Paul Nipper

From: Andy Lombardo [alombardo@sec-tn.com]
Sent: Wednesday, June 23, 2010 9:37 AM
To: Lee, Peter
Cc: McCann, Mike; Paul-Bionomics@comcast.net
Subject: RE: DP Responses

Attachments: Minimum Number of Samples Methodology.doc

Minimum Number of Samples Meth...

Peter,

I have revised the Final Status Survey Protocol (see attached) to include a C-14 DCGL value of 45 pCi/g (below the EPA-NRC MOU criteria of 46 pCi/g) and doubled the sample density from 17 per unit to 34 per unit. This results in identification by sampling alone of an elevated area larger than 27 m2. I also included area factors equal to the size of a Class 1 survey unit of 929 m2 divided by the elevated areas (in appropriate for dose based criteria but conservative for this application) for use in the elevated measurement comparison and included use of scans of soil, when soil moisture content allows, to identify elevated areas for biased sampling.

The proposed sample density alone is better at identifying elevated areas than scanning and sampling for some gamma emitters. I do not believe an additional increase in the sample density is warranted or can be justified. There is no guidance for this scenario provided by the NRC. My personal experience in the implementation of 37 different DCGL derivations and implementation of final status survey lead me to believe we will not miss any residual C-14 contamination during the implementation of the attached protocol. The average and standard deviation of the 34 samples (1 per 27 m2) alone will be enough to know if remediation was successful and if the true average residual contamination in the unit is below the DCGL value. The following is a list of conservatisms we have agreed to:

1. We have reduced the DCGLw value from 210 pCi/g to 45 pCi/g, a factor of 4.7 conservative.

2. We have reduced the maximum area of a Class 1 Survey Unit from 2,000 m2 to 929 m2, a factor of 2.2 conservative.

3. We have increased the minimum number of samples required to achieve a statistically representative average activity concentration in a survey unit from 17 to 34, a factor of 2 conservative.

4. We have used arbitrary area factors based on the ratio of the survey unit area to the elevated area, a technique used when evaluating scan MDC and not relevant to dose based criteria compliance, reducing the area factor in a 20 m2 elevated area from 3776 to 46, a factor of 82 conservative.

The reality is very little remediation is necessary to demonstrate compliance with 25 mrem/yr. We have committed to quite a bit of additional effort and believe this should be acceptable to the NRC.

Andy

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From: Lee, Peter [Peter.Lee@nrc.gov]
Sent: Tuesday, June 22, 2010 3:26 PM
To: Andy Lombardo
Cc: McCann, Mike
Subject: RE: DP Responses

Andy,

Please respond to the following:

1. Run the VSP to determine the percentage of hit for 10 m2 based on 55 m2 per sample.

2. The proposed DCGLw of 46 pCi/g is not based on the 25 mrem. Therefore, the area factor should be based on 935 m2 instead of 40,000 m2. If area factor is based on 40,000 m2 of 25 mrem, you don't have to do any remediation at area of 935 m2. The maximum allowable concentration would be 210 x 40000/ 935 = 8983 pCi/g.

3. Describe the biased sampling and scan in detail to justify the proposed systematical sampling is appropriate.

Peter

-----Original Message-----
From: Andy Lombardo [mailto:alombardo@sec-tn.com]
Sent: Friday, June 11, 2010 11:56 AM
To: Lee, Peter
Cc: McCann, Mike; Paul-Bionomics@comcast.net
Subject: RE: DP Responses

Peter,

I understand your example. A couple of things prevent this scenario. Based on the current distribution of contamination in the lagoon the probability of missing all10 elevated areas of 10 m2 taking one 1 sample per 55 m2 is extremely low. Also, to derive an area factor you must use the appropriate area corresponding to the DCGLw which in this case is 40,000 m2. So the area factor for a 10 m2 elevated area is 4,000 and the DCGLemc is 46 x 4,000, and the survey unit would pass.

We have been able to detect about 300 pCi/g C-14 in dry soil. We can perform biased sampling any where we detect any activity above background.

So if we take 1 sample per 55 m2, scan for biased soil sample locations and evaluate sigma for additional sampling, is this enough?

Andy

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From: Lee, Peter [Peter.Lee@nrc.gov]
Sent: Friday, June 11, 2010 12:21 PM
To: Andy Lombardo
Cc: McCann, Mike
Subject: RE: DP Responses

Andy,

Let assume systematical sampling does not hit elevated areas, and concentration of the survey unit based on the 17 systematic samples is 23 pCi/g.

Number of elevated areas: 10
Size of elevated areas : 10 m2

AF : 935/10 = 93.5
Concentration of elevated areas : 300 pCi/g

23/46 + 10 x (300 -46)/(93.5 x 46) = 1.1

The above example demonstrates that if there are unidentified elevated areas, the systematic sampling cannot determine if the survey unit meets the release criteria. To compensate the infeasibility of scan, additional judgmental samples should be required.

GM-pancake sometimes can detect the C-14 on the surface of soil. Maybe, you can consider scan on the surface of bare soil. That's just a thought.

Peter

-----Original Message-----
From: Andy Lombardo [mailto:alombardo@sec-tn.com]
Sent: Friday, June 11, 2010 8:39 AM
To: Lee, Peter
Cc: Paul-Bionomics@comcast.net
Subject: RE: DP Responses

Peter,

We recognize the inability to identify elevated areas by scanning. The problem is determining a reasonable number of equal distant samples to use to identify elevated areas. The current protocol will identify elevated areas > 50 m2 in size. The question is: what size of elevated area is acceptable to potentially miss? To answer this question you must consider the following:

1. Dose from residual C-14 contamination is directly proportional to the total activity inventory, i.e., the total Ci's of C-14 that can migrate to surface water and then be consumed.

2. For an area of 55 m2 the activity concentration of C-14 required to deliver 25 mrem is 269,196 pCi/g. Scaled down to based on the ratio of the 25 mrem DCGL value of 210 pCi/g to the admin limit of 46 pCi/g, the value acceptable in a 55 m2 elevated area is 59,000 pCi/g.

3. The maximum activity identified during characterization of the lagoon and the discharge area was 3,571 pCi/g. That is 16.5 times less than the maximum activity (DCGLemc) of a 55 m2 elevated area. Conversely, an elevated area of 375 m2 correlates to an activity concentration of 3,571 pCi/g. So sampling at 1 sample per 55 m2 will result in 7 samples within the limiting elevated area of 3,571 pCi/g.

4. 1 sample per 55 m2, based on the dose model and the characterization data is reasonable. In addition, when the 17 samples are taken and the average and standard deviation are calculated, the average must be below 46 pCi/g and the standard deviation must be below 14.2. If the average is > 46 the unit fails. If the standard deviation is > 14.2, the minimum number of samples must be recalculated using the new value and a determination made based on the results, of how many additional samples are needed.

I recommend 17 samples per 935 m2. We can increase the number and reduce the size of the elevated area we could potentially miss. There is no guidance as to what the right number is. I am confident in 17 per 935 m2.

I agree the example does not include any truly elevated sample results but the example is a likely scenario of the as-left sampling. Since the vast majority of activity will be removed during remediation, it is unlikely we will have high sample results. A high sample result will cause an increase in the standard deviation of the 17 samples and result in additional samples. For example, if an elevated area of 500 pCi/g is added to our example, the resulting standard deviation of the sample set will increase the minimum number of samples to 518. So there is ample protection in the protocol if we do see activity, to increase the number of samples.

What do you think?

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From: Lee, Peter [Peter.Lee@nrc.gov]
Sent: Thursday, June 10, 2010 4:03 PM
To: Andy Lombardo
Subject: RE: DP Responses

Andy,

Since the DCGL of 46 pCi/g is applied to the class 1 area of 935 m2. The AF of 55 m2 should be 935/55. Also, since no scan, how can you so sure the survey unit is remediated to 48 pCi/g based on the 17 systematical sampling. In your calculation for the unit rule, you assume the systematical sampling will hit all elevated areas. How you justify that no elevated areas less than 55 m2 ? The four samples you stated in your calculation for elevated areas are within the 3 sigma of the DCGL shouldn't be represent as hot spots. Thanks.

Peter

-----Original Message-----
From: Andy Lombardo [mailto:alombardo@sec-tn.com]
Sent: Thursday, June 10, 2010 2:33 PM
To: Lee, Peter
Subject: RE: DP Responses

Peter,

Please see attached spreadsheet as an example of a final survey of a Class 1 survey unit. 17 equal distant samples taken and analyzed. 4 of the samples > DCGLw and represent (conservative assumption) elevated areas of 55 m2 each. Using the closest area factor (conservative) for 85 m2 (507.8) and corresponding DCGLemc value (23,359 pCi/g), a sum of ratios is calculated with 5 ratios (4 elevated areas and 1 ratio representing the remaining area and using the DCGLw). The unit passes.

Andy

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From: Lee, Peter [Peter.Lee@nrc.gov]
Sent: Thursday, June 10, 2010 3:05 PM
To: Andy Lombardo
Subject: RE: DP Responses

Andy,

Could you provide me an example that the survey unit meets the unit rule ? If the number of the elevated areas unknown, how you apply the unit rule ? The average concentration of the survey unit except elevated areas could be well below DCGL of 46 pCi/g, if there were many elevated areas. Thank you.

Peter

-----Original Message-----
From: Andy Lombardo [mailto:alombardo@sec-tn.com]
Sent: Thursday, June 10, 2010 1:50 PM
To: Paul Nipper; Lee, Peter

Cc: 'Rick'
Subject: RE: DP Responses

Peter,

The plan as presented can detect elevated areas > 50 m2 in contiguous area by sample and analysis since at least one equal distant sample will fall within the elevated area. I have revised the minimum sample document to include a summation of sum of ratios to allow for more than 1 elevated area.

Thanks,

Andy

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From: Paul Nipper [Paul-Bionomics@comcast.net]
Sent: Thursday, June 10, 2010 2:17 PM
To: Peter.Lee@nrc.gov
Cc: Andy Lombardo; 'Rick'
Subject: FW: DP Responses

Peter, Andy reviewed your comment and sent the attached. Please review and thanks for your time and effort.

Paul Nipper
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-----Original Message-----
From: Andy Lombardo [mailto:alombardo@sec-tn.com]
Sent: Thursday, June 10, 2010 1:51 PM
To: Paul Nipper
Cc: 'Rick'
Subject: RE: DP Responses

Sorry Paul,

Send him this one.

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From: Paul Nipper [Paul-Bionomics@comcast.net]
Sent: Thursday, June 10, 2010 1:27 PM
To: Andy Lombardo
Cc: 'Rick'
Subject: FW: DP Responses

SEE BELOW

-----Original Message-----
From: Lee, Peter [mailto:Peter.Lee@nrc.gov]
Sent: Thursday, June 10, 2010 1:03 PM
To: Paul Nipper
Cc: McCann, Mike
Subject: RE: DP Responses

Due to the infeasibility of scan, the number of elevated areas cannot be determined. The unit rule stated in MARSSIM 8.5.2 is not just for one elevated area. If there are more than one elevated area, the sum of all the elevated areas should be included in eq. 8-2. In order to apply the unit rule, the number of elevated area in the survey unit should be determined.

-----Original Message-----
From: Paul Nipper [mailto:Paul-Bionomics@comcast.net]
Sent: Thursday, June 10, 2010 10:56 AM
To: Lee, Peter; 'George M. McCann'
Cc: 'Sheila Hecht'; 'Andy Lombardo'; jturner@sec-tn.com
Subject: FW: DP Responses

Dr. Lee,

Please see Andy's comment below in conjunction with the attached document.
We believe it addresses your concerns however we request any comments or suggestions that you may have.

Thanks

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-----Original Message-----
From: Andy Lombardo [mailto:alombardo@sec-tn.com]
Sent: Thursday, June 10, 2010 8:55 AM
To: Scott Ward; hechts@abclabs.com; Elaine McCoy
Cc: Paul-Bionomics@comcast.net; Jim Turner
Subject: DP Responses

Here we go:

Including tritium (H-3) along with primary constituent of concern Carbon 14 (C-14):

The dose assessment performed to derive the activity concentration of C-14 left in a 6-inch thick surface layer that will result in 25 mrem in the maximum year over the next 1,000 years yielded a result of 210 pCi/g. ABC Labs has committed to remediating to an administrative limit of 46 pCi/g (equal to the NRC-EPA MOU value for C-14, below which no consultation with the EPA is required). Since H-3 is also listed on the NRC Radioactive Materials License for the site, and H-3 is similar to C-14 in that both are low energy beta emitters that can only be detected by sample and analysis at activity concentrations approaching the acceptance criteria, remediation support and final status survey samples will also be analyzed for H-3. The administrative limit for H-3 will be 228 pCi/g equal to the NRC-EPA MOU value for residential soil, consistent with the administrative limit for C-14.

Groundwater Contamination

The dose assessment performed to derive the C-14 acceptance criteria utilized a resident farmer scenario with all environmental pathways, including water bourn pathways, included. None of the RESRAD input parameters used to control the migration of soil contamination to

groundwater and onsite surface water, or any of the input parameters used to model the site groundwater and surface water, are sensitive to the resulting dose or acceptance criteria, i.e., the max dose and resulting DCGL value is the same regardless of these parameters. What the modeling of groundwater and surface water does change is the year the maximum dose occurs but not the magnitude of the dose. Therefore, the DCGL values derived for use are protective (and < 25 mrem/year) regardless of the actual depth, flow, etc. of groundwater.

Minimum Number of Samples (per Survey Unit)

Attached document.

Andy

Andrew J. Lombardo, CHP

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ABC Labs-Columbia MO Site Final Status Survey Implementation

Including tritium (H-3) along with primary constituent of concern Carbon 14 (C-14):

The dose assessment performed to derive the activity concentration of C-14 left in a 6-inch thick surface layer that will result in 25 mrem in the maximum year over the next 1,000 years yielded a result of 210 pCi/g. ABC Labs has committed to remediating to an administrative limit of 45 pCi/g (below the NRC-EPA MOU value for C-14 of 46 pCi/g, below which no consultation with the EPA is required). Since H-3 is also listed on the NRC Radioactive Materials License for the site, and H-3 is similar to C-14 in that both are low energy beta emitters that can only be detected by sample and analysis at activity concentrations approaching the acceptance criteria, remediation support and final status survey samples will also be analyzed for H-3. The administrative limit for H-3 will be 227 pCi/g below the NRC-EPA MOU value for residential soil, consistent with the administrative limit for C-14 of 228 pCi/g.

Minimum Number of Samples (per Survey Unit)

NUREG-1575, Multi-Agency Radiological Site Survey and Investigation Manual (MARSSIM) provides a methodology for deriving the minimum number of samples (N) per survey unit, regardless of the survey unit classification (1, 2 or 3). Based on the following C-14 parameters and selected error rates, the value of N needed to perform the Sign Test is 17:

- Type I (alpha) error = 0.05
- Type II (beta) error = 0.05
- DCGL (pCi/g) = 45
- Lower Bound Grey Region (pCi/g) = ½ the DCGL = 22.5
- Sigma = 14.2, derived from 17 characterization sample results ranging from 2 – 45 pCi/g, selected to represent a set of final status survey samples.
- Delta = DCGL – LBGR = 22.5 pCi/g
- Delta / Sigma = 1.6

The minimum number of samples (17) are taken in each survey unit when elevated areas (> DCGL) can be detected by a surface scan of the soil. When the DCGL value cannot be detected by scanning, the sample density should be increased to a reasonable level to ensure detection of elevated areas by sample and analysis. Soil impacted with C-14 cannot be readily scanned for the low energy beta emitted at the DCGL activity concentration of 45 pCi/g. Therefore, the following sample density and survey units are proposed.

The maximum area of a Class 1 survey unit (area remediated with original activity concentration > DCGL value) is 2,000 m2. Appling the minimum number of samples (17) to this area results in a sample density of 1 sample per 118 m2. Using a random start point, equal distant triangular grid sample pattern, a circular elevated area of 107 m2 or greater will be detected by sample and analysis. ABC proposes limiting the area of a Class 1 survey unit in the lagoon to 929 m2, resulting in 3 Class 1 survey units within the lagoon of 929 m2 each. ABC also proposes doubling the minimum number of samples, from 17 to 34. Appling the minimum number of samples (34) to this area results in a sample density of 1

sample per 27 m2. Using a random start point, equal distant triangular grid sample pattern, a circular elevated area of 25 m2 or greater will be detected by sample and analysis. The discharge area will also be a Class 1 survey unit of 929 m2 and will also be gridded for 34 equal distant samples.

Class 1 Survey Unit Evaluation

Each of the 4 Class 1 survey units will be sampled and the results analyzed for C-14 and tritium for comparison to the following administrative acceptance criteria:

- Average C-14 Activity Concentration in Survey Unit < DCGLw of 45 pCi/g.
- Average H-3 Activity Concentration in Survey Unit < DCGLw of 228 pCi/g
- Average Sum of Ratios for H-3 and C-14 < 1
- Standard Deviation of the 34 C-14 sample results < 14.2.

If the standard deviation of the 34 samples exceeds 14.2, an evaluation of will made to determine additional sampling requirements. Elevated Measurement Criteria (based on each sample representing 27 m2 and each area factor equal to the ratio of the Class 1 Unit area 929 m2 over the elevated area) using the following table and the sum of ratios formula below will be performed as applicable.

Area (m2):	20	85	100	500
Area Factor:	46	11	9.3	1.9
DCGLemc (pCi/g):	2,137	503	427	85

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1$$

where:

δ = is the average activity concentration over the entire survey unit, less the elevated areas

δ_{EMC} = the average activity concentration over the elevated area x within the survey unit,

DCGL = the applicable DCGL value,

$DCGL_{EMC}$ = (area factor for elevated area x) X (DCGL),

x = refers to one of the elevated areas within the survey unit, and

n = the total number of elevated areas within the survey unit.

If soil conditions are dry enough, scanning of soil surface for residual C-14 may be possible, with an MDC of approximately 300 pCi/g. Any activity detected above background in Class 1 survey units, by scan of dry soil will be sampled (biased sample) and the results used to support elevated measurement comparison as appropriate.

Class 2 Survey Unit Evaluation

A graded approach will be applied to the Class 2 areas outside of the lagoon and discharge areas (Class 1 Survey Units) totaling 18,401 m2 as follows:

Class 2 Survey Unit Number 1 – 3,000 m2, immediately adjacent and surrounding lagoon and discharge area survey units. 34 samples will result in a sample density of 1 per 88 m2.

Class 2 Survey Unit Number 2 – 6,000 m2, immediately adjacent to Class 2 Survey Unit Number 1. 34 samples will result in a sample density of 1 per 176 m2.

Class 2 Survey Unit Number 3 – 9,401 m2, immediately adjacent to Class 2 Survey Unit Number 2. 34 samples will result in a sample density of 1 per 277 m2.

Groundwater Contamination

The dose assessment performed to derive the C-14 acceptance criteria utilized a resident farmer scenario with all environmental pathways, including water bourn pathways, included. None of the RESRAD input parameters used to control the migration of soil contamination to groundwater and onsite surface water, or any of the input parameters used to model the site groundwater and surface water, are sensitive to the resulting dose or acceptance criteria, i.e., the max dose and resulting DCGL value is the same regardless of these parameters. What the modeling of groundwater and surface water does change is the year the maximum dose occurs but not the magnitude of the dose. Therefore, the DCGL values derived for use are protective (and < 25 mrem/year) regardless of the actual depth, flow, etc. of groundwater.