **Served as Owner Project Manager for the installation of a ~100,000 gallon above ground leachate storage tank at Bridgeton Landfill, Bridgeton, MO.**

- **Served as Owner Project Manager for the installation of vertical leachate extraction wells at Bridgeton Landfill, Bridgeton, MO. The wells averaged ~275 feet in total depth. One of the extraction wells designs incorporated an innovative telescoping riser design.**

- **Served as Owner Project Manager for the closure of Unit 1 of the Saline County Landfill, Harrisburg, IL. This 20.5-acre closure included a final cover consisting of a low permeability earthen liner, a geosynthetic liner, and a protective layer. Also included was a vegetation layer and stormwater controls, and with leachate and gas collection revisions.**

- **Served s the Owner Project Manager for a Constructed Wetlands treatment system at Saline County Landfill, Harrisburg, IL. The system was designed for the acceptance and treatment of both remedial system-generated groundwater and landfill leachate.**

- **Served as the Owner Project Manager for the closure of 52 acres of the Bridgeton Landfill, Bridgeton, MO. Project involved a final cover consisting of a 2 foot low permeability earthen liner, and 1 foot protective/vegetative layer, and stormwater controls.**

- **Served as the Owner Project Manager for the installation of 60 perimeter gas extraction wells at Bridgeton Landfill, Bridgeton, MO. The wells, 75 to 100 feet below grade, were drilled into the bedrock surrounding the sanitary landfill to mitigate landfill gas migration.**

- **Served as the Owner Project Manager for the design and installation of landfill gas wells and extraction system upgrades at Bridgeton Landfill in Bridgeton, MO, Laubscher Meadows Landfill in Evansville, IN, Butler Landfill in Poplar Bluff, MO, and Lemons Landfill in Dexter, MO.**

- **Served as the Owner Project Manager for a Landfill Gas to Energy at Laubscher Meadows Landfill, Evansville, IN. The project included a ~ 7 mile LFG pipeline from the landfill to a baby food processing plant. The gas will be used to power boilers used in the manufacturing process.**

- **Served as the Owner Project Manager for a stability investigation at Lemons Landfill, Dexter, MO. The project involved investigating a static subgrade slope failure via the advancement of rotosonic and CPT investigatory methods and geotechnical/seismic modeling. The study progressed from the failure slope area to all remaining unconstructed landfill footprint acreage.**

NEAL CLARK, P.E.

Project Engineer

Education

B.S., Civil Engineering, University of Illinois at Urbana-Champaign, 2003

M.S., Civil Engineering University of Illinois at Urbana-Champaign, 2004

Cert #11419 Troxler Electronic Laboratories, Inc. 2005

Licensing

Registered Professional Engineer

- Illinois

Expertise

Landfill Design

Landfill Permitting

Soils Geotechnical Testing

Landfill Gas System Design

Landfill Closure Design

Work History

Feezor Engineering, Inc. Engineer 2008-Present

Feezor Engineering, Inc., Engineer in Training 2002-2008

Professional Experience

Neal Clark is a Project Engineer for Feezor Engineering, Inc (FEI). His duties have included AutoCAD work on design, construction, and as-built drawings for numerous projects. His duties have also included annual volume analyses for various municipal solid waste landfills. Mr. Clark has also prepared several permit applications and construction certification reports to be submitted for state approval. Mr. Clark has also assisted in the preparation of proposals and permit applications. Additionally, Mr. Clark supervises the operation of a soils testing laboratory to carry out in-house moisture-density, plasticity, permeability, and grain size analyses.

Project Experience

Landfill Design

- **Prepared permit drawings and performed volume calculations for waste relocation due to new runway construction over an existing landfill at the Greater Rockford (Illinois) Airport.**
- **Prepared construction drawings for the 20-acre Phase 2006 closure at the Brickyard Landfill in Danville, Illinois.**
- **Prepared construction drawings for the 6.5-acre Cell 6A/B at the Brickyard Landfill in Danville, Illinois, including bid documents and construction and monitoring of a test liner prior to construction.**
- **Prepared construction drawings for the 2008 gas system installation at the Roxana Landfill in Roxana, Illinois.**
- **Prepared construction drawings for the 6.5-acre Cell 6A/B at the Brickyard Landfill in Danville, Illinois, including bid documents and construction and monitoring of a test liner prior to construction.**
- **Prepared construction drawings for the 3.75-acre Cell 6C and stormwater management revisions at the Brickyard Landfill in Danville, Illinois, including bid documents.**

Landfill Permitting

- **Prepared construction and as-built drawings and certification documentation for the South Unit Expansion at Winnebago Landfill in Rockford, Illinois, involving the extensive use of geocomposite drainage net and geosynthetic clay liner as an overliner.**

- Prepared construction and as-built drawings and the construction certification report for the 2.7-acre Area IID construction and waste relocation at the Wayne County Landfill in Fairfield, Illinois.

- Prepared construction and as-built drawings along with the construction certification report for the 2.1-acre Expansion Cell 2B construction at the Illinois Landfill in Hoopeston, Illinois.

- Prepared construction and as-built drawings as well as the construction certification report for the 3.7-acre Cell 4D & 5C construction including mass excavation for railroad tie removal at the Brickyard Landfill in Danville, Illinois.

- Prepared as-built drawings as well as certification documentation for the stormwater revisions to the final cover system at the 62-acre General Motors Foundry Sand Landfill in Danville, Illinois.

- Prepared construction and as-built drawings as well as the construction certification documentation for the 7-acre closure construction including mass excavation for railroad tie removal at the Coles County Landfill in Charleston, Illinois.

- Prepared construction and as-built drawings as well as the construction certification report for the 1.9-acre Cell 3 and 4.5-acre Cell 4A construction including grading for stormwater management and boring for a site soil investigation at the Sangamon Valley Landfill in S, Illinois.

- Prepared as-built drawings along with the construction certification report for the 2.3-acre Phase 2A-1 baseliner construction at the Envirofil of Illinois Landfill in Macomb, Illinois.

- Prepared as-built drawings along with the construction certification report for the 11-acre North Unit Expansion Phase 1 construction at the Winnebago Landfill in Rockford, Illinois.

- Prepared construction as-built drawings along with the construction certification report for the 12.8-acre North Unit Expansion Phase 2 construction at the Winnebago Landfill in Rockford, Illinois.

- Prepared construction as-built drawings along with the construction certification report for the 11.5-acre North Unit Expansion Phase 3 construction at the Winnebago Landfill in Rockford, Illinois.

- Prepared design drawings for a 73.1-acre horizontal and vertical expansion permit application for the Roxana Landfill in Roxana, Illinois.

Landfill Gas System

- Prepared construction and as-built documentation for the South Unit Gas Collection System at the Winnebago Landfill in Rockford, Illinois, including the design and installation of a gas flare with ten gas extraction wells.

- Prepared construction and as-built drawings and certification documentation for the 2006-2007 Leachate Forcemain and Gas Extraction System at the Five Oaks Recycling & Disposal Facility in Taylorville, Illinois.

- **Prepared construction and as-built drawings and certification documentation for the Unit 1 Soil Gas Extraction System at the Brickyard Landfill in Danville, Illinois. This included the design of a solar-powered condensate pumping system to accommodate a system to extract gas outside the waste boundary.**

- **Prepared design drawings and performed design calculations for a gas extraction system expansion at the Coles County Landfill in Charleston, Illinois.**

Transfer Stations

- **Prepared sampling schedule and permit application for the stormwater runoff permit for the Herrin Transfer Station at Herrin, Illinois, involving the training of field personnel in stormwater sampling techniques and data collection.**

Regulatory Services

- **Prepared corporate volume analyses (including remaining constructed airspace and site life calculations), annual inflationary closure cost revisions, and annual Illinois Environmental Protection Agency capacity reports for the following sites:**

Illinois:

Bond County Landfill (Greenville)
Brickyard Landfill (Danville)
Coles County Landfill (Charleston)
Illinois Landfill (Hoopeston)
Litchfield-Hillsboro Landfill (Litchfield)
RCS Landfill (Jerseyville)
Saline County Landfill (Harrisburg)
Veolia ES Wayne County Landfill (Fairfield)
Winnebago Landfill (Rockford)

Indiana:

Laubscher Meadows Landfill (Evansville)

Missouri:

BackRidge Landfill (LaGrange)

Auxier & Associates, Inc.

MICHAEL K. BOLLENBACHER, CHP, REA

Professional Qualifications

Mr. Bollenbacher has 25 years of experience performing a wide range of environmental work with radiological materials and hazardous chemicals on contaminated sites in over 20 states. He has been the principal investigator or task manager for site characterizations, fate and transport modeling, risk assessments, feasibility studies, and site remediations. He has been involved in site remediations, and has actively participated in decontamination and decommissioning of land, buildings and equipment. He has also performed as the radiation safety officer for a uranium mill tailings cover pilot project and designed specialized equipment used by the U.S. Environmental Protection Agency (EPA) to measure the permeability of soil to radon gas.

Education

M.S., Environmental Engineering, Clarkson University, Potsdam, New York; 1982.

B.A., Biology, New York State University College at Oswego, New York; 1976.

Registrations/Certifications

Certification by the American Board of Health Physics in 1992.

Registered Environmental Assessor in California; 1990.

OSHA 40-hour Hazardous Waste Operations Training and 8-hour Hazardous Waste Supervisor Training meeting the requirements of 29 CFR 1910.120.

Experience and Background

1993 - Present **_Senior Scientist, Auxier & Associates, Inc., Knoxville, TN._**
Provides consultant services in health physics and environmental science, with particular emphasis on site characterization and remediation, dose reconstruction, environmental auditing, due-diligence and both long-term and short-term risk assessment. Project management and technical activities include site characterization surveys, work plan preparation, dosimetry, radiological risk analysis, environmental transport modeling, derivation of cleanup levels, radiological support during planning and field operation phases of site and equipment remediation, interaction with regulatory agencies and the public, and data evaluation, validation, and analysis.

1990 - 1993 ***Health Physicist, IT Corporation, Knoxville, TN.***
Provided health physics, risk assessment, and environmental modeling services to government and private clients. Served as the principal investigator for the CERCLA risk assessment of the eight radioactive waste disposal areas at the Fernald Environmental Management Project (FEMP) known collectively as Operable Unit One. Provided radiological and risk assessment support for remedial investigations and feasibility studies at DOE and DOD facilities. Developed technical approaches used to model contaminant transport and exposures for a variety of projects. Developed health and safety plans for the excavation of a low-level mixed waste underground storage tank at Oak Ridge National Laboratory. Prepared the radiological sampling and analysis plan for a 300 acre soil survey. Provided technical support for negotiations with regulatory agencies. Designed the radon measurement system used by IT labs to determine radon emission rates from laboratory samples.

1985- 1990 ***Environmental Engineer, Rogers, and Associates Engineering Corp., Salt Lake City, UT.*** Provided site characterization, decontamination and decommissioning, fate and transport modeling, dose and risk assessment, and laboratory services to a variety of private, industrial and government clients. Planned and conducted field sampling programs to characterize sites contaminated with hazardous or radioactive materials in nine states and the Gulf of Mexico. Actively participated in remediation of sites and decontamination/decommissioning of structures contaminated with radioactive materials. Established survey protocols, conducted equipment surveys, coordinated survey activities, and supervised dirt-moving operations. Participated in verification of cleanup for a 64,000 sq. ft. manufacturing facility. Characterized radon distribution and migration potential in soils and structures. Performed NESHAPS compliance surveys of radon fluence at a variety of federal and commercial facilities. Designed and built specialty sampling equipment, including radon/soil gas sampling and measurement equipment (standard used by EPA at that time). Established and maintained monitoring programs to track and document internal and external occupational exposures to 23 employees while acting as a radiation safety officer during a uranium mill tailings cover project. Performed radiological entrance and exit surveys to verify status of personnel and equipment. Wrote protocols on the shipping and handling of naturally occurring radioactive material (NORM) for a major oil company's domestic operations. Conducted dose and risk assessments for several disposal facilities at humid and arid sites handling mixed waste, low-level radioactive waste, and NORM. Ancillary work included modeling the fate and transport of environmental contaminants at these sites. Established and managed large project databases using FORTRAN, Excel, and dBase III.

1983 - 1985 ***Environmental Engineer, Aerojet Heavy Metals Company, Jonesborough, TN.***

Coordinated environmental monitoring programs and supported the remediation of portions of a manufacturing and milling facility contaminated with uranium and thorium. Upgraded and maintained the site's compliance monitoring network, and expanded the existing environmental program. Set up and managed an on-site radiological soils laboratory. Improved runoff control for a 1.2 acre pond contaminated with radioactive and chemical wastes. Operated 20,000 gpd industrial wastewater treatment plant during evening shifts. Prepared documentation for shipments of contaminated sludge and soil to a LLW disposal facility. Tracked costs for the final two stages of a three stage, two million dollar remediation project. Developed unique computer applications for analysis of waste, contaminated soils and building materials. Developed "Rapid Air Quality Analysis" computer code to subtract radon interference from air samples used to monitor occupational and environmental airborne levels of uranium. This application cut remedial response time from three days to one day, and reduced program manpower requirements by approximately 25%. Performed equipment decontamination and radiological surveys to verify status of equipment prior to release from the facility.

1980 - 1982 ***Research Assistant, Clarkson University, Potsdam, NY***.

Used ion exchange resins to estimate bio-available phosphorous in river systems. Established and maintained project databases. Developed conceptual models describing the fate of pollutants in river, lake, and estuarine systems. Wrote computer codes to apply these models. Course work emphasized water/waste water processes and aquatic chemistry.

Prior to 1980 ***Various technician level positions***.

Collected fish and small mammals for an Environmental Impact Statement (EIS) on the pesticide DIMILIN prepared by the SURCO Corporation, Oswego, New York. Collected data on near-shore fish populations for two EISs on proposed nuclear power plant complexes for Hazelton Environmental Services, Syracuse, New York. Tested and developed chemical coatings as an R&D technician at Strathmore Products, Syracuse, NY. Served as an open water volunteer instructor for Peace Corps sponsored courses in tropical marine biology at the University of Honduras at Tegucigalpa.

1972 1976 ***Co-Recipient, National Science Foundation, Oswego, NY***.

Co-authored the first student-originated research proposal from a NY State University College Center to be accepted for funding by the National Science Foundation (NSF). Performed a baseline population survey of amphibians and reptiles along a 35-mile coastal zone shoreline. Co-authored the first comprehensive wildlife and habitat-based land-use plan ever developed for Oswego County's shoreline. The State cited this report during its acquisition of 250 acres of highly sensitive wetlands.

Professional Affiliations

Health Physics Society
Director-Elect of the American Academy of Health Physics
American Chemical Society
New York Academy of Sciences

Awards/Activities

IT Technical Associate, 1990 – 1993
Aerojet General's, R. B. Young Technical Innovation Award, 1985
Dean's List, State University College at Oswego, Spring, 73 through Spring, 76
Graduated Cum Laude
Past Reviewer for Health Physics Journal

Publications

Mr. Bollenbacher has prepared or contributed to over 100 reports and publications in the fields of health physics and environmental science.

LESLIE W. COLE, CHP

Professional Qualifications

Mr. Cole has more than 40 years of experience in applied health physics field and environmental health physics with specific emphasis in environmental sampling, analysis and data evaluation, health physics and safety program evaluations, radiological and mixed waste management, site characterization and remediation, NORM evaluation and assessment and uranium health physics. He is a past Director of Environmental Health and Safety at a uranium metal fabrication facility and is also a member of the NCRP Task Group developing national recommendations for handling uranium. He served as a Radiation Safety Officer for a major decontamination facility that processes material from nuclear power plants. He has also served as a Health Physics Team Leader in an Environmental Radiological Assessment Program.

Education

M.S., Chemistry (Nuclear Effects Engineering), U. S. Naval Post-Graduate School; 1968.

B.S., Chemistry, East Tennessee State University; 1958.

MBA, post-graduate courses, George Washington University; 1969-1970.

Advanced post-graduate courses in Environmental Chemistry, University of Tennessee; 1981-1983.

Advanced post-graduate courses towards Ph.D. (Biochemistry) program at East Tennessee State University; 1986-1988.

Registrations/Certifications

Comprehensive Certification by the American Board of Health Physics, 1982.

Member Task Group 15, "Uranium in Man", Scientific Committee 57, National Council on Radiation Protection and Measurements

Experience and Background

Present ***Independent Consultant.***
Consultant on a verity of health physics and environmental issues. The range of projects include preparation of work plans for unrestricted release of major facilities, laboratory measurements, licensing and permitting for a major transuranic and mixed waste processing facility, and risk analysis for the unrestricted release of

decontaminated metal. Serves as Radiation Safety Officer for a metal recycle facility that processes contaminated metal.

1996 - 1998 ***Senior Associate, Auxier and Associates, Knoxville, Tennessee.***
Work involves environmental monitoring and surveying, radiological remediation, radiation risk assessment, environmental radioactivity dispersion and measurement, internal and external dosimetry and general health physics. Served as technical director for major decontamination and decommissioning of a firing range where uranium metal munitions had been tested (project total over $2.2 million). Advised on NORM site characterization at a large military installation. Served as Safety Manager for four NORM characterization efforts related to oil fields. Served as Radiation Safety Officer for major waste processing facility start-up and for a mixed waste processing facility.

1994 - 1996 ***Vice President, Regulatory Affairs, SEG, Oak Ridge, Tennessee***.
Direct activities related to SEG's six radioactive material licenses, RCRA permit, nine air permits, POTW permit and EPA treatability studies permit. Deal directly with state regulatory offices on these matters. Also direct activities related to inventory management of three million cubic feet radiological waste processing annually. Direct health and safety and laboratory activities.

1992 - 1994 ***Senior Associate, Auxier and Associates, Knoxville, Tennessee.***
(See above description)

1988 - 1992 ***Director, Environmental Health and Safety for Aerojet Ordnance Tennessee, Inc., in Jonesborough, Tennessee***.
Direct all safety and environmental functions. Interact with other departments, directors, and managers on integrating safety and environmental concerns into production matters. Coordinate all regulatory matters with state regulatory authorities in Radiological Health, Air Quality, Water Quality and Solid Waste. Act as Aerojet General expert on Radiological matters at other sites. Project manager for a major D&D project. Manage budget of 2.5 million dollars.

1983 - 1988 ***Radiation Safety Officer for Aerojet Ordnance Tennessee, Inc., in Jonesborough, Tennessee***.
Manage all radiological protection activities involving fabrication of uranium metal products. Supervise the technical aspects of large-scale environmental improvement program and for a major decontamination and decommissioning of a manufacturing facility. Assist the industrial safety officer in evaluating respiratory protective requirements. Plan and supervise Health Physics analytical processes. Interact with plant engineering on radiation protection requirements, including ALARA considerations, for process improvements. Inspect industrial x-ray equipment to maintain regulatory compliance. Responsible for assuring regulatory compliance on all radioactive shipments including waste. Technical advisor for legal team involved with long-term labor dispute concerning health and safety

issues. Served as expert witness during legal hearing on the labor issue. Supervise seven technical personnel.

1982 - 1983 ***Health and Safety Officer for Quadrex Fixed Base Decontamination Facility in Oak Ridge, Tennessee.***
Supervise all radiological protection and safety activities involving handling multicurie decontamination processes; recordkeeping to certify releasability of cleaned materials, personnel dosimetry, maintain environmental effluents to acceptable levels, radioactive shipments (incoming and outgoing), radiation safety, ALARA and industrial safety. Developed mechanical techniques for surveying cleaned material to minimize labor efforts and improve quality control. Develop analytical procedures for laboratory and quality control. Supervise 15 professional and technical personnel.

1980 - 1982 ***Senior Health Physics Team Leader in the Radiological Site Assessment Program with Oak Ridge Associated Universities in Oak Ridge, Tennessee.***
Responsible for planning, conducting, and preparing reports on radiological assessments at various industrial and past-government facilities where radionuclides are, or have been, in use. Projects included radiopharmaceutical manufacturing facilities, mill tailings sites, and thorium manufacturing facilities. Assisted with developing laboratory analytical procedures. Supervise six to twelve health physics professionals.

1979 - 1980 ***Staff Officer, HQI Corps Group, South Korea***.
Responsible for nuclear, chemical and biological training and preparedness. Had staff responsibility for nuclear accident/incident control for approximately one-third of South Korea.

1974 - 1978 ***Senior Instructor at mid-level U.S. Army Staff College***.
Primary course is year long, leading to Master's Degree. Planned and directed instruction on radiation safety, radiological defense and radiation measurements and dosimetry. Supervised eight to twelve other instructors. Reviewed all Army literature in development for topics related to nuclear weapons effects, radiation safety and measurements. Served as Nuclear Accident/Incident Control Officer (NAICO) for North Central United States area. Supervised the NAIC teams to maintain readiness in measurement and monitoring techniques for uranium and plutonium.

1971 - 1973 ***Administrative Officer for Military Science Department at East Tennessee State University.***

1968 - 1970 ***Nuclear Efforts Officer at Continental Army Command Headquarters in Fort Monroe, Virginia.***
Responsible for planning of radiation safety matters for all Army installations in the continental United States. Coordinated the evaluation of new radiation detection devices for military use. Instrumental in the adoption of the "Fiddler" instrument

for use in detection of plutonium. Held an Atomic Energy Commission license for small radiation sources and was the certifying authority for other similar licenses. Coordinate the nuclear accident/incident control procedures for all Army posts in the United States. Developed procedures for monitoring and measuring uranium and plutonium contamination. Supervised the installation of a "hands-on" decontamination facility using short-lived radionuclides for training specialized nuclear decontamination teams.

1966 - 1968 ***Student at U.S. Naval Post-Graduate School, Monterey, California.***

1963 - 1966 ***Staff Officer, HQ U.S. Army, Europe*.**
Responsible for training and readiness preparation in nuclear chemical and biological officers for all U.S. Army personnel in Europe. Assistant Nuclear Accident/Incident Control Officer. Was directly involved in a large-scale nuclear accident in Spain. Clean-up from this accident involved several hundred people and several weeks of work. Primary concern was monitoring personnel and equipment for plutonium contamination.

Awards

R.B. Young Award (recognition for technological innovation within Aerojet General Corporation).

Professional Affiliations

Health Physics Society
Member NCRP Scientific Committee 57-15

Publications

Mr. Cole has prepared or contributed to numerous reports and publications on radiological surveys and assessments and applied health physics.

List of Publications

Cole, L. W., J. D. Berger, P. R. Cotton, R. C. Gosslee, T. J. Sowell, and C. F. Wever, "Radiological Assessment of Ballod & Associates Property (Stephen Chemical Company), Maywood, New Jersey," July 1981.

Cole, L. W., J. D. Berger, W. O. Helton, B. M. Putnam, T. J. Sowell, and C. F. Wever, "Radiological Evaluation of Decontamination Debris Located at the Futura

Coatings Company Facility, 9200 Latty Avenue, Hazelwood, Missouri", September 1981.

Cole, L. W., J. D. Berger, G. W. Foltz, P. W. Frame, B. P. Rocco, and C. F. Wever, "Preliminary Survey of Igloo 9050, Former L00W Site, Lewiston, New York," September 1981.

Cole, L. W., J. D. Berger, R. D. Condra, W. O. Helton, B. M. Putnam, T. J. Sowell, and C. F. Wever, "Preliminary Radiological Survey of Proposed Street Right-of-Way at Futura Coatings, Inc., 9200 Latty Avenue, Hazelwood, MO," December 1981.

Cole, L. W., J. D. Berger, R. D. Condra, P. W. Frame, W. O. Helton, C. W. Kuechle, S. E. Trench, and C. F. Wever, "Environmental Survey of the Manufacturing Facility, Medi-Physics, Inc., Arlington Heights, IL," January 1982.

Cole, L. W., J. D. Berger, P. W. Frame, G. W. Foltz, R. C. Gosslee, and C. F. Wever, "Environmental Survey of the Mallinckrodt Diagnostics Facility, Maryland Hights, MO," March 1982.

Cole, L. W., J. D. Berger, R. D. Condra, G. W. Foltz, P. W. Frame, B. M. Putnam, B. P. Rocco, T. J. Sowell, and C. F. Wever, "Radiological Assessment of the Breckenridge Disposal Site, Velsicol Chemical Corporation, St. Louis, MO," July 1982.

Berger, J. D., L. W. Cole, R. D. Condra, G. R. Foltz, C. W. Kuechle, J. C. Mann, and C. F. Wever, "Environmental Survey of the Engineered Products Department, Monsanto Research Corporation, Dayton, OH," December 1981.

Rocco, B. P., J. D. Berger, L. W. Cole, R. D. Condra, R. C. Gosslee, C. F. Riemke, T. J. Sowell, Wever, and L. A. Young, "Environmental Survey of the Medi-Physics Facility, South Planfield, NJ," January 1982.

Rocco, B. P., J. D. Berger, L. W. Cole, R. D. Condra, R. C. Gosslee, C. F. Riemke, T. J. Sowell, C. F. Wever, and L. A. Young, "Environmental Survey of the E.R. Squibb & Sons Facility, New Brunswick, NJ," March 1982.

Berger, J. D., L. W. Cole, R. D. Condra, P. R. Cotton, W. O. Helton, T. J. Sowell, and C. F. Wever, "Environmental Survey of the Static Control Systems Department, Minnesota Mining & Manufacturing Company, New Brighton, MN," March 1982.

Frame, P. W., J. D. Berger, L. W. Cole, R. D. Condra, P. R. Cotton, W. O. Helton, A. J. Liu, C. M. Plott, and C. F. Wever, "Confirmatory & Post-Stabilization Radiological Survey of the AMAX Site, Parkersburg, West Virginia," March 1984.

Contributing Author

U.S. Army Field Manual 3 - 15 "Nuclear Accident/Incident Control Procedures" - 1970.

U.S. Army Field Manual 101-31 "Nuclear Weapon Employment" - 1975.,
U.S. Army Field Manual 101-5 "Staff Officer's Guide" - 1976.
U.S. Army Field Manual 100-5 "Maneuver Control" - 1976.
U.S. Army Field Manual 71-100 "Corps Operations" - 1976.
U.S. Army Field Manual 71-101 "Division Operation" - 1977.
U.S. Army Field Manual FM101-31-1 "Nuclear Weapons Employment - Data and Procedures" - 1977.
U.S. Army Command & General Staff College Reference Book 3-1 "NBC Operations" - 1977.
U.S. Army Command & General Staff College Reference Book 3-1 "NBC Operations" - 1978.

Technical Papers Presented

"Consideration of Potential Kidney Injury" - Tennessee Section, American Toxicological Society, Johnson City, Tennessee, June 1984.

"Uranium Incineration" - Conference on Incineration of Low Level Waste, Tucson, Arizona, March 21-23, 1985.

"Remedial Action Guides for Depleted Uranium and Thorium in Soil" - Waste Management '85, March 25-28, 1985.

"Health Physics Experience During a Uranium and Thorium Pond Closure" - Health Physics Mid-Year Symposium, March 1-3, 1986.

"Analysis of Uranium and Thorium in Soil" - Health Physics Mid-Year Symposium, March 1-3, 1986.

"Particle Size Characterization of Airborne Uranium Compounds" - American Industrial Hygiene Association Annual Meeting, May 15-18, 1986.

"Health Risk Assessment of Field Use of DU Munitions" - Health Physics Society Annual Meeting, June 29-July 3, 1986.

"As Case Study of a Worker with an Embedded Piece of Uranium in His Chest" - Health Physics Society Annual Meeting, July 5-10, 1987.
"Rapid Air Quality Measurements" - Health Physics Society Annual Meeting, December 1988.

"Measurements of Surface Deposited DU After CE Warhead Firing" - Health Physics Society, December 1988.

"Challenges in Decontamination of DU Manufacturing Facility" - Waste Management Symposium, February 1989.

"Unrestricted Release of a Depleted Uranium Manufacturing Facility" - Waste Management Symposium, February 1989.

"Depleted Uranium Waste Disposal" - Environmental. Compliance in Armaments Facilities and Demilitarization Symposium, October 1991.

MARSHA A. JOSEPH

Professional Qualifications

Ms. Joseph has over 25 years of research experience. She performs evaluations and assessments of internal and external irradiation exposures. Routine work tasks include performing field radiation surveys, collecting soil and water samples in the field, validating the quality of radiological sample analytical data, and assembling and evaluating all radiological data in support of litigation cases. Ms. Joseph also evaluates and reviews documents regarding radiological characterization and remedial action activities. In addition, Ms. Joseph provides AutoCAD illustrations and data base management.

Education

M.S., Science Education, University of Tennessee, Knoxville, Tennessee; 1981.

B.A., Zoology, Miami University, Oxford, Ohio; 1975.

Registrations/Certifications

Active Q Clearance

OSHA 40-hour Site Worker Health and Safety Training meeting the requirements of 29 CFR 1910.120.

OSHA 24-hour Hazardous Waste Operations Training meeting the requirements of 29 CFR 1920.120.

OSHA 8-hour Hazardous Waste Refresher meeting the requirements of 29 CFR 1920.120.

OSHA 24-hour Professional Development Program for Hazardous Waste Remediation and Emergency Response Workers meeting the requirements of 29 CFR 1910.120.

AutoCAD MAP/Land Development Desktop Certificate of Completion, Advanced Solutions, Inc.

Teaching Certificate, Biology and Chemistry

Assistant Laboratory Animal Technician Certification, ALAS, ORAU

Experience and Background

1994 - Present **_Scientist and Technical Illustrator, Auxier & Associates, Knoxville, Tennessee._**
Serves as assistant to senior health physicists in the evaluation and assessment of internal and external radiation exposures. Primary responsibilities include assembly and quality control review of radiation measurement and sample analytical data in support of assessments of internal and external radiation exposures. Additional responsibilities include documentation of QC activities, document evaluation and review, data base management, and AutoCAD illustration.

1994 **_Senior Health Physics Technician and Technical Illustrator, Energy/ Environmental Systems Division, Oak Ridge Associated Universities, Oak Ridge, Tennessee._**
Prepared Environmental Survey and Site Assessment Program (ESSAP) survey maps, building drawings, slides, etc. using AutoCAD and other graphics programs. Responsible for the supervision and coordination of AutoCAD technician activities. Responsibilities included planning and scheduling of AutoCAD work, establishing priorities and maintaining records and files of all drawings. Responsible for performing on-site environmental radiological survey services for the formal evaluation of the status and compliance of federal and private facilities with regard to applicable regulatory requirements for deminimus contaminant levels for occupancy.

Responsible for instrument calibration, radiation measurements, sample collection, preparation and analysis, data tabulation, review, and interpretation, and the preparation of site survey reports. Served as administrative and technical contact for on-site work.

1992 - 1994 **_Health Physics Technician, Energy/Environmental Systems Division, Oak Ridge Associated Universities, Oak Ridge, Tennessee._**
Responsible for performing on-site environmental radiological survey services for the formal evaluation of the status and compliance of federal and private facilities with regard to applicable regulatory requirements for deminimus contaminant levels necessary for occupancy. Responsible for instrument calibration, radiation measurements, sample collection, sample preparation and analyses, data review tabulation and interpretation, and the preparation of site survey reports.

1981 - 1992 **_Research Associate, Marmoset Research Center, Oak Ridge Associated Universities, Oak Ridge, Tennessee._**
Directed research studies and programs for private contractors and the government. Responsibilities included designing, scheduling, and carrying out experimental procedures. Utilized parapathology expertise in screening slides to assess colon disease (information used to plan treatment regimens) and to collect epidemiological statistics. Performed necropsies, biopsies, bioassays, clinical

radiographs, sample collection, and numerous other clinical/medical duties. Responsible for data collection and recording, data analysis, report preparation, and maintaining computer database.

1981 - 1990 ***Research Associate, Medical and Health Sciences Division, Oak Ridge Associated Universities, Oak Ridge, Tennessee.***
As a laboratory histology technician, Ms. Joseph performed numerous bioassays to identify colon cancer markers. Carried out radiolabeled antibody experimentation, and was responsible for data collection, analysis, and report preparation as well as computer database management.

1979 - 1981 ***Research Technician, Oak Ridge National Laboratory, Oak Ridge, Tennessee.***
Conducted clinical studies for an Environmental Protection Agency grant on Carcinogenesis of Diesel Emissions; responsibilities included conducting clinical checks, necropsies, as well as data compilation, analysis, and report preparation.

1979 - 1981 ***Research Technician, University of Tennessee, Knoxville, Tennessee.***
Carried out a research study for a National Large Bowel Cancer Society grant: "Effects of Dietary Bran on Colon Cancer in Mice." Responsibilities included necropsies, clinical checks, dietary maintenance and care, data collection, compilation, analysis, and report preparation.

1975 - 1979 ***Substitute Teacher, Oak Ridge City Schools, Oak Ridge, Tennessee.***
Taught in both junior and senior high school levels. Presented curricula in earth science, general science, biology, and chemistry.

Publications

Author and co-author (published under the name of M. A. Henke) of numerous publications on decommissioning and radiological surveys and numerous reports relating to genetic epidemiology and colonic carcinoma in cotton-top tamarins.

List of Publications

Ansari, A. J., and M. A. Henke, "Confirmatory Survey of the Unaffected Indoor Areas and the Electrode Grind Room UNC Naval Products, Montville, Connecticut," (Prepared for the U.S. Nuclear Regulatory Commission, Division of Low-Level Waste Management and Decommissioning), 1993.

Landis, M. R., and M.A. Henke, "Radiological Survey of the General Atomics SVA Facility, San Diego, California," (Prepared for the U.S. Nuclear Regulatory Commission, Region 5 Office), 1993.

Cheverud, J. M., S. Tardif, M.A. Henke, and N. K. Clapp, "Genetic Epidemiology of Colon Cancer in the Cotton-Top Tamarin (Saquinus Oedipus)," 1993.

Clapp, N. K., M.A. Henke, R. Hansard, R. Carson, and D. Fretland, "Anti-Colitic Efficacy of SC-4l930 in Colitic Cotton-Top Tamarins," Agents Actions 39, Special Conference Issue, Birkhauser Verlag, Basel, 1993.

Clapp, N. K., M.A. Henke, R. Hansard, R. Carson, R. Walsh, D. Widomski, C. Anglin, and D. Fretland, "Inflammatory Mediator Changes in Cotton-Top Tamarins (CTT) After SC-4l930 Anti-Colitic Therapy," Agents Actions 39. Special Conference issue, Birkhauser Verlag, Basel, 1993.

Jaberaboansari, A., and M.A. Henke, "Radiological Survey of Rooms 101 and 102 Building SC-I, South Campus Oak Ridge Institute for Science and Education. Oak Ridge Tennessee," (Prepared for the Office of Safety and Environmental Assurance, Oak Ridge Institute for Science and Education), October 1992.

Jaberboansari, A., and M.A. Henke, "Radiological Survey of Building SC-IS, South Campus Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee," (Prepared for the Office of Safety and Environmental Assurance, Oak Ridge Institute for Science and Education), October 1992.

Hawkins, J. V., C. E. Jaquish, R. L. Carson, M.A. Henke, S. D. Tardif, S. Patton, C.T. Faulkner, and N. K. Clapp, "Trichospirura leptostoma Infection in Callithrix Jacchus (Common Marmoset); Disease and Treatment" Lab Animal, (Submitted).

Petrelli, N. J., G. Anderson, L. Herrera, K. Manly, M.A. Henke, and N. K. Clapp, "A Serum Marker for Colon Cancer Detection: The Use of the Cotton-Top Tamarin," A Primate Model for Study of Colitis and Colonic Carcinoma: The Cotton-Top Tamarin (Saquinus Oedipus), N. K. Clapp, Ed. CRC Press, (Submitted).

Cohen, B. I., E. I. Mosbach, M. A. Henke, and N. K. Clapp, "Fecal Steroids in Tamarins and Marmosets," A Primate Model for Study of Colitis and Colonic Carcinoma: The Cotton-Top Tamarin (Saquinus Oedipus), N. K. Clapp, Ed. CRC Press, (Submitted).

Clapp, N. K. and M.A. Henke, "Early Colonic Carcinoma Development in Cotton-Top Tamarins: Evidence of Promoflon by Colitis?" A Primate Model for Study of Colitis and Colonic Carcinoma: The Cotton-Top Tamarin (Saquinus Oedipus), N. K. Clapp, Ed. CRC Press, (Submitted).

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