

**ATTACHMENTS**  
**Consultation on Proposed Updates and Changes to the**  
**Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)**

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**Attachment A**  
**MARSSIM, Revision 1 (August 2000) including the June 2001 updates**  
**Roadmap (from <http://epa.gov/radiation/marssim/marsame.html>)**

## **ROADMAP**

### **Introduction to MARSSIM**

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) provides detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate compliance with a dose- or risk-based regulation. The MARSSIM guidance focuses on the demonstration of compliance during the final status survey following scoping, characterization, and any necessary remedial actions.

The process of planning the survey, implementing the survey plan, and assessing the survey results prior to making a decision is called the Data Life Cycle. MARSSIM Chapter 2 and Appendix D provide detailed guidance on developing appropriate survey designs using the Data Quality Objectives (DQO) Process to ensure that the survey results are of sufficient quality and quantity to support the final decision. The survey design process is described in MARSSIM Chapters 3, 4, and 5. Guidance on selecting appropriate measurement methods (*i.e.*, scan surveys, direct measurements, samples) and measurement systems (*i.e.*, detectors, instruments, analytical methods) is provided in MARSSIM Chapters 6 and 7 and Appendix H. Data Quality Assessment (DQA) is the process of assessing the survey results, determining that the quality of the data satisfies the objectives of the survey, and interpreting the survey results as they apply to the decision being made. The DQA process is described in MARSSIM Chapter 2 and Appendix E and is applied in MARSSIM Chapter 8. Quality Assurance and Quality Control (QA/QC) procedures are developed and recorded in survey planning documents, such as a Quality Assurance Project Plan (QAPP) which is described in MARSSIM Chapter 9.

MARSSIM does not provide guidance for translating the release criterion into derived concentration guideline levels (DCGLs). MARSSIM discusses contamination of surface soil and building surfaces in detail. If other media (*e.g.*, ground water, surface water, subsurface soil, equipment, vicinity properties) are potentially contaminated at the time of the final status survey, modifications to the MARSSIM survey design guidance and examples may be required.

### **The Goal of the Roadmap**

The goal of the roadmap is to present a summary of the major steps in the design, implementation, and assessment of a final status survey and to identify where guidance on these steps is located in MARSSIM. A brief description of each step is included in the

roadmap along with references to the sections of MARSSIM that provide more detailed guidance.

This roadmap provides the user with basic guidance from MARSSIM combined with “rules of thumb” (indicated by →) for performing compliance demonstration surveys. The roadmap is not designed to be a stand-alone document, but to be used as a quick reference to MARSSIM for users already familiar with the process of planning and performing surveys. Roadmap users will also find flow charts summarizing the major steps in the Radiation Survey and Site Investigation Process, combined with references to sections in MARSSIM where detailed guidance may be found. In addition, the roadmap serves as an overview and example for applying MARSSIM guidance at sites with radioactive contamination of surface soil and building surfaces. The roadmap assumes a working knowledge of MARSSIM terminology. If such knowledge is lacking, the user may refer to Section 2.2 of MARSSIM for definitions of key terms. In addition, a complete set of definitions is provided in the Glossary.

## **Data Life Cycle**

Compliance demonstration is simply a decision as to whether or not a survey unit meets the release criterion. For most sites, this decision is supported by statistical tests based on the results of one or more surveys. The initial assumption used in MARSSIM is that each survey unit is contaminated above the release criterion until proven otherwise. The surveys are designed to provide the information needed to reject this initial assumption. MARSSIM recommends using the Data Life Cycle as a framework for planning, implementing, and evaluating survey results prior to making a decision. Figure 1 summarizes the major activities associated with each phase of the Data Life Cycle.

### **Planning Stage**

The survey design is developed and documented using the Data Quality Objectives (DQO) Process (Section 2.3.1, Appendix D). The DQOs for the project are established and preliminary surveys (*e.g.*, scoping, characterization) are performed to provide information necessary to design the final status survey for compliance demonstration. The DQOs for the project are re-evaluated for each of the preliminary surveys. The preliminary surveys may provide information for purposes other than compliance demonstration that are not discussed in MARSSIM. For example, a characterization survey may provide information to support evaluation of remedial alternatives. In addition, any of the preliminary surveys may be designed to demonstrate compliance with the release criterion as one of the survey objectives. These alternate survey designs are developed based on site-specific considerations (Section 2.6). The planning phase of the Data Life Cycle produces a final status survey design that is used for demonstrating compliance with the release criterion. This design is recorded in planning documents, such as a Quality Assurance Project Plan (QAPP) described in Section 9.2.

A minimum amount of information is needed from the preliminary surveys to develop an effective final status survey design. This includes:

**Figure 1 The Data Life Cycle Applied to a Final Status Survey**

- Sufficient information to justify classification and specification of boundaries for survey units (the default is Class 1 which results in the highest level of survey effort)
- An estimate of the variability of the contaminant concentration in the survey unit ( $\sigma_s$ ) and the reference area ( $\sigma_r$ ) if necessary

After the preliminary surveys are completed, the final status survey design can be developed. Figure 2 presents the major steps in the development of a survey design that integrates scanning surveys with direct measurements and sampling. Most of the steps are easy to understand and references to appropriate sections of MARSSIM are included in the flowchart. Several of these steps are important enough to justify additional discussion in this guide. These steps are

- Classify Areas by Contamination Potential
- Group/Separate Areas into Survey Units
- Determine Number of Data Points
- Select Instrumentation
- Develop an Integrated Survey Design

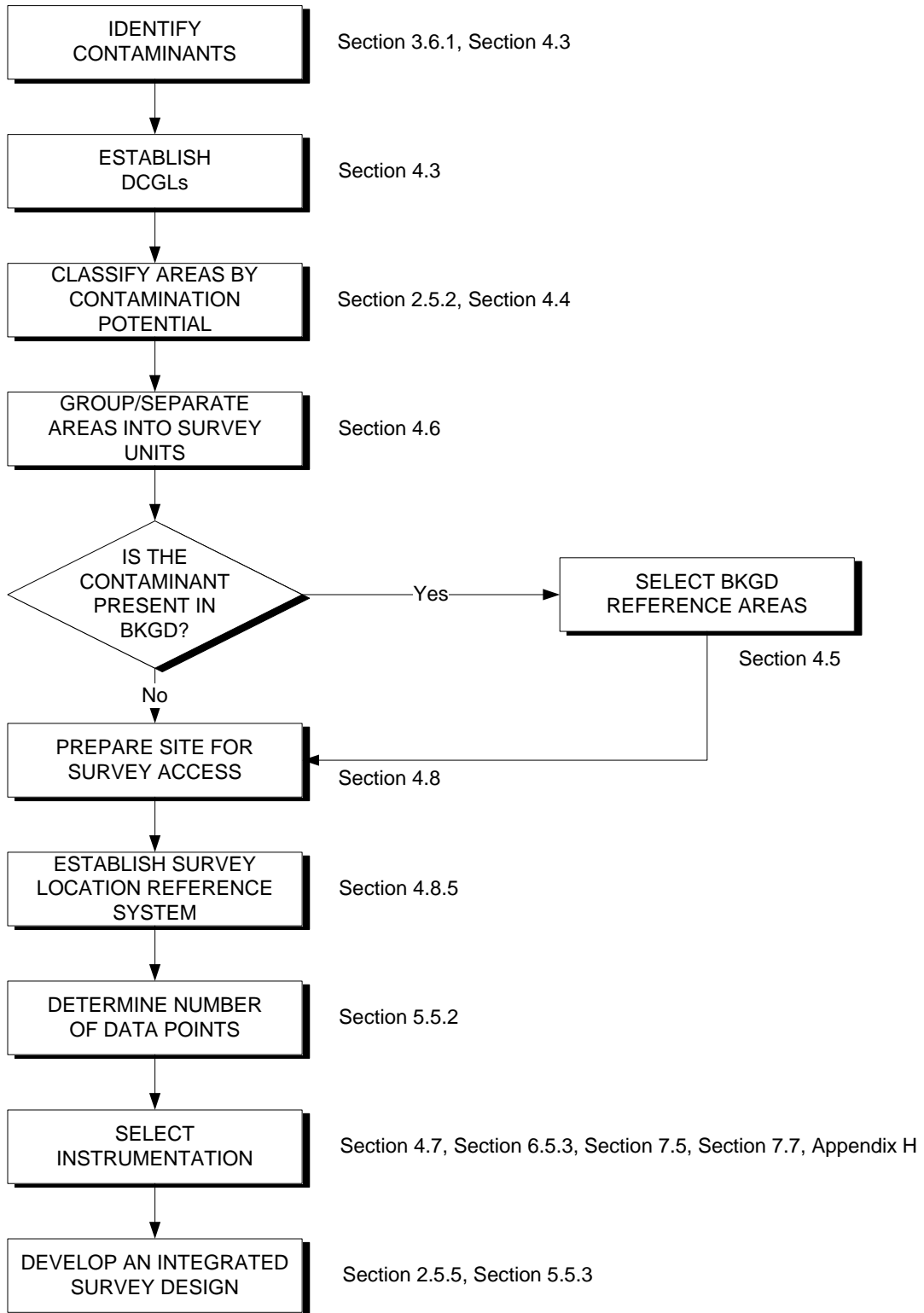
#### Classify Areas by Contamination Potential (Section 4.4)

Classification is a critical step in survey design because it determines the level of survey effort based on the potential for contamination. Overestimating the potential for contamination results in an unnecessary increase in the level of survey effort. Underestimating the potential for contamination greatly increases the probability of failing to demonstrate compliance based on the survey results. There are two key decisions made when classifying areas: 1) is the average activity in the area likely to exceed the  $DCGL_W$ , and 2) is the contamination present in small areas of elevated activity or is the contamination distributed relatively homogeneously across the area. Each of these decisions is considered separately when designing the survey and then combined into an integrated survey design. Class 1 areas, prior to remediation, are impacted areas with concentrations of residual radioactivity that exceed the  $DCGL_W$ . Class 2 areas are impacted areas where concentrations of residual activity that exceed the  $DCGL_W$  are not expected. Class 3 areas are impacted areas that have a low probability of containing areas with residual radioactivity. The information obtained from the preliminary surveys is crucial for classifying areas (see Figure 2.4).

- Area classification considers both the level of contamination relative to the  $DCGL_W$  and the distribution of the contamination. The contamination may be uniformly distributed or present as small areas of elevated activity.

#### Group/Separate Areas into Survey Units (Section 4.6)

Survey units are limited in size based on classification, exposure pathway modeling assumptions, and site-specific conditions. Table 1 provides suggested survey unit areas



**Figure 2 Flow Diagram for Designing a Final Status Survey**

based on area classification. The rationale for selecting a larger survey unit area should be developed using the DQO Process and fully documented.

**Table 1 Suggested Survey Unit Areas**

Classification	Suggested Area
Class 1	
Structures	up to 100 m <sup>2</sup>
Land Areas	up to 2,000 m <sup>2</sup>
Class 2	
Structures	100 to 1,000 m <sup>2</sup>
Land Areas	2,000 to 10,000 m <sup>2</sup>
Class 3	
Structures	no limit
Land Areas	no limit

→ Survey unit areas should be consistent with exposure pathway modeling assumptions used to develop DCGLs.

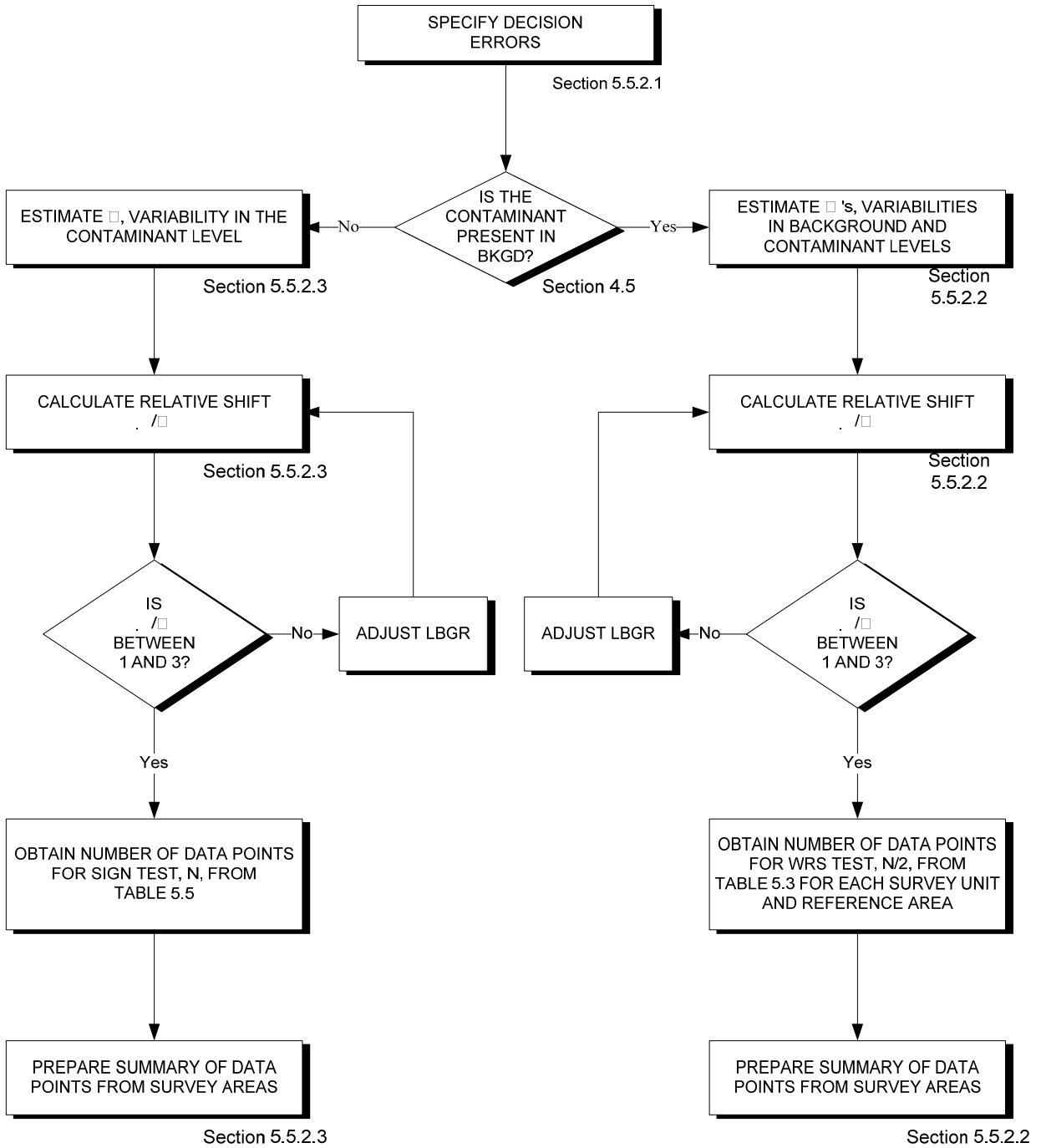
Determine Number of Data Points (Section 5.5.2)

The number of data points is determined based on the selection of a statistical test, which in turn is based on whether or not the contaminant is present in background. Figure 3 presents a flow chart for determining the number of data points.

The first step in determining the number of data points is to specify the acceptable decision error rates,  $\alpha$  and  $\beta$ . Decision error rates are site-specific and selected using the DQO Process. Changes in the values of  $\alpha$  and  $\beta$  may result from successive iterations of the DQO Process.

→ Values for  $\alpha$  and  $\beta$  are site-specific and selected using the DQO Process.

The next step, after determining whether or not the contaminant is present in background, is to estimate the variability of the contaminant concentration,  $\sigma$ . The standard deviation of the contaminant concentration determined from the preliminary survey results should provide an appropriate estimate of  $\sigma$ . If the contaminant is present in background, the variability in the survey unit ( $\sigma_s$ ) and the variability in the reference area ( $\sigma_r$ ) should both be estimated. The larger of the two values should be selected for determining the number of data points. Underestimating  $\sigma$  can underestimate the number of measurements needed to demonstrate compliance with the regulation, which increases the probability the survey unit will fail the statistical test. Overestimating  $\sigma$  can result in collecting more data than is necessary to demonstrate compliance.



**Figure 3 Flow Diagram for Determining the Number of Data Points**

- It is better to overestimate values of  $\sigma_s$  and  $\sigma_r$ .
- When  $\sigma_s$  and  $\sigma_r$  are different, select the larger of the two values.

The third step is to calculate the relative shift,  $\Delta/\sigma$ . The variability of the contaminant concentration,  $s$ , was determined in the previous step. The shift,  $\Delta$ , is equal to the width of the gray region. The upper bound of the gray region is defined as the  $DCGL_w$ . The lower bound of the gray region (LBGR) is a site-specific parameter, adjusted to provide a value for  $\Delta/\sigma$  between one and three.  $\Delta/\sigma$  can be adjusted using the following steps:

Initially select LBGR to equal one half the  $DCGL_w$ . This means  $\Delta = (DCGL_w - LBGR)$  also equals one half the  $DCGL_w$ . Calculate  $\Delta/\sigma$ .

If  $\Delta/\sigma$  is between one and three, obtain the appropriate number of data points from Table 5.3 or Table 5.5.

If  $\Delta/\sigma$  is less than one, select a lower value for LBGR. Continue to select lower values for LBGR until  $\Delta/\sigma$  is greater than or equal to one, or until LBGR equals zero.

If  $\Delta/\sigma$  is greater than three, select a higher value for LBGR. Continue to select higher values for LBGR until  $\Delta/\sigma$  is less than or equal to three.

Alternatively,  $\Delta/\sigma$  can be adjusted by solving the following equation and calculating  $\Delta/\sigma$ :

If LBGR is less than zero,  $\Delta/\sigma$  can be calculated as  $DCGL_w/\sigma$ .

- Adjust the LBGR to provide a value for  $\Delta/\sigma$  between one and three.

The final step in determining the number of data points is to obtain the appropriate value from Table 5.3 or Table 5.5. Table 5.3 provides the number of data points for each survey unit and each reference area when the contaminant is present in background (N/2). Table 5.5 provides the number of data points for each survey unit when the contaminant is not present in background (N).

#### Select Instrumentation (Section 4.7, Section 6.5.3, Section 7.5, Section 7.7, Appendix H)

Instrumentation or measurement techniques should be selected based on detection sensitivity to provide technically defensible results that meet the objectives of the survey. Because of the uncertainty associated with interpreting scanning results, the detection sensitivity of the selected instruments should be as far below the DCGL as possible. For direct measurements and sample analyses, minimum detectable concentrations (MDCs) less than 10% of the DCGL are preferable while MDCs up to 50% of the DCGL are acceptable.

→ Estimates of the MDC that minimize potential decision errors should be used for planning surveys.

### Develop an Integrated Survey Design (Section 5.5.3)

The integrated survey design combines scanning surveys with direct measurements and sampling. The level of survey effort is determined by the potential for contamination as indicated by the survey unit classification. This is illustrated in Figure 4. Class 3 survey units receive judgmental scanning and randomly located measurements. Class 2 survey units receive scanning over a portion of the survey unit based on the potential for contamination combined with direct measurements and sampling performed on a systematic grid. Class 1 survey units receive scanning over 100% of the survey unit combined with direct measurements and sampling performed on a systematic grid. The grid spacing is adjusted to account for the scan MDC (Section 5.5.2.4).

Table 2 provides a summary of the recommended survey coverage for structures and land areas. Modifications to the example survey designs may be required to account for other contaminated media (*e.g.*, ground water, subsurface soil).

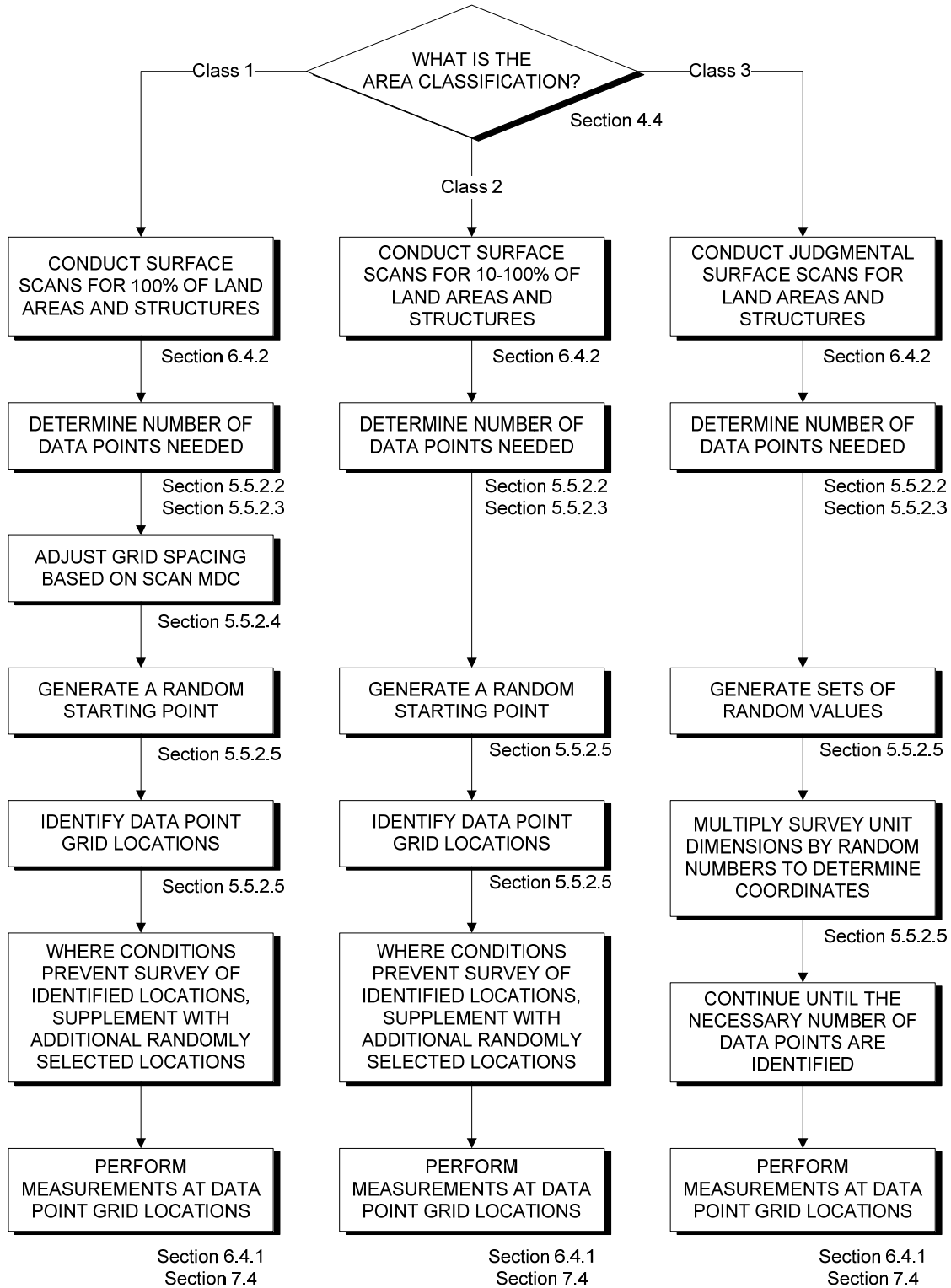
### **Implementation Phase**

The objectives outlined in the QAPP are incorporated into Standard Operating Procedures (SOPs). The final status survey design is carried out in accordance with the SOPs and the QAPP resulting in the generation of raw data. Chapter 6, Chapter 7, and Appendix H provide information on measurement techniques.

### **Assessment Phase**

The assessment phase of the Data Life Cycle includes verification and validation of the survey results combined with an assessment of the quantity and quality of the data. As previously stated, both the average level of contamination in the survey unit and the distribution of the contamination within the survey unit are considered during area classification. For this reason, the assessment phase includes a graphical review of the data to provide a visual representation of the radionuclide distribution, an appropriate statistical test to demonstrate compliance for the average concentration of a uniformly distributed radionuclide, and the elevated measurement comparison (EMC) to demonstrate compliance for small areas of elevated activity.

The survey data are verified to ensure that SOPs specified in the survey design were followed and that the measurement systems were performed in accordance with the criteria specified in the QAPP (Section 9.3.1). The data are validated to ensure that the results support the objectives of the survey, as documented in the QAPP, or permit a determination that these objectives should be modified (Section 9.3.2). The Data Quality Assessment (DQA) process is then applied using the verified and validated data to determine if the quality of the data satisfies the data user's needs. DQA is described in Appendix E and is applied in Chapter 8.



**Figure 4 Flow Diagram for Developing an Integrated Survey Design**

**Table 2 Recommended Survey Coverage for Structures and Land Areas**

Area Classification	Structures		Land Areas	
	Surface Scans	Surface Activity Measurements	Surface Scans	Surface Soil Measurements
Class 1	100%	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3); additional direct measurements and samples may be necessary for small areas of elevated activity (Section 5.5.2.4)	100%	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3); additional direct measurements and samples may be necessary for small areas of elevated activity (Section 5.5.2.4)
Class 2	10 to 100% (10 to 50% for upper walls and ceilings) Systematic and Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)	10 to 100% Systematic and Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)
Class 3	Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)	Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)

The first step in DQA is to review the DQOs and survey design to ensure that they are still applicable. For example, if the data suggest that a survey unit is misclassified, the DQOs and survey design would be modified for the new classification.

The next step is to conduct a preliminary data review to learn about the structure of the data and to identify patterns, relationships, or potential anomalies. This review should include calculating basic statistical quantities (*i.e.*, mean, standard deviation, median) and graphically presenting the data using at least a histogram and a posting plot. The results of the preliminary data review are also used to verify the assumptions of the tests. Some of the assumptions and possible methods for assessing them are summarized in Table 3. Information on diagnostic tests is provided in Section 8.2 and Appendix I.

**Table 3 Methods for Checking the Assumptions of Statistical Tests**

Assumption	Diagnostic
Spatial Independence	Posting Plot (Figure 8.1)
Symmetry	Histogram (Figure 8.2) Quantile Plot (Figure I.2)
Data Variance	Sample Standard Deviation (Section 8.2)
Power is Adequate	Retrospective Power Chart (Sign Test, Figure I.5) (WRS Test, Figure I.6)

The final step in interpreting the data is to draw conclusions from the data. Table 4 summarizes the statistical tests recommended in MARSSIM. Section 8.3 provides

guidance on performing the Sign test when the contaminant is not present in background. Section 8.4 provides guidance on performing the Wilcoxon Rank Sum (WRS) test when the contaminant is present in background.

**Table 4 Summary of Statistical Tests**

**Radionuclide not in background and radionuclide-specific measurements made:**

Survey Result	Conclusion
All measurements less than $DCGL_W$	Survey unit meets release criterion
Average greater than $DCGL_W$	Survey unit does not meet release criterion
Any measurement greater than $DCGL_W$ and the average less than $DCGL_W$	Conduct Sign test and elevated measurement comparison

**Radionuclide in background or radionuclide non-specific (gross) measurements made:**

Survey Result	Conclusion
Difference between maximum survey unit measurement and minimum reference area measurements is less than $DCGL_W$	Survey unit meets release criterion
Difference of survey unit average and reference area average is greater than $DCGL_W$	Survey unit does not meet release criterion
Difference between any survey unit measurement and any reference area measurement greater than $DCGL_W$ and the difference of survey unit average and reference area average is less than $DCGL_W$	Conduct WRS test and elevated measurement comparison

Table 5 provides examples of final status survey investigation levels for each survey unit classification and type of measurement. For a Class 1 survey unit, measurements above the  $DCGL_W$  are not necessarily unexpected. However, a measurement above the  $DCGL_W$  at one of the discrete measurement locations might be considered unusual if it were much higher than all of the other discrete measurements. Thus, any discrete measurement that is above both the  $DCGL_W$  and the statistical-based parameter for the measurements should be investigated further. Any measurement, either at a discrete location or from a scan, that is above the  $DCGL_{EMC}$  should be flagged for further investigation.

In Class 2 or Class 3 areas, neither measurements above the  $DCGL_W$  nor areas of elevated activity are expected. Any measurement at a discrete location exceeding the  $DCGL_W$  in these areas should be flagged for further investigation. Because the survey design for Class 2 and Class 3 survey units is not driven by the EMC, the scanning MDC might exceed the  $DCGL_W$ . In this case, any indication of residual radioactivity during the scan would warrant further investigation.

Because there is a low expectation for residual radioactivity in a Class 3 area, it may be prudent to investigate any measurement exceeding even a fraction of the  $DCGL_W$ . The level one chooses here depends on the site, the radionuclides of concern, and the measurement and scanning methods chosen. This level should be set using the DQO

Process during the survey design phase of the Data Life Cycle. In some cases, the user may also decide to follow this procedure for Class 2 and even Class 1 survey units.

**Table 5 Summary of Investigation Levels**

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	> $DCGL_{EMC}$ or > $DCGL_W$ and > a statistical-based parameter value	> $DCGL_{EMC}$
Class 2	> $DCGL_W$	> $DCGL_W$ or > MDC
Class 3	> fraction of $DCGL_W$	> $DCGL_W$ or > MDC

Both the measurements at discrete locations and the scans are subject to the EMC. The result of the EMC does not in itself lead to a conclusion as to whether the survey unit meets or exceeds the release criterion, but is a flag or trigger for further investigation. The investigation may involve taking further measurements in order to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion.<sup>1</sup> The investigation should also provide adequate assurance that there are no other undiscovered areas of elevated residual radioactivity in the survey unit that might result in a dose exceeding the release criterion. This could lead to a re-classification of all or part of a survey unit—that is, unless the results of the investigation indicate that reclassification is not necessary.

### Decision Making Phase

A decision is made, in coordination with the responsible regulatory agency, based on the conclusions drawn from the assessment phase. The results of the EMC are used to demonstrate compliance with the dose- or risk-based regulation for small areas of elevated activity, while the nonparametric statistical tests are used to demonstrate that the average radionuclide concentration in the survey unit complies with the release criterion. The objective is to make technically defensible decisions with a specified level of confidence.

The EMC consists of comparing each measurement from the survey unit with the investigation levels in Table 5. The EMC is performed for measurements obtained from the systematic or random sample locations as well as locations flagged by scanning surveys. Any measurement from the survey unit that is equal to or greater than the investigation level indicates an area of relatively higher concentration and is investigated, regardless of the outcome of the nonparametric statistical tests.

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<sup>1</sup> Rather than, or in addition to, taking further measurements, the investigation may involve assessing the adequacy of the exposure pathway model used to obtain the DCGLs and area factors, and the consistency of the results obtained with the Historical Site Assessment and the scoping, characterization, and remedial action support surveys.

→ Any measurement from the survey unit that is equal to or greater than the investigation level indicates an area of relatively higher concentration and is investigated, regardless of the outcome of the nonparametric statistical tests.

The result of the Sign test or the WRS test is the decision to reject or not to reject the null hypothesis that the survey unit is contaminated above the  $DCGL_w$ . Provided that the results of any investigations triggered by the EMC have been resolved, a rejection of the null hypothesis leads to the decision that the survey unit meets the release criterion. If necessary, the amount of residual radioactivity in the survey unit can be estimated so that dose or risk calculations can be made. In most cases, the average concentration is the best estimate for the amount of residual radioactivity.

## **Summary**

The roadmap presents a summary of the planning, implementation, assessment, and decision making phases for a final status survey and identifies where guidance on these phases is located in MARSSIM. Each step in the process is described briefly along with references to the sections of MARSSIM to which the user may refer for more detailed guidance. Flow charts are provided to summarize the major steps in the Radiation Survey and Site Investigation Process, again citing appropriate sections of MARSSIM. In addition to providing the user with basic guidance from MARSSIM, the roadmap also includes “rules of thumb” for performing compliance demonstration surveys.

**Attachment B**  
**Summary of Comments Received**  
**from**  
**Request for Public Input on MARSSIM Revisions**

**Comments Received via Phone or Mail**

Via E-mail: Mark R. Ledoux, *EnergySolutions* LLC

I appreciate your help in this matter. *EnergySolutions* routinely uses MARSSIM and looks forward to provide comments. As I stated, we are preparing comments but may not have them ready by the public meeting on February 10, 2010. I am looking for a final acceptance date from the EPA for submitting written comments. Thank you again for your help.

Contacted by phone on 4/21/11 to inquire on comments – no comments to submit.

**Comments Received via E-mail**

**Sarah Roberts, ORAU**

We recommend that a revision is needed to address the following:

1) Updated treatment of measurement uncertainty.

It is assumed this means that the concept of MQOs will be adopted. If so, the major concern then would be any restrictions being placed on the MQC (minimum quantifiable concentration) and the measurement uncertainty.

Among other things, the potentially complicated mathematical calculations involved would become an impediment to the implementation of MARSSIM. MARSSIM surveys are not designed by statisticians. There are enough problems already with the calculation of scan MDCs.

2) Updated measurement methods.

[Regarding] Scenario B ("assumed to pass until proven otherwise")

Good. The statistics of Scenario B (which equates with indistinguishable from background) are already covered fairly well in NUREG 1505. What would be nice would be a guidance regarding classification, investigation levels, requirements for MDCs, etc.

3) Increased emphasis on regulator interface during survey design

4) Incorporate User comments ("lessons learned")

- 5) Recommend that definitions/terms consistent with related documents
- 6) Recommend better discussion of "hotspots" and UMTRCA standards.
- 7) Suggest replacing the area factor discussion in Chapter 5 of MARSSIM with that in NUREG 1505. Unfortunately, RESRAD tends to overestimate the doses due to small areas of contamination which results in small area factors and low DCGL(EMCs). MARSSIM could discuss some possible adjustments to RESRAD's pathways and/or input parameters for the area factor calculations.

This is a very important change, given that failure to demonstrate compliance is most likely to be due to hot spots exceeding the DCGL(EMCs). Failure to demonstrate compliance is less likely a case of the average concentration exceeding the DCGL(W) or failing the statistical tests.

- 8) Suggest the inclusion of alternatives to the use of the Wilcoxon Rank Sum test for structural surveys.

### **Tim Vitkus, ORISE**

Please consider the following comments during the revision process to MARSSIM.

General comment:

1. Method for the a priori determination of a hot spot size of concern. This is of primary concern for the hard-to-detect radionuclides that must be assessed without benefit of a surrogate. Provided there is an acceptable method to predict the maximum probable concentration, an associated area can be selected via area factors. When there is no scan sensitivity, one cannot develop an acceptable sample spacing and/or composite sampling approach for identifying hot spots of concern. Perhaps the characterization data could be used as the predictor via some type of statistical analysis such as Chebyshev's inequality or Bayesian.
2. Support for other sampling strategies to collect the required number of samples for the two non-parametric tests. Consider the RSS approach, for the hard-to-detects.
3. Expansion of the guidance for the sample layout on excavations. Typical practice is to treat the excavation floor and walls as the survey unit, even though differing depths are represented.
4. Evaluation of the scan MDC determination when the site scanning is not based on audio detector output. I have commented innumerable times when licensees are using an alarm set point on a ratemeter to signal them of a possible hot spot rather than the surveyor making a decision based on the signal detection theory outlined in NUREG-1507. There are numerous issues encountered with using set points rather than the audio due to varying site

backgrounds and other factors. It does not seem to be appropriate for sites to apply the ideal observer paradigm for calculating scan MDCs when they are not using that approach. Similarly, the increased use of data capture and analysis of the post-processed data to make decisions as to scan results is not defined in MARSSIM. A few years back I had the opportunity to challenge the capability of these GPS/data collection systems during scanning versus the 1507 recommended approach and the post processing approach failed to identify the presence of known areas of contamination above their reported scan MDC, and well above the DCGLemc.

5. Clarification of the acceptable use of the Sign test when performing gross surface activity measurements on structural survey units. As currently written, MARSSIM gives the impression that the WRS is the test of choice for these gross measurements, rather than the industry accepted method of subtracting a construction material specific background from the gross measurement and using the Sign test on the net results.

6. Clarification for the DQA section regarding excessive negative surface activity measurement results when background subtracting. Excessive negative value[s] indicate an inappropriate non-conservative background was used.

7. A default table of area factors that coincide with the NRC's screening values.

[Also find attached Rad Survey App of RSS 2011 HPS mid-year PowerPoint]

### **Robert Meck, Science and Technology Systems, LLC**

1. MARSSIM revision two will have an effect on MARSAME. Specifically, Tables 1.2 and 1.3 of MARSAME, which list similarities and differences with MARSSIM, respectively will be affected. Thus, the MARSSIM Workgroup should also make revisions to MARSAME to make the documents consistent with each other. The Workgroup should also check for other changes in MARSAME that may need revision for consistency between the two documents.
2. The MARSSIM website needs maintenance. Namely, the e-mail address to submit comments should remove the underline, so that the underscore in the address becomes visible. In addition, the Workgroup Charter should be more prominent on the site, so that visitors can transparently read how the Workgroup functions and its relationship to ISCORS. Further, the Charter currently displayed should be replaced by the current Charter.
3. The MARSSIM revision should address the widely-used technological advances that have taken place since the last revision. Specifically, it should address the automated data collection with large numbers of data that are correlated with their position on the survey unit. The underlying statistics of the current version of MARSSIM explicitly assumes that radionuclide measurements are independent of each other and are not correlated. However, automated measurement techniques, spectral analyses, and

statistical software that are now commonly used are available to generate and analyze the correlated measurements. These newer techniques can lead to considerable cost and labor savings by providing high resolution of the location of radionuclides, the kind of specific radionuclide, and concentration. The Workgroup should address optimization of these methods keeping in mind the objective of technically sound surveys with a minimal cost and labor.

4. Ten years or more have elapsed since State and Federal regulators have been trained on MARSSIM. It is reasonable to expect that there has been significant turnover of the personnel leaving replacements that have not been trained. Further, a training refresher and coverage of how to handle the new methods are greatly needed according to reports from contractors. The success of MARSSIM was a product of mutual understanding of its processes by the property owners, the contractors, the regulators and other stakeholders. This understanding was largely due to the training that was provided immediately after MARSSIM's original publication. Training should be an integral part of the plan for revision two.

### **CRCPD's Working Group on Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) E-35**

I would first like to say that MARSSIM has been extremely useful in determining if a site is clean or not. The public is well-served because of the Workgroup's initial and continuing work on MARSSIM; not only in finalizing the report, but in the Workgroup's continued availability to provide assistance to us when we have questions. We applaud the MARSSIM Workgroup for recognizing the need for a revision.

Our comments follow in no particular order.

1) Like it or not, when subsurface contamination is allowed to be left on site, which is more common with restricted-use releases, MARSSIM users try to conform it to fit the situation. We realize that subsurface contamination is not in the scope of MARSSIM and that a separate document needs to be developed to address subsurface contamination. However, can the MARSSIM Workgroup develop an appendix under this revision to be used on an interim basis to address subsurface contamination? Even some ground rules on what not to do with subsurface contamination would be better than nothing.

2) Abelquist<sup>2</sup> demonstrates that the Sign Test can be used even if the contaminant is present in background not at insignificant levels. Because of the way the MARSSIM text is written ("The sign test should only be used if the contamination is not present in background or is present at such a small fraction of the DCGL<sub>w</sub> value as to be considered insignificant."), it seems that the Sign Test should never be used when the contaminant is present in

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<sup>2</sup> Abelquist, E.W., *Decommissioning Health Physics, A Handbook for MARSSIM Users*, (2001), Institute of Physics Publishing, London, UK.

background. The option of using the Sign Test should be presented when confidence is high that the site will meet the  $DCGL_w$ 's. The objective would be to save money.

3) The 'w' in  $DCGL_w$  stands for the Wilcoxon Rank Sum test (footnote 1 of Section 2.2 of MARSSIM). However,  $DCGL_w$  is also used for the Sign Test. This doesn't make sense, however changing it now would be impractical. Can the 'w' be changed to stand for wide area as opposed to elevated measurement comparison which addresses small areas?

3) Section 8.5.2 needs more prominence. Often consultants will detail how they are going to handle the Elevated Measurement Comparisons (EMCs), but neglect to specify how they will be handled if there are more than one in a survey unit. This is a key provision of MARSSIM that seems to be left out of a lot of final status survey plans, perhaps because it is not referenced in the flow diagrams or Roadmap section of MARSSIM. Is there a reason it is not there? Would the use of the unity rule, applying the sum of the fractions for the EMCs and the systematic values, be appropriate?

4) As with subsurface contamination, MARSSIM users address hot particles using the same guidance as provided in MARSSIM for elevated measurements. Specifically, we believe Area Factors are used inappropriately when the area is extremely small. Experience has shown that this approach is not prudent especially considering the dose from ingesting a hot particle would likely exceed the dose criterion. In some instances, the surface area of the pancake probe is used to inflate the  $DCGL_{EMC}$  to astronomical proportions. Should there be a cap on area factors? In addition, ALARA evaluations for hot particles or small areas of elevated activity appear to be non-existent when clearly a minimal effort would eliminate these situations.

5) It has been suggested by CRCPD members that MARSSIM address ways of integrating an EPA/ITRC TRIAD approach to remediation field activities (dynamic work strategies, in particular). "Increasingly, project managers, regulators, technology providers, and other stakeholders are recognizing the value of implementing a more dynamic and flexible approach to site cleanup that focuses on real-time decision-making in the field to reduce costs, improve decision certainty, and expedite site closeout. The approach, known as Triad, uses (1) systematic project planning, (2) dynamic work strategies, and (3) real-time measurement technologies designed to increase confidence in the project"<sup>3</sup>. The use of real time decision-making in the field could refer to either remedial action support surveys or final status surveys.

Because of potential problems with elevated areas and hot particles, the CRCPD suggests constraints for real-time decision-making regarding final status surveys. For example, at Maine Yankee, hot particles were consistently missed by ISOCS. ISOCS is considered a real-time measurement technology. Examples of hot particles missed include 194, 855, and 1,204 pCi/g of Co-60, 712 pCi/g of Cs-137, 502 pCi/g of Eu-152, and 69 pCi/g of Eu-154. Many other specific examples are available from Pat Dostie at [pat.dostie@maine.gov](mailto:pat.dostie@maine.gov).

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<sup>3</sup> Environmental Protection Agency, <http://www.epa.gov/tio/download/char/epa542f07001.pdf>, EPA 542-F-07-001, May, 2007.

Uniform geometry of the area and homogeneous contamination would be prerequisites for allowing the use of such systems. Otherwise, we believe that these methods do not improve decision certainty. Decision certainty should override the ability to expedite site closeouts and reduce costs.

6) We agree that MARSSIM should put an increased emphasis on regulator interface during the survey design. Ideally, the characterization survey and final status survey should each have plans approved before beginning work. This is where issues such as hot particles, *a priori* MDCs and area factors can be agreed upon.

7) A better discussion of multiple contaminants in soil would be helpful. How do you set the LBGR for multiple contaminants? How are the  $MDC_{scan}$  and  $MDC_{required}$  determined? How is the reference area handled in relation to a DCGL of 1? How does one determine area factors for multiple contaminants? What if there is a consistent ratio? What if there isn't? How does one determine if there is a consistent ratio? What are acceptable correlation coefficients? How do you determine the relative shift with multiple standard deviations? An example in an appendix outlining how to handle all of these issues (and more) would be extremely helpful to regulators and licensees/consultants.

8) We agree with your plans to include more information on Scenario B. Another appendix with an example is recommended.

## U.S. Army Corps of Engineers

### SURVEY DESIGN:

1. While Section 4.6 of MARSSIM, Rev. 1, makes it clear that larger Class 1 and 2 survey unit sizes can be used if rationale is provided during DQO development, 2,000 and 10,000 m<sup>2</sup> have in practice become de facto maximums for residual radioactivity. At these same sites, the acceptable sample density of final status samples for residual chemical contamination is generally significantly less. This revision of MARSSIM should provide additional guidance on the development of survey unit size with the hope of reconciling the current disparity between radioactive and chemical sampling densities acceptable to regulatory agencies.

2. Also, clarify the indoor SU size guidance. The suggested Class 1 size is 100 m<sup>2</sup> of floor area, which has led to many different interpretations as to how the wall/ceilings areas should be handled (incorporated without regard to size, or every 100 sq. meters is also an SU).

3. The Introduction to MARSSIM identifies three reasons why the scope is limited to surface soils and building surfaces, however, there are a significant number of environmental remediation sites that contain subsurface contamination, and in many cases in survey units that will not require excavation. Final status surveys for subsurface residual radioactive contamination developed from MARSSIM guidance have been used successfully to confirm the attainment of cleanup levels. This is routinely done for subsurface chemical contamination. It is recommended this revision MARSSIM increase its scope and provide

additional guidance on the final status survey of subsurface radioactivity. This will also be useful for the UMTRCA cleanup standards that contain a specific subsurface concentration limit.

4. Include additional guidance on the use of Scenario B (indistinguishable from background).
5. Discuss the various computer programs, Compass, VSP, etc. that have been developed to assist in MARSSIM survey design.
6. Discuss the potential uses of composite sampling throughout the survey process. Identify surveys when composite sampling would be acceptable for use.

#### UPDATED MEASUREMENT METHODS - SCANNING:

7. The revision should provide additional guidance on the selection of appropriate source size for area factor calculation. The use of small source areas, less than a square meter, may not be appropriate for most environmental cleanups.
8. Provide method(s) to determine a scan MDC, or other measure of scanning quality, when the survey is performed using data loggers and GPS plots.
9. Provide guidance for calculating scan MDC at sites with multiple adjacent Class 1 survey units where the gamma radiation levels fluctuate across the survey unit due to "shine" from adjacent unremediated survey units. (Assume that the remediated survey units cannot be left open, and need to be surveyed and backfilled prior to moving to the next SU.)
10. Recommend ways to present the vast amount of data captured by the new scanning methods and indicate the preferred method(s) to compare to reference area data.
11. Update cost information in App. H.

#### DATA ANALYSIS:

12. When discussing background levels that may be a "small fraction" of the DCGLw, an example of 10% is given. Though not clearly specified in MARSSIM, this value has been referred to when assessing the need to potentially reclassify a Class 3 survey unit based on a single result that exceeds 10% of the DCGLw. The revision should provide additional guidance on what should be considered a "small fraction" of the DCGLw in a Class 3 survey unit, taking into account that 10% of many screening levels is near background levels.
13. The estimation of the percentage of the dose criterion from residual radionuclide concentrations measured during the FSS is very briefly mentioned in Appendix I (last sentence of I.11.4). Additional discussion should be included as it has been useful in at several sites.
14. Clarify or delete the statement in section 8.4.1, that "The WRS test is most effective when residual radioactivity is uniformly present throughout a survey unit." This is never the

case in a SU that has been remediated and this statement has been misinterpreted by some to argue for increased remediation due to the misinterpretation of a test limitation.

15. Include additional discussion on how to assess low power surveys that pass the statistical test.

UMTRCA

16. When addressing surveys for compliance with the UMTRCA surface and subsurface concentration limits, provide guidance on determining where the surface soil layer begins and how the survey should be completed in cases where the Class 2 or Class 3 soil is covered by an asphalt or concrete layer.

### **Comments Received via Public Meeting**

[Also find attached Agenda and Presentation by Workgroup]

#### **Members of the Public Present:**

Tom Hansen, Ameriphysics (865-228-1997, [tom@ameriphysics.com](mailto:tom@ameriphysics.com))  
Rose Gogliotti, SC&A, Inc. (810-599-5130, [rgogliotti@scainc.com](mailto:rgogliotti@scainc.com))

#### **Members of the Public on the Phone:**

Robert Meck, Science and Technology Systems, LLC  
Tim Vitkus, ORISE

#### **Members of the Workgroup Present:**

Kathryn Snead, EPA  
Darrell Liles, EPA  
Colleen Petullo, EPA  
Alexander Williams, DOE  
Ram Bhat, Air Force

#### **Facilitator Present:**

Helen Burnett, EPA

#### **Meeting Notes:**

Introductions and Logistics  
Workgroup PowerPoint Presentation on the Proposed Revisions

## **Public Comments (via Public Meeting):**

### **1) Tom Hansen, Ameriphysics**

Indicated that he had seen the meeting announcement posted to “Radsafe” and felt that the word had gotten out regarding the meeting.

Recommended changes to MARSSIM:

- Include Scan-only Surveys
- Update hotspot methodology to make it less complicated, possibly using an approach recommended by Eric Abelquist, ORAU
- Discuss methods for sites where scanning is not possible, or “hard-to-scan” nuclides such as H-3
- Correcting for background not using the Wilcoxon Rank Sum Test. This is commonly done by both regulators and technicians, and is considered common practice.
- Erroneous classification of areas. Need stronger language on not classifying too low. Better training and understanding for regulators is probably needed.
- Emphasize stronger need for regulator interaction

### **2) Tim Vitkus, ORISE**

Recommended changes to MARSSIM:

- Developing a largest area of concern for hotspots
- Need information on performing characterization. Some insufficient characterization surveys currently serving as FSS. Need guidance or cookbook on scoping or characterization, and information on what or how earlier surveys can be used for FSS.
- Make terminology consistent with MARSAME
- Look at all changes necessary before issuing a revision

### **3) Robert Meck, Science and Technology Systems, LLC**

Recommended changes to MARSSIM:

- Revision of MARSSIM will impact MARSAME and lead to some revisions there
- Need to include information about ISCORS on our website, and include the Charter where it can be found
- MARSSIM changes based on technology use, for example, GPS-correlated measurements. Need to update technologies to reflect this.
- Training is important – the success of MARSSIM is based on its training program. Workgroup should consider training updates following the manual updates.
- See Jeff Lively (MACTEC) Presentation from the HPS Mid-Year Meeting [MPM-A.5 “The Power of Data Imaging”]. Looking at technically sound surveys with optimized cost and labor for the survey. Perhaps he could address the Workgroup.

(Tom Hansen indicated that while he was using the MACTEC technology, he wouldn't recommend abandoning the old ways yet.)

**4) Rose Gugliotti, SC&A, Inc.**

No comments or questions

Wrap-Up

## Attachment C

### Considerations for Revision 2 to MARSSIM

The state of the science in radiation measurement has improved and the type and number of radiation measurement methods have increased since MARSSIM was first issued in 1997. In addition, “lessons learned” over the past fourteen years of use have yielded improvements to the MARSSIM process. In order to update the document, the MARSSIM Workgroup planned to include the following changes:

1. **Updated treatment of measurement uncertainty:** MARLAP introduced the concept of performing a full uncertainty analysis for measurements, in keeping with new ISO and NIST recommendations, and MARSAME followed suit. Need to revise MARSSIM to incorporate a full uncertainty analysis for measurements, especially in the calculation of Scan-MDCs.
2. **Updated measurement methods:** MARSAME introduced the concept of scan-only surveys. Need to revise MARSSIM to incorporate scan-only surveys.
3. **Scenario B (“assumed to pass until proven otherwise”):** In MARSAME, Scenario B is treated as an equal option to Scenario A; whereas in MARSSIM, Scenario A is considered the preferred method. Need to revise MARSSIM to consider both Scenarios equal.
4. **Increased emphasis on regulator interface during survey design:** Too many regulators are indicating that they do not get enough input on the design of the survey before the survey is implemented. Need to revise MARSSIM to add a new section further emphasizing the importance of getting regulatory buy-off on the survey design, and possible other steps in the survey framework, before implementation.
5. **User comments (“lessons learned”):** Includes: Glossary review, updating references, and QA sections of MARSSIM that were added after the final peer review, and a few other miscellaneous updates. Also includes addressing some additional suggested changes generated during a public “Request for MARSSIM Revision Input” period (further discussion below.)
6. **Definitions/terms consistent with related documents:** In MARSSIM classification is a term that means two different things; whereas in MARSAME, the term categorization was introduced to mean the decision between impacted and non-impacted. Need to revise MARSSIM to use the term categorization consistent with MARSAME. This is only one example of inconsistent terms between the three MAR- series documents.
7. **Better discussion of “hotspots” and UMTRCA standards:** In the current implementation of MARSSIM, different radionuclides can result in different area factors. Need to revise MARSSIM to add guidance for choosing an area factor when different radionuclides are present. MARSSIM does not address UMTRCA standards, which appears to be an omission from the original document.