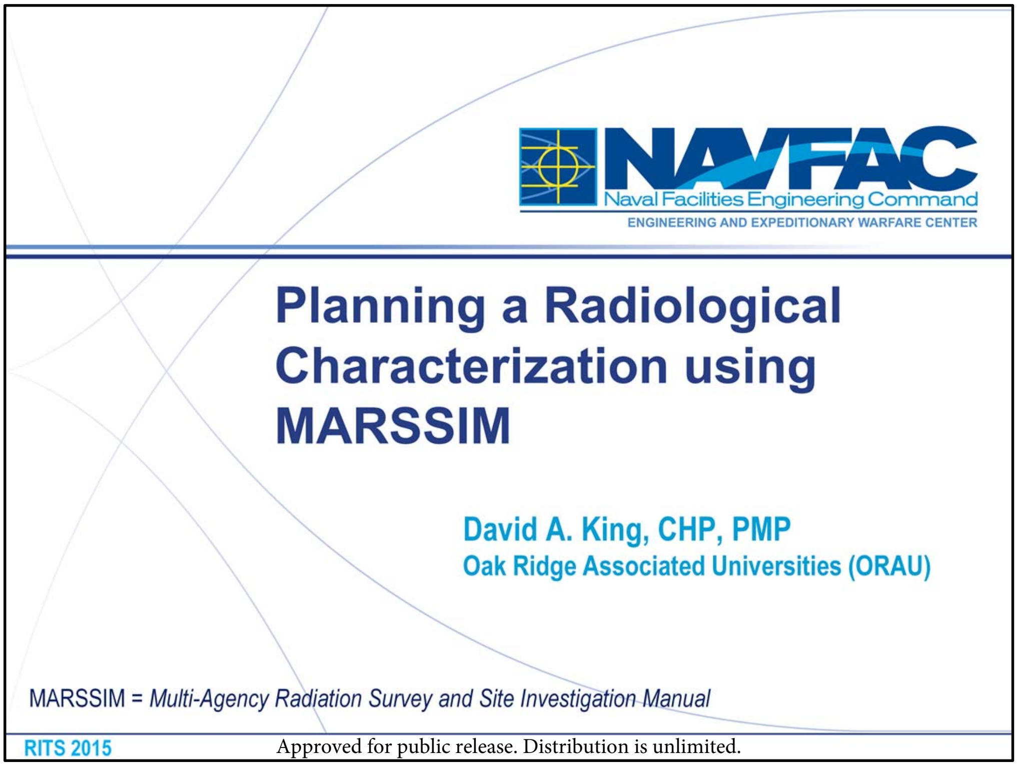


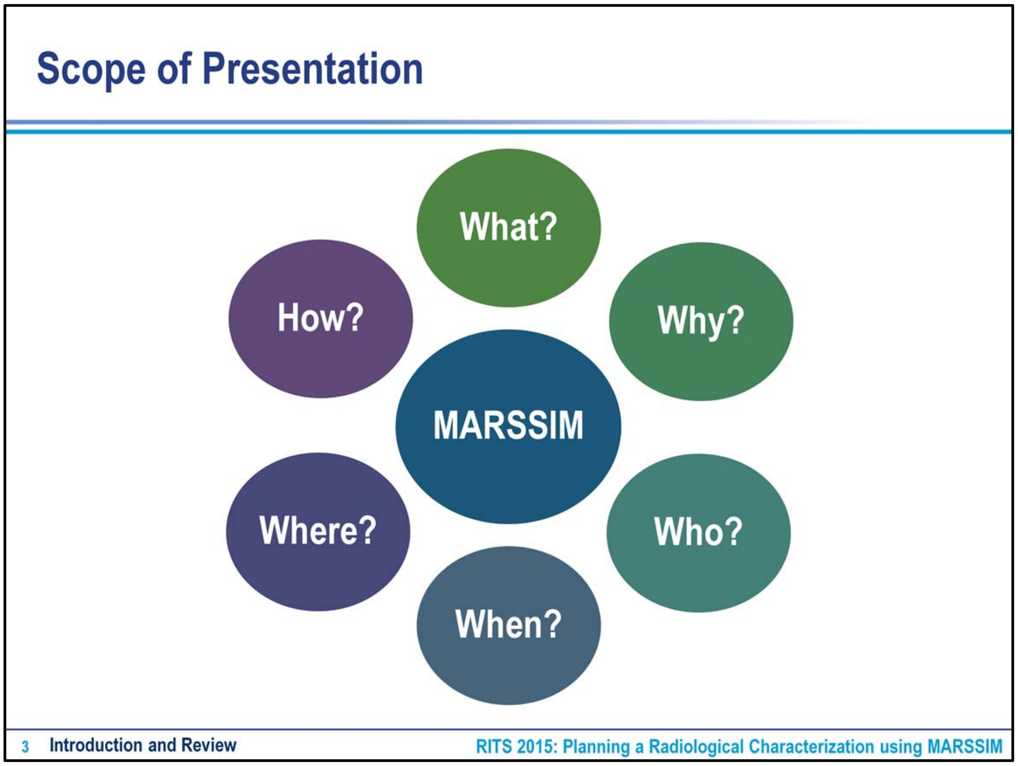
- I'm a health physicist who has been working with risk assessors (the chemical kind) for about two decades and have often been required to deal with dueling paradigms

- I was a junior staff HP when MARSSIM came out. What I've learned since is that, while MARSSIM can be quite confusing at first, it is a valuable and flexible resource for planning environmental investigations through the entire project life cycle

Presentation Overview

Introduction and Review

- What is MARSSIM?
- Why do RPMs need to know about MARSSIM?
- Who, when, where and how?
- Wrap Up



- While there a lot of questions that could be discussed regarding radiation and MARSSIM as part of ER, this presentation was developed to answer six questions:
- First off, what is MARSSIM?
  - Summarize MARSSIM's history, purpose, use advantages, and limitations
- Then, why do RPMs need to know about MARSSIM? (Current and Future Work)
  - RPMs may use MARSSIM on an ER project
  - Potential applications at Naval Installations
- Finally, the meat of the presentation: Who, when, where and how?
  - These questions are answered by using an example ER project
  - Walk through the development of a MARSSIM-based plan using data quality objectives

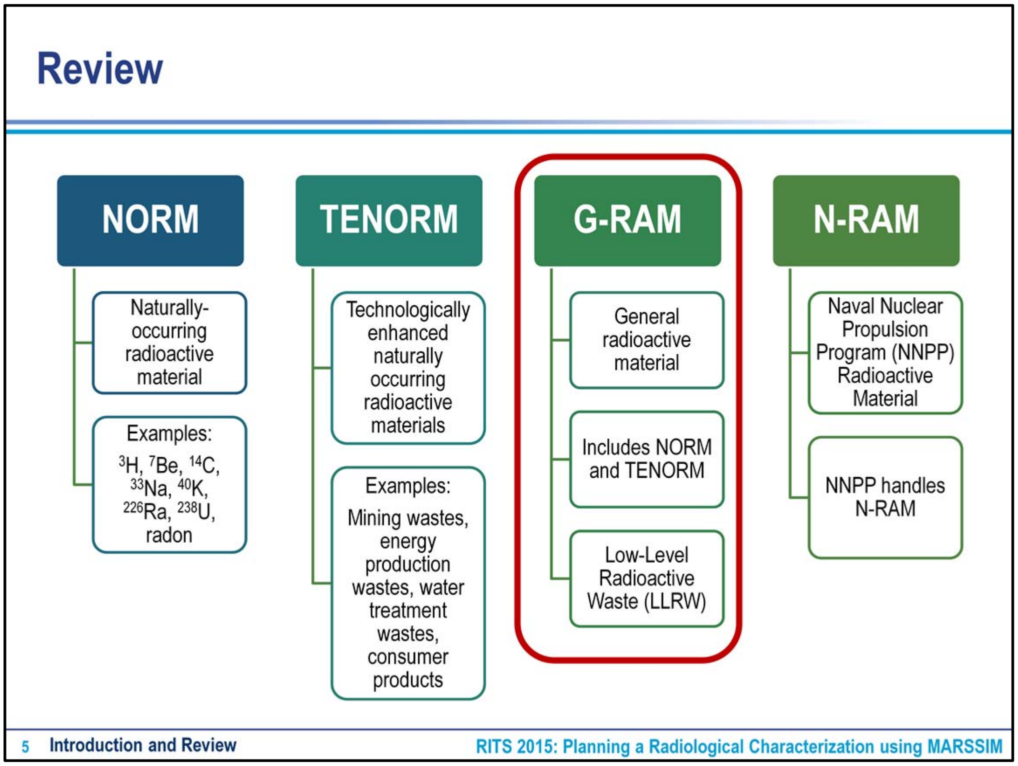
Acronyms and Definitions

- **NAVSEADET RASO (RASO)**
  - Delegated technical authority and cognizance for administering and enforcing the NRSC G-RAM policies and requirements
- **HRA**
  - Historical Radiological Assessment
- **Radiologically-Impacted Site**
  - Known, suspected, or possible that G-RAM were used, stored, or disposed
- **G-RAM**
  - General Radioactive Material
- **RPM**
  - Remedial Project Manager
- **ER**
  - Environmental restoration, e.g., of a radiologically-impacted site
- **MARSSIM**
  - Multi-Agency Radiation Survey and Site Investigation Manual
- **ROC**
  - Radionuclide of concern
- **COC**
  - Contaminant (or chemical) of concern
- **Radionuclide**
  - Atom with an unstable nucleus, undergoes radioactive decay by emitting radiation
- **Radiation**
  - Alpha particles, beta particles, and gamma rays

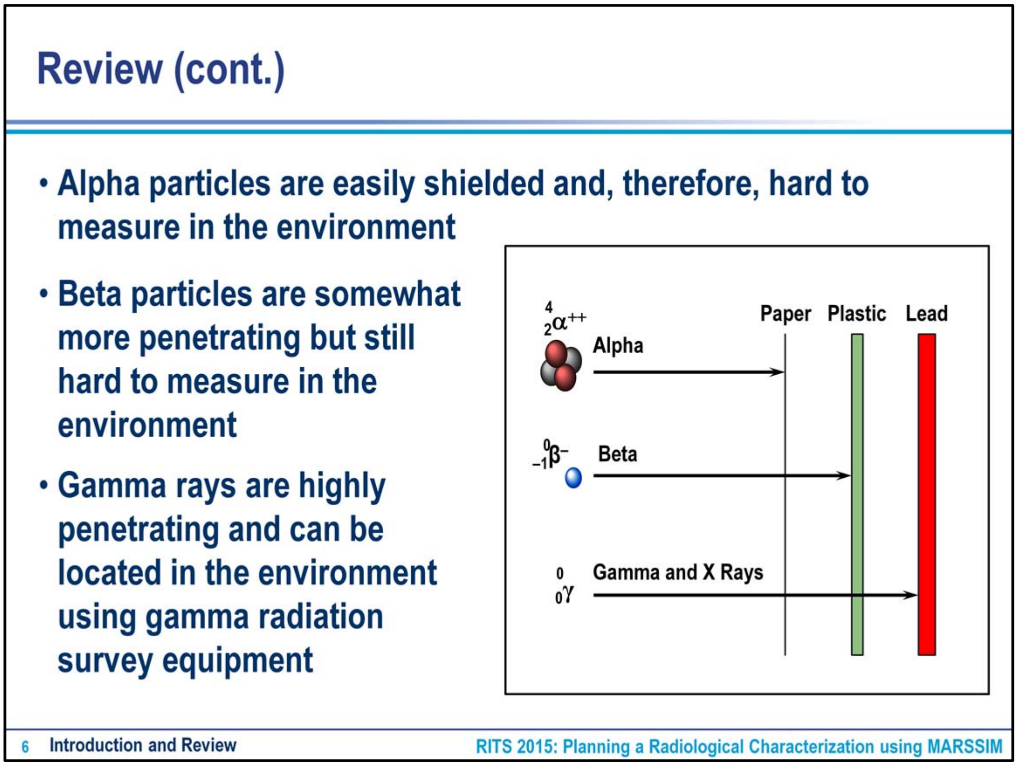
4 Introduction and Review RITS 2015: Planning a Radiological Characterization using MARSSIM

- Story-line. RASO is given authority by the Naval Radiation Safety Committee (NRSC) to perform a HRA of a potential contaminated site. The HRA uncovers evidence suggesting the presence of G-RAM. An RPM is assigned the ER project. Because there are potential ROCs (and maybe COCs), the RPM will use MARSSIM to measure radionuclide concentrations and levels of radiation.

- The NRSC is chaired by CNO N45 - establishes and oversees policy and requirements for use, storage, and disposal of all G-RAM including material related to ER/BRAC Programs.



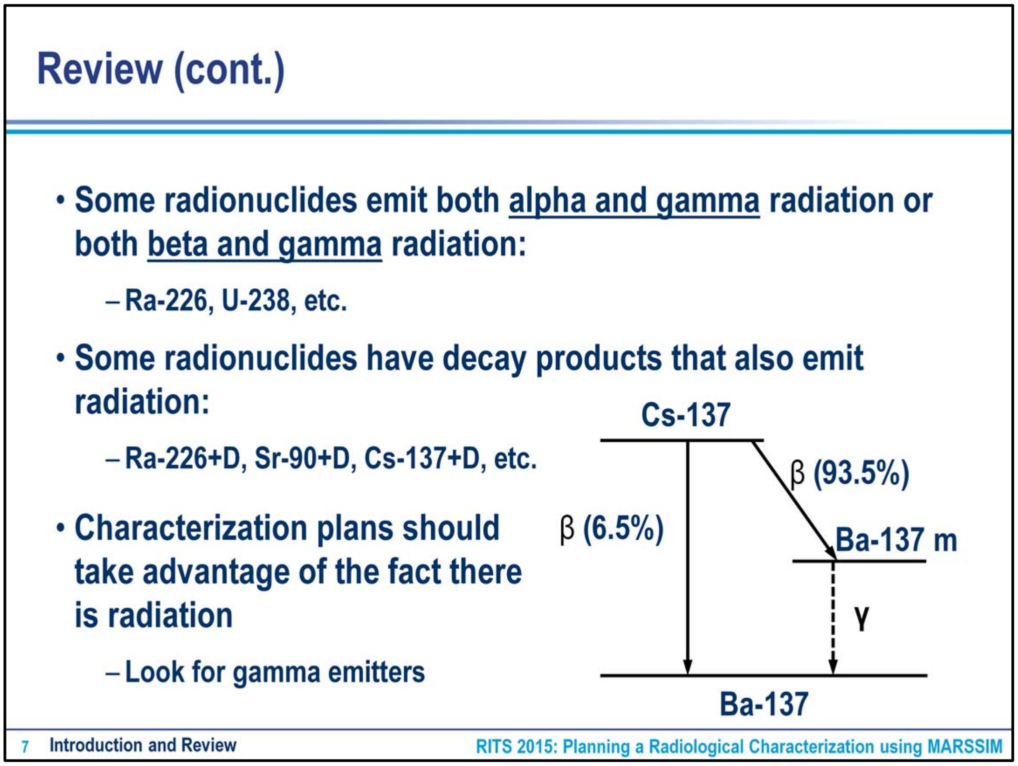
- Let's categorize the radioactive materials using terms that might be familiar to RPMs.
- NORM: Naturally-occurring terrestrial sources and radionuclides created through interactions with cosmic radiation
- TENORM: Technically-enhanced natural radioactive material
- G-RAM: Note that NORM and TE-NORM are included in G-RAM
- N-RAM: Handled by the NNPP folks, so it is not applicable here
- CLICK 1: Highlight G-RAM – this type is the focus of this discussion



- Alpha particles: ground moisture, grass, dirt, etc. may preclude measurement.
  - Rule-of-thumb: travels only about an inch in the air.
  - Often need laboratory data to characterize alpha-emitting radionuclides (similar to chemicals!).

- Beta particles: grass, dirt, etc. may preclude measurement in the field.
  - Rule-of-thumb: travels only about 10 ft in the air.
  - Often need laboratory data to characterize beta-emitting radionuclides (again, similar to chemicals!).

- Gamma particles: can “see” some gamma-emitters covered by about a foot of soil
  - No real rule-of-thumb: can travel very long distances in air.
  - Can often find it during radiation surveys (unlike chemicals) to help direct sampling
  - BIG ADVANTAGE over chemicals



- Pure alpha or pure beta emitters are very difficult to locate in the environment using radiation survey instruments. For example, Sr-90 is a pure beta emitter (no gamma).

- Key is to target radionuclides that emit gamma radiation.

Class Exercise 1 – Plan a Radiation Survey

- **Pick the radionuclides from each group that can be located during a gamma walkover survey:**

Group 1	Group 2	Group 3
U-238+D (α/β/γ)	Sr-90+D (β)	H-3 (β)
U-234 (α)	H-3 (β)	Sr-90+D (β)
Th-230 (α)	Cs-137+D (β/γ)	Pu-239 (α)
Ra-226+D (α/β/γ)		
Pb-210+D (β)		

- Pick the radionuclides to target during a gamma walkover survey from these groups.

- Note that if a radionuclide does not emit gamma radiation it can still be located if there are gamma-emitters present in the G-RAM.

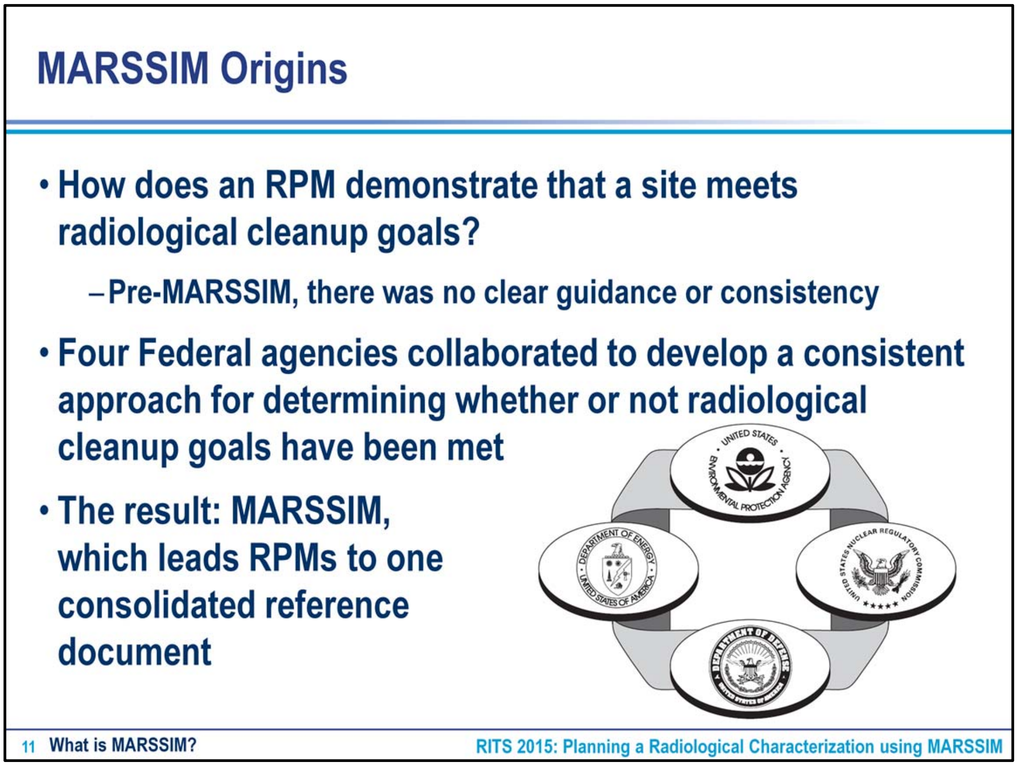
- Group 3 contains no gamma-emitters – these are “hard-to-detects”. Surveys are ineffective and they act like any chemical contaminant.

Presentation Overview

- Introduction and Review
- **What is MARSSIM?** History, purpose, advantages, and limitations
- Why do RPMs need to know about MARSSIM?
- Who, when, where and how?
- Wrap Up

- MARSSIM is literally 3-inches thick! The introduction to MARSSIM at ORAU's week-long course takes the entire first day.

- This presentation demonstrates high-level, top-down G-RAM characterization planning. Ultimately RASO will help with the details.



- One pre-MARSSIM example: the construction contractor used one composite sample and the verifying contractor used a combination of random and judgmental samples – there was frequent disagreement.
- **Ask audience**
    - Who is right in this scenario?
    - Answer: both of them – there was no guidance.

- Flexibility means RPMs use professional judgment based on the conditions at hand.

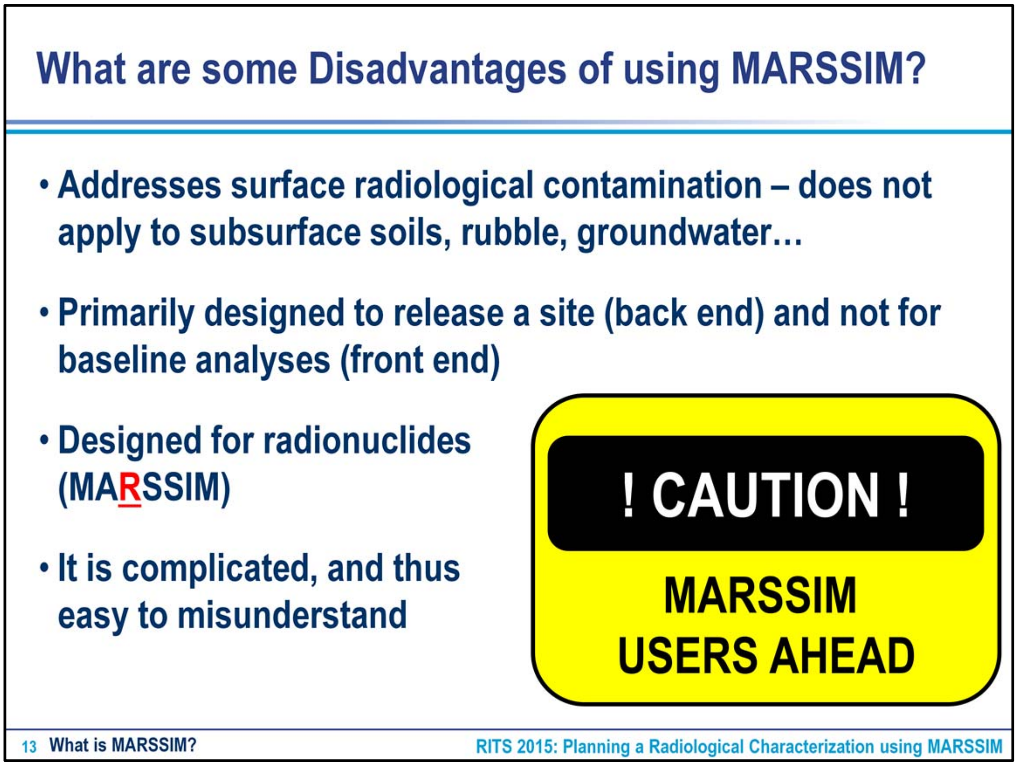
- Graded approach means more resources are used where they are needed most.

- *In situ* measurement – not when COCs are involved! Radiation surveys are tools for guiding the investigation.

- **Ask audience:**
  - What if a survey identifies contamination in a “clean” area?
  - What if a survey finds nothing in a “contaminated” area?

- The CSM is a physical description of the study area. It is used to plan activities (how big is the area, what are the contaminated media, where is contamination expected to be located and where could it go, etc.)

- The DQO process may be familiar to regulators and helps focus the investigation to make sure the data collected help answer the study questions.



- These disadvantages can be overcome.

- Many investigators use MARSSIM even though it might not be a perfect fit. In all my years of using MARSSIM, I have never seen a textbook application of MARSSIM. A MARSSIM project is…a project…that includes unknown conditions, human error, weather, contracts, etc. that are not unlike every other ER project.

- Samples collected using a MARSSIM design can still be analyzed for COCs. DQOs can account for multiple contaminant types, media, criteria, etc.

- It’s complicated but RASO will help work through technical challenges.

What is an RPM's Bottom Line on MARSSIM?

- **MARSSIM is industry's go-to guidance for characterizing radiological contamination (i.e., G-RAM)**
- **MARSSIM follows a flexible graded approach**
- **MARSSIM provides excellent guidance for planning, executing, and reporting on G-RAM investigations**
  - **MARSSIM inputs impact cost and schedule**

Key Point **RASO uses MARSSIM**

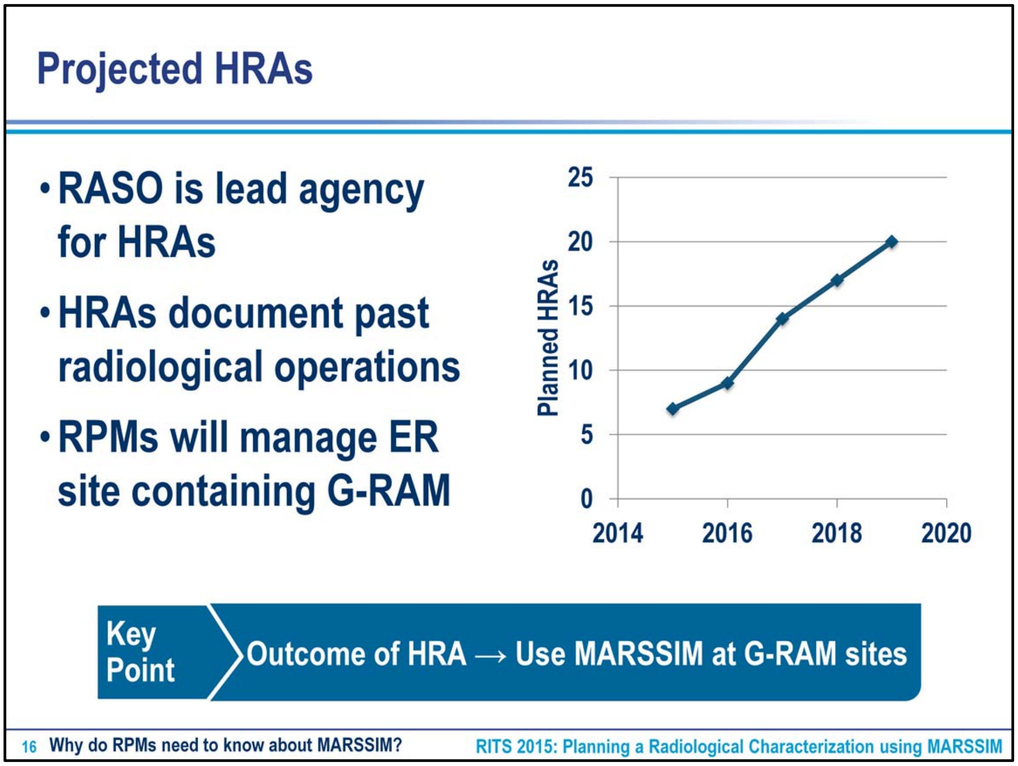
14 **What is MARSSIM?** **RITS 2015: Planning a Radiological Characterization using MARSSIM**

- Mostly, RASO uses MARSSIM.

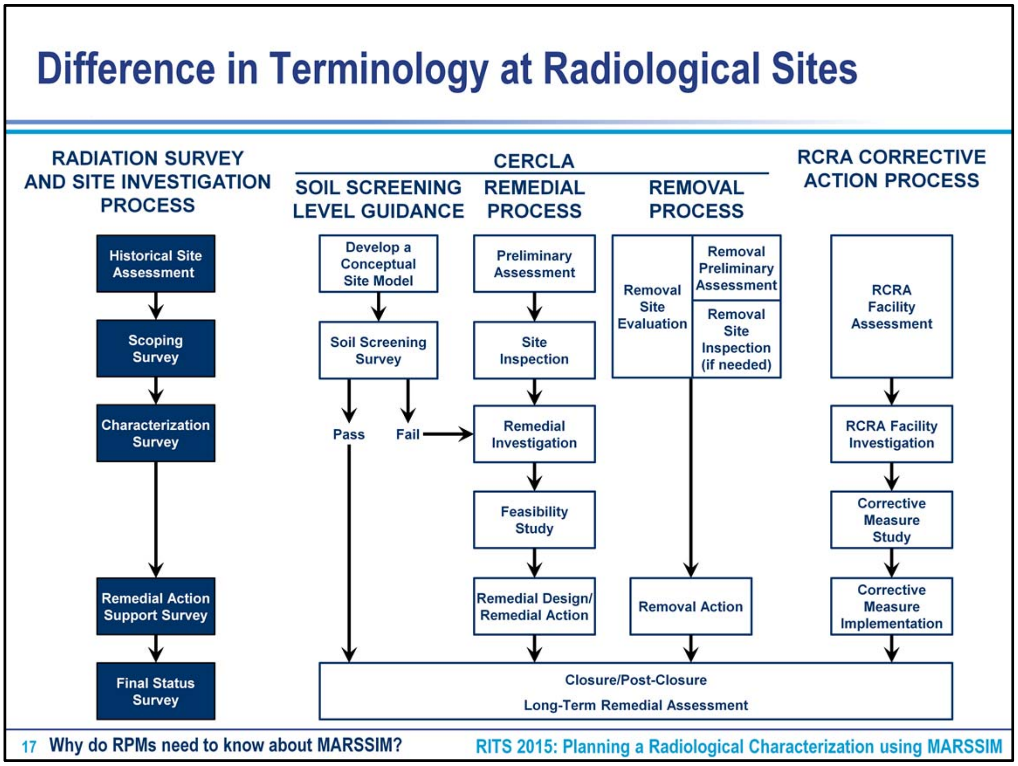
Presentation Overview

- Introduction and Review
- What is MARSSIM?
- **Why do RPMs need to know about MARSSIM?**
- Who, when, where and how?
- Wrap Up

Potential applications at Naval Installations



- On average 3 new HRAs are planned to start each year and typically take 2 years to complete.
- The HRA will document past radiological operation at the Installation. Specifically, G-RAM which encompasses practically everything EXCEPT radioactive material associated with Navy's Nuclear Propulsion Program, Medical, and Weapons.
- RASO will oversee HRAs, and RPMs will manage ER projects including the characterization of G-RAM in the environment.
    - RPMs should coordinate radiological work with the Navy's technical experts, NAVSEA RASO, to accomplish ER program goals
- At the end of the day:
    - RPMs may be required to manage a site with G-RAM contamination.
    - RASO uses MARSSIM, so RPMs should have a basic understanding of how MARSSIM will be used at a G-RAM site.

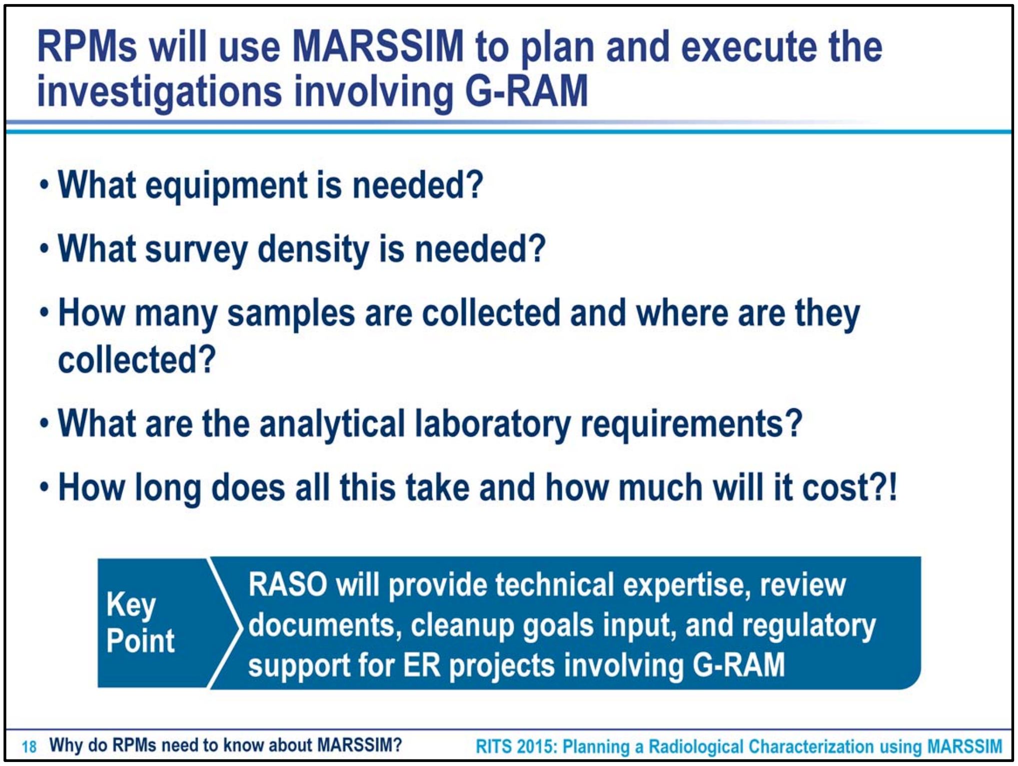


- This chart shows the descriptive difference used between multiple programs for the same phases of work. MARSSIM is a jointly recognized (EPA/DOD/State/BRAC) guidance document that operates within an overarching regulatory framework (CERCLA/RCRA) to provide for investigation/remediation of a G-RAM site. Radiological sites addressed under CERLCA/RCRA are addressed in the same manner as any other site, with the difference being terminology used to describe the various phases from the guidance documents.

- http://www.epa.gov/rpdweb00/marssim/

- For more information on MARSSIM, please refer to the above link.

- Note that under MARSSIM there is a similar sounding initial investigation called the Historical Site Assessment (HSA). The MARSSIM term is site specific, whereas the HRA is a Navy term for a facility assessment. There will be future training on MARSSIM to follow in preparation of addressing the outcome of the HRAs, as this is intended to inform/provide background that G-RAM sites are similar, yet different from a traditional ER site.



- Equipment: Typically includes sodium iodide detectors integrated with GPS equipment and data loggers. Data management and analysis must be addressed.

- Survey: MARSSIM described survey methods/techniques and measurement data densities. Uses graded approach.

- Sample: MARSSIM is used to set sample densities and location/distribution (e.g., random or systematic). Uses graded approach.

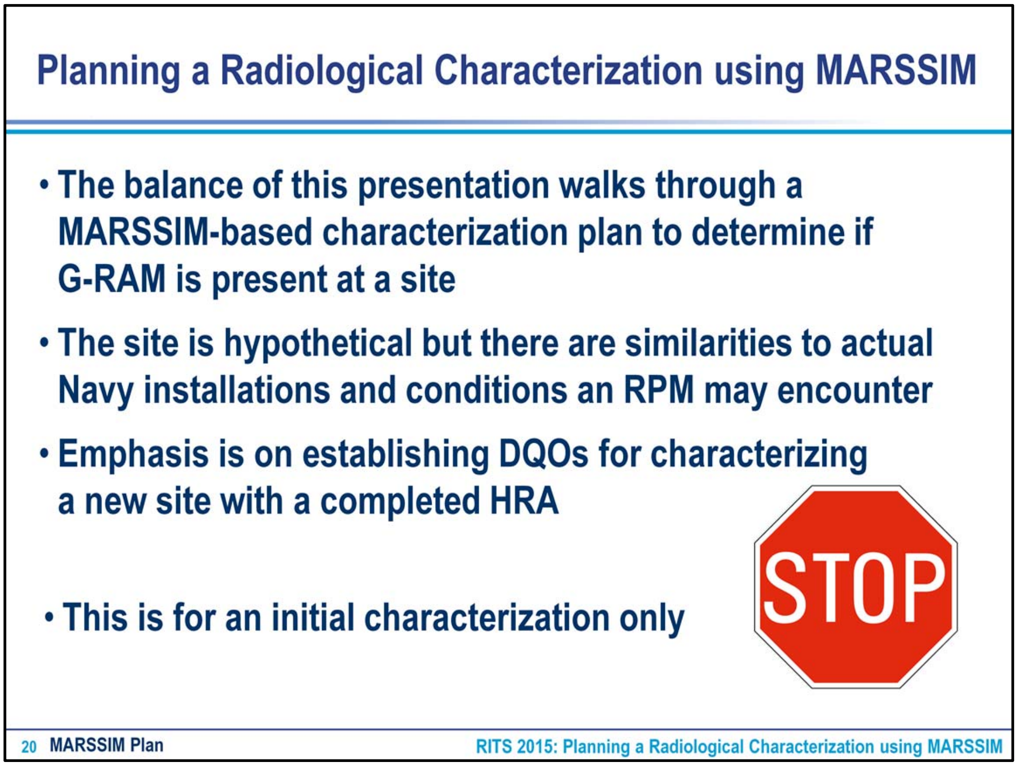
- Laboratory: MARSSIM described what analyses may be used to characterize ROCs.

- Cost and Schedule: All are inputs to cost and schedule.

- No worries: RASO's got your back. 2010 Memo describes roles and responsibilities (included in 2015 NERP – Coming Soon)

Presentation Overview

- Introduction and Review
- What is MARSSIM?
- Why RPMs need to know about MARSSIM
- **Who, when, where and how?** — Answer using a MARSSIM-based application at an ER site (MARSSIM Plan)
- Wrap Up



- Learn by doing.

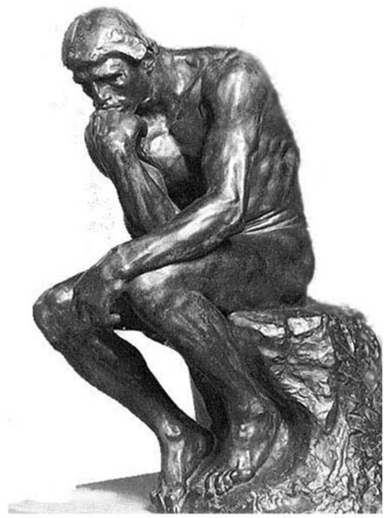
- This is an example, a high-level template for planning an investigation of G-RAM at a new site. RPMs will see what kinds of resources are needed, what time commitments are made, what laboratory analyses are required, etc., that are inputs to the overall project cost and schedule.

- The development of cleanup goals, radiological risk and assessments, remedial actions, etc., that an RPM may encounter later in the project life cycle may be discussed at future seminars.

Planning a Radiological Characterization using MARSSIM

Ponder this during the course of the presentation:

- **How does the MARSSIM plan compare to a traditional (chemical) plan?**



- If there were no radiological contaminants and MARSSIM is not used, how would the plan change?

MARSSIM Plan – Outline

- Introduction
- Site History and Description
- Data Quality Objectives (DQOs)
  1. State the problem
  2. Identify the decision
  3. Identify inputs to the decision
  4. Define the study boundaries
  5. Develop a decision rule
  6. Specify limits on decision errors
  7. Optimize the design for obtaining data

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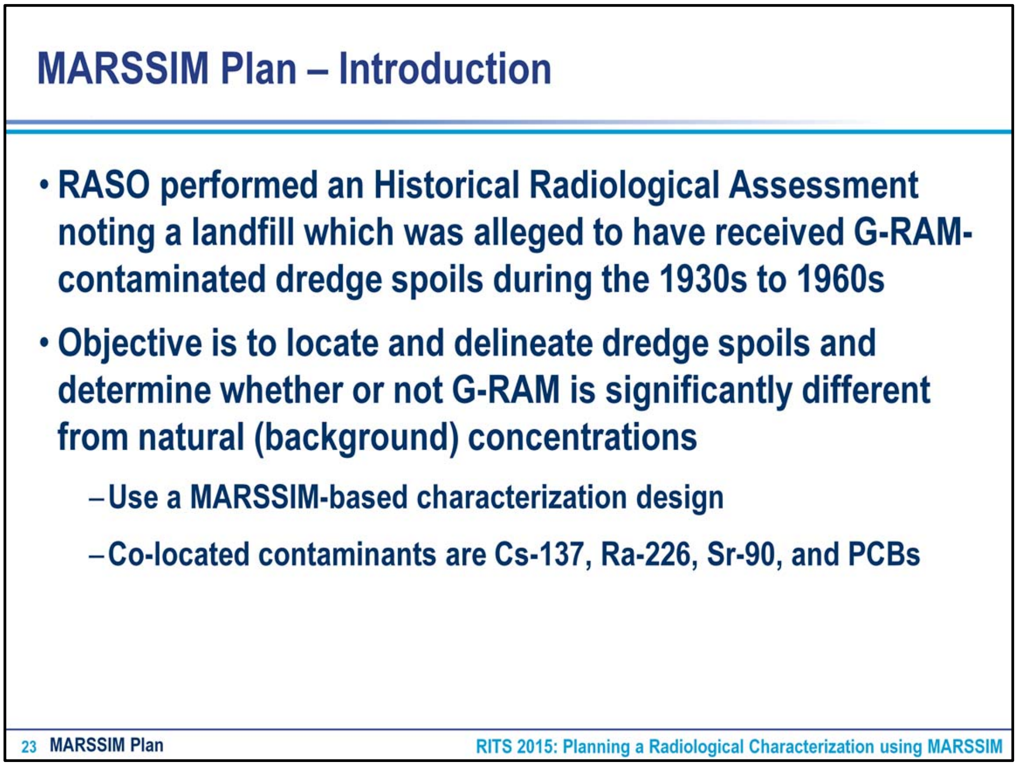
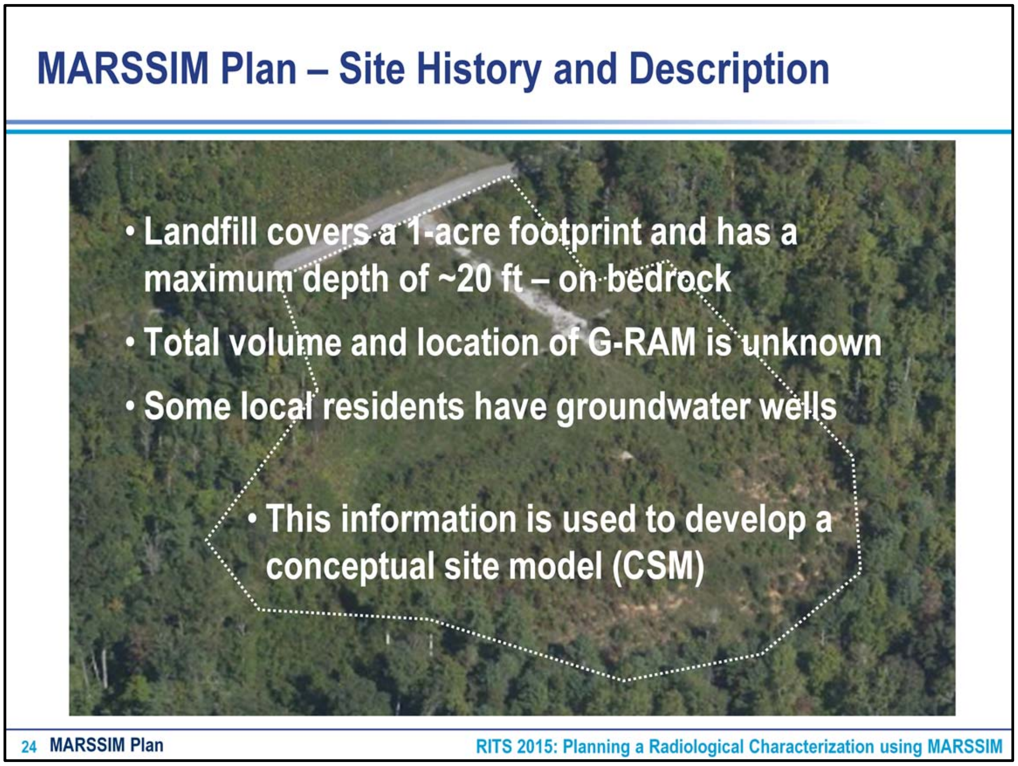
- Most of the meat is in DQO development. But for completeness the presentation touches each part of the plan
- Plan could also include a quality assurance project plan (QAPP), safety plan, etc. Emphasis here is the MARSSIM design.



- Co-located = if present they will all be together. How convenient!

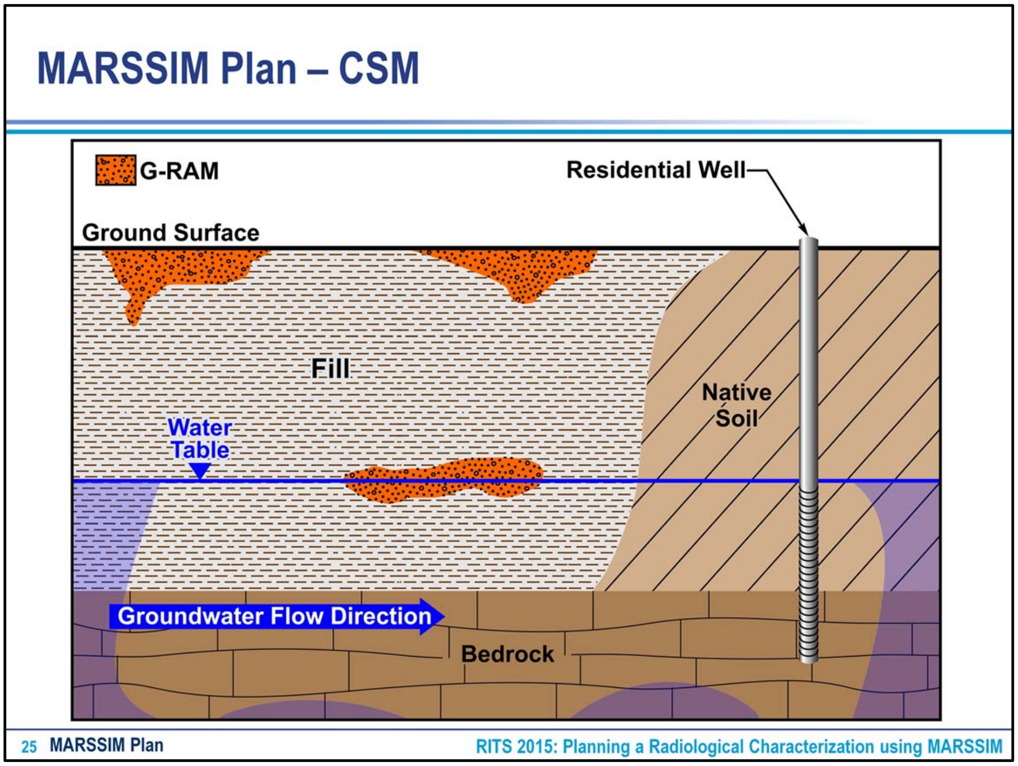
- RPM is assigned the site and needs to prove or disprove that G-RAM is present above background concentrations.

- PCBs are not radionuclides.
- **Ask Audience:**
    - Does that make a difference?



- Location: G-RAM could be on the surface, could be 20-ft deep. Plan needs to consider that G-RAM could be anywhere within the landfill footprint.

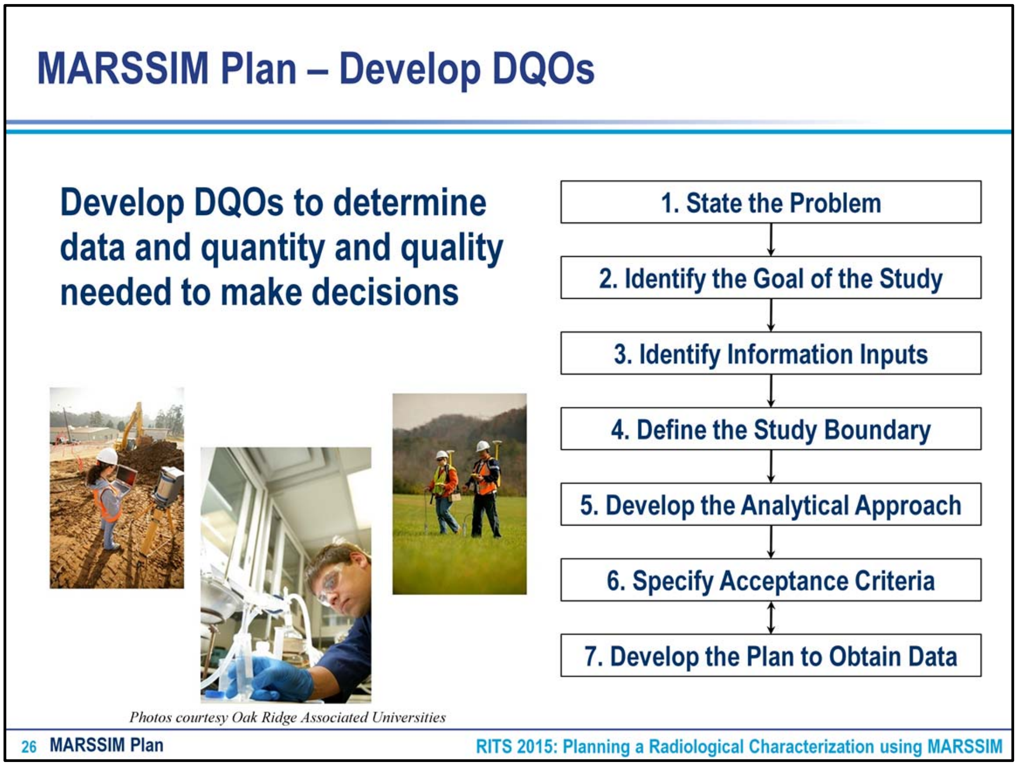
- Bedrock is the base of the landfill… and top of the water table. If G-RAM is identified, especially near the base, could mean a threat to residents with groundwater wells.



- The CSM is used to plan characterization activities.

- **Ask Audience:**
- Does this visual suggest what kind of characterization data should be collected?
    - Surface samples,
    - Radiation scans/surveys
    - Subsurface samples/drilling

- CSM shows that G-RAM could be at the surface or buried.



- DQOs are iterative. After Step 7 is complete, go back and look again to make sure all data needs have been addressed – look for areas of improvement.

DQO Step 1 – State the Problem

- Define the problem that necessitates the study
- Identify the planning team, and examine the budget and schedule
- Start with problem statement

Conduct a MARSSIM-based characterization to locate and delineate G-RAM in the former industrial landfill so data may be used to plan future actions under CERCLA.

- Identify decision makers and develop schedule

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- **WHAT** is the project trying to do, **WHO** is doing it, and **WHEN** is it done? All in DQO Step 1.
- All the rest answers **HOW**.

DQO Step 1 – State the Problem (cont.)

Name	Organization	Role
C. Nimitz	NAVSEADET RASO	Policy and Technical Support
D. MacArthur	BRAC/NAVFAC	RPM
G.S. Patton	BRAC/NAVFAC	Field Manager
M. Curie	BRAC/NAVFAC	Lead HP Technician
B. Random	Risk Inc.	Lead Risk Analyst
List specialists, other decision makers, here…		

- **Schedule inputs discussed in Step 7**

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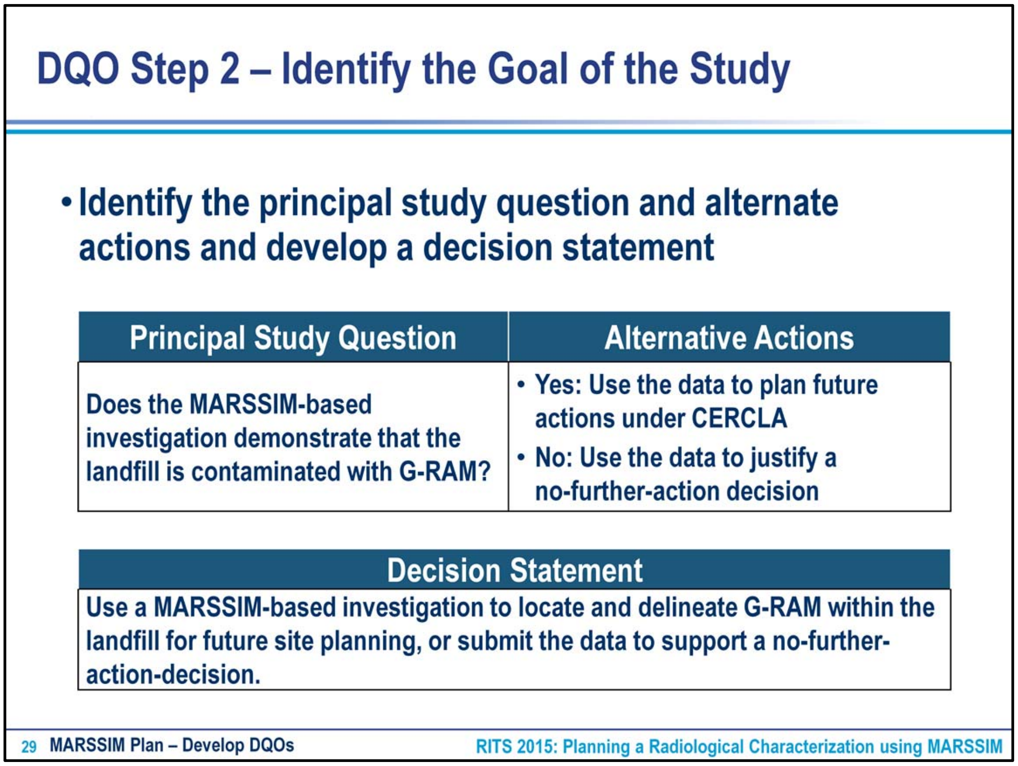
- Hypothetical key personnel and decision makers.

- Consult *DON Policy Activities Involving General Radioactive Material (G-RAM) at Environmental Restoration Program Sites* (DON 2010) for the roles and responsibilities of RASO and RPMs.

- Schedule inputs might be expressed as a table or the project Gantt chart. Step 7 of this presentation provides example task-durations.



- Rework the problem statement in the form of a question then explain what happens when the question is answered.

DQO Step 3 – Identify Information Inputs

- **Identify both the information needed and the sources for this information, determine the basis for action levels, and identify sampling and analytical methods that will meet data requirements**

Info. Sources	Action Levels	Methods
HRA and MARSSIM	Background concentrations	Survey and sampling equipment and procedures
Risk and Data Assessment guidelines	Use local borrow pit	VSP for mapping
Local records, drawings, photos, etc.	Outlier rules	Analytical laboratory procedures

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- Need to consult with the risk assessor to make sure the data will be sufficient to complete future risk analyses, if needed.

- Need to compare site data with background concentrations, so a suitable background (reference) area must be selected. The reference area should ideally:
    - Contain the same physical characteristics as the site
    - Be uncontaminated
    - Be accessible for surveys and sampling

- Because the "action level" is background, the plan should consider a small set of samples that could bias averages (outlier or hot spot rules).

DQO Step 4 – Define the Study Boundary

- Define target populations and spatial boundaries, determine the timeframe for collecting data and making decisions, address practical constraints, and determine the smallest subpopulations, area, volume, and time for which separate decisions must be made
- Finally! This is where MARSSIM first asserts itself
- Classify the area per MARSSIM and set boundaries

DQO Step 4 – Define the Study Boundary (cont.)

Probability of Exceeding Limits	Class	Area Guidelines
High (e.g., known spill/storage area)	Class 1	≤ 0.5 acres
Medium (often a buffer)	Class 2	≤ 2.5 acres
Low (cannot rule out some impact)	Class 3	None

Key Point: The MARSSIM graded approach focuses resources where the risk of contamination is the highest

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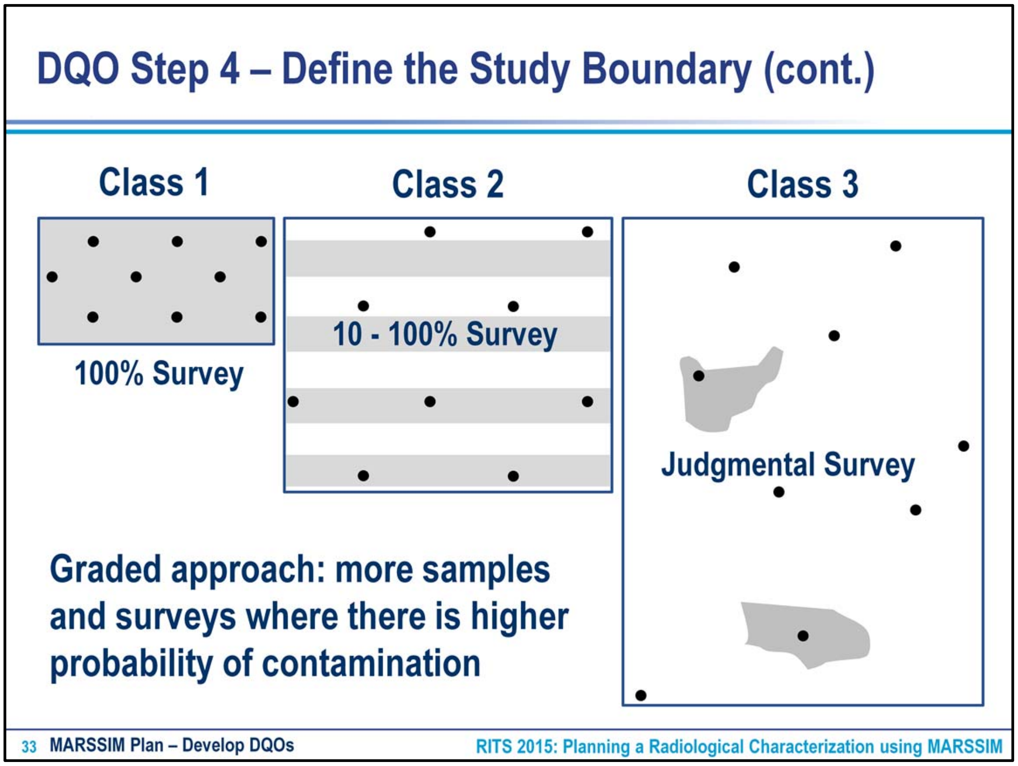
- **Ask Audience:**
- Is there a size-limiting approach outside of MARSSIM?

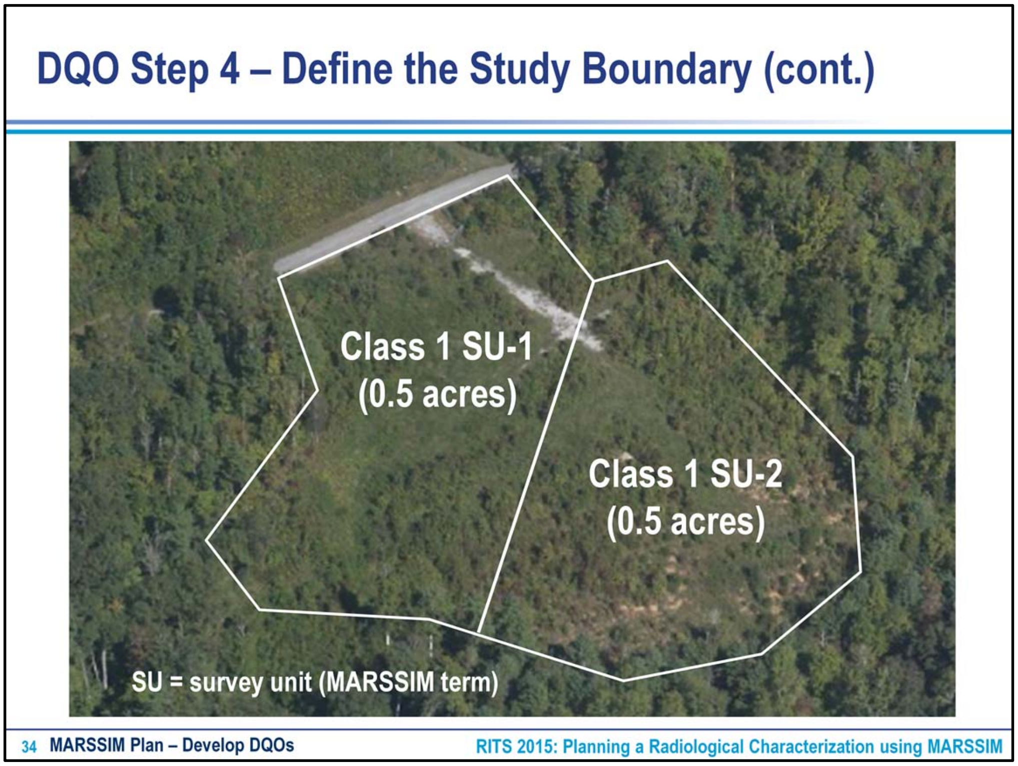
- Risk assessors may set data densities based on a plot of farmland. Survey units outside of a MARSSIM design can be very large.



- Classification under MARSSIM leads to rules about sample density.

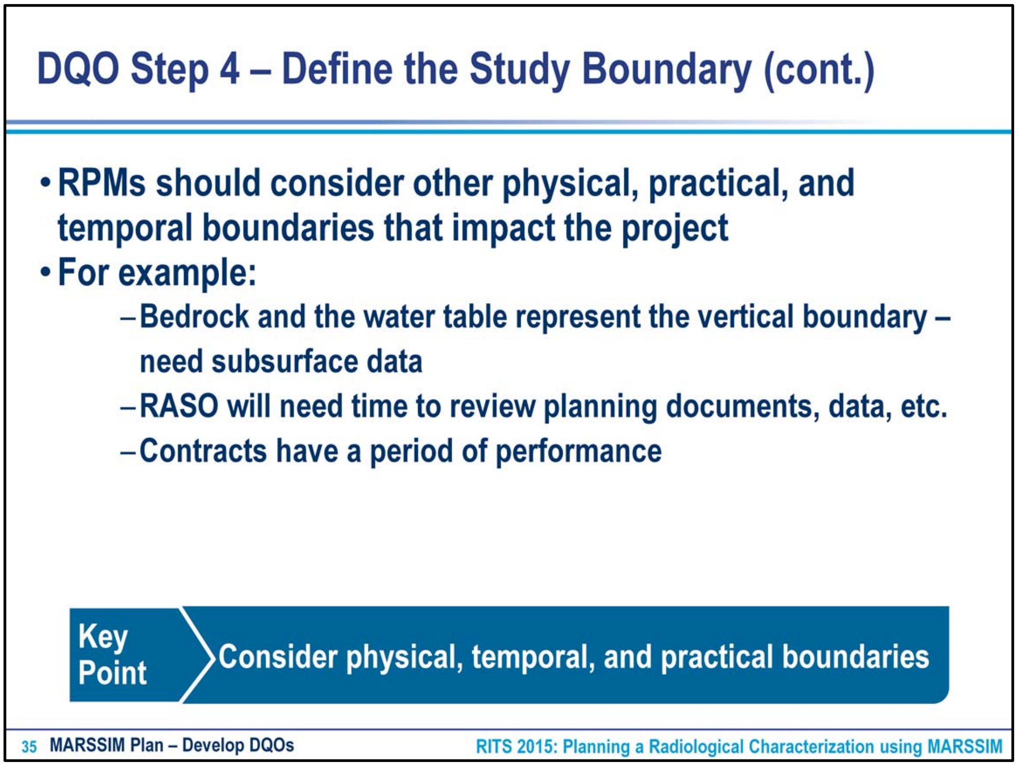
- Class 1 ~ more samples per acre; high density survey
- Class 2 ~ fewer samples per acre; low-to-high density survey
- Class 3 ~ few samples per units acre; low density survey

- How does classification impact the project costs and schedule?
- Collect more data for Class 1 = more time in the field collecting samples and performing surveys, higher analytical and data management costs



- The entire landfill is presumed to be impacted by G-RAM, thus is designated as Class 1
- Landfill footprint is 1-acre, so divided into two 0.5 acres Class 1 survey units (SUs):
- SU-1 and SU-2.
- Need to find out how many samples to collect in each Class 1 SU
- Plan 100% survey of each Class 1 SU

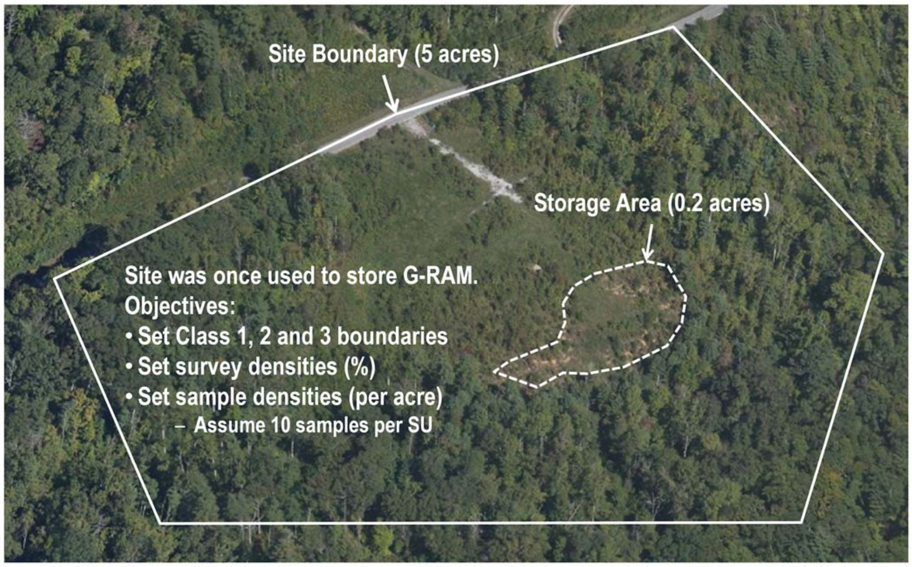
- Notice that classification has nothing to do with the subsurface! Subsurface is outside of MARSSIM, but the DQOs still have to address potential buried contamination.



- Temporal boundary examples: could be weather-/season-related, based on a contractual period of performance (e.g., the driller and analytical lab), etc.

- Practical boundary examples: administrative rules/policies, contractual limitations, resource limitations (e.g., no local driller)

Class Exercise 2 – Plan a MARSSIM Survey



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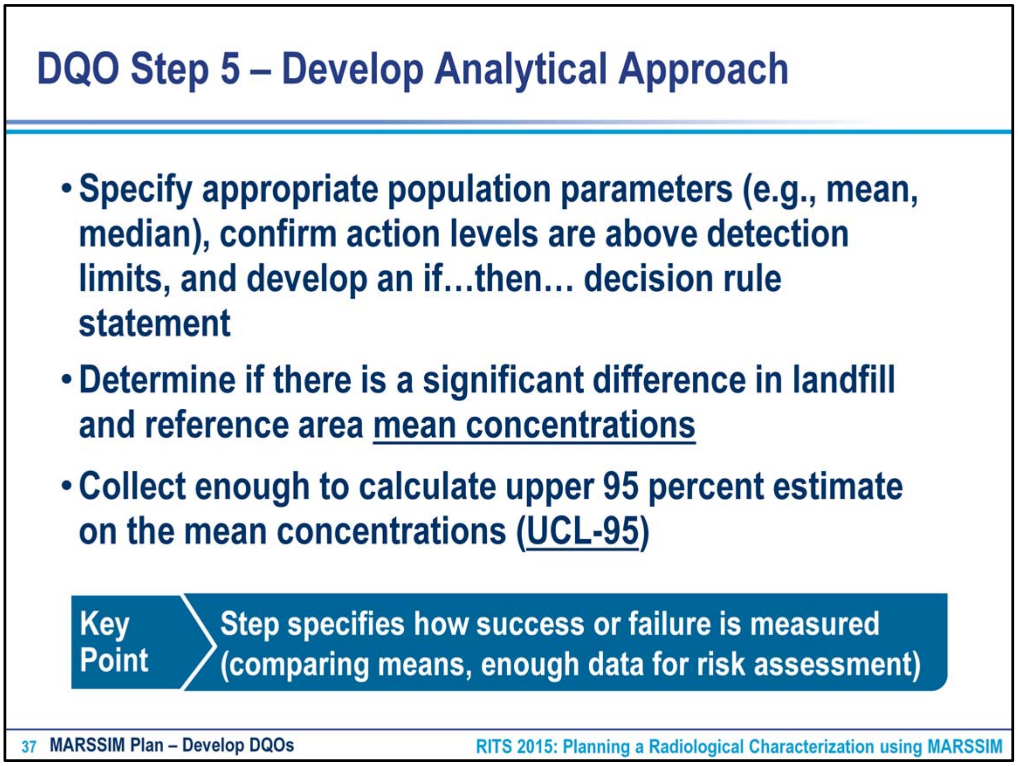
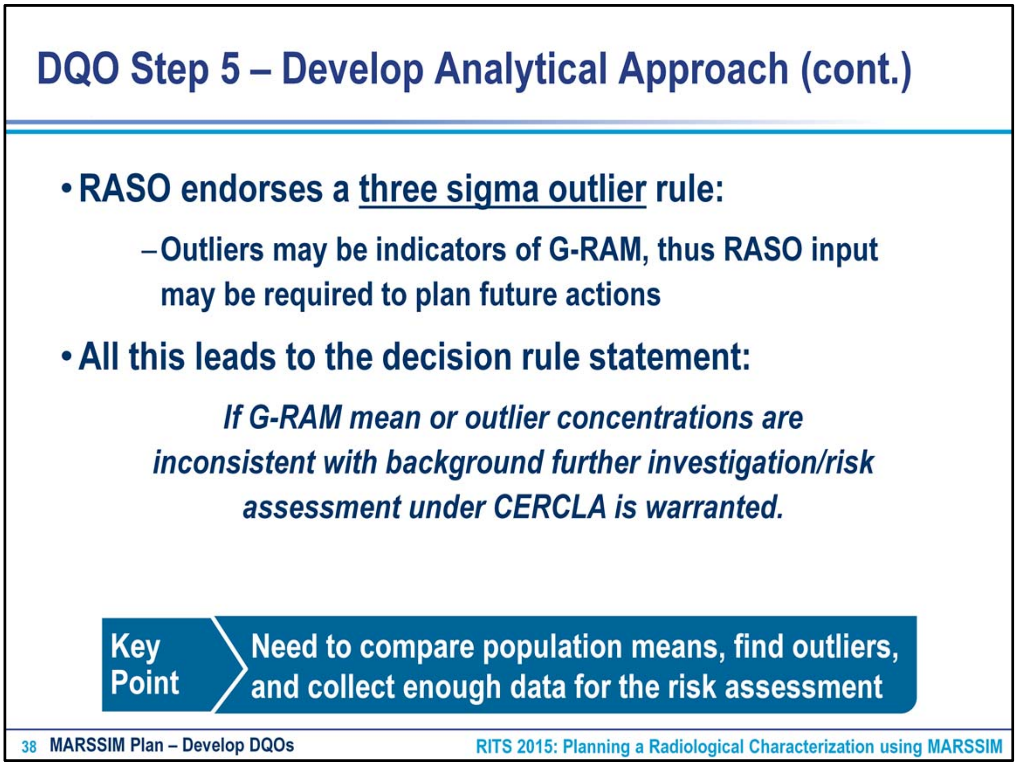
- **NEED AN EASEL OR WHITE BOARD FOR THIS EXERCISE**

- Look at an example site and plan characterization activities.
- Set boundaries
    - Class 1 guideline is 0.5 acres
    - Class 2 guideline is 2.5 acres
    - Class 3, no limit
- Set survey densities
    - Class 1 guideline is 100%
    - Class 2 guideline is 10-100%
    - Class 3, no limit
- Set sample densities



- Back to DQO development for the case study.
- Main idea under Step 5 is to select the appropriate test to define success or failure.
- Expect RASO to provide guidance here.



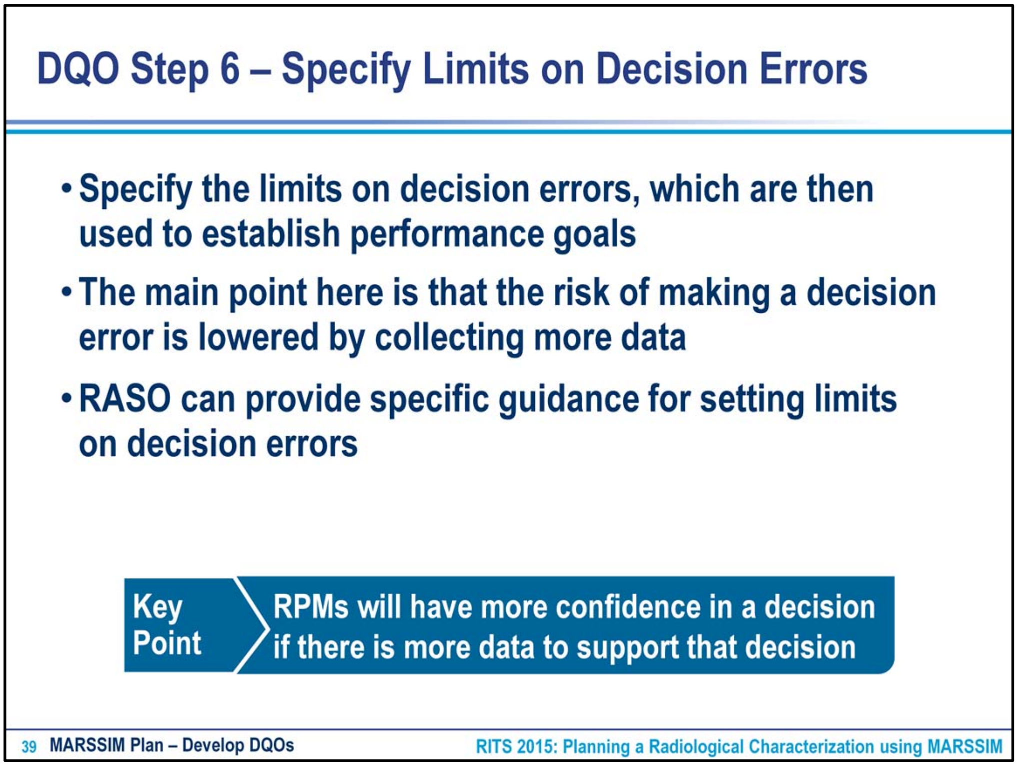
- Why is there an outlier rule:
  - Any sample results greater that three standard deviations from the mean of the respective population will be considered, at least initially, to be an outlier.

- Notice the refinement from the problem statement in Step 1 (which basically says to go find contamination):

- *Conduct a MARSSIM-based characterization to locate and delineate G-RAM in the former industrial landfill so data may be used to plan future actions under CERCLA.*

- To the Decision Rule Statement in Step 5 (specifically, gives a clearer definition of “contamination”):

- If G-RAM mean or outlier concentrations are inconsistent with background further investigation/risk assessment under CERCLA is warranted.

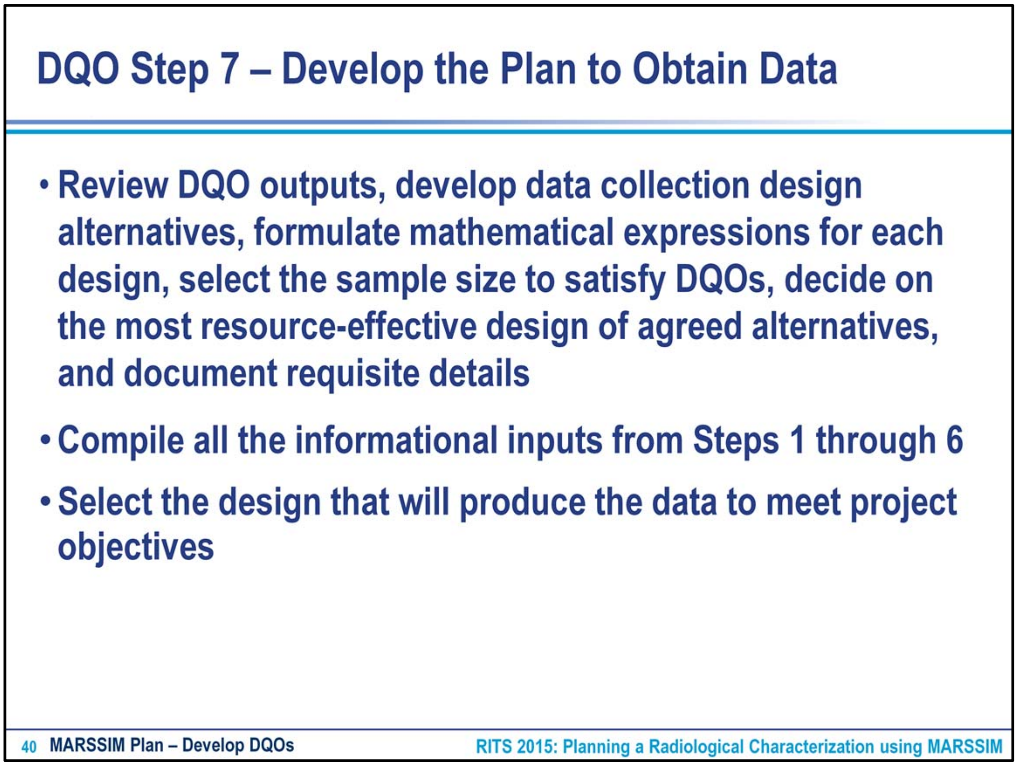


- Main point: lower the risk of a decision error by collecting more samples.

- Typically set Type 1 decision error to 5% (5% false negative, or 5% chance of concluding that the site is “clean” when it is actually “contaminated”)

- The Type 2 decision error can be set to 5%, 10%, etc. (e.g., 10% false positive, or 10% chance of concluding that the site is “contaminated” when it is actually “clean”)

- RASO can provide specific guidance here.

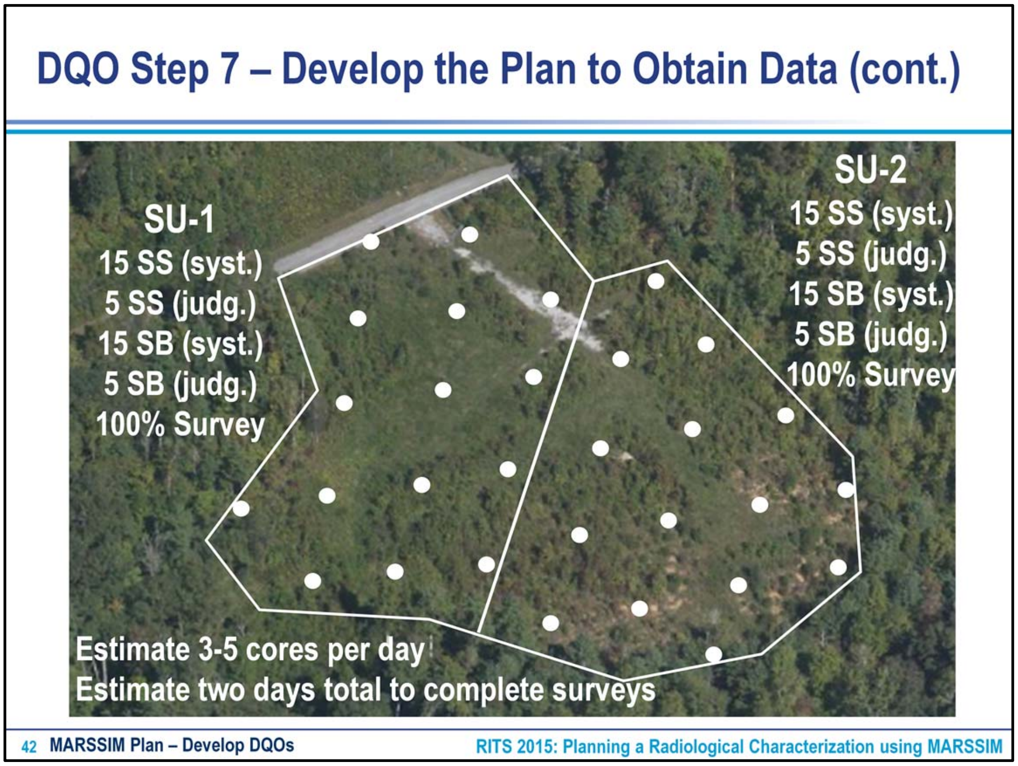


- This is where the plan provides specific details on the characterization design.

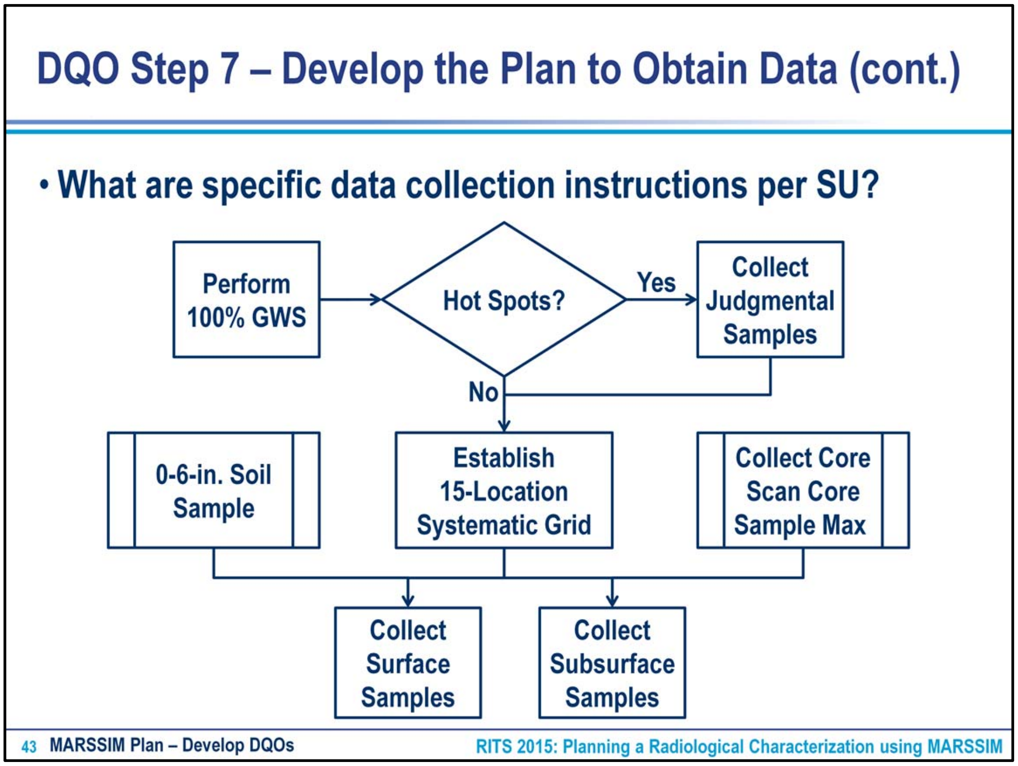
DQO Step 7 – Develop the Plan to Obtain Data (cont.)

- **How many samples (*N*) are needed in each SU?**
  - **How many to compare means? MARSSIM suggests about 15 samples for moderate contamination potential**
  - **What about potential outliers? Use gamma walkover data to direct judgmental samples (up to 5 samples)**
  - **What about subsurface soils? Scan cores and collect at least one subsurface sample at location of maximum response (15-20 samples)**
- **At least 15 surface and 15 subsurface samples per SU is plenty for the risk assessment (i.e., the UCL-95 calculation)**

- *N* needs to be large enough to perform the statistical test and to estimate the UCL-95.
- Consult MARSSIM Tables 5.2 and 5.4
- Also need to look for outliers (hot spots) on the surface and at depth.



- Data collection parameters:
  - Estimate two days total to complete surveys
  - Estimate 3-5 cores per day
  - Surface sample and subsurface sample will be collected at each location.
  - Judgmental samples could be collected anywhere.
- SS = surface sample
- SB = subsurface sample



- At a very high level…
- "Sample Max" means to collect a sample from the core section that produces the maximum scan result. It is a way to use scan data to bias sampling decisions.

DQO Step 7 – Develop the Plan to Obtain Data (cont.)

Analyte Type	Matrix	Container Type Volume	Preserv-ation	Holding Time
RAD	Soil	1-liter HDPE jar	None	180 d
PCB	Soil	Glass/8-oz. jar	≤6°C	14 d

- **Sample collection parameters**
  - **Need to plan container requirements**
  - **Need to know sample preservation and holding time requirements**

- Shows sample container and special handling requirements.
- Table can be used by RPMs to plan

DQO Step 7 – Develop the Plan to Obtain Data (cont.)

Analyte	Units	Analytical Method	MDC
Cs-137	pCi/g	Gamma spectroscopy	0.2
Ra-226	pCi/g	Gamma spectroscopy	0.2
Sr-90	pCi/g	Low background proportional	0.5
PCB	mg/kg	SW-846	1

- **Laboratory analysis parameters**
  - **Assume 30-day analytical "turns"**
  - **Laboratory generates Level III data packages**
  - **MDCs should be below background levels**

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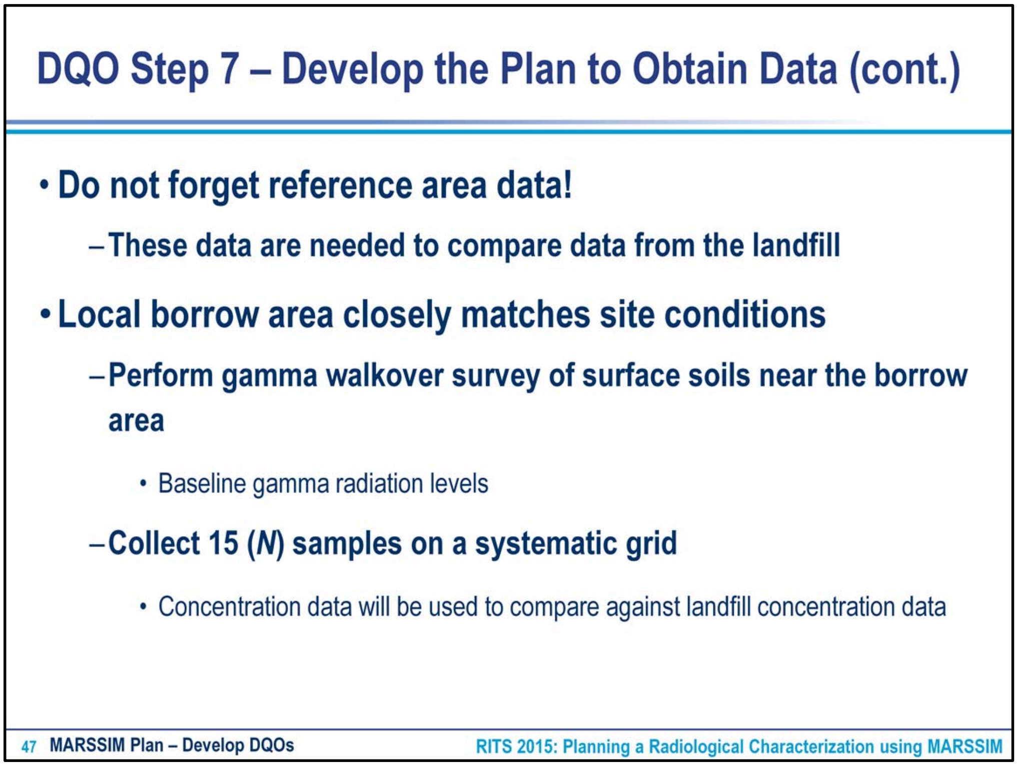
- Shows analytical laboratory requirements.
- Table can be used by RPMs to plan

DQO Step 7 – Develop the Plan to Obtain Data (cont.)

Survey	Sampling	Drilling
Sodium Iodide/GM Detectors	Bowls/Trowels	Drill Rig
GPS Equipment	Decon. Materials	Split Spoons
Data Loggers	Coolers/Ice	Decon. Pad
Logbook/Forms	Logbook/Forms	Physical Controls

- **Basic equipment/resources need to cover surveys, sampling, and drilling operations**

- Shows basic equipment and resource requirements.
- Table can be used by RPMs to plan



- This is basically another SU, but clean.

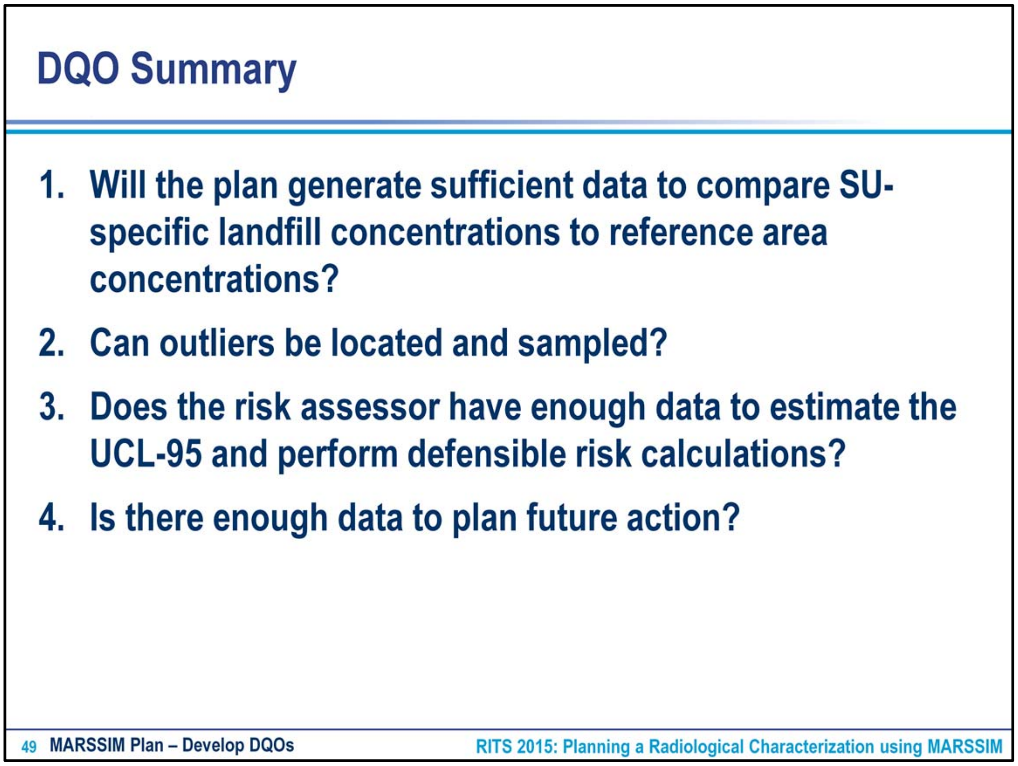
DQO Step 7 – Develop the Plan to Obtain Data (cont.)

SU	Total Acres	GWS (%)	Syst. Surf.	Judge. Surf.	Syst. Sub.	Judge. Sub.	Lab Analyses
SU-1	0.5	100%	15	5	15	5	40
SU-2	0.5	100%	15	5	15	5	40
Ref.	0.2	100%	15	0	0	0	15
Totals	1.2	100%	45	10	30	10	95

Ref. = reference area for obtaining background data/samples

- **Judgmental surface sample locations based on surveys**
- **Judgmental subsurface sample locations based on scans**

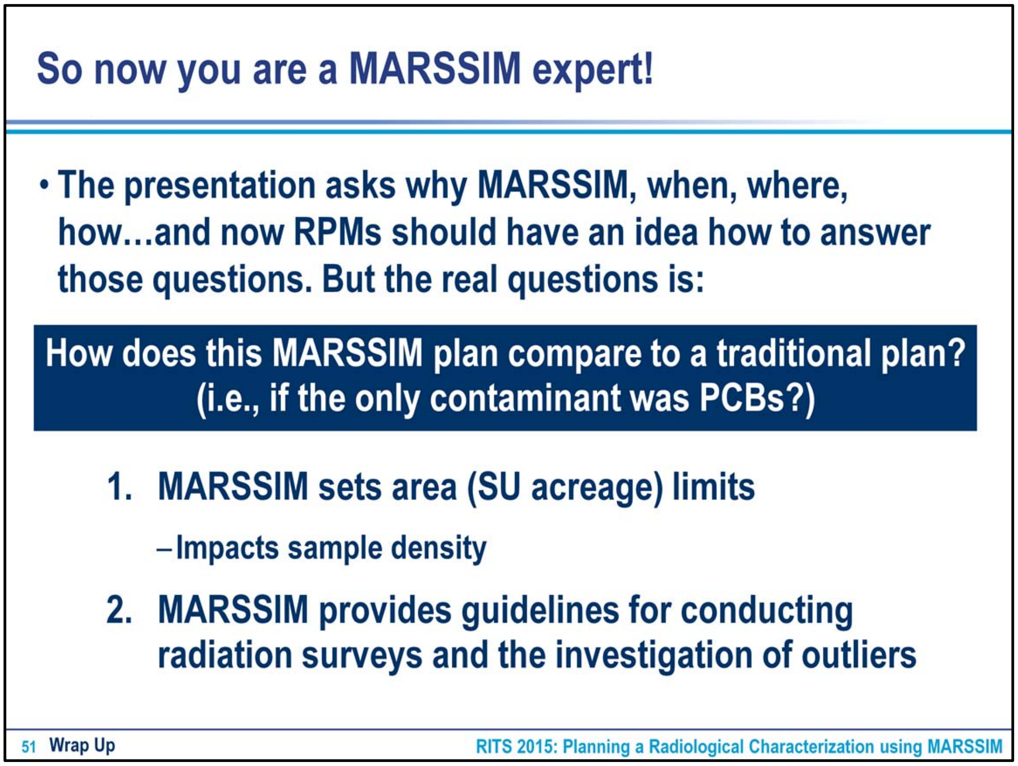
- Is this enough information for RPMs to plan the project? Knowns:
  - Surveys requirements,
  - Sample requirements,
  - Laboratory requirements, and
  - Equipment/resource requirements



1) 15 surface soil and 15 subsurface samples per SU and 15 samples in the reference area
2) Gamma walkover surveys and judgmental samples, scan of cores and judgmental samples
3) 15 surface samples and 30 total samples per SU
4) **Ask Audience:**
   - DQOs are iterative – think, observe, learn, improve
   - What additional data are needed? Where can this plan be improved?
   - Options to think about include:
     - Sampling local groundwater wells
     - Add contingency drilling locations to bound contamination, if found
     - Add rules for dealing with refusal during drilling

Presentation Overview

- Introduction and Review
- What is MARSSIM?
- Why RPMs need to know about MARSSIM
- Who, when, where and how?
- Wrap Up



- **Before numbered bullets, ask audience:** Truly, what else would be different?

- Think about this. If the only contaminant was TCE, how would be design be different:

1. The “SU” might have been the whole landfill footprint
2. 15 surface plus 15 subsurface samples produces enough for all stated data needs
3. No scanning. Cores would be sampled based on visual inspection or other rules-of-thumb

MARSSIM (Health Physics) Training in Oak Ridge, TN

- 8-12 June 2015, and 9-13 Nov 2015
- Cost $1,995
- Note that neither the speaker nor the RITS is endorsing, but recommending
- http://www.orau.org/environmental-assessments-health-physics/capabilities/health-physics-training/marssim.htm?KeepThis=true&

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- The Navy Marine Corps Public Health Center can also recommend some EPA sponsored courses if you are interested in learning more. So, if you need more knowledge, take the above class or the one referenced in this slide!

NAVFAC Points of Contact

- Steve Hurff (NAVFAC HQ)
  - (202) 685-9318
  - Stephen.Hurff@navy.mil
- Chris Murray (NAVFAC EXWC)
  - (805) 982-4805
  - Christopher.R.Murray@navy.mil
- Dan Goodman (NAVFAC EXWC)
  - (805) 982-1622
  - Daniel.Goodman@navy.mil

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