DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
8945 LATTY AVENUE
BERKELEY, MISSOURI 63134

REPLY TO
ATTENTION OF:

September 24, 2003

Formerly Utilized Sites Remedial Action Program

SUBJECT: *Integrated Survey Plan for Consolidated Materials, Crushate, Overburden, Equipment and Materials*, Final, September 22, 2003

Mr. Dan Wall
U.S. Environmental Protection Agency
Region VII, Superfund Branch
901 North Fifth Street
Kansas City, KS 66101-2907

Dear Mr. Wall:

Enclosed is a copy of the *Integrated Survey Plan for Consolidated Materials, Crushate, Overburden, Equipment and Materials*, Final, September 22, 2003 for your records. Copies of this document are also being provided to Mr. Robert Geller and Mr. Eric Gilstrap of the Missouri Department of Natural Resources. Please destroy draft copies of this document.

If you have any questions regarding this document please contact Mr. Dennis Chambers at (314) 260-3917 or Mr. Brian Harcek at (314) 260-3933.

Sincerely,

Sharon Cotner

SHARON R. COTNER
FUSRAP Program Manager

Enclosure

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SUBJECT: *Integrated Survey Plan for Consolidated Materials, Crushate, Overburden, Equipment and Materials*, Final, September 22, 2003

Mr. Robert Geller
Federal Facilities Section, HWP
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, Missouri 65102-0176

Dear Mr. Geller:

Enclosed are two copies of the *Integrated Survey Plan for Consolidated Materials, Crushate, Overburden, Equipment and Materials*, Final, September 22, 2003 for your records. Copies of this document are also being provided to Mr. Dan Wall, USEPA, and Mr. Eric Gilstrap of your staff. Please destroy draft copies of this document.

If you have any questions regarding this document please contact Mr. Dennis Chambers at (314) 260-3917 or Mr. Brian Harcek at (314) 260-3933.

Sincerely,

Sharon R Cotner

SHARON R. COTNER
FUSRAP Program Manager

Enclosure

FINAL

INTEGRATED SURVEY PLAN FOR CONSOLIDATED MATERIALS, CRUSHATE, OVERBURDEN, EQUIPMENT AND MATERIALS

ST. LOUIS, MISSOURI

SEPTEMBER 22, 2003

prepared by
U.S. Army Corps of Engineers, St. Louis District Office, Formerly Utilized Sites Remedial Action Program

with assistance from
Science Applications International Corporation
Shaw Environmental and Infrastructure, Inc.
under Contract No. DACW43-00-D-0515, Task Order 0005

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
cm^2	square centimeter
COC	Contaminant(s) of Concern
cpm	counts per minute
$DCGL_C$	Derived Concentration Guideline Level for Clearance (NUREG-1761)
$DCGL_{EMC}$	Derived Concentration Guideline Level for Clearance – elevated measurement criteria
CHP	Certified Health Physicist
dpm	disintegrations per minute
DQA	data quality assessment
DQO	data quality objective
EPA	Environmental Protection Agency
FSS	Final Status Survey
FUSRAP	Formerly Utilized Sites Remedial Action Program
g/cm^3	grams per centimeter cubed
GPS	global positioning system
LBGR	lower bound gray region
m^2	square meter
m^3	cubic meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
pCi/g	picocuries per gram
PDI	Pre-Design Investigation
QA	quality assurance
QC	quality control
Ra	radium
RAC	remedial action contractor
RG	Regulatory Guide
ROD	Record of Decision
RSO	Radiation Safety Officer
SAG	Sampling and Analysis Guide
SLS	St. Louis Site
TCLP	Toxic Characteristics Leaching Properties
Th	thorium
U	uranium
UCL_{95}	Upper 95% Confidence Level
USACE	U.S. Army Corps of Engineers
VC	verification contractor
WAC	Waste Acceptance Criteria
WRS	Wilcoxon Rank Sum

1.0 PURPOSE AND SCOPE

This document provides a single reference to be used to guide the survey and/or sampling of equipment/materials, consolidated materials, crushate, and overburden that is removed from, and *in-situ* overburden that are located within, the impacted areas of St. Louis Formerly Utilized Sites Remedial Action Program (FUSRAP) Sites.

The objective of the sampling and/or survey activities is to obtain data of sufficient quality to evaluate the suitability of the material for clearance, for off-site disposal, or on-site reuse as FUSRAP backfill. The evaluation process may include both radiological and chemical sampling activities, depending on the nature of the material and the requirements of the applicable decision document(s).

The final status survey of structures and monoliths that are to be left *in-situ* is discussed in the *Final Status Survey Plan For Structures And Other Consolidated Material Left In Place At The St. Louis Sites* (USACE, 2003).

The principles outlined in this document may also be applied to those materials that are currently located outside of impacted areas.

This document supercedes any guidance relative to:

- survey design
- sampling and sampling protocols
- sample analysis
- the interpretation of sample results

that may be contained within the following documents:

- *Backfill Study for the St. Louis Downtown Site*, Preliminary Draft, IT Corporation, March 1999.
- *Materials Handling and Transportation Plan*, Revision 1, IT Corporation, July 1999.
- *Work Assignment Plan for Crushate, Soil, and Concrete Sampling*, Revision 1, Shaw Corporation, May 2002.
- *Sampling and Analysis Plan for the 50 Series Building Crushate*, USACE Review Draft, USACE, November 1997.
- *Waste Management Plan for Unexpected Materials Found During Remediation at the FUSRAP St. Louis Sites*, USACE, November 1998.
- *Methodology For Release Of Railroad Ties From The St. Louis Downtown Site*, TWR-01-010, Revision 0, SAIC, August 2002.
- *Final Status Survey Plan for Accessible Soil within Mallinckrodt Property and the Vicinity Properties, Excluding Plants 1,2 and the City Property at the St. Louis Downtown Site*, Rev. 2, USACE, February 2002.

2.0 ROADMAP

2.1 INTRODUCTION

This document describes the processes to be followed in planning and executing the survey of four categories of materials. Each category is briefly described in Table 1.

Table 1. Materials Summary

	Category	Process Inputs	Dispensation[a]	Survey Protocol
1.	Equipment/Materials	• Known Impacted Areas • Undetermined Adjacent Areas	• Clearance • Disposal	• RG 1.86/ANSI N13.12 • NUREG-1761
2.	Consolidated Materials	• Ex-situ pavement in/from impacted areas • Ex-situ building materials in/from impacted areas • Undetermined Adjacent Areas	• Crusher → Crushate Piles • Clearance • Disposal	• RG 1.86/ANSI N13.12 • NUREG-1761
3.	Crushate Piles/ Overburden Piles	• Consolidated Materials • Overburden • Existing piles with known history • Existing piles with poor history	• Clearance • Use as Backfill • Disposal	• Piles Evaluation Process (MARSSIM Techniques)
4.	*In-situ* Overburden	• Impacted Areas	• Clearance • Use as Backfill • Disposal • Overburden Piles (stockpile)	• MARSSIM

[a] Materials that exceed the CERCLA risk range for release with unrestricted use generally require institutional controls and/or long-term stewardship.

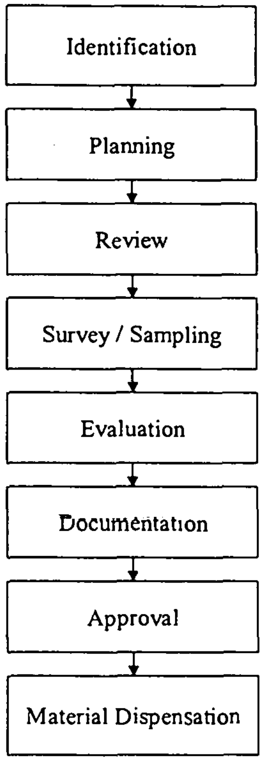
Detailed directions for the survey and evaluation of each category of materials are provided in Sections 3.0 and 4.0 of this document.

2.2 PROCESS OVERVIEW

Procedures for the survey and evaluation of Equipment/Materials using Regulatory Guide (RG) 1.86 techniques within radiologically controlled areas are well established at FUSRAP. Responsible parties will continue to follow the Sampling and Analysis Guide (SAG, reference 7.1.7) and other relevant U.S. Army Corps of Engineers (USACE)-approved work plans, which promulgate these procedures. Some requirements are repeated, and some supplementary information is added in Section 4.1 of this text in an effort to provide a comprehensive document.

This document also presents new procedures for the survey and evaluation of Materials, Consolidated Materials, Crushate/Overburden Piles, and *in-situ* Overburden. The procedures follow the general outline shown in Figure 1.

Figure 1. Overview of Survey and Evaluation Steps



Identification: The material to be surveyed, evaluated, and dispensed is identified. This includes the segregation of matcrials into similar types and characteristics, dividing materials into piles or groups so that volume, surface, or area limits are met, and the flagging or tagging of materials so that trace-ability can be maintained.

Planning: Information is gathered and decisions are made about how the materials will be dispensed (i.e., where the materials should go based on suspected contamination levels and waste goals), and what survey approach is most beneficial. Specific details of the survey and sampling design and data quality objectives (DQOs) are documented by the verification contractor (VC) in a planning package, based upon the guidance from this document. Historical information and characterization data for the materials and/or area where the materials originated, as appropriate, are included in the planning package.

Review: The planning package is presented to USACE for review and concurrence. The data that was used in decision making is reviewed and validated. USACE decides who will perform the survey and sampling functions, who will perform the data evaluation and reporting, and what government oversight will be necessary during the survey and sampling operations.

Survey/Sampling: Samples are obtained and surveys are taken in support of the planning package. VC or government oversight may be required.

Evaluation: Survey and sample results are evaluated and conclusions are drawn as to the acceptability of the materials for dispensation as described in the planning package. Additional survey or sampling may be required.

Documentation: Information from the planning package is combined with evaluation results and supporting data to create a report. The report will eventually be filed as a permanent record.

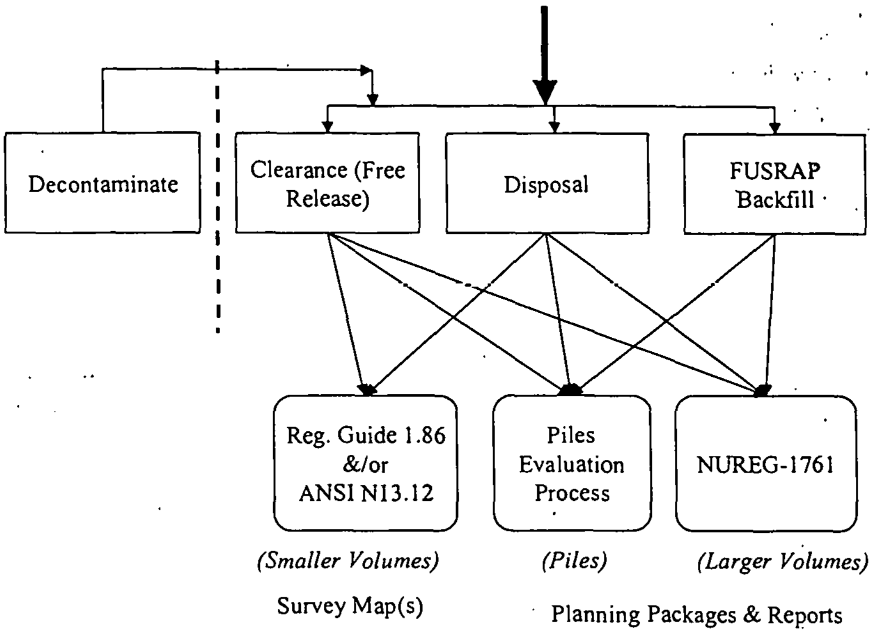
Approval: The evaluation report is sent to USACE for review and approval. Approval indicates that the material is acceptable to be dispensed as described in the planning package.

Material Dispensation: The responsible party physically moves the material. The destination is determined in the planning package, validated in the evaluation phase, and confirmed in the approval phase. Some confirmatory surveys or surveying may be required (as discussed in this document and the planning package) during material dispensation to provide an additional assurance that areas of elevated activity that were missed during the survey/sampling phase are not uncovered.

2.3 SURVEY OPTIONS

The user should choose the survey option from this document that is most beneficial for the circumstances and yet meets the data quality and documentation requirements that are needed. The options are summarized in Figure 2 and described in Section 3.0.

Figure 2. Survey Options



2.4 USE OF THIS DOCUMENT

The general sequence of steps for the use of this document are summarized below.

2.4.1 Review the roadmap explained in Section 2.0 to become familiar with the overall process..
2.4.2 Identify the material to be evaluated and gather history/process knowledge for the material.
2.4.3 Select an option for the dispensation of the material (i.e., Clearance, Disposal, or Backfill).
2.4.4 Select the best survey and evaluation option for the material from Section 3.0. (NOTE: For piles, the piles evaluation approach discussed in Section 3.3 is the preferred method).
2.4.5 Review the responsibilities, supplementary information, and data analysis criteria from Section 4.0 for the type of material being evaluated.
2.4.6 Prepare a planning package for the material, route for review and concurrence, and perform surveys/sampling.
2.4.7 Evaluate survey/sampling data. Compare data to the limits/criterion/ Derived Concentration Guideline Level for Clearance ($DCGL_C$).
2.4.8 Review the material's dispensation option for acceptability. Choose a new option, if necessary.
2.4.9 Solicit concurrence from USACE Health Physics before material dispensation.

2.4.10 Dispense material as approved by USACE.

2.5 RESPONSIBILITES

Responsibilities are outlined in each sub-section of Section 4.0 in this document.

NOTE: USACE may direct the remedial action contractor (RAC) or VC to perform any and/or all of the steps outlined in any sub-section of this procedure. This will generally be established in the review phase.

3.0 SURVEY OPTIONS

3.1 REGULATORY GUIDE 1.86 AND ANSI N13.12 APPROACH

3.1.1 Radionuclide Contaminants of Concern - Limits/Criteria

(a) Refer to Attachment 1 for more detailed information on the basis for limits, minimum detectable concentration (MDC) calculations, and guidance on the averaging of measurements.

(b) The limits from Table 2 and Table 3 apply when using this approach:

NOTE 1: The reader should refer to the referenced documents for additional guidance on the implementation of these limits/criteria.

NOTE 2: Surficial release criteria <u>shall</u> be used when the item's size or shape reasonably allows direct radiological surveys for surface radioactive contamination[1].

NOTE 3: Items known to be contaminated at activity levels that are in excess of release criteria <u>should not</u> be intentionally blended with lower specific activity material for the purpose of meeting volumetric release criteria[2].

Table 2. RG 1.86 Surficial Release Criteria

	Average Contamination $DCGL_C$ ($dpm/100\ cm^2$)	**Maximum Contamination ($dpm/100cm^2$)**	**Removable Contamination ($dpm/100\ cm^2$)**
Gross Alpha[3]	100	300	20
Gross Beta[5]	5,000	15,000	1,000

Table 3. ANSI 13.12 Volumetric Release Criteria

Radionuclide Groups	**Volume Screening[4] $DCGL_C$ (pCi/g)**
Radium, and Thorium: Ra-226, Ra-228, Th-228, Th-230, Th-232, and associated decay chains, and others	3
Uranium: U-234, U-235, U-238, Natural Uranium, and others	30

(c) Multiple surface contamination measurements should not be averaged over more than 1 square meter (m^2). For objects of less surface area, the average should be derived for each such object.

1 This is consistent with guidance in ANSI/HPS N13.12-1999.
2 This is consistent with guidance in ANSI/HPS N13.12-1999.
3 From the MED/AEC radiological contaminants of concern.
4 The sum of the fractions rule applies to each radionuclide that is present. FUSRAP contaminants do not necessarily exist in proportions that are consistent with natural decay chains.

(d) No single volume screening measurement shall exceed three times the volume screening limit.

(e) Multiple volumetric measurements should not be averaged over more than 1 m^3 or a mass of 1 metric ton. For items with a mass less than 1 metric ton, an average over the entire mass shall be derived for each item.

(f) When collecting additional survey data for the purposes of averaging, a minimum of three additional measurements should be taken (or collected).

3.1.2 Chemical Contaminants of Concern (COC)

(a) Sampling for chemical COCs is required only when volumetric sampling is used to evaluate a material.

(b) Chemical COCs are defined in, and their limits/evaluation criteria will be taken from, the applicable Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) decision document or the Waste Acceptance Criteria (WAC) for the intended disposal facility.

(c) Clearance - the number of chemical samples to be obtained and analyzed is calculated using Attachment 8. In any case, at least one (composite) sample for chemical COCs will generally be obtained.

(d) Disposal - the number of chemical COC samples will be determined by the disposal facility's WAC.

3.1.3 Toxic Characteristics Leaching Procedure (TCLP) Samples

(a) Clearance - sampling for TCLP is generally required if total metals exceed relevant criteria.

(b) Disposal - sampling for TCLP may be required by the disposal facility's WAC.

(c) The number of TCLP samples to be obtained and analyzed is calculated using Attachment 8.

3.1.4 Quality Assurance/Quality Control (QA/QC) Samples

(a) Requirements for QA/QC samples are provided in reference 7.1.7.

(b) QA/QC sampling is required only when volumetric sampling is used to evaluate material.

(c) QA (split) samples should be collected and analyzed at a frequency of about once every twenty samples. If fewer than ten radiological samples are required, then no QA (split) samples will be obtained.

(d) QC (duplicate) samples should be collected and analyzed at a frequency of about once every twenty samples. If fewer than ten radiological samples are required, then no QC (duplicate) samples will be obtained.

3.1.5 MDC Calculation – Fixed Measurements

(a) MDCs shall be calculated for each instrument type to be used and for each radiation to be detected.

(b) MDCs shall be less than the applicable limit (i.e., Table 2) that is to be applied to the material.

(c) The measurement MDC shall be documented on the material's survey record.

(d) For laboratory analysis of material samples (i.e., smears or volumetric samples) existing laboratory protocols will be used to determine and document MDCs.

(e) Equation 1, taken from NUREG-1507, will be used to determine the MDC.

Equation 1

$$MDC = \frac{3 + 3.29\sqrt{R_b t_g \left(1 + \frac{t_g}{t_b}\right)}}{t_g E_i E_s \left(\frac{\text{Probe Area cm}^2}{100\text{ cm}^2}\right)}$$

where: R_b = the background count rate (counts per minute [cpm])
t_g = the gross sample count time (min)
tb = the background count time (min)
E_i = the detector efficiency
E_s = the surface efficiency5 [0.25 for alpha and low-energy beta, 0.50 for Beta > 0.4 MeV]

3.1.6 MDC Calculation – Scanning Measurements

(a) Scan MDCs shall be calculated for each instrument type to be used and for each radiation to be detected.

(b) Scan parameters should be adjusted such that the Scan MDCs are less than the applicable limit (i.e., Table 2) that is to be applied to the material.

(c) The Scan MDC shall be documented on the material's survey record.

(d) When calculating the Scan MDC, the index of detectability (d′) will be set at a value of 1.38, and the surveyor efficiency[6] (p) will be assumed to be 0.50.

(e) The following equations, taken from NUREG-1507, will be used to determine the Scan MDC:

[5] Per NUREG-1507's reference to ISO 7503-1.
[6] These values were established in existing Final Status Survey (FSS) Plans, and are repeated here for consistency.

Equation 2

$$i = \frac{w}{s}$$

where: i = the time that the probe face is exposed to a point of contamination (sec)
w = the probe face width, in the direction of scanning (in)
s = the scan speed (in/sec)

Equation 3

$$MDCR = d'\sqrt{b\left(\frac{i}{60}\right)}\left(\frac{60}{i}\right)$$

where: d' = the index of detectability [Table 6.1 in NUREG-1507] (i.e., 1.38)
b = the background count rate (cpm)
i = taken from Equation 2 (sec)

Equation 4

$$MDC = \frac{MDCR}{\sqrt{p}E_iE_s\left(\frac{probe\ area\ cm^2}{100\,cm^2}\right)}$$

where: MDCR = the minimum increase above background that can be seen reliably (cpm)
p = the surveyor efficiency (i.e., 0.5)
Ei = the detector efficiency
Es = the surface efficiency [see Equation 1]

3.1.7 Data Evaluation

(a) Radiological COCs

(1) Clearance – Compare individual survey results directly to Table 2 and Table 3 limits.

(2) Disposal – Calculate the upper 95% confidence limit (UCL_{95}) per Equation 6 (see Section 3.3.15) of this document, and compare to the WAC for the desired waste disposal facility.

(b) Chemical COCs

(1) Clearance - Compare individual sample results to the UCL_{95} value for that contaminant as listed in the relevant background study[7] or to the values found in Reference 7.1.10.

(2) Disposal – Compare individual sample results to the disposal facility's WAC.

(c) TCLP Samples – Inspect individual sample results to verify that the material does not exhibit hazardous characteristics.

(d) QA/QC Samples

(1) Verify that results meet the goals of Table 3-1 of reference 7.1.7.

3.2 NUREG-1761 APPROACH

3.2.1 General

(a) Draft Report NUREG-1761 describes a method in which a Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)-based approach may be taken to evaluate a wide variety of materials, including metals, building concrete, equipment, piping and others.

(b) The NUREG indicates that statistical survey designs (rather than reliance on complete scanning) are warranted in cases where the scan MDC is > DCGLC. This is nearly always the case where alpha contamination is suspected.

(c) USACE has determined that the NUREG-1761 approach for the survey and evaluation of material is acceptable for use at the St. Louis FUSRAP Sites.

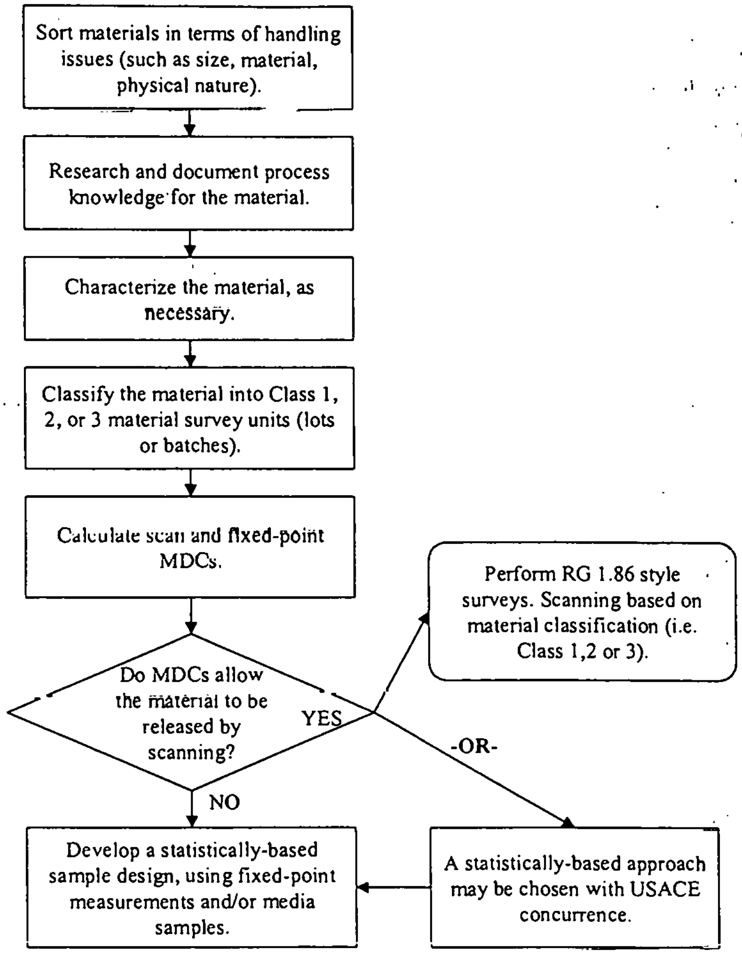
(d) DQOs are provided in Attachment 3 to this document.

3.2.2 Process Map

(a) The general steps to be followed in the decision to use the NUREG-1761 approach are summarized in Figure 3.

[7] The choice is to be established during the DQO process in the Planning stage.

Figure 3. NUREG Approach, Decision Making Process



3.2.3 Survey Design

(a) Classification of Survey Units (batches, lots)

(1) The area classification guidance from MARSSIM will be directly applied to the batches or lots of materials (i.e. survey units) that are evaluated using the NUREG-1761 process.

REMINDER: The classification guidance compares contamination potential to the applicable limit. If a disposal option is chosen, the limit(s) may be significantly higher.

(2) A fraction of the MARSSIM survey unit area recommendations for structures will be applied to survey units where materials are laid out flat for survey and evaluation. These are provided in Table 4.

Table 4. Maximum Survey Areas

Material (Survey Unit) Classification	Maximum Survey Unit Area
Class 1	10 m^2
Class 2	25 m^2
Class 3	50 m^2

(3) Materials should be laid out flat, and spaces between materials should be minimized. The outer perimeter of materials will be used as the survey unit boundary and to estimate the area of the survey unit.

(b) Decision Errors

(1) Type I errors: 0.05

(2) Type II errors: 0.20

(3) Quality control splits and duplicates will agree within 30% for measurements that are ≥ 50% of the limit.

(4) The H_0 will be: The contamination on/in the material surveyed exceeds the release criterion.

(c) Limits/Criterion/DCGLs

(d) Limits are discussed in Table 2 and Table 3 of this document.

(e) Relative Shift and the Number of Samples (n)

(f) Follow the guidance provided in Section 3.3.7 of this document.

(g) Estimate the Sample Grid Spacing

(1) Triangular grids will be used.

(2) Grid spacing will be determined by use of Equation 5.

3.2.5 TCLP Samples

(a) Clearance - sampling for TCLP is generally required if total metals exceed relevant criteria.

(b) Disposal - sampling for TCLP may be required by the disposal facility's WAC.

(c) The number of TCLP samples to be obtained and analyzed is calculated using Attachment 8.

3.2.6 Quality Assurance/Quality Control Samples

(a) Requirements for QA/QC samples are provided in reference 7.1.7.

(b) Surficial Contamination Measurements[8]:

(1) A minimum of 5% of the total fixed point measurements will be re-performed by a second independent technician with a second survey meter (i.e., QC Duplicate).

(2) QA/QC measurements will be performed "apart in time" from the first measurements.

(c) Volumetric Contamination Measurements:

(1) QA (split) samples should be collected and analyzed at a frequency of about once every twenty samples. If less than ten radiological samples are required, then no QA (split) samples will be obtained.

(2) QC (duplicate) samples should be collected and analyzed at a frequency of about once every twenty samples. If less than ten radiological samples are required, then no QC (duplicate) samples will be obtained.

3.2.7 MDCs

(a) Use the guidance in Sections 3.1.5 and 3.1.6 to determine MDCs.

(b) MDCs shall be less than the applicable limit/criterion/$DCGL_C$ from Table 2 and Table 3 of this plan.

(c) For the disposal option, MDCs shall also meet any WAC requirements.

(d) Where possible, the target value for MDCs should be 50% or less of the applicable limit/criterion/$DCGL_C$.

3.2.8 Scanning

(a) Scanning will be performed on all materials within the survey unit, regardless of the calculated Scan MDC.

(b) The amount of scanning will be based on the survey unit's classification, as discussed in MARSSIM.

8 QA/QC is required for surficial contamination measurements due to the reliance on a statistical survey design.

(c) Scanning may warrant that additional fixed-point measurements be taken to confirm the results of suspect scan results. These additional fixed-point measurements are biased, and shall not be included in the statistical analysis of the material in the survey unit.

3.2.9 Data Evaluation

(a) Radiological COCs

(1) Clearance – Compare individual survey results directly to Table 2 and Table 3 limits.

(2) Disposal – Calculate the UCL_{95} per Equation 6 (see Section 3.3.15) of this document, and compare to the WAC for the desired waste disposal facility.

(b) Chemical COCs

(1) Clearance - Compare individual sample results to the UCL_{95} value for that contaminant as listed in the relevant background study or[9] to the values found in Reference 7.1.10.

(2) Disposal – Compare individual sample results to the disposal facility's WAC.

(c) TCLP Samples – Inspect individual sample results to verify that the material does not exhibit hazardous characteristics.

(d) QA/QC Samples

(1) Verify that sample results meet the goals of Table 3-1 of reference 7.1.7.

3.3 THE CRUSHATE/OVERBURDEN PILES APPROACH

3.3.1 General

(a) MARSSIM-based techniques will be used in the survey and evaluation of crushate piles and/or *ex-situ* overburden.

(b) Piles should consist of similar material types (e.g., soil and crushate should not be mixed into a single pile).

(c) Consolidated materials should be excluded from crushate/overburden piles when the piles are formed and/or when piles are relocated.

(d) A separate planning package should be written for each pile to be surveyed.

(e) Simple random sampling during the creation of the crushate/overburden pile is preferred to *in-situ* pile sampling, as there are fewer logistical and safety concerns.

(f) A systematic grid and systematic sampling scheme for *in-situ* piles may be substituted for the simple random sampling techniques described in this section, when directed to do so by USACE.

[9] The choice is to be established during the DQO process in the Planning stage.

3.3.2 Prerequisites

(a) Materials have been isolated, segregated, quarantined, etc. such that surveyed materials will not be cross-contaminated or that non-surveyed materials will not be inadvertently mixed with surveyed materials.

(b) Refer to Attachment 2 for more detailed information on the basis for the survey approach.

3.3.3 Radiological and Chemical COCs - Limits/Criteria

Table 5 summarizes the limits to be applied when evaluating the survey results.

Table 5. Crushate/Overburden Limits - Radiological and Chemical COCs

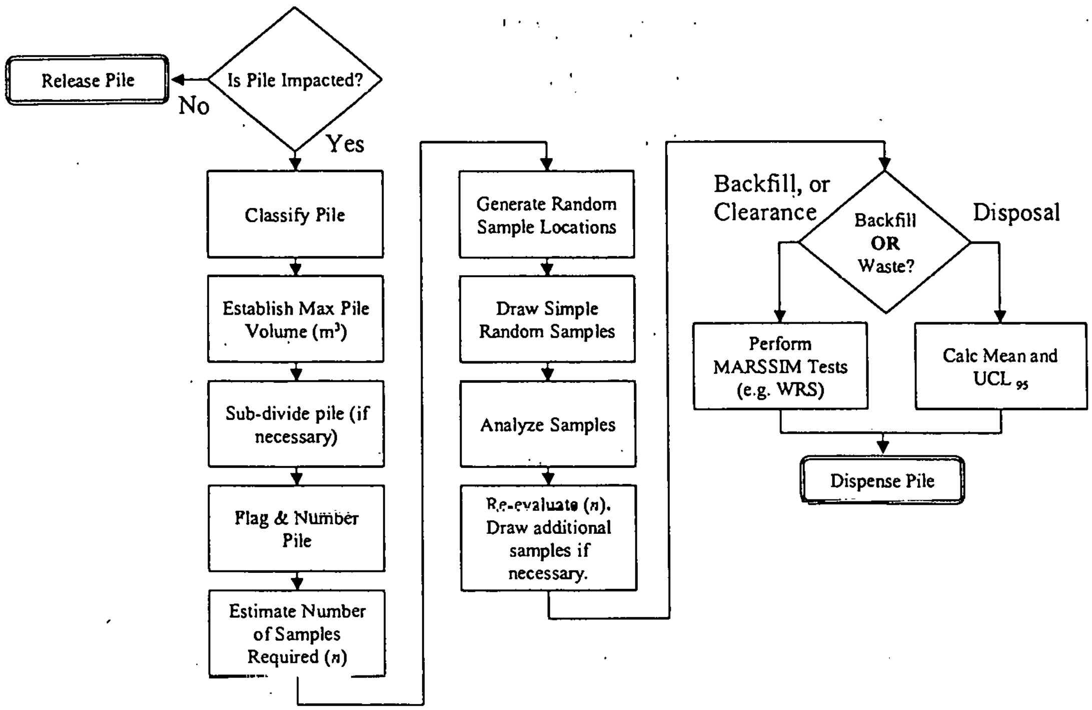
Dispensation	Limit[10]
Properly Permitted Subtitle D Landfill	Per Landfill's Waste Acceptance Criteria (WAC)
Properly Permitted Subtitle C Landfill	Per Landfill's Waste Acceptance Criteria (WAC)
FUSRAP Backfill	Per the applicable Record of Decision (ROD)
Clearance	Per the applicable ROD

3.3.4 Survey Protocol

(Refer to Attachment 2 for more detailed information)

[10] NOTE: Care must also be taken to assure compliance with the source material disposal requirements of 10 CFR 40.

Figure 4. MARSSIM-Based Evaluation Process for Piles



3.3.5 Pile Classification

(a) The standard MARSSIM criteria for the classification of land areas will be applied to the classification of crushate/overburden piles.

(b) Information used in the classification of crushate/overburden piles will be based upon the location, e.g., survey unit, impacted area that the material originated in.

(c) If the crushate/overburden pile is located in an area where surrounding activities could impact the radiological status of the pile, then that information will also be considered in the pile classification.

(d) Each pile will constitute a survey unit. Separate survey units should not be applied to a single pile.

(e) In accordance with MARSSIM guidance, a pile of impacted materials will be initially considered to be Class 1, unless there is adequate supporting evidence to assign a different classification. The rationale used shall be documented.

3.3.6 Maximum Pile Volumes

(a) Crushate/overburden piles will be limited in volume (based upon MARSSIM guidance for land areas, and modified to consider a theoretical contamination depth of 15 cm to create a volume limit).

(b) Table 6 provides maximum pile volumes based upon the pile's survey classification.

Table 6. Maximum Pile Volumes

Survey Unit Classification	Maximum Pile Volume[a]
Class 1	300 m^3
Class 2	1,500 m^3
Class 3	7,500 m^3

[a] Maximum pile volumes are guidelines and variances of ± 10% are acceptable.

(c) If a crushate/overburden pile is estimated to exceed the Table 6 value, then the pile should be physically sub-divided and each new pile should be evaluated separately[11].

3.3.7 Estimating the Number of Radiological Samples (n)

The number of samples to be obtained from a crushate/overburden pile will be calculated using standard MARSSIM techniques. The steps are summarized below for ease of reference.

(a) Calculate the Relative Shift (Δ/σ)

(1) Determine the intended dispensation of the pile, and then the corresponding limit from Table 5.

(2) Determine the lower bound of the gray region (LBGR).

(3) MARSSIM recommends initial selection of the LBGR as ½ of the limit.

(4) Δ = Table 5 limit(s) – LBGR

(5) Estimate σ

An initial value for σ can be determined from previous survey data from the pile or from the land area that the pile was obtained from.

Alternately, σ can be estimated by[12]:

$$\sigma = \text{RANGE}/6$$

Where range is the expected spread between the smallest and largest measured values from the pile.

Alternately, σ can be estimated via a small preliminary investigation technique[13] in which some small number of samples are obtained and analyzed. The resulting value of σ from the initial sample set is used to calculate a value of n that is used to complete the sampling.

Alternately, σ may be assumed to be on the order of 30% if it is reasonable (based on previous experience).

[11] In certain circumstances, USACE may elect not to physically sub-divide a pile, or may elect to evaluate physically separate piles with a single sampling campaign and a single evaluation.

[12] Reference 7.1.5, Section 6.3.1.3.

[13] Discussed in Reference 7.1.5, Section 6.3.1 and Reference 7.1.4, Section 5.5.2.2.

(6) Determine the relative shift by:

$$\text{Relative Shift} = \Delta/\sigma$$

(b) Determine the Decision Error Percentiles

Decision errors are to be set at 0.05 for Type I and 0.20 for Type II errors.

(c) Determine the Number of Data Points

Refer to the tables in Attachment 6 to determine (n), the number of samples required for MARSSIM statistical tests.

A minimum of 20 samples[14] should be obtained on any pile, regardless of the calculated value of n.

3.3.8 Generating Simple Random Sample Locations

(a) Samples will be obtained from each crushate/overburden pile using a simple random sampling strategy (unless USACE dictates that systematic sampling should be performed).

(b) Where feasible, samples will be obtained during pile creation by selecting random end-loader buckets of pile material. Care should be taken to ensure that some samples are representative of the later portions of the material.

(c) Sample locations for existing piles will be identified using three values: angle of rotation (a_r), height above ground level (h_s), and depth from the pile surface (d_s) in a horizontal direction, as depicted in Figure 5.

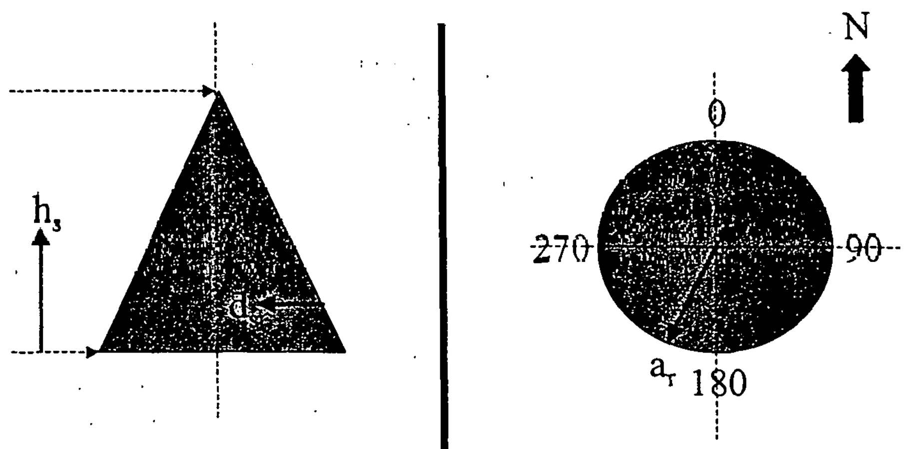
(1) 0 degrees pile rotation will be established as true North.

(2) Values for a_r, h_s, and d_s should be generated via random number generator, table, etc. (a Microsoft Excel worksheet is available that takes the pile height and radius, and generates random sample points that are restricted to the bounds of the physical pile).

(3) A tabulation of random sample points, along with documentation of the method used to generate the sample points, should be retained in the planning package.

[14] Refer to Attachment 2 for an explanation.

Figure 5. Identifying a Pile Sample Location



h_s is sample height
d_s is sample depth

a_r is angle of rotation

Elevation View

Plan View

3.3.9 Drawing Simple Random Samples

(a) Using approved FUSRAP methods (i.e. reference 7.1.7 and relevant USACE-approved work plans), obtain samples at the locations and/or frequencies identified in Section 3.3.8.

(b) Radiological samples taken from *in-situ* piles shall not be composited.

(c) Portable radiation instrumentation shall not be used to bias the sample locations or the sample aliquot.

3.3.10 Re-evaluate the Number of Samples

(a) When laboratory analysis is complete, re-calculate *n* (for radiological, chemical, and TCLP samples, as appropriate) using actual data as described in Section 3.3.7.

(b) If the new value for *n* is greater than 20 for radiological samples, then identify, obtain, and analyze *n*-20 additional simple random samples.

(c) If the new value for *n* is larger that what was obtained for chemical or TCLP samples, then obtain and analyze the additional samples.

3.3.11 Sampling for chemical COCs

(a) Chemical COCs are defined in, and their limits/evaluation criteria will be taken from, the applicable CERCLA decision document or the WAC for the intended disposal facility.

(b) FUSRAP Backfill or Clearance - the number of chemical samples to be obtained and analyzed is calculated using Attachment 8. In any case, at least one (composite) sample for chemical COCs will generally be obtained.

(c) Disposal - the number of chemical COC samples will be determined by the disposal facility's WAC.

3.3.12 TCLP Samples

(a) FUSRAP Backfill or Clearance - sampling for TCLP is generally required if total metals exceed relevant criteria.

(b) Disposal - sampling for TCLP may be required by the disposal facility's WAC.

(c) The number of TCLP samples to be obtained and analyzed is calculated using Attachment 8.

3.3.13 QAQC Samples

(a) FUSRAP Backfill or Clearance:

(1) QA (split) samples should be collected and analyzed at a frequency of about once every twenty samples. If fewer than ten radiological samples are required, then no QA (split) samples will be obtained.

(2) QC (duplicate) samples should be collected and analyzed at a frequency of about once every twenty samples. If fewer than ten radiological samples are required, then no QC (duplicate) samples will be obtained.

(b) Disposal - The number of quality control samples will be determined by the WAC of the disposal facility and feedback by the applicable regulatory body.

3.3.14 Radiological Data Evaluation - FUSRAP Backfill or Clearance

(a) If a Crushate/Overburden pile is to be placed into backfill on a FUSRAP property, then evaluate the laboratory results via the WRS test as described in MARSSIM Section 8.4.1.

(b) In the Wilcoxon Rank Sum (WRS) test, use reference area measurements that are appropriate to the location that the overburden pile came from.

(c) If a suitable background data set is not available for the material, then evaluate the laboratory results via the Sign test as described in MARSSIM Section 8.3.1. (i.e., background will not be subtracted).

(d) The $DCGL_{EMC}$ will not be applied to crushate/overburden piles. Small areas of elevated activity will not be allowed.

(e) If the H_0 cannot be rejected, then the pile is not acceptable for backfill.

(1) Areas of elevated activity may be removed from the pile. Re-sampling of the pile may not be necessary. The sample results from the removed portion of the pile should be excluded from the final data set.

OR

(2) The pile's dispensation will need to be re-evaluated.

OR

(3) The pile will need to be flattened to a 15 cm thickness and re-evaluated using standard MARSSIM techniques for land areas.

3.3.15 Radiological Data Evaluation - Disposal Option

(a) If the crushate/overburden pile is to be sent for disposal, then parametric statistics[15] will be calculated for the pile in order to provide a "best estimate" of the contamination concentration(s) for shipping and disposal purposes.

(b) Calculate the mean and the sample standard deviation for the laboratory results (for results that are below the detection limit, substitute ½ of the detection limit in the calculations)

(c) Determine the UCL_{95} per Equation 6.

Equation 6

$$\mu_{U\alpha} = \bar{x} + t_{1-\alpha,df} \frac{s}{\sqrt{n}}$$

Where: $\bar{x}$ = the mean
s = the sample standard deviation
$t_{1-\alpha,df}$ = taken from the table in Attachment 4
n = the number of samples evaluated

(d) Determine if the crushate/overburden pile meets the appropriate limit from Table 5 (for the intended dispensation) by using the following inequalities:

If $\mu_{U\alpha}$ < Limit, conclude that the pile is acceptable for the intended dispensation.

If $\mu_{U\alpha} \geq$ Limit, conclude that the pile is not acceptable for the intended dispensation.

(e) If a pile is not acceptable for the intended dispensation, then:

(1) Areas of elevated activity may be removed from the pile. Re-sampling of the pile may not be necessary. The sample results from the removed portion of the pile should be excluded from the final data set, and pile statistics should be recalculated.

OR

(2) Another dispensation may be chosen. Re-test as described in (d) above.

[15] Reference 7.1.5, Section 6.3.3.

3.3.16 Data Evaluation - Chemical COCs

(a) If required pursuant to FUSRAP Backfill or Clearance - Compare individual sample results to the UCL_{95} value for that contaminant as listed in the relevant background study or[16] to the values found in reference 7.1.10.

(b) Disposal – Compare individual sample results to the disposal facility's WAC..

3.3.17 Data Evaluation – TCLP; Inspect individual sample results to verify that the material does not exhibit hazardous characteristics.

3.3.18 Data Evaluation - QA/QC Samples

(a) Verify that sample results meet the goals of Table 3-1 of reference 7.1.7.

3.3.19 Scanning

(a) Informational scanning should be performed in an attempt to identify areas of elevated activity.

(1) Global positioning system (GPS)-assisted scans are not required.

(2) The results of scans should be documented on a survey map, or as an entry (or series of entries) in an appropriate logbook.

(b) Scanning will be performed:

(1) On *in-situ* materials, prior to excavation and subsequent deposition of soil/material in a pile, where applicable, or on end-loader buckets of materials as the pile is being formed.

(2) On intact piles as part of the sampling protocol.

(3) On excavator buckets of pile material and exposed faces of the pile as material is removed from the pile for disposal or backfill.

(c) Scanning action levels for piles will be:

(1) Established by the site Radiation Safety Officer (RSO) and/or Certified Health Physicist (CHP).

(2) Documented in a planning package.

(3) Based upon the results of the laboratory analysis of pile samples.

(d) If elevated scan readings are found during pile removal (i.e., dispensation of the pile), then:

(1) The area of elevated readings should be removed from the pile.

(2) The elevated material should be placed in an appropriate location so that it can be subsequently sent to the correct disposal facility.

(3) Re-sampling of the pile is not required.

16 The choice is to be established during the DQO process in the Planning stage.

3.3.20 Minimum Detectable Activity (MDA)

(a) FUSRAP Backfill or Clearance – The MDAs necessary to properly evaluate sample results will be determined by the applicable decision document.

(b) Disposal - The MDAs necessary to properly evaluate sample results will be determined by the applicable WAC.

3.4 IN-SITU APPROACH

3.4.1 General

(a) Survey of *in-situ* overburden is not the preferred method to evaluate the material. USACE will critique the selection of this option in the review stage (prior to survey), and may prohibit the *in-situ* approach. This is because:

(1) Some amount of potentially clean overburden could be in close contact with contaminated materials.

(2) Contaminated material may be inadvertently removed with the surveyed overburden during the excavation process.

(3) If the overburden was surveyed *in-situ* and then removed, there is no mechanism to detect this contamination.

(4) Survey *in-situ* will require MARSSIM land-area techniques, which will result in a large number of samples.

(b) There are Final Status Survey Plans currently available for all St. Louis Site property types. The appropriate existing plan will be used to design and execute a survey of *in-situ* overburden, with the modifications provided below.

(c) Data analysis, requirements of sampling for chemical COCs, TCLP, and requirements for QA/QC samples will all be performed in accordance with the relevant existing final status survey plan that is applicable to the overburden area.

3.4.2 Limits

(a) Table 5 limits apply, based on the intended dispensation of the overburden.

(b) The area limitations of MARSSIM survey units will be applied to overburden sampling.

3.4.3 Overburden Classification

(a) Overburden that is separated from contaminated materials by an intact liner material may be considered to be a Class 3 survey unit, in the absence of other information to the contrary.

(b) Overburden that is in contact with contaminated materials may be considered to be a Class 2 survey unit, in the absence of other information to the contrary.

(c) The boundaries of an overburden Class 2 survey unit may extend no closer than 1 foot in any direction to contaminated materials.

3.4.4 Survey Protocol

(a) Each overburden area and media type will be approved by USACE prior to sampling.

(b) The survey contractor will submit a survey design to USACE for approval prior to sampling.

(c) Survey laboratory results will be evaluated using MARSSIM guidance (e.g., sign or WRS test, as appropriate).

(d) Samples in each survey unit will be obtained at 6-inch (15 cm) intervals, up to the depth of interest (e.g., within 1 foot of the contaminated region).

(e) Each grouping of 6-inch intervals (i.e., each 6 inch layer) will be evaluated as an independent data set, using the sign or WRS test as appropriate.

(f) If analysis of an interval fails to reject the H_0, then:

(1) The entire interval (layer) must be excluded from the overburden, or

(2) The region of samples that caused the failure must be excluded from the overburden and must be included in a remediation effort.

If a region is excluded, then additional samples may need to be obtained to:

- better define the boundary of the contaminated region.
- raise the number of samples in the remainder of the overburden interval to an acceptable level of statistical power.

(g) Where feasible, each 6-inch lift of material should receive an *in-situ* gamma walkover prior to removal, to look for the presence of small areas of elevated activity.

4.0 MATERIAL-SPECIFIC INSTRUCTIONS

4.1 EQUIPMENT/MATERIALS OR CONSOLIDATED MATERIALS

4.1.1 Responsibilities

(a) Remedial Action Contractor (RG 1.86 Approach)

(1) Identify materials for survey and evaluation

(2) Obtain samples and conduct the surveys necessary to evaluate the materials in question. Existing FUSRAP procedures will be followed.

(3) Compare survey results to Table 2 and/or Table 3 limits.

(4) Document survey results on survey maps and/or logs.

(5) Dispense materials, as appropriate.

(b) Remedial Action Contractor (NUREG-1761 Approach)

(1) Identify materials for survey and evaluation.

(2) Gather and document historical information/process knowledge for the material to be evaluated.

(3) Classify the materials (i.e., MARSSIM class).

(4) Notify the verification contractor of the need for a NUREG-1761-based planning package. Supply historical information and supply input to the planning package.

(5) Using an approved planning package, obtain samples and conduct the surveys necessary to evaluate the materials in question.

(6) Solicit USACE approval before the clearance or disposal of materials.

(c) Verification Contractor (RG 1.86 Approach)

(d) No actions required.

(e) Verification Contractor (NUREG-1761 Approach)

(1) Solicit remedial action contractor input for planning packages.

(2) Develop NUREG-1761 based planning packages, and review them with the RAC.

(3) Submit planning packages to USACE for concurrence.

(4) Perform supplementary sampling and/or confirmatory measurements of materials as needed.

(5) Evaluate data and generate a material survey evaluation report to be used by USACE in decision making.

4.1.2 General

(a) A separate NUREG-1761 based package should be written for each type of material and for each MARSSIM classification of the material to be surveyed.

(b) Any and all of the survey and evaluation steps may be performed by the remedial action contractor when directed to do so by USACE.

4.1.3 Prerequisites

(a) Materials are sufficiently dry so as not to adversely impact the survey results.

(b) Materials are free from large amounts of dirt, soils, oils, grease, and vegetation.

(c) Materials have been isolated, segregated, quarantined, etc. such that surveyed materials will not be cross-contaminated or that non-surveyed materials will not be inadvertently mixed with surveyed materials.

4.2 CRUSHATE PILES/OVERBURDEN PILES

4.2.1 Responsibilities (Clearance or Disposal Option)

(a) Remedial Action Contractor

(1) Identify materials for survey and evaluation.

(2) Gather and document historical information/process knowledge for the material to be evaluated.

(3) Create a piles planning package.

(4) Submit the planning package to USACE for concurrence.

(5) Using an approved planning package, obtain samples from crushate/overburden piles.

(6) Scan pile materials in an attempt to identify areas of elevated activity.

(7) Evaluate pile sample results and scan data.

(8) Determine the appropriate disposal option.

(9) Submit survey documentation and basis for disposal option to USACE for concurrence.

(b) Verification Contractor

No actions required.

4.2.2 Responsibilities (FUSRAP Backfill Option)

(a) Remedial Action Contractor

(1) Identify materials for survey and evaluation.

(2) Gather and document historical information/process knowledge for the material to be evaluated.

(3) Notify the verification contractor of the need for a piles planning package. Supply historical information and supply input to the planning package.

(4) When directed by USACE (using an approved planning package) obtain samples from crushate/overburden material while generating a pile, or from *in-situ* piles. The degree of government oversight will be determined by USACE.

(5) Scan pile materials in an attempt to identify areas of elevated activity, while generating a pile, and during pile removal. This will be done under government oversight, with the degree of oversight to be determined by USACE.

(6) Solicit USACE approval before using the material as backfill.

(b) Verification Contractor

(1) Solicit remedial action contractor input for planning packages.

(2) Develop piles planning packages, and review them with the RAC.

(3) Submit piles planning packages to USACE for concurrence.

(4) Obtain samples from *in-situ* crushate/overburden piles (unless USACE has directed the RAC to do this).

(5) Scan piles *in-situ* in an attempt to identify areas of elevated activity (unless USACE has directed the RAC to do this).

(6) Evaluate data and generate a material survey evaluation report to be used by USACE in decision making.

4.2.3 General

(a) A separate piles planning package should be written for each type of material and each pile of material to be surveyed.

(b) Any and all of the survey and evaluation steps may be performed by the RAC when directed to do so by USACE.

4.2.4 Prerequisites

(a) Materials are relatively dry.

(b) Materials have been isolated, segregated, quarantined, etc. such that surveyed materials will not be cross-contaminated or that non-surveyed materials will not be inadvertently mixed with surveyed materials.

4.3 IN-SITU OVERBURDEN

4.3.1 Responsibilities

(a) Remedial Action Contractor

(1) Identify materials for survey and evaluation.

(2) Gather and document historical information/process knowledge for the material to be evaluated.

(3) Classify the material.

(4) Notify the VC of the need for a planning package. Supply historical information and supply input to the package.

(5) Obtain samples from *in-situ* overburden under government oversight, when directed by USACE. The degree of oversight will be determined by USACE.

(6) Develop cut lines from pre-design investigation (PDI) and *in-situ* overburden sample results, and submit an excavation package to USACE for concurrence prior to excavation.

(b) Verification Contractor

(1) Solicit RAC input for planning packages.

(2) Develop *in-situ* overburden planning packages, and review them with the RAC.

(3) Submit planning packages to USACE for concurrence.

(4) Obtain samples from *in-situ* overburden.

(5) Scan overburden in an attempt to identify areas of elevated activity.

(6) Evaluate sample results and scan data.

(7) Create and submit survey documentation to USACE prior to excavation.

4.3.2 Prerequisites

(a) The area of interest has been characterized. The depth and expected boundaries of subsurface contamination is known.

(b) Known areas of surface contamination have been removed/remediated.

(c) The area has been barricaded and/or quarantined to prevent cross-contamination during overburden removal.

5.0 RECORDS

No new records or record types are generated as a result of this procedure.

6.0 ATTACHMENTS

1.	Attachment 1:	Technical Basis For Survey Of Consolidated Materials and Equipment
2.	Attachment 2:	Technical Basis For Survey Of Crushate/Overburden Piles
3.	Attachment 3:	Data Quality Objectives for NUREG-1761 Material Surveys
4.	Attachment 4:	Statistical Table For Evaluating Samples For Disposal
5.	Attachment 5:	Information To Be Submitted When Requesting A Planning Package
6.	Attachment 6:	MARSSIM Tables For Selecting (*n*) Number Of Samples
7.	Attachment 7:	Soil DQO Summary For St. Louis Sites
8	Attachment 8:	Determining The Number (*n*) Of Chemical Samples To Be Obtained

7.0 REFERENCES AND DEFINITIONS

7.1 REFERENCES

7.1.1 *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities,* NIOSH Publication No. 85-115, October 1985.

7.1.2 *Termination of Operating Licenses for Nuclear Reactors*, Regulatory Guide 1.86, June 1974.

7.1.3 *Surface and Volume Radioactivity Standards for Clearance*, ANSI/HPS N13.12-1999.

7.1.4 *Multi-Agency Radiation Survey And Site Investigation Manual,* NUREG-1575, EPA, Rev. 1, August 2000.

7.1.5 *Methods for Evaluating the Attainment of Cleanup Standards Volume 1: Soils and Media*, EPA 230/02-89-042, February 1989.

7.1.6 *Radiological Surveys for Controlling Release of Solid Materials*, NUREG-1761 Draft, July 2002.

7.1.7 *Sampling and Analysis Guide for the St. Louis Sites (SAG),* Rev. 0, USACE, September 2000.

7.18 *Final Status Survey Plan For Structures And Other Consolidated Material Left In Place At The St. Louis Site*, Draft, USACE 2003.

7.1.9 *Final Status Survey Plan for Accessible Soil within Mallinckrodt Property and the Vicinity Properties, Excluding Plants 1,2 and the City Property at the St. Louis Downtown Site,* Rev. 2, USACE, February 2002.

7.1.10 *Geochemical Survey of Missouri*, Geological Survey Professional Paper 954-H,I, U.S. Dept of the Interior, 1984 (Tidball Document).

7.1.11 *Background Soils Characterization Report for the St. Louis Downtown Site*, Final, USACE, March 1999.

7.1.12 *SLAPS Implementation Report*, Final, USACE, June 2001.

7.1.13 *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, Volume II, Chapter 9*, SW-846, EPA, 1988.

7.1.14 *Methods for Evaluating the Attainment of Cleanup Standards, Volume I: Soils and Solid Media*, PB89-234959, EPA, February 1989.

7.1.15 *Results of Implementation of Sampling and Analysis Plan at the St. Louis Airport Site*, Draft, USACE, December 1998.

7.2 DEFINITIONS

a-priori: Calculated before the parameters that are specific to a particular sample are known.

Clearance: The survey and subsequent removal of items or materials from any further institutional or administrative control.

Consolidated Materials: For the purposes of this document, pieces of concrete or asphalt that have at least one dimension that is greater than 25.4 centimeters (cm) (10 inches). This may also include items such as monoliths, railroad ties, metal beams, piping, etc.

Crushate: Consolidated materials that have been crushed and are now in aggregate form (generally concrete or asphalt that is processed so that the size averages less than 10 inches).

ex-situ: Not in the original position; having been moved.

Impacted: Material(s) or area(s) with some potential for residual contamination.

in-situ: Being in the original position; not having been moved.

Overburden: Material that is covering the soils of interest. This may consist of clean backfill, paving materials, sand, gravel, or any combination thereof. For the purposes of this document, overburden is considered to be potentially clean material.

Volumetric Contamination: Contamination residing in or throughout the volume of an item.

ATTACHMENT 1

TECHNICAL BASIS FOR SURVEY OF CONSOLIDATED MATERIALS and EQUIPMENT

Background

The purpose of this Attachment is to provide an appropriate methodology for the survey of impacted (i.e., potentially contaminated) materials encountered during remedial activities at the St. Louis Sites (SLS) for eventual release without radiological restrictions.

Materials surveyed for release without use restrictions shall meet the appropriate surficial release criteria specified in the Nuclear Regulatory Guide 1.86 (RG 1.86), *Termination of Operating Licenses for Nuclear Reactors* and the volumetric release criteria specified in American National Standard ANSI/HPS N13.12 – 1999, *Surface and Volume Radioactivity Standards for Unrestricted release*.

RG 1.86 and ANSI 13.12 guidance meet the intent of the CERCLA decision document(s) for the attainment of applicable or relevant and appropriate requirements (ARARs).

The materials that are determined to be impacted and are to be released without radiological restrictions will require surveying with handheld instrumentation (for total contamination levels), survey for removable contamination levels, and volumetric testing (when applicable) as outlined in Figure 1 of this plan.

The surveyor shall document the results of all surficial and volumetric testing results demonstrating that the appropriate release criteria have been met.

Basis for Limits – Surficial Contamination

RG 1.86 provides criteria which are protective of the public health and the environment, and have historically been used as the basis for the surficial limits for unrestricted release of equipment and material from nuclear facilities.

RG 1.86 contains no risk- or dose-based support for the surficial limits that are presented; however, the limits are conservative as compared to more recent guidance such as ANSI 13.12 and NUREG-1640, *Radiological Assessments for Unrestricted Release of Equipment and Materials From Nuclear Facilities*, which were derived based on a primary dose criterion of 1 mrem/yr to a member of the modeled critical group of receptors. As such, the criteria specified in RG 1.86, NUREG-1640, and ANSI N13.12 are all fully protective of human health.

Basis for Limits – Volumetric Contamination

RG 1.86 does not address materials that may be volumetrically contaminated, therefore ANSI/HPS N13.12 – 1999 *Surface and Volume Radioactivity Standards for Unrestricted Release* will be used to test materials for volumetric contamination (if required).

The release criteria in the ANSI standard are divided into four groups based on similarity of exposure and potential dose. For St. Louis Site projects, natural uranium, U-238, Ra-226, Th-230 and associated decay chains are the primary contaminants. The two groups that are applicable to the St. Louis Sites are provided in Table 2 of this plan.

ANSI/HPS N13.12 provides criteria for unrestricted release that are protective of the public health and the environment in that the limits were derived from a primary dose criterion of 1 mrem/yr to a member of the modeled critical group of receptors.

Minimum Detectable Concentrations

NUREG 1507 *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, and NUREG 1575 *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) provide a methodology for the calculation of minimum detectable concentrations (MDCs).

The MDC is the minimum concentration (activity) of the contaminant that can be measured with certainty. The MDC is dependent on background count rate and the efficiency of the detector to detect the contaminant on the surface being surveyed.

A Scanning MDC is strongly dependent on the speed at which the surveyor moves the detector probe along the surface being surveyed.

It is necessary to determine the MDCs for an instrument to demonstrate that the instrument selected for the survey is sensitive enough to detect the contaminant at or below the release criterion. The steps include:

1. Calculating the minimum detectable count rate (MDCR) by selecting a given level of performance, scan speed, and background level of the detector, and

2. Selecting a surveyor efficiency, if applicable.

Units of concentration (MDC) are used here in lieu of units of activity (MDA) to provide consistency with NUREG-1507.

Volumetric Contamination

NOTE: Loose aggregate materials such as crushate, crushate piles, soils, and soils piles are addressed in Section 3.3 and Attachment 2 of this document.

Some materials, e.g., concrete slabs, asphalt, monoliths, and railroad ties may have the potential for volumetric contamination. ANSI N13.12 states that "volumetric measurements for clearance shall be used when volumetric radioactive materials are known or potentially present." The determination of whether to make volumetric measurements at FUSRAP should be based on two factors:

1. A review of the material's history and process knowledge.
2. An evaluation of the surface contamination information.

Industry history has shown that, for the materials being addressed in this section, the presence of volumetric contamination in excess of limits is very unlikely where there is no indication of surface contamination in excess of limits (this may not be the case in loose aggregate materials).

The trigger at 80% of the total surface contamination limit was set based upon engineering judgment and was designed to allow for errors in measurements when performing alpha contamination surveys.

To further support the methodology in this document, a simple calculation was performed to estimate the volumetric contamination of a material that was contaminated at the alpha limit of 100 dpm/100cm^2. Assuming asphalt with a density of 0.72 grams per centimeter cubed- (g/cm^3) and a contamination depth of 1cm, the resulting volumetric contamination should be about 0.63 picocuries per gram (pCi/g). This is about 20% of the most restrictive volumetric limit and is conservative.

Averaging

When small areas of elevated (fixed) surface contamination or volumetric contamination exist, reference documents allow for a limited averaging of measurements in demonstrating compliance with limits. The following guidelines shall be applied if averaging will be used to support the clearance of materials:

1. USACE permission shall be granted (and documented) before using averaging to support the clearance of materials.

2. Loose surface contamination measurements may not be averaged[17].

3. Multiple surface measurements may be averaged over a surface area not to exceed 1 m^2. For items with a surface area less than 1 m^2, an average over the entire surface shall be derived for each item.

4. Multiple volumetric measurements may be averaged over a total volume not to exceed 1m^3 or a mass of 1 metric ton. For items with a mass of less than 1 metric ton, an average over the entire mass shall be derived for each item.

[17] This is a FUSRAP-specific restriction.

5. No single measurement used in calculating an average surface activity or an average volumetric concentration shall exceed three times the release criteria[18].

6. Process knowledge may be used to support the determination that the volumetric activity concentrations are homogeneously distributed throughout the material.

[18] This is a more restrictive FUSRAP-specific criteria.

ATTACHMENT 2

TECHNICAL BASIS FOR SURVEY OF CRUSHATE/OVERBURDEN PILES

Background

The scope of MARSSIM is limited to surface soils. Surveys are based on area units, and the scope of the survey evaluation is limited to the first 15 cm of soils. Because of these limitations, MARSSIM cannot be directly applied to volumes such as crushate or overburden piles.

However, with some modifications, MARSSIM statistical techniques can be applied to volume units.

Limitations of the MARSSIM Technique

In attempting to apply the MARSSIM directly to a volume unit, one should consider the following limitations:

- MARSSIM relies on scanning to detect small areas of elevated activity. Scanning will not detect contaminants at a depth in excess of 6 inches (15 cm), therefore much of the volume will not be evaluated by scanning.
- Using MARSSIM to evaluate each 6-inch interval independently would result in a large number of samples that would need to be obtained and analyzed.
- Variations in the surface contour can make the assessment of individual 6-inch intervals difficult.
- The shape and contours of a crushate/overburden pile make gridding and the collection of accurate systematic samples difficult.

Parametric vs. Non-Parametric Statistics

MARSSIM uses non-parametric statistical techniques because:

- Contamination within a survey unit may not be normally distributed (i.e., contamination gradients and areas of elevated activity).
- Survey unit data is obtained systematically vs. randomly.

Parametric techniques may be appropriate for crushate/overburden piles because:

- The excavation, movement, and stockpiling of materials will tend to distribute the contamination more normally.

- Simple random sampling is more readily achievable in a "pile" geometry.
- Parametric procedures perform well even when their underlying assumptions of the distribution of the data are not strictly true. This occurs with sample sizes in the range of 20 or greater.

Field detection equipment is <u>not used</u> to scan the piles prior to simple random sampling because this might lead to bias in the sampling results. Such bias can have a significant impact on a parametric evaluation of the survey data.

The compositing of field samples is not performed for crushate/overburden piles. Compositing will "mechanically average" the individual sample result, and skew the UCL_{95} result.

ATTACHMENT 3

DATA QUALITY OBJECTIVES FOR NUREG-1761 MATERIAL SURVEYS

State the Problem

The sample design will be used to demonstrate that radionuclide concentrations comply with the limits of Table 2 and Table 3 of this plan, based upon the intended dispensation of the material.

Identify the Decision

The sample design assumes that materials are expected to meet the applicable limits prior to final survey and evaluation. Several questions must be answered:

1. Is the average of the contamination measurements below the applicable limit?
2. Is the maximum contamination measurement below the maximum measurement limit?
3. Are there inaccessible areas for measurement, and have they been adequately addressed?
4. Does the material meet the disposal site's WAC, if applicable?
5. Does the material meet the requirements of the applicable CERCLA decision document for backfill, where applicable?

The UCL_{95} of the mean of contamination concentrations will be compared to the WAC when deciding if a material is acceptable for a particular disposal site.

Sub-surface criteria will be applied to material that is destined for FUSRAP backfill[19].

Areas of elevated activity will not be allowed. The $DCGL_{EMC}$ will be set equal to the $DCGL_{C}$.

Identify Inputs to the Decision

Field activities will consist of:

- Surface scans with contamination detection equipment to identify areas of elevated activity.
- Fixed-point measurements of suspect areas, and of systematic measurement locations in order to determine the average surface contamination level.
- Smear surveys to evaluate the levels of removable contamination.
- Volumetric sampling and laboratory analysis, where applicable.

[19] Special care must be taken to ensure that all requirements of the applicable CERCLA decision document(s) is/are met in regards to backfill.

Scan, fixed-point measurement, and smear survey MDCs will be calculated using guidance from Sections 3.1.5 and 3.1.6 of this document. Volumetric samples are analyzed in the laboratory, and *a-priori* MDCs are provided by the laboratory analytical software.

Define the Study Boundary

Survey units will be established so that material of similar physical characteristics and contamination potential are grouped together.

Materials within a survey unit will be laid-out in an orderly fashion in order to facilitate gridding and the collection of survey data.

Develop the Decision Rule

1. Equipment/Materials - Clearance: If the average surface contamination level is > Table 2 (and/or volumetric contamination is > Table 3, when applicable) limits, then consider decontamination or disposal options.

2. Consolidated Materials – Backfill: If the H_0 cannot be rejected when applying the WRS Test (or Sign test, as applicable), then consider disposal options.

3. Consolidated Materials – Clearance: If the average surface contamination level is > Table 2 limits (and/or volumetric contamination is > Table 3, when applicable), then consider disposal options.

Specify Tolerable Limits on Decision Error

1. Type I errors: 0.05

2. Type II errors: 0.20

3. QC splits and duplicates will agree within 30% for measurements that are ≥50% of the limit.

4. The H_0 will be: *The contamination on/in the material surveyed exceeds the release criterion.*

Optimize the Design

Field screening techniques, sampling, sampling analysis, and the data quality assessment (DQA) process will be used, as appropriate, throughout the survey and evaluation to focus efforts and minimize impacts.

ATTACHMENT 4

STATISTICAL TABLE FOR EVALUATING SAMPLES FOR DISPOSAL

(Student's *t* Distribution, right-tail test)

This table is to be used with Section 3.3.15 and Equation 6 to determine the value for $t_{1-\alpha,df}$.

This table is also used with Attachment and Equation 7 of this plan to determine (n) for chemical COCs and TCLP sampling.

df[20]	.05[21]
1	6.314
2	2.920
3	2.353
4	2.132
5	2.015
6	1.943
7	1.895
8	1.860
9	1.833
10	1.812
11	1.796
12	1.782
13	1.771
14	1.761
15	1.753
16	1.746
17	1.740
18	1.743
19	1.729
20	1.725
21	1.721
22	1.717
23	1.714
24	1.711
25	1.708
26	1.706
27	1.703
28	1.701
29	1.699
30	1.697
40	1.684
60	1.671
120	1.658
Infinite	1.645

[20] *df* is equal to n-1 (or the number of samples evaluated minus one)

[21] This represents the Upper One-Sided 95% Confidence Level or (UCL_{95})

ATTACHMENT 5

INFORMATION TO BE SUBMITTED WHEN REQUESTING A PLANNING PACKAGE

This attachment details the minimum information that should be supplied by the RAC to USACE when requesting a planning package.

- A detailed description of the material.
- Historical information on the materials.
- Characterization data, including any PDI data and/or PDI reports.
- Current survey maps or survey reports.
- Rationale and basis for the material's MARSSIM classification.
- Rationale for the selection of the survey approach.
- Intended dispensation of the material, and time-frame/schedule.
- Current location of the material.
- Dimensions, weights, volumes of the material.
- Any existing drawings, sketches, or photographs of the material.

ATTACHMENT 6

MARSSIM TABLES FOR SELECTING (n) NUMBER OF SAMPLES

WRS Test[22]

MARSSIM Table 5.3			
$\alpha = 0.05$			
	β		
rel shift	0.10	0.20	0.25
0.10	2,157	1,558	1,355
0.20	542	391	341
0.30	243	175	153
0.40	139	100	87
0.50	90	65	57
0.60	64	46	40
0.70	48	34	30
0.80	38	27	24
0.90	31	22	20
1.00	26	18	16
1.10	22	16	14
1.20	19	14	12
1.30	17	12	11
1.40	15	11	10
1.50	14	10	9
1.60	13	9	8
1.70	12	8	8
1.80	11	8	7
1.90	11	7	7
2.00	10	7	7
2.25	9	6	6
2.50	9	6	6
2.75	8	6	5
3.00	8	5	5
3.50	8	5	5
4.00	7	5	5

Sign Test

MARSSIM Table 5.5			
$\alpha = 0.05$			
	β		
rel shift	0.10	0.20	0.25
0.10	1,620	1,170	1,018
0.20	410	295	258
0.30	185	133	117
0.40	107	77	68
0.50	71	51	45
0.60	52	36	33
0.70	40	28	26
0.80	32	22	21
0.90	27	19	17
1.00	23	16	15
1.10	21	14	14
1.20	18	13	12
1.30	17	11	11
1.40	16	11	10
1.50	15	8	10
1.60	14	9	9
1.70	14	9	9
1.80	12	9	9
1.90	12	8	9
2.00	12	8	8
2.50	11	8	8
3.00	11	7	8

NOTE 1: The values for n provided in these tables have already been increased by 20% as recommended in MARSSIM.

NOTE 2: If an actual value of the relative shift is not listed, always select the next lower value that appears in the table. For example, if the rel. shift = 1.67, then 1.6 should be used to determine n.

[22] Listed values for n reflect the number of samples to be taken in the survey unit only. Strictly speaking, the values provided for Table 5.3 above are actually N/2 values. See MARSSIM for further explanation.

ATTACHMENT 7
SOIL DQO SUMMARY FOR ST. LOUIS SITES

NOTE: Table 3-1 is repeated here for ease of use. Reference 7.1.7 remains the governing document and it should be referenced frequently to ensure that the provided table is true and correct.

Table 3-1 of Reference 7.1.7

Data Use	Sample Type	Analytical Method	Precision Field Duplicates (RPD[a])	Lab Dups (RPD)	Acceptable Accuracy (% Recovery)	Completeness (%)
Confirmation of contamination extent	Discrete	SW-8260B Volatile Organics	<50	<35	50-150	90%
	Discrete or Composite	SW-8270C Semivolatile Organics	<50	<35	30-140	90%
		SW-8081A/8082 Pesticides/PCBs	<50	<35	35-135	90%
		SW-6010A/6020/7000 Metals	<50	<35	75-125	90%
		Radiochemical various	<50	<35	75-125	90%
		Other Waste Characteristics	N/A	<40	50-150	90%
		Physical Testing	N/A	<40	N/A	90%

[a] RPD = Relative Percent Difference. At values within five times the reporting level the comparison is acceptable when values are plus or minus three times the reporting level.

ATTACHMENT 8
DETERMINING THE NUMBER (n) OF CHEMICAL SAMPLES TO BE OBTAINED

Two separate Environmental Protection Agency (EPA) statistical methods have been identified for estimation of the required number of chemical and/or TCLP samples (n) needed to determine, with a specified level of confidence, the average contaminant concentrations in soil, concrete, crushate, etc. Each of these methods is described below, followed by a discussion their application.

Method 1

This method is derived from *SW-846, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, Volume II, Chapter 9* (reference 7.1.13). This method is based on the following equation:

Equation 7

$$n = \frac{t^2 s^2}{d^2}$$

Where:
- n is the sample size.
- t is the Student's t value at a specified significance level[23] (see Attachment 4).
- s is a sample estimate of the population standard deviation.
- d is the regulatory threshold (cleanup standard) minus the sample mean[24] .

Method 2

This method is derived from guidance presented in *Methods for Evaluating the Attainment of Cleanup Standards, Volume I: Soils and Solid Media* (reference 7.1.14). This method is based on the following equation:

Equation 8

$$n = s^2 \left[\frac{Z_{1-\beta} + Z_{1-\alpha}}{cs - \mu_1} \right]^2$$

[23] Use a 5% significance level (or $t_{0.95}$) to determine (t)

[24] If the sample mean is unknown, use a value of 20% of the regulatory threshold (cleanup standard) for the value of (d).

Where:

n is the required sample size.
s is an estimate of the standard deviation.
$z_{1-\beta}$ and $z_{1-\alpha}$ are the critical values for the normal distribution with probabilities of $1-\alpha$ and $1-\beta$.
α is the false negative rate for the statistical test[25].
β is the false positive rate for the statistical test[26].
CS is the cleanup/release standard.
μ_1 is an estimate of the mean concentration.

Sample Number (n) Determination

Equation 7 and Equation 8 require sample estimates of the mean and standard deviation of the "true" (population) contaminant concentrations to calculate sample size. The basic approach for determining these statistics is as follows:

Analytical data are already available (for COC concentrations and/or TCLP results in the material to be evaluated): use this data to calculate (n).

Analytical data are not available:

1. Use existing data from related areas/materials or from a prior study to calculate (n).

2. When sample results become available, use these results to re-calculate (n) to validate that the appropriate number have been taken (as illustrated in Figure 4).

3. Obtain additional samples, if needed, to satisfy (n).

Neither equation includes a variable for material volume, therefore the estimate of sample size is independent of the total volume of material. The sample size estimate is dependent only on the characteristics of the sample concentration distribution. The required number of samples for each chemical COC should be calculated separately from both equations, and the largest resulting sample size should be used.

Additionally, Equation 7 and Equation 8 may result in unusually small or large sample sizes, dependent on the value of the sample standard deviation. Therefore, it is appropriate to place bounds on the total number of samples collected by relating this number to the material volume. For any volume of material to be sampled, the minimum number of samples

25 The false negative rate is the probability that the area will be declared clean when it actually contains COCs with levels above cleanup criteria. For this project, α has been set equal to 0.05.

26 The false positive rate is the probability that the area will be declared to contain COCs above cleanup levels when it is actually clean. For this project, β has been set equal to 0.20.

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