Dose Compliance Concentrations for Radionuclides at Superfund Sites (DCC) Calculator

External Peer Review Record

August 11 – November 7, 2022

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Theodore Wentworth (Michigan Department of Environment, Great Lakes, and Energy, NRC-SLO)

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Peer Review Charge for:

U.S. Environmental Protection Agency (EPA), "Dose Compliance Concentrations for Radionuclides at Superfund Sites (DCC) Electronic Calculator."

Background:

EMS, under contract EP-W-13-016 with EPA's Office of Superfund Remediation and Technology Innovation, has been requested to obtain external, independent reviews of an update to the "Dose Compliance Concentrations (DCC) for Radionuclides at Superfund Sites Electronic Calculator." EPA developed the electronic calculator to help risk assessors, remedial project managers, and others involved with risk assessment and decision making at sites with radioactively contaminated soil, water, air, and biota. The electronic calculator provides guidance for calculating dose-based, site-specific, dose compliance concentrations (DCCs) for radionuclides that comply with Applicable or Relevant and Appropriate Requirements (ARARs).

The purpose of this peer review is to identify any technical problems, omissions, or inconsistencies in the calculator, and to obtain expert opinion as to the calculator's usefulness and appropriateness for calculating DCCs.

Peer Review Charge:

Answer the charge questions in the attached Excel spreadsheet. We request that you review the overall website, User's Guide, and the calculator to answer the charge questions and become familiar with its organization (https://epa-dccs.ornl.gov/):

- Home Page, with introduction and links to subpages.
- User's Guide, which includes explanations, recommended default exposure parameters, common land uses and exposure assumptions, and sources.
- What's New, which includes information on previous revisions to the calculator that change the results of modeling runs.
- Frequent Questions.
- Equations.
- Radionuclide Decay Chain.
- Generic Tables (unavailable until further notice).

When your review is complete, please e-mail the spreadsheet with answers to the charge questions and any additional comments to EMS's Project Manager, Cindy Eyer (cindy.eyer@emsus.com) on or before **November 5, 2022**. For specific comments or text edits on the user's guide, please reference the section number and line number, bullet number, or figure/table number in the spreadsheet so that it is clear what you are referring to.

Charge Questions:

1. Is there anything you would recommend to improve the website? In particular:
    a. Is the website clearly organized, described, easy to navigate, and generally "user friendly"? If not, what do you recommend?
    b. Do the online DCC calculator tools match the information provided in the User's Guide and vice versa? If not, what do you recommend?
    c. Do you have any other recommendations to improve the usability of the website?

2. Is there anything you would recommend to improve the User's Guide? In particular:
    a. Are the tool and website clearly explained?
    b. Are the assumptions clear and reasonable? If not, what do you recommend?
    c. Is the guide well written and clearly organized? If not, what do you recommend?
    d. Is the technical support documentation complete, organized and easy to follow? If not, what do you recommend?
3. Are the DCC models for the following scenarios comprehensive and accurate, and do they represent the current state of knowledge? Are they supported appropriately by citations? If not, what do you recommend?
    a. Resident
    b. Indoor Worker
    c. Outdoor Worker
    d. Composite Worker
    e. Construction Worker (Site-specific only)
    f. Recreator (Site-specific only)
    g. Farmer
    h. Soil to Groundwater
4. Is the choice of radionuclides and how decay chains are addressed appropriate and based on supportable reasoning? If not, what do you recommend? Are the standard recommended default factors adequately explained, sourced, and reasonable?
5. Are the results of the calculator clearly explained and presented for the given scenarios? If not, what do you recommend?
    a. In particular, we are interested in your review of the calculator results when selecting the DCC Output Option "Peak DCC".
6. Are the results appropriately described and qualified (to the extent that they may be relied upon and defended)? If not, what do you recommend?
7. Do the results provide a defensible explanation of how they were derived, or are they the result of a "black box"? Do you recommend anything different?
8. Is there anything else you would recommend to improve the utility, accuracy, completeness, or supportability of the calculator?

How to Use the Calculator (hover over any form section for additional instructions):

Step 1: Select a dose limit of 1 or select "Other" to manually enter an alternate risk value.

Step 2: Choose one of eight exposure scenarios (resident, indoor worker, outdoor worker, composite worker, construction worker (site-specific only), recreator (site-specific only), farmer, or soil to groundwater) and choose the media (soil, air, tap water, 2-D external exposure, or fish). Some of these exposure scenarios have multiple media choices; other scenarios will only involve one media so a choice will not appear.

Step 3: Under the Select Site Info Type choose either "Defaults" to get DCCs based on default exposure parameters or "Site-Specific" to change some of the exposure parameters.

Step 4: Choose whether or not dose output is desired.

Step 5: Select the International Commission on Radiological Protection (ICRP) Rule (107, 60/68/72, or 30).

Step 6: Select the units for the results – picocuries per gram, which are the units usually used in the United States, or becquerels per gram, which most of the rest of the world uses.

Step 7: Select one or more radionuclides for which to develop DCCs. Do not use the Select All option.

Step 8: Choose from one of the four Source and Decay Output Options.

Step 9: Choose from one of the five Peak Time Period Options.

Jim Hondros

JHRC-Australia

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Hondros	1	Is there anything you would recommend to improve the website? In particular:	Please see separate document for improvement opportunities
Hondros	1a	Is the website clearly organized, described, easy to navigate, and generally “user friendly”? If not, what do you recommend?	I have some minor concerns about the user interface. Please see separate document.
Hondros	1b	Do the online DCC calculator tools match the information provided in the User’s Guide and vice versa? If not, what do you recommend?	The user guides match the calculator tools very well. Even though there are examples of the mechanics of data entry, I think some worked examples showing how the tool can be used woudl be useful. Alternatively the worked examples may be more useful in a training package.
Hondros	1c	Do you have any other recommendations to improve the usability of the website?	See separate document for minor website "annoyances".
Hondros	2	Is there anything you would recommend to improve the User’s Guide? In particular:	User guides should be clear and easy to read with the ability for the reader to go deeper if necessary. The current user guide is quite dense. I can not offer any improvement suggestions, other than suggesting some on line training material (via a worked example) to help users navigate the document and system.
Hondros	2a	Are the tool and website clearly explained?	Yes - however it took a while to read through the user guide. There is a lot of background information.
Hondros	2b	Are the assumptions clear and reasonable? If not, what do you recommend?	I think the assumptions are clear and reasonable
Hondros	2c	Is the guide well written and clearly organized? If not, what do you recommend?	As noted above, the user guide is quite dense (and long).
Hondros	2d	Is the technical support documentation complete, organized and easy to follow? If not, what do you recommend?	I could not find any specific "technical support documentation" and assume that it is contained in the User Guide.
Hondros	3	Are the DCC models for the following scenarios comprehensive and accurate, and do they represent the current state of knowledge? Are they supported appropriately by citations? If not, what do you recommend?	For dose factors, the ICRP has released more recent information (ICRP 137) and also specific factors for radon decay products. See deparate document for comments on radon decay products. I checked a number of equations and they are appropriate. Some minor concerns with one citation (as indicated in the separate document) and some definitions. Overall, the models appear complete.
Hondros	3a	Resident	No specific comments
Hondros	3b	Indoor Worker	No specific comments
Hondros	3c	Outdoor Worker	No specific comments
Hondros	3d	Composite Worker	No specific comments
Hondros	3e	Construction Worker (Site-specific only)	No specific comments
Hondros	3f	Recreator (Site-specific only)	No specific comments
Hondros	3g	Farmer	No specific comments
Hondros	3h	Soil to Groundwater	No specific comments
Hondros	4	Is the choice of radionuclides and how decay chains are addressed appropriate and based on supportable reasoning? If not, what do you recommend? Are the standard recommended default factors adequately explained, sourced, and reasonable?	I mainly reviewed the NORM radionuclides (based on my background) and the radionuclides are appropriate. It is worth noting that there is a different method for assessing the impacts of inhaled radon decy products - see separate document.
Hondros	5	Are the results of the calculator clearly explained and presented for the given scenarios? If not, what do you recommend?	The scenarios are very clear and well explained in the support documentation. However, the outputs of the calculator are unclear (as noted in the separate document, this may be because I am unfamiliar with the US system). I found the outputs difficult to interpret for practical use and purposes. It may be useful to give a worked example of how the outputs are then practically used (for example; "the outputs provide values which much be demonstrated through modelling or measurement").
Hondros	5a	In particular, we are interested in your review of the calculator results when selecting the DCC Output Option “Peak DCC”.	The peak Dose Compliance Concentrations feature needs to be used with caution because it can give unrealistically conservative results. These results may then be used as part of a conservative regualtory control system. As noted previously, it is important that users of the system are trained and understand exactly what the system is telling them and what the results mean. I have no opinion peak DCC apart from ensuring that it is well understood by the user and not automatically selected and used as the most conservative case.
Hondros	6	Are the results appropriately described and qualified (to the extent that they may be relied upon and defended)? If not, what do you recommend?	As noted above, I am not sure how the results would be used in practice.
Hondros	7	Do the results provide a defensible explanation of how they were derived, or are they the result of a “black box”? Do you recommend anything different?	While the equations have been provided, there does remain an element of "black box" as I have noted in my separate comments. I suggest that a training package is necessary so that users understand what they are doing and what the outputs mean. This way the tool can also be used as part of an optimsation process. The tool works and is good, but it does need a qualfied or experienced user to get value from it.
Hondros	8	Is there anything else you would recommend to improve the utility, accuracy, completeness, or supportability of the calculator?	As noted - a training package or arranement would be useful and almost necessary.

Hondros Additional Comments for the Peer Review of the US EPA's DCC Calculator

13th October 2022

Updated 27th October 2022

Overall

- Let me start by saying that I am not entirely familiar with the US EPA approach to radiological impact assessment. My comments are therefore based on a quick (over the last few weeks) review of the US EPA approach.
- The one overall comment is that the approach seems to very overly complex, and this is likely to cause difficulties for users. It is very important that users understand what they are doing rather than blindly punching numbers into a system to a obtain a "result" (I note that this is also recognised in the user manual and notes). I would suggest that a training package be developed for casual users and more experienced users. This would make the tool more useful for radiation protection practitioners in an interactive manner.
- Another overall comment is that the documentation and system is acronym rich. Many times I had to go searching for meanings of definitions and what they actually meant. A link to acronyms and definitions would be very useful – especially if this could be present on the desktop and accessible at all times – including when adding information (rather than jumping out of information entry and then back in).
- I think that natural background levels need to be considered. It all cases, the DCC values are many orders of magnitude lower than natural background levels (for NORM radionuclides).
- While doing this review, I took the perspective of a user – someone who has to use the software tool to implement management measures.

Online Tool - Overall

- Output graph is nicely interactive – this is a good feature
- One of the graph tabs links to an external proprietary graphing program (Plotly) and this could be seen to be endorsing this product.
- The export function works well to both pdf and spreadsheets. It may be worthwhile adding a header within the document that gives a date and name of program that the output. This would make it more useful for users.

Online Tool – Radionuclide Decay Chain Calculator

- The mode columns should be as α, β rather than A, B. Capital letters are not the usual way to represent the types of radioactive emissions.
- Throughout there is reference to "daughters". The more correct term is "decay product".
- A number of tables do not have units, and this is confusing as to what is being presented in the tables.

Online Tool – DDC Calculator

- I am not quite sure how the results would be used in practice and the documentation is not clear. For example, for airborne levels of Ra226, I use the default limit of 1mR with default variables and the result is a DCC of 1×10^{-4} Bq/m^3. In practice, does this mean that the monitoring has to show that the airborne concentrations of Ra226 need to be continuously less than this value ? If yes, then that is problematic because that value is barely measurable and therefore demonstrating compliance with the value is difficult.

- All variable names should be consistent (otherwise it creates confusion for the users).
- I note that the more recent ICRP 137 dose factors and recent ICRP radon factors have not been incorporated.

Online Tool Issues/Difficulties/Annoyances

- General reference through the tool and the support material to "lambda". The correct or regularly used name is "decay constant".
- In the tool, one of the data entry options is “Source and Decay Output Options - assumes secular equilibrium". The explanation then says that this means that the source is being “constantly replenished”. This is not the correct meaning of “secular equilibrium”. The correct definition is that the decay products are in equilibrium with the source. Secular equilibrium would be maintained, even if the source activity reduced and the decay products remained in equilibrium. Maybe the definition should say “decay products constantly replenished”.
- The output tables that appear in the tool (for example: Outdoor Worker 2-D External Inputs) extends off screen. Initially I thought that I had to print the outputs to xlsx or pdf to see the whole table. I latter found that there is a slider bar under the table. Maybe make this slider bar a little bigger.
- I understand the difficulty and am not sure of an answer, however, the x-axis (time in years) on the output graphs seems odd – it reports as, for example, 1.295e-08 years. Is it possible to have this as days or seconds?
- A footnote to the graphs says that the activities have been calculated for 1e16 years. This may be technically correct but might be seen as comical given that the age of universe is 1.4e10 years
- When doing data entry and moving the cursor across the screen, the information pop up boxes appear immediately which is annoying. It means that you have to guide the cursor around the highlighted areas otherwise the pop up boxes appear.
- When entering a value, you need to then move the cursor to the next data entry box. If you press “enter”, then the whole screen moves forward rather than allowing you to enter the next value.
- When entering “media concentrations” (for example) when putting in user inputs under the PRG screen, the entry screen does not fit on the screen. Slider bar helps, but maybe smaller text.

Manual/User Notes

- The manual is a pdf of the online material – which is fine, however, a glossary would be useful. Again – far too many acronyms.
- Please check the links. In a number of cases, there were no websites (although this might be because I tried to access from out of the US). Additionally, some of links go to general sites rather that the specific area of the website being referenced in the text.
- Section 2.2.1.1 refers to a "Bateman solver… out to a trillion years". A trillion years may be conservative and technically appropriate, however, it is a slightly comical.
- Similar comment for 2.2.1.2, which references a peak in year 3,981,072. These times are so far in the future as to be meaningless. Suggest wording that says something like "beyond 10,000 or 100,000 years".
- A similar comment applies generally for the graphs which show units of nano year through to mega year. As noted, this might be correct, however, can this be presented better ? (ie; "nyears" is a very odd unit)
- Table in Section 2.2.5 – half-life of U238 is incorrect. I did not check the online tool.
- Diagram in 3.1 is excellent and gives a very clear overview.
- There may need to be more explanation of background radiation and its impacts. I noted when doing some example assessments, the output target values were well below background levels. (Section 3.2)
- The point in section 3.3 is important and supports the idea that training should accompany the system. As noted earlier, I think a training package (maybe on line lecture or video could be useful).
- The examples and scenarios in section 4 are very clear and well explained. Providing the equations is good. There is quite a bit of repetition, but this is appropriate.
- Section 5 – Table 1: Tissue Transfer Factors and Animal Intake Rates of Fodder, Water, and Soil – reference cannot be "personal communication"
- Section 5 – Table 1: Mechanical Particulate Emission Factor Variables from Other Construction Activities – the first three symbols and definitions are meaningless.

DCC Models and Equations

I went through each of the equations for each of the scenarios and they are comprehensive and appear to be in order. I did not see any errors in equations or approach.

Radon Decay Products

The approach to radon decay products is not comprehensive. It is unclear how exposure and dose factors for radon decay products are being incorporated and the various factors that contribute to the dose factor, such as attached and unattached fraction and particle size. If radon (both Rn-222, Rn-220 and Rn-219) concentrations are being used as the basis for assessment, then other factors such as equilibrium factor need to be considered. I think further work is required on radon.

Jim Hondros

Director – JRHC Enterprises Pty Ltd

CV - 2022

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PO Box 372,
Stirling, SA 5152

PROFESSIONAL EXPERIENCE

37 years working in the mining industry, in operational, management and consulting roles.

Work with BHP Billiton, Rio Tinto, OZ Minerals, Toro Energy, Cameco, Alkane, Northern Minerals, ERA, REX Minerals and Arafura Resources. More recent work with the WNA, IRPA and the IAEA in Vienna, Brazil, Bulgaria, Indonesia, Jordan, Mongolia and Pakistan. Voluntary work - Environmental Defenders Office.

Technical expertise & skills;

- occupational health and safety (OH&S) policy, management, systems and practices,
- technical understanding of environmental and occupational radiation,
- risk management (including risk assessment and facilitation),
- environmental management, and
- Indigenous and community relations.

Competencies;

- focus on the practical implementation of strategies and standards,
- effectively provide advice and guidance on strategy,
- risk and impact assessment,
- operate at, and across, all layers in an organisation,
- communicate difficult and complex concepts, and
- recognise and work with different organisational cultures.

Since 2002, I have been consulting through my company JRHC Enterprises Pty Ltd. Recent work includes:

- Policy advice and direction in relation to radiation for various companies whose materials and products contain Naturally Occurring Radioactive Materials (NORM).
- Occupational and environmental radiological impact assessment for numerous projects (both uranium and non-uranium) as part of for State and Commonwealth approvals.
- Specific radiation, OH&S and environmental project work, both nationally and internationally, (including advice on design, development of practical management measures and competency development).
- Provision of ongoing radiological advice and support to numerous companies (including; mentoring and training of technical staff, technical advice, development of management systems, establishing design criteria, working with design teams, monitoring, waste management, transport of radioactive materials, and nuclear fuel cycle implications).
- Establishment and management of baseline environmental radiation monitoring programs and designing and implementing occupational radiation monitoring and training.
- Radiation advice to Traditional Owner groups.
- Liaising with companies, regulators and communities (including public forums) on radiation protection.
- Facilitation of workshops for industry, regulators and community on radiation protection and OH&S.
- Working with operations staff and Indigenous community groups on the development of engagement strategies, developing partnerships, workshop facilitation and mentoring, for a number of mine-sites across Australia.
- Review and interpretation of specialised technical reports.
- OH&S audits, Research & development road-mapping.

Prior to consulting I worked:

- Six years in senior operational management and corporate roles for Pasminco, an Australian lead and zinc mining, smelting and refining company, globally and at the Century Mine in the areas of Safety, Health, Environment, Community Affairs and Policy
- 12 years in operational and senior management roles at the WMC - Olympic Dam Project, including monitoring, government liaison (State and Federal), statutory roles and departmental management, in the areas of Radiation, OH&S, Environment and Emergency Response.

GOVERNANCE

2022-present	President of the Australian Radiation Protection Society
2020–present	Member of ARPANSA Radiation Health Advisory Council
2019- present	Co-chair of IRPA working group on NORM
2014-present	Member of the Australian Radiation Protection Society Executive Committee
2006 – 2009	Member - Radiation Health Committee and Nuclear Safety Committee, ARPANSA
2006 – 2008	Chair– Trust for Nature (Victoria)
2004 - 2006	Trustee – Trust for Nature (Victoria)
2004 - 2012	Director – Parakeelya Foundation
2002 - 2006	Honorary Lay Person - Deakin University Research Ethics Committee
1999 - 2002	Chairman – Lawn Hill and Riversleigh Pastoral Holding Company
1998 - 2002	Director – Aboriginal Development Benefits Trust
2000 - 2002	Director – World Alliance for Community Health
1997	Member – Minerals Council of Australia – OHS Taskforce

QUALIFICATIONS

BAppSci (1984) GradDipOHM (1987) MAppSci (1991)

PROFESSIONAL AFFILIATIONS

Member - Australian Radiation Protection Society

Member – Australian Institute of Occupational Hygienists

Member – Environmental Institute of Australia and New Zealand

PRESENTATIONS, PUBLICATIONS & DEVELOPMENT

Involvement with the IAEA through document development, workshop attendance, training and review missions in various member states.

Part time consulting radiation safety adviser to the World Nuclear Association

Regular attendance and presentation of papers at numerous national and international conferences and workshops on radiation protection, NORM, occupational and environmental management, sustainable development and OH&S.

Radiation protection and OH&S papers published in national and international journals.

Industry representative on the development of documentation on the implementation of the ICRP60 recommendations.

Site visits to numerous national and international uranium and non-uranium mines and processing facilities and nuclear facilities.

Peer Reviewer Conflict of Interest Certification

Peer Review: **Dose Compliance Concentrations (DCC) for Radionuclides at Superfund Sites Electronic Calculator**

A conflict of interest or lack of impartiality exists when the proposed participant personally (or the peer reviewer's immediate family), or his or her employer, has financial interests that may be affected by the results of the peer review; or may provide an unfair competitive advantage to the participant (or employer); or if the participant's objectivity in performing the peer review may be impaired due to other factors. When the participant knows that a reasonable person with knowledge of the facts may question the participant's impartiality or financial involvement, an apparent lack of impartiality or conflict of interest exists.

The following questions, if answered affirmatively, represent potential or apparent lack of impartiality (*any affirmative answers should be explained in an attachment*):

- Did you contribute to the development of the calculator (and associated webpages) under peer review, or were you consulted during its development, or did you offer comments or suggestions to any drafts or versions of the calculator during its development? ☑ No ☐ Yes
- Do you know of any reason that you might be unable to provide impartial advice on the matter under consideration in this peer review, or any reason that your impartiality in the matter might be questioned? ☑ No ☐ Yes
- Have you had any previous involvement with the DCC calculator under consideration? ☑ No ☐ Yes
- Have you served on previous advisory panels, committees, or subcommittees that have addressed the topic under consideration? ☑ No ☐ Yes
- Have you made any public statements (written or oral) on the issue? ☑ No ☐ Yes
- Have you made any public statements that would indicate to an observer that you have taken a position on the issue under consideration? ☑ No ☐ Yes
- Do you, your family, or your employer have any financial interest(s) in the matter or topic under peer review, or could someone with access to relevant facts reasonably conclude that you (or your family or employer) stand to benefit from a particular outcome of this peer review? ☑ No ☐ Yes

With regard to real or apparent conflicts of interest or questions of impartiality, the following provisions shall apply for the duration of this peer review:

(a) Peer Reviewer warrants, to the best of his/her knowledge and belief, that there are no relevant facts or circumstances that could give rise to an actual, apparent, or potential organizational or personal conflict of interest, or that Peer Reviewer has disclosed all such relevant information to EMS or to EPA.
(b) Peer Reviewer agrees that if an actual, apparent, or potential personal or organizational conflict of interest is identified during performance of this peer review, he/she immediately will make a full disclosure in writing to EMS. This disclosure shall include a description of actions that Peer Reviewer (or his/her employer) has taken or proposes to take after consultation with EMS to avoid, mitigate, or neutralize the actual, apparent, or potential organizational conflict of interest. Peer Reviewer shall continue performance until notified by EMS of any contrary action to be taken.

23AUG2022

Signature Date

☐ Check here if any explanation is attached

PETER JAMES HONDROS

Printed Name

JRHC ENTERPRISES.

Affiliation/Organization

Daria Koliabina

AFRY-Ukraine

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Koliabina	1	Is there anything you would recommend to improve the website? In particular:	Check all links, and check how it works when user is opening links in new tabs.
Koliabina	1a	Is the website clearly organized, described, easy to navigate, and generally "user friendly"? If not, what do you recommend?	It is user friendly. Maybe it could be good to place link to calculator as button somewhere above/below the picture to make it more visible. *Download* as well as *Download Area* links (Home page) redirects to the page with info - "Unavailable until further notice". Maybe somewhere should be presented conversion from mrem/yr to mSv/yr in FAQ. Also, maybe it is good to specify Child in table in FAQ (1 y.o, 10 y.o etc).
Koliabina	1b	Do the online DCC calculator tools match the information provided in the User's Guide and vice versa? If not, what do you recommend?	It is perfect that there is redirection to DCC FAQ in User`s guide. They match each other.
Koliabina	1c	Do you have any other recommendations to improve the usability of the website?	Maybe open each new link in new tab, to work at the same time with Guide and Calculator as example. During work with user Guide in Edge browser when I was trying to open some links in new tab, all the time site was redirecting me to the Disclaimer (not to the linked topic).
Koliabina	2	Is there anything you would recommend to improve the User's Guide? In particular:	In PDF version there is no navigation in the document.
Koliabina	2a	Are the tool and website clearly explained?	Yes, it is understandable. "DCC Download area" is not available for now.
Koliabina	2b	Are the assumptions clear and reasonable? If not, what do you recommend?	Yes, they are.
Koliabina	2c	Is the guide well written and clearly organized? If not, what do you recommend?	It is, but navigation in PDF version is not comfortable (no navigation links).
Koliabina	2d	Is the technical support documentation complete, organized and easy to follow? If not, what do you recommend?	Yes, documentation is clear and easy to follow. Maybe it is good to add some short description of the contamination of foods (only transfer from soil to plant, or some leaves uptake, is contamination due resuspension from the soil taken into account…is the translocation taken into account for mobile elements etc.). Maybe I couldn't find ithis information in the documentation.
Koliabina	3	Are the DCC models for the following scenarios comprehensive and accurate, and do they represent the current state of knowledge? Are they supported appropriately by citations? If not, what do you recommend?	They are.
Koliabina	3a	Resident	No comments
Koliabina	3b	Indoor Worker	No comments
Koliabina	3c	Outdoor Worker	No comments
Koliabina	3d	Composite Worker	No comments
Koliabina	3e	Construction Worker (Site-specific only)	No comments
Koliabina	3f	Recreator (Site-specific only)	No comments
Koliabina	3g	Farmer	No comments
Koliabina	3h	Soil to Groundwater	"The Kd of the parent was used for all the short-lived progeny in the soil-to-water partitioning DCCs to calculate downgradient water concentrations" why Kd of progeny, is not used for it?
Koliabina	4	Is the choice of radionuclides and how decay chains are addressed appropriate and based on supportable reasoning? If not, what do you recommend? Are the standard recommended default factors adequately explained, sourced, and reasonable?	Yes, it is. Age-adjusted cereal ingestion fraction is not clear and couldn't be found in user's guid easily (some more clean description should be presented). In the Radionuclide decay chain tab, halflife is shown in different format for different RNs and may confuse user. The same with Time (yrs) in the table -"Activities for RN and daughters". Data format is different for different time-points.
Koliabina	5	Are the results of the calculator clearly explained and presented for the given scenarios? If not, what do you recommend?	Yes, mostly they are. "Soil Ingestion of Beef ' as example is not very understandable. Maybe it is good to add the same tips as are presented for input data.
Koliabina	5a	In particular, we are interested in your review of the calculator results when selecting the DCC Output Option "Peak DCC".	It manages radioactive decay, but can not be postprocessed directly.
Koliabina	6	Are the results appropriately described and qualified (to the extent that they may be relied upon and defended)? If not, what do you recommend?	Yes, just some clarifications may be added.

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Koliabina	7	Do the results provide a defensible explanation of how they were derived, or are they the result of a “black box”? Do you recommend anything different?	Results look understandable and could be then analyzed by the user.
Koliabina	8	Is there anything else you would recommend to improve the utility, accuracy, completeness, or supportability of the calculator?	It would be more user friendly to add possibility to use some filter or search window during radionuclides selection. In the tip in Calculator where Chapters from guide are listed they may be presented as hyperlinks to the chapters. There is no option to use scientific format (1E5 etc) when inputting media concentrations. Age-adjusted cereal grain ingestion fraction is not clear and couldn’t be found in user's guide easily (some more clean description should be presented).

Koliabina Daria

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Ms Daria Koliabina is a consultant of ÅF subsidiary in Kyiv with more than 7 year experience and is active in the fields of safety assessments in radioactive waste management and radiation protection, environmental and radiation risk assessment. She was involved as expert in different International Atomic Energy Agency and Europian Union projects. Also, she was involved in the development and delivery of online and face-to-face training courses in the field of simulation modelling and radiological risks assessment.

WORK EXPERIENCE

AFRY UKRAINE

Lesya Ukrainka BLVD 34, Kyiv, Ukraine

Consultant
January 2019 – Present

> Simulation modelling and radiological risk assessment for different radioactive waste management options.
> Face-to-face trainings on NORMALYSA and ECOLEGO tools.
> Face-to-face trainings on DSS based on JRodos tool and models developed by using Ecolego.
> Scenario development and dose calculations for reuse case.
> Participated as non-key expert in the project "Conducting an integrated environmental impact assessment and feasibility study for the management and remediation of uranium production legacy site of Mailuu-Suu in the Kyrgyz Republic" (INSC Project MC4.01/14), in which was tasked with assessments of risks for the current situation at the Mailuu-Suu site.

> Participation in Task 3 of the project "Professional consulting services to develop nuclear and radiological impact assessment".
> One of the developers of the Decision Support System to the Saudi Regulator's Emergency Management Centre.

FACILIA INTERNATIONAL

Lesya Ukrainka BLVD 34, Kyiv, Ukraine

Consultant
May 2015 – January 2019

> Modeling, calculations and assisting in the safety and risk assessment of decommissioning, remediation, and associated radioactive waste management activities at radioactive and nuclear contaminated sites.
> Participated in the IAEA MODARIA I and MODARIA II projects where I was engaged in the development and application of the NORMALYSA tool for assessment of radiological risks in legacy sites contaminated with NORM.
> Has been also involved in the BIOPROTA project dedicated to evaluating key uncertainties in long-term assessments of contaminant releases into the environment arising from radioactive waste disposal. Within this project, she developed a model for prediction of C-14 levels in grass resulting from atmospheric releases of this radionuclide.

National Technical University of Ukraine "Igor Sikorsky Kyiv polytechnic institute"

37, Prosp. Peremohy, Kyiv, Ukraine, 03056

Assistant
November 2013 – October 2015

> Helping professors with courses "Macrokinetics and Hydrodynamics", "Fundamental Numerical Methods", "System Analysis of Complex Chemical

Engineering", "Mathematical methods of optimization" and "Modeling in chemical industry".
Preparing learning materials for students and teaching seminars for MSc. students.
Consulting of MSc. student with master thesis "Integrated risk assessment of facilities".
Responsibility for the "Horizon 2020" in my department.

Radioenvironmental Centre of NASU

55-b, O. Gonchara str., Kyiv, Ukraine

Engineer
September 2007 – July 2015

Conducting an assessment of the possible impact of microorganisms on the safety of the geological repository of radioactive waste of shaft type.
Helping with the monograph.
Working with literary sources (Radionuclide properties, safety functions, criteria and indicators for geological repository descriptions).

Qualifications

Taras Shevchenko National University of Kyiv
"Radiation protection in waste management field" courses 04/2019.

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" 37, Prosp. Peremohy, Kyiv, Ukraine, 03056
Master's Degree 05/2012
Subject : Computer-Integrated Technological Processes and Production.

Peer Reviewer Conflict of Interest Certification

Peer Review: **Dose Compliance Concentrations (DCC) for Radionuclides at Superfund Sites Electronic Calculator**

A conflict of interest or lack of impartiality exists when the proposed participant personally (or the peer reviewer's immediate family), or his or her employer, has financial interests that may be affected by the results of the peer review; or may provide an unfair competitive advantage to the participant (or employer); or if the participant's objectivity in performing the peer review may be impaired due to other factors. When the participant knows that a reasonable person with knowledge of the facts may question the participant's impartiality or financial involvement, an apparent lack of impartiality or conflict of interest exists.

The following questions, if answered affirmatively, represent potential or apparent lack of impartiality (*any affirmative answers should be explained in an attachment*):

- Did you contribute to the development of the calculator (and associated webpages) under peer review, or were you consulted during its development, or did you offer comments or suggestions to any drafts or versions of the calculator during its development? □ No □ Yes
- Do you know of any reason that you might be unable to provide impartial advice on the matter under consideration in this peer review, or any reason that your impartiality in the matter might be questioned? □ No □ Yes
- Have you had any previous involvement with the DCC calculator under consideration? □ No □ Yes
- Have you served on previous advisory panels, committees, or subcommittees that have addressed the topic under consideration? □ No □ Yes
- Have you made any public statements (written or oral) on the issue? □ No □ Yes
- Have you made any public statements that would indicate to an observer that you have taken a position on the issue under consideration? □ No □ Yes
- Do you, your family, or your employer have any financial interest(s) in the matter or topic under peer review, or could someone with access to relevant facts reasonably conclude that you (or your family or employer) stand to benefit from a particular outcome of this peer review? □ No □ Yes

With regard to real or apparent conflicts of interest or questions of impartiality, the following provisions shall apply for the duration of this peer review:

(a) Peer Reviewer warrants, to the best of his/her knowledge and belief, that there are no relevant facts or circumstances that could give rise to an actual, apparent, or potential organizational or personal conflict of interest, or that Peer Reviewer has disclosed all such relevant information to EMS or to EPA.

(b) Peer Reviewer agrees that if an actual, apparent, or potential personal or organizational conflict of interest is identified during performance of this peer review, he/she immediately will make a full disclosure in writing to EMS. This disclosure shall include a description of actions that Peer Reviewer (or his/her employer) has taken or proposes to take after consultation with EMS to avoid, mitigate, or neutralize the actual, apparent, or potential organizational conflict of interest. Peer Reviewer shall continue performance until notified by EMS of any contrary action to be taken.

09.07.2022

□ Check here if any explanation is attached

Signature Date

Daria Koliabina

Printed Name

AFRY Ukraine

Affiliation/Organization

Dr. Elizabeth LaBone

Savannah River National Laboratory

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
LaBone	1	Is there anything you would recommend to improve the website? In particular:	1) FAQ; Farmer Direct Consumption of Agricultural Products CDIs: equation for consumption of sheep milk is missing. 2) Supporting equations: first three equations do not load. 3) Radionuclide Decay chain; fourth paragraph of description: "Priminary Remediation Goals" misspells "preliminary". 4) Radionuclide Decay chain; paragraph after figure 1: space between "are specificed" and "."
LaBone	1a	Is the website clearly organized, described, easy to navigate, and generally “user friendly”? If not, what do you recommend?	The results for the calculator could be improved. 1) Adding a progress bar for calculations that will take several minutes would help. The notification that calculations could take several minutes shows up below the list of radionuclides when there are a large number of them (e.g., selected all) and it isn't immediately obvious why the links are dead. 2) Making the download options more noticeable and with a consistent layout would be more user friendly. Currently, some downloads are buttons, some are at the top, and others are scattered among the output tables and figures. 3) Adding a "return to the top" option after each FAQ entry would improve user friendliness.
LaBone	1b	Do the online DCC calculator tools match the information provided in the User’s Guide and vice versa? If not, what do you recommend?	Yes, it matches the user guide.
LaBone	1c	Do you have any other recommendations to improve the usability of the website?	
LaBone	2	Is there anything you would recommend to improve the User’s Guide? In particular:	1) Some of the figures do not load (section 2.1, 2.5.1.2, 4.10) on Edge, Chrome, or Firefox. Checking back after intial review, the figures that load are inconsistent. 2) section 2.1 paragraph 5: "resident" is not capitalized in "resident air". 3) section 2.5.1.1: second paragraph, make include past tense, i.e. "...particularly for food exposures not include[d] in the Exposure Factors..." 4) 4.5.1 5cm equation is the same as the 1cm equation.
LaBone	2a	Are the tool and website clearly explained?	Yes
LaBone	2b	Are the assumptions clear and reasonable? If not, what do you recommend?	Yes
LaBone	2c	Is the guide well written and clearly organized? If not, what do you recommend?	The guide could use some proofreading (see main part of question 2).
LaBone	2d	Is the technical support documentation complete, organized and easy to follow? If not, what do you recommend?	Yes
LaBone	3	Are the DCC models for the following scenarios comprehensive and accurate, and do they represent the current state of knowledge? Are they supported appropriately by citations? If not, what do you recommend?	I do not have the expertise to answer this question.
LaBone	3a	Resident	
LaBone	3b	Indoor Worker	
LaBone	3c	Outdoor Worker	
LaBone	3d	Composite Worker	
LaBone	3e	Construction Worker (Site-specific only)	
LaBone	3f	Recreator (Site-specific only)	
LaBone	3g	Farmer	
LaBone	3h	Soil to Groundwater	
LaBone	4	Is the choice of radionuclides and how decay chains are addressed appropriate and based on supportable reasoning? If not, what do you recommend? Are the standard recommended default factors adequately explained, sourced, and reasonable?	I do not have the expertise to answer this question.
LaBone	5	Are the results of the calculator clearly explained and presented for the given scenarios? If not, what do you recommend?	The calculator results are somewhat jumbled looking, especially in runs with a large number of radionuclides. Having the results for each radionuclide be collapsable would help with presenation and readability. Having explanation at the start of results and not requiring the user to scroll through all the tables and figures to find the explanations would improve the user experience.
LaBone	5a	In particular, we are interested in your review of the calculator results when selecting the DCC Output Option “Peak DCC”.	This mode in particular would benefit from having collapsable sections for each radionuclide and the downloads being more obvious (e.g., buttons).

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
LaBone	6	Are the results appropriately described and qualified (to the extent that they may be relied upon and defended)? If not, what do you recommend?	I do not have the expertise to answer this question.
LaBone	7	Do the results provide a defensible explanation of how they were derived, or are they the result of a “black box”? Do you recommend anything different?	The model equations and methods are given sufficient description so that the model is not a "black box".
LaBone	8	Is there anything else you would recommend to improve the utility, accuracy, completeness, or supportability of the calculator?	The user cannot enter scientific notation in the user provided entries of the PRG calculator. Adding that functionality would increase the user experience and accuracy when adding values that are recorded as scientific notation and could be mistyped and thus off by an order of magnitude.

Elizabeth LaBone

Curriculum Vitae

803-221-7392
elizabeth.labone@srnl.doe.gov

Education

2010–2016 **Doctor of Philosophy in Oceanography**, *Louisiana State University*, Baton Rouge, LA.

2006–2010 **Bachelor of Science in Biology**, *University of South Carolina Honor's College*, Columbia, SC.
Minor in Computer Science

Computer skills

Visualization	R, Shiny, Inkscape, Paraview, GIMP	OS	Linux (Desktop, HPC), Windows
Web design	HTML, CSS, PHP, MySQL	Scientific	R (Modeling, GIS), Matlab
Programming	FORTRAN, C/C++, Java	Writing	Lyx, Open Office, Microsoft Office

PhD Dissertation

Title Modeling the Effects of Hypoxia on Fish Movement in the Gulf of Mexico Hypoxic Zone

Supervisors Dubravko Justic

Description Atlantic Croaker movement relative to the Gulf of Mexico hypoxic zone was modeled in 2-D and 3-D.

- I evaluated the performance of movement algorithms, including movement algorithms I developed based on the literature, and how they affected fish exposure to hypoxia using data from an individual-based model (IBM) and hydrodynamic-water quality model (FVCOM-WASP) using R for several analyses including calculating cumulative exposure, estimating the effects of hypoxia exposure on growth, and calculating the sinuosity of fish movement. I found that hypoxia exposure did not vary greatly between the movement algorithms and that one of the algorithms was better suited to model domains with large model cells and small time steps.
- Model fish movement and dissolved oxygen values were visualized to identify areas of interest in time and space using fish IBM output, a US coastline shapefile, and FVCOM-WASP dissolved oxygen output by plotting with ggplot2 after manipulating the data into the correct format with R. I wrote an R function to interpolate the dissolved oxygen data and to trim the result to match the FVCOM-WASP model domain.

- The number of field samples needed to calibrate or validate model fish using different movement algorithms was calculated by analyzing the hypoxia exposure of model fish with a categorization test using a Linear Discriminant Analysis (LDA) in R and it was found that sample sizes would need to be prohibitively large to get a miscategorization rate of less than 5%.

Honor's Thesis

Title Demographic model of Thalassinid shrimp in the Eastern North Pacific

Supervisors David Wethey and Sara Woodin

Description A model using Leslie-Lefkovitch matrices was written in R and used to model shrimp larvae dispersal between meta-populations off the Oregon coast.

Experience

2020-present **Senior Scientist**, *Savannah River National Lab*, Aiken, SC.
My main tasks have been data analysis and QA of data, models, and documents. I performed data analysis, visualization, and QA for a number of projects, including the creation of graphical user interfaces using R Shiny to make data analysis tools available to people without programming backgrounds.

2020 **General Research Assistant**, *University of Maryland*, Cambridge, MD.
I worked on developing a fish IBM in the Gulf of Mexico hypoxic zone as part of a larger project to model hypoxia in the Gulf of Mexico from physical processes to fish. My tasks included incorporating code for reading in NetCDF files of environmental data, debugging the code, and performing model runs to test the effect of different extents of hypoxia (including future climate scenarios) on fish.

2017-2020 **Postdoctoral Researcher**, *Louisiana State University*, Baton Rouge, LA.
I continued to work on developing a fish IBM in the Gulf of Mexico hypoxic zone as part of a larger project to model hypoxia in the Gulf of Mexico from physical processes to fish.

- FVCOM-WASP output with certain ranges of hypoxic area and variability was chosen by subsetting the output to only the hypoxic data points and calculating the area with the raster package and the spatial variability using Ripley's K function. The results of Ripley's K were compared by calculating the area under the curve. The time steps of FVCOM-WASP output could then be compared and some chosen for use in experiments with the IBM model.
- I calculated a reasonable population of Atlantic Croaker in the FVCOM-WASP model domain using the online SEAMAP database on fish catch in the Gulf of Mexico that was cleaned, subsetted to only include croaker in the model domain area, and a range of reasonable estimates were calculated by extrapolating the population to the model domain.
- Debugged a new version of the fish IBM that added fish bioenergetics to the fish movement. The model was written in FORTRAN.
- Manipulated environmental data from FVCOM-WASP in NetCDF format, using bash scripts and NCO, to use the output as input for the new version of the fish IBM.

- The relationship of shrimp boat locations to hypoxia was visualized using output from FVCOM-WASP and shrimp fleet data that was manipulated with R into a format that could be visualized using Paraview. I wrote a custom Paraview filter using Python to compare the location of the shrimp nets and hypoxia. The visualization showed that shrimp boats tended to avoid thick areas of hypoxic water.

2010-2016 **Graduate Assistant**, *Louisiana State University*, Baton Rouge, LA.
I worked on my dissertation project, attended meetings, and gave lectures in my professor's class. I gained experience explaining complicated research, here modeling, to people with a range of scientific backgrounds.

2014 **Graduate Student Symposium Planning Committee**, *Coast and Environment Graduate Organization*, Baton Rouge, LA.
I helped plan and run the Graduate Student Symposium. I was part of the committee that organized the food, housing, and presentations. I also ran the website for the event.

2012–2016 **Coast and Environment Graduate Organization Webmaster**, *Louisiana State University*, Baton Rouge, LA.
I was in charge of maintaining the CEGO website. I used HTML, CSS, MySQL, and PHP to redesign the website to look more modern and cohesive with the design of the department website.

February 2009–April 2010 **Honor's Thesis Oregon Research**, *University of South Carolina Honor's College*, Columbia, SC.
I conducted fieldwork in Oregon estuaries by counting shrimp population numbers. The project was on the biogeography of the shrimp *Neotrypaea californiensis.* I created a model in R language for several meta populations of shrimp, each having a Leslie-Lefkovitch matrix.

Summers 2007–2010 **Savannah River National Lab Internships**, *South Carolina Universities Research and Education Foundation*, Aiken, SC.
I analyzed radionuclide and other databases of the CAP88 (Clean Air Act Assessment Package-1988) environmental dose program. I worked with another student researcher studying the impacts of radiation exposure on Medaka fish (*Oryzias latipes*). Our tasks included cleaning fish eggs, collecting and processing fin samples, and running PCRs on the samples.

Summer 2005 **Savannah River Ecology Lab Internship**, *South Carolina Governor's School for Science and Mathematics*, Aiken, SC.
I researched the differences in mycorrhizae found on pine seedlings growing under varying canopy types. This included collecting samples and writing general descriptions of mycorrhizae as seen under a microscope.

Publications

[1] Elizabeth D. LaBone, Kenneth A. Rose, Dubravko Justic, Lixia Wang, and Haosheng Huang. Effects of spatial variability on the exposure of fish to hypoxia: a modeling analysis for the Gulf of Mexico. *Biogeosciences*, 18(2):487–507, 2021.

[2] Elizabeth D. LaBone, Dubravko Justic, Kenneth Rose, Lixia Wang, and Haosheng Huang. Modeling fish movement in 3-D in the Gulf of Mexico hypoxic zone. *Estuaries and Coasts*, 42(6):1662–1685, 2019.

[3] Elizabeth D. LaBone, Dubravko Justic, Kenneth Rose, Lixia Wang, and Haosheng Huang. Comparing default movement algorithms for individual fish avoidance of hypoxia in the Gulf of Mexico. In *Modeling Coastal Hypoxia: Numerical*

Simulations of Patterns, Controls and Effects of Dissolved Oxygen Dynamics. Springer, 2017.

[4] Elizabeth D. LaBone, Eduardo B. Farfan, Patricia L. Lee, G. Timothy Jannik, Elizabeth H. Donnelly, and Trevor Q. Foley. Assessment of radionuclide databases in Cap88 Mainframe version 1.0 and Windows-based version 3.0. *Health Physics*, 97(3):242–247, September 2009.

Volunteer Experience

2010-2013, 2014-2015 **Environmentors Mentor**, *Louisiana State University Environmentors Chapter (http://environmentors.lsu.edu/)*.
I mentored at-risk high school students as part of the Environmentors program. The purpose of the program is to encourage interest in STEM fields. Each school year, a high school student would be matched with two mentors. As a mentor, I helped the student with a science fair project and with applications for college and scholarships.

Meetings/Workshops

June 18-22, 2018 **Animal Movement Analyses: A to Z, with lots of R**, *The University of British Columbia*, Vancouver, BC.

May 28-29, 2018 **1st LBRN/LONI Scientific Computing Bootcamp**, *LBRN/LONI*, Baton Rouge, LA.

December 5-6, 2017 **Big Data**, *Pittsburgh Supercomputing Center - Webcast*, Baton Rouge, LA.

February 20, 2015 **Data Analysis with R in HPC**, *Texas Advanced Computing Center - Webcast*, Baton Rouge, LA.

August 25-26, 2014 **Science Visualization**, *Texas Advanced Computing Center - Webcast*, Baton Rouge, LA.

July 14-16, 2014 **The 5th Annual NOAA/NGI Gulf Hypoxia Research Coordination Workshop**, *Northern Gulf Institute*, Stennis Space Center, MS.

June 2-4, 2014 **3rd Annual LONI HPC Parallel Programming Workshop**, *LONI*, Baton Rouge, LA.

February 17-22, 2013 **ASLO 2013 Aquatic Sciences Meeting**, *Association for the Sciences of Limnology and Oceanography*, New Orleans, LA.

November 12, 2012 **EdGCM Climate Modeling Workshop**, *Louisiana State University*, Baton Rouge, LA.

Awards/Scholarships

2010 **NSF Graduate Research Fellowship Award**, *National Science Foundation.*

2010 **Board of Regents Fellowship**, *Louisiana State University.*

2006 **Palmetto Fellows Scholarship**, *South Carolina Commission on Higher Education.*

Presentations

2019 **Effects of Tides on Hypoxia and Fish Avoidance Movement in the Gulf of Mexico**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 25th Biennial Coastal and Estuarine Research Federation Conference.
November 3-7, 2019; Mobile, AL

2019 **Modeling Fish Movement in 3-D**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 2019 Aquatic Sciences Meeting.
February 23-March 2, 2019; San Juan, PR

2018 **Modeling 3-D Fish Movement in the Gulf of Mexico Hypoxic Zone [Invited]**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, ACS National Meeting & Expo: Nexus of Food, Energy & Water.
March 18-22, 2018; New Orleans, LA

2018 **Modeling Fish Movement in 3-D**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 2018 Ocean Sciences Meeting.
February 11-16, 2018; Portland, OR

2017 **Modeling Fish Movement in 3-D**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 24th Biennial Conference of the Coastal and Estuarine Research Federation.
November 5-9, 2017; Providence, RI

2016 **Modeling the Effects of Hypoxia on Fish Movement in the Gulf of Mexico Hypoxic Zone**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 2016 Ocean Sciences Meeting.
February 21-26, 2016; New Orleans, LA

2015 **Modeling the Effects of Hypoxia on Fish Movement in the Gulf of Mexico Hypoxic Zone**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 23rd Biennial Conference of the Coastal and Estuarine Research Federation.
November 8-12, 2015; Portland, OR

2015 **Modeling the Effects of Hypoxia on Fish Movement in the Gulf of Mexico Hypoxic Zone**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 16th Annual Graduate Student Symposium, March 13-15, 2015; Dauphin Island, AL.

2014 **Random Walks in a Dead Zone: Simulating the Effects of Hypoxia on Fish Movement in the Gulf of Mexico Hypoxic Zone.**, *Justic, D., LaBone, E., Wang, L., Rose, K., Huang, H., Creekmore, S.*, 2nd International Ocean Research Conference, November 17-21, 2014; Barcelona, Spain.

2014 **Modeling the Effects of Hypoxia on Fish Movement in the Gulf of Mexico Hypoxic Zone [poster]**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 3rd Biennial State of the Coast Conference, March 18-20, 2014; New Orleans, LA.

2014 **Modeling the Effects of Hypoxia on Fish Movement in the Gulf of Mexico Hypoxic Zone**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 15th Annual Graduate Student Symposium, February 21-23, 2014; Cocodrie, LA.

2013 **Modeling the Effects of Hypoxia on Fish Movement in the Gulf of Mexico Hypoxic Zone [poster]**, *LaBone, E., Justic, D., Rose, K., Wang, L., Huang, H.*, 22nd Biennial Conference of the Coastal and Estuarine Research Federation, November 3-7, 2013; San Diego, CA.

2010 **Demographic model of Thalassinid shrimp in the Eastern North Pacific [poster]**, *LaBone, E.D., Woodin, S.A., Wethey, D.S.*, 39th Benthic Ecology Meeting, March 10-13, 2010; Wilmington, NC.

2008 **Assessment of Differences in Radionuclide Databases for CAP88 v. 1.0 and 3.0 [poster]**, *LaBone, E.D., Farfan, E.B., Lee, P.L., Jannik, G.T.*, 53rd Annual Meeting of the Health Physics Society, July 13-17, 2008; Pittsburgh, PA.

2005 **Do Canopy Type and Land Use Affect Loblolly Pine (Pinus taeda) Mycorrhizae?**, *LaBone, E.D.*, South Carolina Junior Academy of Science Annual Meeting, Columbia, SC.

Peer Reviewer Conflict of Interest Certification

Peer Review: **Dose Compliance Concentrations (DCC) for Radionuclides at Superfund Sites Electronic Calculator**

A conflict of interest or lack of impartiality exists when the proposed participant personally (or the peer reviewer's immediate family), or his or her employer, has financial interests that may be affected by the results of the peer review; or may provide an unfair competitive advantage to the participant (or employer); or if the participant's objectivity in performing the peer review may be impaired due to other factors. When the participant knows that a reasonable person with knowledge of the facts may question the participant's impartiality or financial involvement, an apparent lack of impartiality or conflict of interest exists.

The following questions, if answered affirmatively, represent potential or apparent lack of impartiality (*any affirmative answers should be explained in an attachment*):

- Did you contribute to the development of the calculator (and associated webpages) under peer review, or were you consulted during its development, or did you offer comments or suggestions to any drafts or versions of the calculator during its development? □ No □ Yes
- Do you know of any reason that you might be unable to provide impartial advice on the matter under consideration in this peer review, or any reason that your impartiality in the matter might be questioned? □ No □ Yes
- Have you had any previous involvement with the DCC calculator under consideration? □ No □ Yes
- Have you served on previous advisory panels, committees, or subcommittees that have addressed the topic under consideration? □ No □ Yes
- Have you made any public statements (written or oral) on the issue? □ No□ Yes
- Have you made any public statements that would indicate to an observer that you have taken a position on the issue under consideration? □ No □ Yes
- Do you, your family, or your employer have any financial interest(s) in the matter or topic under peer review, or could someone with access to relevant facts reasonably conclude that you (or your family or employer) stand to benefit from a particular outcome of this peer review? □ No □ Yes

With regard to real or apparent conflicts of interest or questions of impartiality, the following provisions shall apply for the duration of this peer review:

(a) Peer Reviewer warrants, to the best of his/her knowledge and belief, that there are no relevant facts or circumstances that could give rise to an actual, apparent, or potential organizational or personal conflict of interest, or that Peer Reviewer has disclosed all such relevant information to EMS or to EPA.
(b) Peer Reviewer agrees that if an actual, apparent, or potential personal or organizational conflict of interest is identified during performance of this peer review, he/she immediately will make a full disclosure in writing to EMS. This disclosure shall include a description of actions that Peer Reviewer (or his/her employer) has taken or proposes to take after consultation with EMS to avoid, mitigate, or neutralize the actual, apparent, or potential organizational conflict of interest. Peer Reviewer shall continue performance until notified by EMS of any contrary action to be taken.

ELIZABETH LABONE (Affiliate) Digitally signed by ELIZABETH LABONE (Affiliate) Date: 2022.08.10 14:43:29 -04'00'

Signature Date

□ Check here if any explanation is attached

Printed Name

Affiliation/Organization

Thomas Siard

Strata-G

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Siard	1	Is there anything you would recommend to improve the website? In particular:	
Siard	1a	Is the website clearly organized, described, easy to navigate, and generally “user friendly”? If not, what do you recommend?	I find the web site to be generally easy to navigate and user friendly. A substantial comment is that the calculator does not consistently provide accurate results when the back arrow is used. Initially, it appeared to me that hitting the back arrow worked fine--and I believe it sometimes did. Regardless, it became clear to me that something was amiss with some of my test DCC runs. Once I began to close out after each run, these "problems" disappeared when I re-did my runs. Also, I was not able to use the online User's Guide trying a couple different browsers (Edge and Chrome)--I had to use the pdf version. This was workable, except that the links on the pdf version are not live. SUGGESTIONS: 1) Either fix the Calculator so that using the back arrow provides accurate results for a subsequent run, or disable the back arrow so that one cannot use it to go from results to input. 2. Make sure that the User's Guide can open online and/or make sure that the pdf version links are live.
Siard	1b	Do the online DCC calculator tools match the information provided in the User’s Guide and vice versa? If not, what do you recommend?	In general, the DCC Calculator and the User's Guide match up reasonably well. However, a couple items are noted here for suggested changes. 1) As mentioned in other responses, I think the treatment of the 2-D External Exposure is a bit confusing. 2-D External Exposure is listed as a "medium," but it is not mentioned/footnoted in the CSM on page 32 (Section 3.1.1) of the pdf. SUGGESTION: If the 2-D External Exposure is left as a medium, then I suggest that it be identified in the CSM. (However, I would prefer having the ability to select the contamination layer thickness under the soil medium and eliminate 2-D from the list of media.) 2) Another item is that the Peak Dose DCC output lists an ED of 26 years for the resident, but with respect to dose, this is inconsistent with Page 4 Section 2.1.2.2 which states: "For instance, if the time period of 100 years is selected for default resident soil for U-238 (ED of 1 year), year 100 will be selected by default, because U-238 peak 0 dose isn’t until year 3,981,072." Please also see response No. 5a (and elsewhere) regarding the SUGGESTION to eliminate "ED" from the output.
Siard	1c	Do you have any other recommendations to improve the usability of the website?	Nothing in addition to the suggestions provided in 1a and 1b, but I will emphasize with respect to 1b that I recommend that 2-D be eliminated as a medium and depth options be used for soil. (The ACF options for area are already included.)
Siard	2	Is there anything you would recommend to improve the User’s Guide? In particular:	I recommend changing the title of Section 2.8 to "Sensitivity/Uncertainties Analysis" and to restructure the first couple sentences to introduce the fact that multiple uncertainties exist. Before the discussion of changing a value, it should be made clear that the existence of uncertainties is the typical reason why one would consider changing a value. I note that the current Section 2.8 text opens without any discussion of uncertainties: "A sensitivity/uncertainty analysis is the quantitative assessment of how changing a single value impacts the DCC calculation. Sensitivity analyses are generally conducted to determine what changed variable in a DCC has the greatest impact." Also, I suggest paginating the pdf of the User's Guide for easier reference--especially useful if a page or section is printed.
Siard	2a	Are the tool and website clearly explained?	The User's Guide lists a default dose limit of 1 mrem/year but does not provide adequate discussion as to why this value might be a reasonable value or a reasonable starting place. SUGGESTION: Additional discussion should be added to Section 2.6 regarding the selection of dose limit values.
Siard	2b	Are the assumptions clear and reasonable? If not, what do you recommend?	I found the discussion of external exposure to ionizing radiation for e.g., Resident Soil and Resident Soil 2-D External Exposure to be a bit confusing. The second short paragraph of Section 4.1.2 (p. 36) states: "This analysis is designed to look at external exposure from contamination of different area sizes. Areas considered are 1 to 1,000,000 square meters. Isotope-specific area correction factors (ACF) were developed for this analysis." Although this is correct, it is also true that for "Residential Soil" on p. 34, the same isotope-specific values were also used based on infinite soil volume ($ACF_{ext\text{-}sv}$). Note that the last equation on p. 34 and the first equation on p. 37 (direct exposure at infinite depth) are exactly the same and use the same isotope-specific, area (i.e., m^2)-specific ACF values. SUGGESTION: Include "isotope-specific" also on page 34 (Section 4.1.1) and emphasize in Section 4.1.2 that the difference between the external exposure in Sections 4.1.1 an 4.1.2 is the multiple depths in Section 4.1.2 and that Section 4.1.1 defaults to the "soil volume" (i.e., infinite) depth selection.
Siard	2c	Is the guide well written and clearly organized? If not, what do you recommend?	As suggested above, the pdf should be paginated for easier reference. Additionally, based on my comments in response 2b, I suggest clarifying that Section 4.1.1 likewise includes external exposure, but that it assumes an infinite depth.
Siard	2d	Is the technical support documentation complete, organized and easy to follow? If not, what do you recommend?	In general, the technical support documentation appears to be appropriately complete and organized. However, I note that the values listed for each of the receptors on page 106 of the pdf listed for all of the Dose and Decay Constant Variables are not found in the references listed except for the construction worker (t-cw = 1). The values for the other receptors (except for the site-specific recreator) are likewise t=1, which is correct for a mrem/yr dose rate, but the references listed provide exposure duration values (e.g., resident = 30 years; worker = 25 years; both are from EPA [1991], which was revised by the 2014 EPA revised default exposure values). SUGGESTION: Correct the source of these values, perhaps stating something like: "Because the dose rate is based on mrem/yr, t=1yr is used as as default for this receptor," for the workers, resident, and farmer scenarios. Refer to Attachment A.
Siard	3	Are the DCC models for the following scenarios comprehensive and accurate, and do they represent the current state of knowledge? Are they supported appropriately by citations? If not, what do you recommend?	

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Siard	3a	Resident	I found a few issues with the calculations and/or model for the resident. 1) If Soil and 2-D are selected as media, the resultant dose rate associated with external exposure under "soil" is 26 times lower than the resultant dose rate associated with external exposure (soil volume) under 2-D (See Attachments B, C, and D that accompany this review); the resultant DCCs associated with external exposure under soil are accordingly 26 times higher than under 2-D (soil volume). From pages 34 and 37 in the User's Guide, the equation and parameter values are the same for these two scenarios. The factor of 26 is also equal to the ED for the resident (combined child and adult). If the dose limit is based on mrem/yr and ED is not a parameter value in the equation on pages 34 and 37 for external exposure, it does not seem that this factor should be related to exposure duration. SUGGESTION: Correct this apparent error. 2) The 26-yr exposure duration appears in the DCC graphs for the resident and is reflected in the DCC results summary. Dose values associated with ARARs are in units of mrem/yr. Therefore, it is unclear to me why the DCC calculator includes a 26-year period for "peak dose" as would be done for risk calculations See also response 5a. SUGGESTION: Eliminate the 26-year ED from the calculation. The child/adult ratios associated with exposure via certain pathways (not including external exposure) are factored in the AAF-res(c) and AAF res(a) shown on page 39 of the pdf. 3) Because the dose (i.e., mrem/yr) is based on t=1yr, as shown on page 108 of the pdf, an individual would be either an adult or a child--not both--during the year of highest dose. SUGGESTION: Consider revising the model to run the adult and child residents separately and base the DCC on the lower of the two. Note that this would eliminate use of the child/adult resident receptor and the associated AAF values referenced in the previous suggestion. 4) Additionally, please see discussion for the indoor worker (3b) regarding the 0.4 dilution factor for indoor dust inhalation included in EPA (2000) Soil Screening Guidance for Radionuclides which is supported by the current EPA (2018) Exposure Factors Handbook. SUGGESTION: Include the 0.4 factor for the indoor dust pathway in the resident scenario, consistent with EPA guidance.
Siard	3b	Indoor Worker	This model appears to be set up correctly in general, and t=1 yr is used correctly in the output. However, I notice that the calculation does not include the "dilution factor" for indoor dust inhalation of 0.4 that is found on page 2-20 of the EPA (2000) Soil Screening Guidance for Radionuclide: User's Guide (EPA/540-R-00-007). This dilution factor acknowledges that indoor dust occurs at a concentration that is ~40% that found in associated ambient outdoor air. Note that Chapter 19 (2018) of the current EPA Exposure Factors Handbook (EFH) states , " In the absence of indoor sources, indoor concentrations of particulate matter are significantly lower than outdoor levels," citing a paper by Wallace (1996). The Wallace (1996) paper includes an equation that includes an indoor dust concentration factor of 0.385 (compared to particulates in ambient outdoor air) which is the same values used in the EPA (2000) SSG for rad document (and RESRAD). Ignoring the 2000 guidance and the statement included in the current EFH results in a ~2.5X overestimate of dose associated with dust-borne exposure. RECOMMENDATION: Add the 0.4 indoor dust inhalation factor for the indoor worker. This comment regarding the outdoor-to-indoor factor also applies to the resident, composite worker (if recommendation of 3d is implemented) and farmer.
Siard	3c	Outdoor Worker	The model appears to be set up correctly and operating properly. The t=1yr is correctly reflected in the results.
Siard	3d	Composite Worker	The composite worker is defined in the User's Guide as, "This long-term receptor is a full time employee working on-site who spends most of the workday conducting maintenance activities outdoors." This definition is EXACTLY THE SAME as the definition given for the outdoor worker. Social Security Ruling 82-61 states “Composite jobs have significant elements of two or more occupations ..." For purposes of exposure assessment of a given exposure unit, I have always seen a "composite worker" treated as representing individuals who are engaged in tasks where they spend significant time both indoors and outdoors. Using the outdoor worker scenario for a composite worker who may spend 50 percent or more of his/her time indoors will typically overestimate exposure, especially with respect to the external exposure pathway. Because of the DCC not truly including a composite worker, the DCC user is forced to run both the indoor and outdoor worker scenarios, and then multiply each result by a relative indoor/outdoor exposure factor (e.g., for a 2 hour outdoor/6 hour indoor, the factors would be 0.25 and 0.75, respectively). RECOMMENDATION: Mathematically rework the composite worker exposure scenario to include both indoor and outdoor exposure. If a screening-only DCC value is desired for an indoor/outdoor composite worker, the default settings of 0.9 for outdoor and 0.1 for indoor factors might be considered. This is because the more-exposed outdoor worker is assumed to be exposed for 225 days/yr (90% of 250 days/yr) and the remaining 25 days (10% of 250 days/yr) could be assumed as indoor exposure. Alternatively, the outdoor worker DCC values should typically be adequately conservative for a composite worker because more than 10% of time would likely be spent indoors. Also, please see note under 3b regarding the use of outdoor-to-indoor dust factor of 0.4 for the indoor portion of the composite worker that is recommended in the previous sentences.
Siard	3e	Construction Worker (Site-specific only)	The model appears to be set up correctly and operating properly. The default t=1yr is correctly reflected in the results.

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Siard	3f	Recreator (Site-specific only)	The model appears to be set up correctly and generally working properly. However, comments on the resident receptor with respect to inclusion of the in the calculation of the DCC also applies to this receptor also apply to this receptor. I used a 10-year exposure duration, with 2 years as an child and 8 years as an adult (i.e., child AAF=0.3; adult AAF=0.8) using the Peakrisk option. The external exposure dose under the "soil" option was exactly 10X less than the external exposure dose using the 2-D (soil volume), and the DCC values were inversely related, where the DCC based on the soil option was exactly 10 higher than the DCC based on 2-D (soil volume). (See Attachments E, F, and G.) SUGGESTION: Correct this apparent error. 2) The selected "site-specific" 10-yr exposure duration appears in the DCC graphs for the resident and is reflected in the DCC results summary. Dose values associated with ARARs are in units of mrem/yr. Therefore, it is unclear to me why the DCC calculator includes a 10-year period for "peak dose" as would be done for risk calculations. SUGGESTION: Eliminate the ED from the calculation under the 2D selection. The child/adult ratios associated with exposure via certain pathways (not including external exposure) are factored in the AAF-rec(c) and AAF-rec(a) shown on page 62 of the User's Guide pdf. 3) Because the dose (i.e., mrem/yr) is based on t=1yr, as shown on page 108 of the pdf, an individual would be either an adult or a child--not both--during the year of highest dose. SUGGESTION: Consider revising the model to run the adult and child recreators separately and base the DCC on the lower of the two. Note that this would eliminate use of the child/adult recreator and the associated AAF values referenced in the previous suggestion.
Siard	3g	Farmer	I found a few issues with the calculations and/or model for the farmer. Comments on the resident receptor and indoor worker also apply to this receptor. Additionally, I found one output that provides an unexpected result but after further review appears to be akin to "rounding error," and I question the use of the soil-to-fish pathway. These issues are as follows: 1) The 40-yr exposure duration appears in the DCC graphs for the farmer and is reflected in the DCC output summary (Appendix H). Dose values associated with ARARs are in units of mrem/yr. Therefore, it is unclear to me why the DCC calculator includes a 40-year period for "peak dose" as would be done for risk calculations. SUGGESTION: Eliminate the 40-yr ED from the results. The child/adult ratios during exposure via certain pathways (not including external exposure) are factored in the AAF-far(c) and AAF far(a) shown on page 77 of the pdf. 2) Because the dose (i.e., mrem/yr) is based on t=1yr, as shown on page 108 of the pdf, an individual would be either an adult or a child--not both--during the year of highest dose. SUGGESTION: Consider revising the model to run the adult farmer and child farmer separately and base the DCC on the lower of the two. Note that this would eliminate use of the child/adult farmer receptor and the associated AAF values referenced in the previous suggestion. 3) Additionally, please see discussion for the indoor worker (3b) regarding the 0.4 dilution factor for indoor dust inhalation included in EPA (2000) Soil Screening Guidance for Radionuclides which is supported by the current EPA (2018) Exposure Factors Handbook. SUGGESTION: Include the 0.4 factor for the indoor dust pathway in the resident scenario, consistent with EPA guidance. 4) The farmer scenario was run for U-234 for combined soil and biota at 1 pCi/g U-234 in soil, using Peakrisk and a maximum of 1,000 years. For each farmer pathway except swine ingestion, the maximum dose rate was between 960 and 1,000 years. For swine ingestion, the maximum dose rate was between years 0-40 (actually year 0-1) and for all other pathways, the maximum dose rate was at between years 960-1,000 (actually year 999-1,000). The magnitude of differences between swine ingestion dose at years 0-1 and 999-1,000 are negligible, but it would seem that the dose at year 999-1,000 should be higher than at year 0-1. (See Attachment H). SUGGESTION: Revisit the swine ingestion calculation to verify that this is not a mathematical error. 5) I question the practice shown on page 83 of the User's Guide pdf that includes the calculation of fish and shellfish concentrations based on soil concentrations. SUGGESTION: Provide an explanation and reference for this practice.
Siard	3h	Soil to Groundwater	My review found the model to be set up correctly and operating reasonably.
Siard	4	Is the choice of radionuclides and how decay chains are addressed appropriate and based on supportable reasoning? If not, what do you recommend? Are the standard recommended default factors adequately explained, sourced, and reasonable?	The choice of radionuclides and decay chains appear to be addressed appropriately. In general, default factors appear to be adequately defined. Please note exception in my response for 2d regarding the t=1 values.
Siard	5	Are the results of the calculator clearly explained and presented for the given scenarios? If not, what do you recommend?	The results are adequately explained in general. I have made a suggestion in 5a regarding the use of "ED." I have also commented on what I think to be heading errors in the DCC output.
Siard	5a	In particular, we are interested in your review of the calculator results when selecting the DCC Output Option “Peak DCC”.	Please see 3a concerning the apparent error with respect to the 26-year ED shown in the final column of the Peak results summary. It is suggested that "ED" be deleted as this value typically relates to a receptor scenario at a given site (e.g., 26 years for residents, 25 years for workers), as these values are provided only to derive the age adjustment factors (AAF) for the resident, recreator and farmer (shown on e.g., pages 34, 62, and 71 of the pdf User's Guide, respectively) for certain pathways. Because dose relates to mrem/yr, the focus should be on the maximum dose year over the time period selected. Therefore, the final column of the dose summary should not include "ED" as this is confusing. Instead, a heading such as "Maximum Dose Year" is suggested. Also see response 7 and Attachment I.

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Siard	6	Are the results appropriately described and qualified (to the extent that they may be relied upon and defended)? If not, what do you recommend?	Please see my response to Question 7 with respect to DCC output. Also, response 2a is intended to clarify the existence/importance of uncertainties.
Siard	7	Do the results provide a defensible explanation of how they were derived, or are they the result of a “black box”? Do you recommend anything different?	I do not think they suffer from "black box" syndrome with respect to the program. As stated by comments above, I think the use of a 26-year (resident) or 40-year farmer for calculating a dose of the entire exposure duration is not applicable to verifying compliance with ARARs that are based on mrem/yr. Also, some of the headings on the DCC output (for all receptors) appear to be incorrect, described as follows (and shown in Attachment I): 1) The 3rd column of the output is labeled "Maximum dose during peak interval (unitless)." The calculation is 26X the maximum dose rate; thus, the units would seemingly be "mrem" over the entire exposure duration. Because ARARs are based on mrem/year, the third column should either be eliminated or an explanation should be provided as to how it is used to calculate a DCC that is based on the 1-yr period of maximum dose rate (mrem/yr). 2) The 4th column is headed "Maximum dose rate during peak interval" (risk/yr). The units should be "mrem/yr". 3) In the 5th column, “Maximum dose interval” should be replaced with a heading such as, “Maximum Dose Year.” Mention of ED should be eliminated, or an explanation should be provided as to how it is used to calculate a DCC that is based on the 1-yr period of maximum dose rate (mrem/yr). Note that the ED is (errantly) applied only to the resident, recreator and farmer receptors, whereas the t=1 values is correctly applied to the worker scenarios such that the length of the maximum dose interval is correctly shown as 1 year. Again, p. 108 of the pdf User's Guide also uses a t=1 for the resident and farmer receptors as well as for the worker scenarios; t=1 is reflected in the 5th column of the DCC output summaries for the worker scenarios rather than a multi-year ED value.
Siard	8	Is there anything else you would recommend to improve the utility, accuracy, completeness, or supportability of the calculator?	The Calculator does not calculate the total dose of multiple radionuclides. Conservatively, one may simple add the Peak dose values for each radionuclide. However, it is possible that four radionuclides present in site media may have greatly different maximum dose rates and dose curves. An estimate of the maximum dose may be inferred by comparing the maximum total dose of each radionuclide. However, this approach relies on presentation of the curves and a description of the method used. It is recommended that the Calculator is revisited to calculate a total dose of multiple radionuclides to which a receptor may be exposed.

ATTACHMENT A—t (Time) Values for Receptors (See Response 2d)

Dose and Decay Constant Variables			
Symbol	Definition (units)	Default	Reference
DL	Dose Limit (mrem/year)	1	
t_{cw}	Time - construction worker (year)	1	U.S. EPA 2002b Exhibit 5-1
t_{far}	Time - farmer (year)	1	U.S. EPA 2005 (pg. C-24/C-26)
t_{iw}	Time - indoor worker (year)	1	U.S. EPA 1991a (pg. 15)
t_{ow}	Time - outdoor worker (year)	1	U.S. EPA 1991a (pg. 15)
t_{rec}	Time - recreator (year)	site-specific	site-specific
t_{res}	Time - resident (year)	1	U.S. EPA 2011a, Table 16-108; 90th percentile or current residence time.
t_{w}	Time - worker (year)	1	U.S. EPA 1991a (pg. 15)

The sources shown are incorrect for these values. These sources shown only exposure duration values but not t values. Suggest changing Reference to: “Because the dose rate is based on mrem/yr, a default t value of 1 year was selected for these receptors.”

ATTACHMENT B—DCC/Dose Rate Comparison of Resident External Exposure Under "Soil" Option and 2-D (Soil Volume) Option DCC *(See Response 3a)*

External radiation DCC value is 26X greater for the "soil only" medium selection than for the 2-D external exposure selection "External Exposure – Soil Volume." DCC values (circled in blue) and associated dose rate values should be equal. It appears that the resident ED value of 26 years was mistakenly factored into the 2-D DCC and associated dose rate values.

Also, because the dose is based on mrem/yr, the maximum dose interval for U-234 should be at year 999 -1,000 and not years 974 – 1,000 as shown. It is noted that the worker scenarios correctly show the maximum dose at year 999 – 1,000 for U-234. Please see page 4 of the User's Guide, which states: *For instance, if the time period of 100 years is selected for default resident soil for U-238 (ED of 1 year), year 100 will be selected by default, because U-238 peak 0 dose isn't until year 3,981,072*. Technically, the ED for the resident is 26 years, but with respect to DCC, the result should focus on the year within the time period over which the maximum dose occurs (not the 26-year period). It is suggested that the last column be revised to "Maximum Dose Year."

Resident Peak Dose DCCs for Soil (complete chain decay)

Exposure Route	Peak DCC for U-234 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=26 (yrs)**
Ingestion	*9.60E+01*	*1.04E-02*	*4.01E-04*	*9.74E+02 - 1.00E+03***
Inhalation	*5.37E+03*	*1.86E-04*	*7.17E-06*	*9.74E+02 - 1.00E+03***
External Exposure	*1.68E+02*	*.96E-03*	*2.35E-04*	*9.74E+02 - 1.00E+03***
Total	*6.04E+01*	*1.66E-02*	*6.43E-04*	*9.74E+02 - 1.00E+03***

Resident Peak Dose DCCs for 2-D Direct External Exposure (complete chain decay)

Exposure Route	Peak DCC for U-234 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=26 (yrs)**
External Exposure - Soil Volume	*6.46E+00*	*1.55E-01*	*6.10E-03*	*9.74E+02 - 1.00E+03***
External Exposure - Ground Plane	*2.86E+01*	*3.49E-02*	*1.37E-03*	*9.74E+02 - 1.00E+03***
External Exposure - 1cm	*3.41E+01*	*2.93E-02*	*1.16E-03*	*9.74E+02 - 1.00E+03***
External Exposure - 5cm	*1.20E+01*	*8.30E-02*	*3.27E-03*	*9.74E+02 - 1.00E+03***
External Exposure - 15cm	*7.60E+00*	*1.32E-01*	*5.18E-03*	*9.74E+02 - 1.00E+03***

ATTACHMENT C--Site-Specific
Resident Soil Inputs (Response 3a)

Variable	Resident Soil Default Value	Site-Specific Value
A (PEF Dispersion Constant)	16.2302	16.2302
B (PEF Dispersion Constant)	18.7762	18.7762
City (Climate Zone)	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
Cover thickness for GSF_{a} (gamma shielding factor) cm	0 cm	0 cm
Cover thickness for GSF_{b} (gamma shielding factor) cm	0 cm	0 cm
AAF_{res-a} (biota age adjustment factor - resident adult) unitless	0.77	0.77
AAF_{res-c} (biota age adjustment factor - resident child) unitless	0.23	0.23
$CF_{res-produce}$ (contaminated plant fraction) unitless	1	1
DL (dose limit) mrem/yr	1	1
ED_{res-a} (produce exposure duration - resident adult) yr	20	20
ED_{res-c} (produce exposure duration - resident child) yr	6	6
EF_{res-a} (produce exposure frequency - resident adult) day/yr	350	350
EF_{res-c} (produce exposure frequency - resident child) day/yr	350	350
F(x) (function dependent on U_{m}/U_{t}) unitless	0.194	0.194
PEF (particulate emission factor) m^{3}/kg	1359344438	1359344438
Q/C_{wind} (g/m^{2}-s per kg/m^{3})	93.77	93.77
A_{e} (acres)	0.5	0.5
Site area for ACF (area correction factor) m^{2}	1000000 m^{2}	1000000 m^{2}
AAF_{res-a} (soil age adjustment factor - resident adult) unitless	0.77	0.77
AAF_{res-c} (soil age adjustment factor - resident child) unitless	0.23	0.23
DL (dose limit) mrem/yr	1	1
ED_{res} (soil exposure duration - resident) yr	26	26
ED_{res-a} (soil exposure duration - resident adult) yr	20	20
ED_{res-c} (soil exposure duration - resident child) yr	6	6
EF_{res} (soil exposure frequency - resident) day/yr	350	350
EF_{res-a} (soil exposure frequency - resident adult) day/yr	350	350
EF_{res-c} (soil exposure frequency - resident child) day/yr	350	350
ET_{res} (soil exposure time - resident) hr/day	24	24
ET_{res-a} (soil exposure time - resident adult) hr/day	24	24
ET_{res-c} (soil exposure time - resident child) hr/day	24	24
ET_{res-i} (soil exposure time - indoor resident) hr/day	16.416	16.416
ET_{res-o} (soil exposure time - outdoor resident) hr/day	1.752	1.752

Resident Soil Inputs

Variable	Resident Soil Default Value	Site-Specific Value
GSF_i (gamma shielding factor - indoor) unitless	0.4	0.4
$IFA_{res\text{-}adj}$ (age-adjusted soil inhalation factor - resident) m^3	6195	6195
$IFS_{res\text{-}adj}$ (age-adjusted soil ingestion factor - resident) mg	43050	43050
$IRA_{res\text{-}a}$ (soil inhalation rate - resident adult) m^3/day	20	20
$IRA_{res\text{-}c}$ (soil inhalation rate - resident child) m^3/day	10	10
$IRS_{res\text{-}a}$ (soil intake rate - resident adult) mg/day	100	100
$IRS_{res\text{-}c}$ (soil intake rate - resident child) mg/day	200	200
t_{res} (time - resident) yr	1	1
Soil type	Default	Default
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Resident DCCs for Soil (complete chain, no decay)

Isotope	Parent	ICRP Lung Absorption Type	Ingestion DCF (mrem/pCi)	Inhalation DCF (mrem/pCi)	External Exposure DCF (mrem/yr per pCi/g)	Halflife (years)	1000000 m^2 Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Total Indoor GSF Soil Volume	Particulate Emission Factor (m^3/kg)	Ingestion DCC DL=1.0E+00 (pCi/g)
U-234	U-234	S	2.15E-04	3.74E-02	3.46E-04	2.46E+05	1.00E+00	1.00E+00	4.00E-01	1.36E+09	1.08E+02
Th-230		F	9.36E-04	3.85E-01	1.11E-03	7.54E+04	1.00E+00	1.00E+00	4.00E-01	1.36E+09	2.48E+01
Ra-226		S	1.68E-03	3.81E-02	3.18E-02	1.60E+03	1.00E+00	1.00E+00	4.00E-01	1.36E+09	1.39E+01
Rn-222		-	0.00E+00	6.55E-06	2.13E-03	1.05E-02	1.00E+00	1.00E+00	4.00E-01	1.36E+09	-
Po-218		-	0.00E+00	7.62E-06	9.23E-09	5.90E-06	9.00E-01	1.00E+00	4.00E-01	1.36E+09	-
At-218		-	0.00E+00	0.00E+00	5.57E-05	4.76E-08	9.00E-01	1.00E+00	4.00E-01	1.36E+09	-
Rn-218		-	0.00E+00	0.00E+00	4.26E-03	1.11E-09	1.00E+00	1.00E+00	4.00E-01	1.36E+09	-
Pb-214		S	7.36E-07	4.66E-05	1.26E+00	5.10E-05	1.00E+00	1.00E+00	4.00E-01	1.36E+09	3.15E+04
Bi-214		S	5.51E-07	3.66E-05	9.13E+00	3.79E-05	1.00E+00	1.00E+00	4.00E-01	1.36E+09	4.21E+04
Po-214		-	0.00E+00	0.00E+00	4.80E-04	5.21E-12	1.00E+00	1.00E+00	4.00E-01	1.36E+09	-
Tl-210		-	0.00E+00	0.00E+00	1.68E+01	2.47E-06	1.00E+00	1.00E+00	4.00E-01	1.36E+09	-
Pb-210		S	3.77E-03	2.23E-02	2.09E-03	2.22E+01	1.00E+00	1.00E+00	4.00E-01	1.36E+09	6.15E+00
Bi-210		S	6.66E-06	5.40E-04	5.47E-03	1.37E-02	1.00E+00	1.00E+00	4.00E-01	1.36E+09	3.49E+03
Po-210		S	6.48E-03	1.73E-02	5.64E-05	3.79E-01	1.00E+00	1.00E+00	4.00E-01	1.36E+09	3.59E+00
Hg-206		-	0.00E+00	0.00E+00	6.13E-01	1.55E-05	1.00E+00	1.00E+00	4.00E-01	1.36E+09	-
Tl-206		-	0.00E+00	0.00E+00	1.28E-02	7.99E-06	1.00E+00	1.00E+00	4.00E-01	1.36E+09	-

Resident DCCs for Soil (complete chain, no decay)

Inhalation DCC DL=1.0E+00 (pCi/g)	External Exposure DCC DL=1.0E+00 (pCi/g)	Produce Consumption DCC DL=1.0E+00 (pCi/g)	Total DCC DL=1.0E+00 (pCi/g)	Total DCC DL=1.0E+00 (mg/kg)
5.87E+03	8.71E+03	-	**1.05E+02**	1.69E-02
5.70E+02	2.72E+03	-	**2.36E+01**	1.14E-03
5.76E+03	9.47E+01	-	**1.21E+01**	1.22E-05
3.35E+07	1.41E+03	-	**1.41E+03**	9.20E-09
2.88E+07	3.62E+08	-	**2.67E+07**	9.60E-08
-	6.01E+04	-	**6.01E+04**	1.74E-12
-	7.06E+02	-	**7.06E+02**	4.79E-16
4.71E+06	2.39E+00	-	**2.39E+00**	7.31E-14
6.00E+06	3.29E-01	-	**3.29E-01**	7.47E-15
-	6.27E+03	-	**6.27E+03**	1.96E-17
-	1.79E-01	-	**1.79E-01**	2.61E-16
9.83E+03	1.44E+03	-	**6.12E+00**	8.00E-08
4.06E+05	5.50E+02	-	**4.74E+02**	3.83E-09
1.27E+04	5.33E+04	-	**3.59E+00**	7.99E-10
-	4.91E+00	-	**4.91E+00**	4.39E-14
-	2.35E+02	-	**2.35E+02**	1.09E-12

Resident Produce DCCs for Soil

Isotope	Total Produce DCC DL=1.0E+00 (pCi/g)
U-234	-
Th-230	-
Ra-226	-
Rn-222	-
Po-218	-
At-218	-
Rn-218	-
Pb-214	-
Bi-214	-
Po-214	-
Tl-210	-
Pb-210	-
Bi-210	-
Po-210	-
Hg-206	-
Tl-206	-

Resident Peak Dose DCCs for Soil (complete chain decay)

Exposure Route	Peak DCC for U-234 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=26 (yrs)**	
Ingestion	*9.60E+01*	*1.04E-02*	*4.01E-04*	*9.74E+02 - 1.00E+03*	**
Inhalation	*5.37E+03*	*1.86E-04*	*7.17E-06*	*9.74E+02 - 1.00E+03*	**
External Exposure	*1.68E+02*	*5.96E-03*	*2.35E-04*	*9.74E+02 - 1.00E+03*	**
Total	*6.04E+01*	*1.66E-02*	*6.43E-04*	*9.74E+02 - 1.00E+03*	**

** Peak dose time has not been achieved. The maximum dose interval has been defined as the last 26 years before the user-entered time point.

ATTACHMENT D--Site-Specific Resident 2-D External Inputs (Response 3a)

Variable	Resident 2-D External Default Value	Site-Specific Value
Cover thickness for GSF_a (gamma shielding factor) cm	0 cm	0 cm
Cover thickness for GSF_b (gamma shielding factor) cm	0 cm	0 cm
DL (dose limit) mrem/yr	1	1
EF_{res} (exposure frequency - resident) day/yr	350	350
$ET_{res,i}$ (exposure time - indoor resident) hr/day	16.416	16.416
$ET_{res,o}$ (exposure time - outdoor resident) hr/day	1.752	1.752
GSF_i (gamma shielding factor - indoor) unitless	0.4	0.4
t_{res} (time - resident) yr	1	1
Site area for ACF (area correction factor) m^2	1000000 m^2	1000000 m^2

Resident DCCs for 2-D Direct External Exposure (complete chain, no decay)

Isotope	External Exposure DCF (mrem/yr per pCi/g)	External Exposure DCF (1 cm) (mrem/yr per pCi/g)	External Exposure DCF (5 cm) (mrem/yr per pCi/g)	External Exposure DCF (15 cm) (mrem/yr per pCi/g)	External Exposure DCF (Ground Plane) (mrem/yr per pCi/cm²)	Lambda (1/yr)	Halflife (years)	1000000 m² Soil Volume Area Correction Factor	1000000 m² Ground Plane Area Correction Factor	1000000 m² 1 cm Area Correction Factor	1000000 m² 5 cm Area Correction Factor	1000000 m² 15cm Area Correction Factor
U-234	3.46E-04	1.57E-04	2.91E-04	3.44E-04	6.78E-04	2.82E-06	2.46E+05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Th-230	1.11E-03	3.94E-04	8.87E-04	1.09E-03	7.49E-04	9.19E-06	7.54E+04	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ra-226	3.18E-02	7.92E-03	2.19E-02	3.10E-02	7.81E-03	4.33E-04	1.60E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Rn-222	2.13E-03	4.41E-04	1.26E-03	1.94E-03	4.35E-04	6.62E+01	1.05E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-218	9.23E-09	4.33E-09	8.11E-09	9.23E-09	7.77E-09	1.17E+05	5.90E-06	9.00E-01	9.00E-01	9.00E-01	9.00E-01	9.00E-01
At-218	5.57E-05	3.16E-05	4.43E-05	5.34E-05	1.46E-04	1.46E+07	4.76E-08	9.00E-01	9.00E-01	9.00E-01	9.00E-01	9.00E-01
Rn-218	4.26E-03	8.57E-04	2.45E-03	3.81E-03	8.46E-04	6.24E+08	1.11E-09	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pb-214	1.26E+00	2.80E-01	7.90E-01	1.17E+00	2.84E-01	1.36E+04	5.10E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Bi-214	9.13E+00	1.63E+00	4.71E+00	7.62E+00	1.66E+00	1.83E+04	3.79E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-214	4.80E-04	9.34E-05	2.67E-04	4.22E-04	9.20E-05	1.33E+11	5.21E-12	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tl-210	1.68E+01	3.06E+00	8.80E+00	1.41E+01	3.09E+00	2.80E+05	2.47E-06	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pb-210	2.09E-03	1.33E-03	2.05E-03	2.09E-03	2.54E-03	3.12E-02	2.22E+01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Bi-210	5.47E-03	3.14E-03	4.54E-03	5.36E-03	4.10E-02	5.05E+01	1.37E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-210	5.64E-05	1.09E-05	3.14E-05	4.93E-05	1.08E-05	1.83E+00	3.79E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Hg-206	6.13E-01	1.39E-01	3.87E-01	5.73E-01	1.74E-01	4.47E+04	1.55E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tl-206	1.28E-02	7.58E-03	1.06E-02	1.25E-02	7.15E-02	8.67E+04	7.99E-06	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Resident DCCs for 2-D Direct External Exposure (complete chain, no decay)

0 cm Soil Volume Gamma Shielding Factor	0 cm Ground Plane Gamma Shielding Factor	0 cm 1 cm Gamma Shielding Factor	0 cm 5 cm Gamma Shielding Factor	0 cm 15 cm Gamma Shielding Factor	Total Indoor GSF Soil Volume	Total Indoor GSF Ground Plane	Total Indoor GSF @ 1cm	Total Indoor GSF @ 5cm	Total Indoor GSF @ 15cm	Soil Volume DCC DL=1.0E+00 (pCi/g)	Soil Volume @ 1cm DCC DL=1.0E+00 (pCi/g)	Soil Volume @ 5cm DCC DL=1.0E+00 (pCi/g)
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**8.71E+03**	**1.92E+04**	**1.03E+04**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**2.72E+03**	**7.63E+03**	**3.39E+03**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**9.47E+01**	**3.80E+02**	**1.38E+02**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**1.41E+03**	**6.83E+03**	**2.39E+03**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**3.62E+08**	**7.71E+08**	**4.12E+08**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**6.01E+04**	**1.06E+05**	**7.55E+04**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**7.06E+02**	**3.51E+03**	**1.23E+03**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**2.39E+00**	**1.07E+01**	**3.81E+00**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**3.29E-01**	**1.85E+00**	**6.39E-01**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**6.27E+03**	**3.22E+04**	**1.13E+04**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**1.79E-01**	**9.82E-01**	**3.42E-01**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**1.44E+03**	**2.26E+03**	**1.46E+03**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**5.50E+02**	**9.59E+02**	**6.63E+02**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**5.33E+04**	**2.75E+05**	**9.59E+04**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**4.91E+00**	**2.17E+01**	**7.78E+00**
1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	**2.35E+02**	**3.97E+02**	**2.85E+02**

Resident DCCs for 2-D Direct External Exposure (complete chain, no decay)

Soil Volume @ 15cm DCC DL=1.0E+00 (pCi/g)	Ground Plane DCC DL=1.0E+00 (pCi/cm²)	Soil Volume DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 1cm DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 5cm DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 15cm DCC DL=1.0E+00 (mg/kg)	Ground Plane DCC DL=1.0E+00 (mg/cm²)
8.75E+03	**4.44E+03**	1.40E+00	3.09E+00	1.66E+00	1.41E+00	7.14E-04
2.76E+03	**4.02E+03**	1.32E-01	3.71E-01	1.65E-01	1.34E-01	1.95E-04
9.70E+01	**3.85E+02**	9.59E-05	3.85E-04	1.39E-04	9.82E-05	3.90E-07
1.55E+03	**6.92E+03**	9.20E-09	4.44E-08	1.56E-08	1.01E-08	4.51E-11
3.62E+08	**4.30E+08**	1.30E-06	2.78E-06	1.48E-06	1.30E-06	1.55E-09
6.26E+04	**2.29E+04**	1.74E-12	3.07E-12	2.19E-12	1.82E-12	6.64E-16
7.90E+02	**3.56E+03**	4.79E-16	2.38E-15	8.33E-16	5.35E-16	2.41E-18
2.56E+00	**1.06E+01**	7.31E-14	3.28E-13	1.16E-13	7.82E-14	3.24E-16
3.95E-01	**1.81E+00**	7.47E-15	4.19E-14	1.45E-14	8.96E-15	4.11E-17
7.13E+03	**3.27E+04**	1.96E-17	1.01E-16	3.52E-17	2.22E-17	1.02E-19
2.13E-01	**9.75E-01**	2.61E-16	1.43E-15	4.97E-16	3.09E-16	1.42E-18
1.44E+03	**1.19E+03**	1.88E-05	2.95E-05	1.91E-05	1.88E-05	1.55E-08
5.61E+02	**7.33E+01**	4.44E-09	7.74E-09	5.35E-09	4.53E-09	5.92E-13
6.10E+04	**2.79E+05**	1.19E-05	6.13E-05	2.14E-05	1.36E-05	6.22E-08
5.25E+00	**1.73E+01**	4.39E-14	1.94E-13	6.96E-14	4.69E-14	1.54E-16
2.41E+02	**4.21E+01**	1.09E-12	1.83E-12	1.31E-12	1.11E-12	1.94E-16

Resident Peak Dose DCCs for 2-D Direct External Exposure (complete chain decay)

Exposure Route	Peak DCC for U-234 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=26 (yrs)**
External Exposure - Soil Volume	*6.46E+00*	*1.55E-01*	*6.10E-03*	*9.74E+02 - 1.00E+03* **
External Exposure - Ground Plane	*2.86E+01*	*3.49E-02*	*1.37E-03*	*9.74E+02 - 1.00E+03* **
External Exposure - 1cm	*3.41E+01*	*2.93E-02*	*1.16E-03*	*9.74E+02 - 1.00E+03* **
External Exposure - 5cm	*1.20E+01*	*8.30E-02*	*3.27E-03*	*9.74E+02 - 1.00E+03* **
External Exposure - 15cm	*7.60E+00*	*1.32E-01*	*5.18E-03*	*9.74E+02 - 1.00E+03* **

** Peak dose time has not been achieved. The maximum dose interval has been defined as the last 26 years before the user-entered time point.

ATTACHMENT E—DCC/Dose Rate Comparison of Recreator External Exposure Under "Soil" Option and 2-D (Soil Volume) Option DCC *(See Response 3f)*

Recreator Peak Dose DCCs for Soil (complete chain decay)

Exposure Route	Peak DCC for Am-241 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=10 (yrs)
Ingestion	*9.54E+01*	*1.05E-02*	*1.06E-03*	*1.00E-08 - 1.00E+01*
Inhalation	*2.96E+04*	*3.38E-05*	*3.40E-06*	*1.00E-08 - 1.00E+01*
External Exposure	*1.40E+03*	*7.16E-04*	*7.21E-05*	*1.00E-08 - 1.00E+01*
Total	*8.90E+01*	*1.12E-02*	*1.13E-03*	*1.00E-08 - 1.00E+01*

Recreator Peak Dose DCCs for 2-D Direct External Exposure (complete chain decay)

Exposure Route	Peak DCC for Am-241 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=10 (yrs)
External Exposure - Soil Volume	*1.40E+02*	*7.16E-03*	*7.21E-04*	*1.00E-08 - 1.00E+01*
External Exposure - Ground Plane	*2.04E+02*	*4.91E-03*	*4.95E-04*	*1.00E-08 - 1.00E+01*
External Exposure - 1cm	*2.84E+02*	*3.52E-03*	*3.55E-04*	*1.00E-08 - 1.00E+01*
External Exposure - 5cm	*1.50E+02*	*6.65E-03*	*6.71E-04*	*1.00E-08 - 1.00E+01*
External Exposure - 15cm	*1.40E+02*	*7.16E-03*	*7.21E-04*	*1.00E-08 - 1.00E+01*

The blue circled values and red circled values should be equal, respectively, as these use the same equations and same input values as indicated on pp. 63 and 65 of the User's Guide pdf. Instead, these values are off by a factor of 10, which is equal to the exposure duration (ED) (10 yr) selected for this site-specific receptor. See Attachments F and G for output. Note from the equations in the User's Guide that the ED value is not included in the calculation of external radiation dose rate or DCC.

ATTACHMENT F
Site-Specific
Recreator Soil

Inputs

Variable	Recreator Soil Default Value	Site-Specific Value
A (PEF Dispersion Constant)	16.2302	16.2302
B (PEF Dispersion Constant)	18.7762	18.7762
City (Climate Zone)	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
$CF_{rec\text{-}fowl}$ (fowl contaminated fraction) unitless	1	1
$CF_{rec\text{-}game}$ (game contaminated fraction) unitless	1	1
DL (dose limit) mrem/yr	1	1
ED_{rec} (exposure duration - recreator) yr		10
EF_{rec} (exposure frequency - recreator) day/yr		100
$f_{p\text{-}fowl}$ (fowl on-site fraction) unitless	1	1
$f_{p\text{-}game}$ (land game on-site fraction) unitless	1	1
$f_{s\text{-}fowl}$ (fraction of year fowl is on site) unitless	1	1
$f_{s\text{-}game}$ (fraction of year land game is on site) unitless	1	1
$MLF_{pasture}$ (pasture plant mass loading factor) unitless	0.25	0.25
t_{rec} (time - recreator) yr	1	1
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
A_s (acres)	0.5	0.5
$AAF_{rec\text{-}a}$ (age adjustment factor - recreator adult) unitless		0.8
$AAF_{rec\text{-}c}$ (age adjustment factor - recreator child) unitless		0.2
DL (dose limit) mrem/yr	1	1
ED_{rec} (exposure duration - recreator) yr		10
$ED_{rec\text{-}a}$ (exposure duration - recreator adult) yr		8
$ED_{rec\text{-}c}$ (exposure duration - recreator child) yr		2
EF_{rec} (exposure frequency - recreator) day/yr		100
$EF_{rec\text{-}a}$ (exposure frequency - recreator adult) day/yr		100
$EF_{rec\text{-}c}$ (exposure frequency - recreator child) day/yr		100
ET_{rec} (exposure time - recreator) hr/day		1.7
$ET_{rec\text{-}a}$ (exposure time - recreator) hr/day		1.7
$ET_{rec\text{-}c}$ (exposure time - recreator) hr/day		1.7
$IFA_{rec\text{-}adj}$ (age-adjusted inhalation rate - recreator) m^3		127.5
$IFS_{rec\text{-}adj}$ (age-adjusted soil intake rate - recreator) mg		12000

Recreator Soil Inputs

Variable	Recreator Soil Default Value	Site-Specific Value
IRA_{rec-a} (inhalation rate - recreator adult) m^3/day	20	20
IRA_{rec-c} (inhalation rate - recreator child) m^3/day	10	10
IRS_{rec-a} (soil intake rate - recreator adult) mg/day	100	100
IRS_{rec-c} (soil intake rate - recreator child) mg/day	200	200
t_{rec} (time - recreator) yr	1	1
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Recreator DCCs for Soil (complete chain, no decay)

Isotope	Parent	ICRP Lung Absorption Type	Ingestion DCF (mrem/pCi)	Inhalation DCF (mrem/pCi)	External Exposure DCF (mrem/yr per pCi/g)	Lambda (1/yr)	Half-life (years)	1000000 m^2 Soil Volume Area Correction Factor	Particulate Emission Factor (m^3/kg)	Dry Soil-to-plant transfer factor (pCi/g-fresh plant per pCi/g-dry soil)	Plant-to-beef transfer factor (day/kg)
Am-241	Am-241	F	8.81E-04	3.63E-01	3.72E-02	1.60E-03	4.32E+02	1.00E+00	1.36E+09	2.53E-05	5.00E-04
Np-237		S	4.63E-04	4.66E-02	6.71E-02	3.23E-07	2.14E+06	1.00E+00	1.36E+09	3.33E-03	1.00E-04
Pa-233		S	4.88E-06	1.69E-05	1.02E+00	9.38E+00	7.39E-02	1.00E+00	1.36E+09	1.00E-01	5.00E-06
U-233		S	2.23E-04	3.81E-02	9.19E-04	4.35E-06	1.59E+05	1.00E+00	1.36E+09	7.13E-03	3.90E-04
Th-229		S	2.25E-03	2.79E-01	2.88E-01	9.44E-05	7.34E+03	1.00E+00	1.36E+09	2.41E-03	2.30E-04
Ra-225		S	8.81E-04	3.11E-02	8.91E-03	1.70E+01	4.08E-02	1.00E+00	1.36E+09	1.95E-02	1.70E-03
Ac-225		S	1.94E-04	3.40E-02	5.29E-02	2.53E+01	2.74E-02	1.00E+00	1.36E+09	1.00E-01	2.00E-05
Fr-221		-	0.00E+00	0.00E+00	1.33E-01	7.43E+04	9.32E-06	1.00E+00	1.36E+09	1.00E-01	3.00E-02
At-217		-	0.00E+00	0.00E+00	1.19E-03	6.77E+08	1.02E-09	1.00E+00	1.36E+09	9.00E-01	1.00E-02
Bi-213		S	9.92E-07	1.31E-04	6.87E-01	7.99E+03	8.67E-05	1.00E+00	1.36E+09	5.00E-01	2.00E-03
Po-213		-	0.00E+00	0.00E+00	2.17E-04	5.20E+12	1.33E-13	1.00E+00	1.36E+09	2.76E-04	3.00E-03
Tl-209		-	0.00E+00	0.00E+00	1.29E+01	1.69E+05	4.11E-06	1.00E+00	1.36E+09	8.00E-03	4.00E-02
Pb-209		S	2.76E-07	2.58E-07	7.53E-04	1.87E+03	3.71E-04	9.00E-01	1.36E+09	1.26E-02	7.00E-04

Recreator DCCs for Soil (complete chain, no decay)

Plant-to-poultry transfer factor (day/kg)	0 cm Soil Volume Gamma Shielding Factor	Ingestion DCC DL=1.0E+00 (pCi/g)	Inhalation DCC DL=1.0E+00 (pCi/g)	External Exposure DCC DL=1.0E+00 (pCi/g)	Soil to Game Consumption DCC DL=1.0E+00 (pCi/g)	Soil to Fowl Consumption DCC DL=1.0E+00 (pCi/g)	Total DCC DL=1.0E+00 (pCi/g)	Total DCC DL=1.0E+00 (mg/kg)
6.00E-03	1.00E+00	9.46E+01	2.94E+04	1.39E+03	-	-	**8.83E+01**	2.58E-05
-	1.00E+00	1.80E+02	2.29E+05	7.68E+02	-	-	**1.46E+02**	2.08E-01
-	1.00E+00	1.71E+04	6.32E+08	5.06E+01	-	-	**5.05E+01**	2.43E-09
7.50E-01	1.00E+00	3.74E+02	2.80E+05	5.61E+04	-	-	**3.71E+02**	3.85E-02
-	1.00E+00	3.70E+01	3.82E+04	1.79E+02	-	-	**3.06E+01**	1.44E-04
-	1.00E+00	9.46E+01	3.43E+05	5.78E+03	-	-	**9.31E+01**	2.39E-09
-	1.00E+00	4.31E+02	3.14E+05	9.75E+02	-	-	**2.98E+02**	5.15E-09
-	1.00E+00	-	-	3.87E+02	-	-	**3.87E+02**	2.23E-12
-	1.00E+00	-	-	4.34E+04	-	-	**4.34E+04**	2.70E-14
-	1.00E+00	8.40E+04	8.12E+07	7.50E+01	-	-	**7.49E+01**	3.87E-12
2.40E+00	1.00E+00	-	-	2.38E+05	-	-	**2.38E+05**	1.89E-17
-	1.00E+00	-	-	4.00E+00	-	-	**4.00E+00**	9.63E-15
-	1.00E+00	3.02E+05	4.13E+10	7.61E+04	-	-	**6.07E+04**	1.32E-08

Recreator Peak Dose DCCs for Soil (complete chain decay)

Exposure Route	Peak DCC for Am-241 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=10 (yrs)
Ingestion	*9.54E+01*	*1.05E-02*	*1.06E-03*	*1.00E-08 - 1.00E+01*
Inhalation	*2.96E+04*	*3.38E-05*	*3.40E-06*	*1.00E-08 - 1.00E+01*
External Exposure	*1.40E+03*	*7.16E-04*	*7.21E-05*	*1.00E-08 - 1.00E+01*
Total	*8.90E+01*	*1.12E-02*	*1.13E-03*	*1.00E-08 - 1.00E+01*

Recreator DCCs for Soil (complete chain, no decay)

Isotope	Parent	ICRP Lung Absorption Type	Ingestion DCF (mrem/pCi)	Inhalation DCF (mrem/pCi)	External Exposure DCF (mrem/yr per pCi/g)	Lambda (1/yr)	Half-life (years)	1000000 m^2 Soil Volume Area Correction Factor	Particulate Emission Factor (m^3/kg)	Dry Soil-to-plant transfer factor (pCi/g-fresh plant per pCi/g-dry soil)	Plant-to-beef transfer factor (day/kg)
U-234	U-234	S	2.15E-04	3.74E-02	3.46E-04	2.82E-06	2.46E+05	1.00E+00	1.36E+09	7.13E-03	3.90E-04
Th-230		F	9.36E-04	3.85E-01	1.11E-03	9.19E-06	7.54E+04	1.00E+00	1.36E+09	2.41E-03	2.30E-04
Ra-226		S	1.68E-03	3.81E-02	3.18E-02	4.33E-04	1.60E+03	1.00E+00	1.36E+09	1.95E-02	1.70E-03
Rn-222		-	0.00E+00	6.55E-06	2.13E-03	6.62E+01	1.05E-02	1.00E+00	1.36E+09	0.00E+00	0.00E+00
Po-218		-	0.00E+00	7.62E-06	9.23E-09	1.17E+05	5.90E-06	9.00E-01	1.36E+09	2.76E-04	3.00E-03
At-218		-	0.00E+00	0.00E+00	5.57E-05	1.46E+07	4.76E-08	9.00E-01	1.36E+09	9.00E-01	1.00E-02
Rn-218		-	0.00E+00	0.00E+00	4.26E-03	6.24E+08	1.11E-09	1.00E+00	1.36E+09	0.00E+00	0.00E+00
Pb-214		S	7.36E-07	4.66E-05	1.26E+00	1.36E+04	5.10E-05	1.00E+00	1.36E+09	1.26E-02	7.00E-04
Bi-214		S	5.51E-07	3.66E-05	9.13E+00	1.83E+04	3.79E-05	1.00E+00	1.36E+09	5.00E-01	2.00E-03
Po-214		-	0.00E+00	0.00E+00	4.80E-04	1.33E+11	5.21E-12	1.00E+00	1.36E+09	2.76E-04	3.00E-03
Tl-210		-	0.00E+00	0.00E+00	1.68E+01	2.80E+05	2.47E-06	1.00E+00	1.36E+09	8.00E-03	4.00E-02
Pb-210		S	3.77E-03	2.23E-02	2.09E-03	3.12E-02	2.22E+01	1.00E+00	1.36E+09	1.26E-02	7.00E-04
Bi-210		S	6.66E-06	5.40E-04	5.47E-03	5.05E+01	1.37E-02	1.00E+00	1.36E+09	5.00E-01	2.00E-03
Po-210		S	6.48E-03	1.73E-02	5.64E-05	1.83E+00	3.79E-01	1.00E+00	1.36E+09	2.76E-04	3.00E-03
Hg-206		-	0.00E+00	0.00E+00	6.13E-01	4.47E+04	1.55E-05	1.00E+00	1.36E+09	1.00E+00	1.00E-02
Tl-206		-	0.00E+00	0.00E+00	1.28E-02	8.67E+04	7.99E-06	1.00E+00	1.36E+09	8.00E-03	4.00E-02

Recreator DCCs for Soil (complete chain, no decay)

Plant-to-poultry transfer factor (day/kg)	0 cm Soil Volume Gamma Shielding Factor	Ingestion DCC DL=1.0E+00 (pCi/g)	Inhalation DCC DL=1.0E+00 (pCi/g)	External Exposure DCC DL=1.0E+00 (pCi/g)	Soil to Game Consumption DCC DL=1.0E+00 (pCi/g)	Soil to Fowl Consumption DCC DL=1.0E+00 (pCi/g)	Total DCC DL=1.0E+00 (pCi/g)	Total DCC DL=1.0E+00 (mg/kg)
7.50E-01	1.00E+00	3.88E+02	2.85E+05	1.49E+05	-	-	**3.86E+02**	6.21E-02
-	1.00E+00	8.90E+01	2.77E+04	4.66E+04	-	-	**8.86E+01**	4.30E-03
-	1.00E+00	4.97E+01	2.80E+05	1.62E+03	-	-	**4.82E+01**	4.88E-05
-	1.00E+00	-	1.63E+09	2.42E+04	-	-	**2.42E+04**	1.58E-07
2.40E+00	1.00E+00	-	1.40E+09	6.20E+09	-	-	**1.14E+09**	4.11E-06
-	1.00E+00	-	-	1.03E+06	-	-	**1.03E+06**	2.99E-11
-	1.00E+00	-	-	1.21E+04	-	-	**1.21E+04**	8.20E-15
-	1.00E+00	1.13E+05	2.29E+08	4.10E+01	-	-	**4.10E+01**	1.25E-12
-	1.00E+00	1.51E+05	2.91E+08	5.64E+00	-	-	**5.64E+00**	1.28E-13
2.40E+00	1.00E+00	-	-	1.07E+05	-	-	**1.07E+05**	3.35E-16
-	1.00E+00	-	-	3.07E+00	-	-	**3.07E+00**	4.47E-15
-	1.00E+00	2.21E+01	4.78E+05	2.46E+04	-	-	**2.21E+01**	2.88E-07
-	1.00E+00	1.25E+04	1.97E+07	9.41E+03	-	-	**5.37E+03**	4.34E-08
2.40E+00	1.00E+00	1.29E+01	6.16E+05	9.13E+05	-	-	**1.29E+01**	2.87E-09
3.00E-02	1.00E+00	-	-	8.41E+01	-	-	**8.41E+01**	7.52E-13
-	1.00E+00	-	-	4.03E+03	-	-	**4.03E+03**	1.86E-11

Recreator Peak Dose DCCs for Soil (complete chain decay)

Exposure Route	Peak DCC for U-234 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=10 (yrs)**
Ingestion	*3.44E+02*	*2.91E-03*	*2.91E-04*	*9.90E+02 - 1.00E+03* **
Inhalation	*2.61E+05*	*3.84E-06*	*3.84E-07*	*9.90E+02 - 1.00E+03* **
External Exposure	*2.83E+03*	*3.53E-04*	*3.56E-05*	*9.90E+02 - 1.00E+03* **
Total	*3.06E+02*	*3.26E-03*	*3.27E-04*	*9.90E+02 - 1.00E+03* **

** Peak dose time has not been achieved. The maximum dose interval has been defined as the last 10 years before the user-entered time point.

Attachment G--Site-Specific
Recreator 2-D External Inputs

Variable	Recreator 2-D External Default Value	Site-Specific Value
DL (dose limit) mrem/yr	1	1
EF_{rec} (exposure frequency - recreator) day/yr		100
ET_{rec} (exposure time - recreator) hr/day		1.7
t_{rec} (time - recreator) yr	1	1

Recreator DCCs for 2-D Direct External Exposure (complete chain, no decay)

Isotope	External Exposure DCF (mrem/yr per pCi/g)	External Exposure DCF (1 cm) (mrem/yr per pCi/g)	External Exposure DCF (5 cm) (mrem/yr per pCi/g)	External Exposure DCF (15 cm) (mrem/yr per pCi/g)	External Exposure DCF (Ground Plane) (mrem/yr per pCi/cm²)	Lambda (1/yr)	Half-life (years)	1000000 m² Soil Volume Area Correction Factor	1000000 m² Ground Plane Area Correction Factor	1000000 m² 1 cm Area Correction Factor	1000000 m² 5 cm Area Correction Factor	1000000 m² 15cm Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	0 cm Ground Plane Gamma Shielding Factor
Am-241	3.72E-02	1.83E-02	3.46E-02	3.72E-02	2.55E-02	1.60E-03	4.32E+02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Np-237	6.71E-02	2.24E-02	5.34E-02	6.69E-02	2.85E-02	3.23E-07	2.14E+06	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pa-233	1.02E+00	2.37E-01	6.59E-01	9.64E-01	2.36E-01	9.38E+00	7.39E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
U-233	9.19E-04	2.71E-04	6.56E-04	8.89E-04	5.56E-04	4.35E-06	1.59E+05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Th-229	2.88E-01	8.57E-02	2.19E-01	2.84E-01	9.06E-02	9.44E-05	7.34E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ra-225	8.91E-03	6.46E-03	8.87E-03	8.91E-03	1.29E-02	1.70E+01	4.08E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ac-225	5.29E-02	1.46E-02	3.81E-02	5.14E-02	1.54E-02	2.53E+01	2.74E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Fr-221	1.33E-01	3.19E-02	8.93E-02	1.28E-01	3.14E-02	7.43E+04	9.32E-06	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
At-217	1.19E-03	2.69E-04	7.51E-04	1.11E-03	2.65E-04	6.77E+08	1.02E-09	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Bi-213	6.87E-01	1.49E-01	4.15E-01	6.30E-01	1.92E-01	7.99E+03	8.67E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-213	2.17E-04	4.22E-05	1.21E-04	1.91E-04	4.17E-05	5.20E+12	1.33E-13	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tl-209	1.29E+01	2.35E+00	6.76E+00	1.08E+01	2.36E+00	1.69E+05	4.11E-06	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pb-209	7.53E-04	2.95E-04	5.96E-04	7.42E-04	3.73E-03	1.87E+03	3.71E-04	9.00E-01	9.00E-01	9.00E-01	9.00E-01	9.00E-01	1.00E+00	1.00E+00

Recreator DCCs for 2-D Direct External Exposure (complete chain, no decay)

0 cm 1 cm Gamma Shielding Factor	0 cm 5 cm Gamma Shielding Factor	0 cm 15 cm Gamma Shielding Factor	Soil Volume DCC DL=1.0E+00 (pCi/g)	Soil Volume @ 1cm DCC DL=1.0E+00 (pCi/g)	Soil Volume @ 5cm DCC DL=1.0E+00 (pCi/g)	Soil Volume @ 15cm DCC DL=1.0E+00 (pCi/g)	Ground Plane DCC DL=1.0E+00 (pCi/cm²)	Soil Volume DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 1cm DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 5cm DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 15cm DCC DL=1.0E+00 (mg/kg)	Ground Plane DCC DL=1.0E+00 (mg/cm²)
1.00E+00	1.00E+00	1.00E+00	**1.39E+03**	**2.81E+03**	**1.49E+03**	**1.39E+03**	**2.02E+03**	4.04E-04	8.21E-04	4.35E-04	4.04E-04	5.90E-07
1.00E+00	1.00E+00	1.00E+00	**7.68E+02**	**2.30E+03**	**9.65E+02**	**7.71E+02**	**1.81E+03**	1.09E+00	3.27E+00	1.37E+00	1.10E+00	2.57E-03
1.00E+00	1.00E+00	1.00E+00	**5.06E+01**	**2.17E+02**	**7.81E+01**	**5.35E+01**	**2.18E+02**	2.44E-09	1.05E-08	3.77E-09	2.58E-09	1.05E-11
1.00E+00	1.00E+00	1.00E+00	**5.61E+04**	**1.90E+05**	**7.86E+04**	**5.80E+04**	**9.26E+04**	5.82E+00	1.98E+01	8.16E+00	6.02E+00	9.62E-03
1.00E+00	1.00E+00	1.00E+00	**1.79E+02**	**6.01E+02**	**2.36E+02**	**1.81E+02**	**5.69E+02**	8.43E-04	2.83E-03	1.11E-03	8.54E-04	2.68E-06
1.00E+00	1.00E+00	1.00E+00	**5.78E+03**	**7.97E+03**	**5.81E+03**	**5.78E+03**	**4.01E+03**	1.49E-07	2.05E-07	1.49E-07	1.49E-07	1.03E-10
1.00E+00	1.00E+00	1.00E+00	**9.75E+02**	**3.53E+03**	**1.35E+03**	**1.00E+03**	**3.34E+03**	1.68E-08	6.10E-08	2.33E-08	1.73E-08	5.76E-11
1.00E+00	1.00E+00	1.00E+00	**3.87E+02**	**1.61E+03**	**5.77E+02**	**4.02E+02**	**1.64E+03**	2.23E-12	9.31E-12	3.33E-12	2.32E-12	9.45E-15
1.00E+00	1.00E+00	1.00E+00	**4.34E+04**	**1.92E+05**	**6.86E+04**	**4.64E+04**	**1.94E+05**	2.70E-14	1.19E-13	4.27E-14	2.89E-14	1.21E-16
1.00E+00	1.00E+00	1.00E+00	**7.50E+01**	**3.47E+02**	**1.24E+02**	**8.19E+01**	**2.69E+02**	3.88E-12	1.79E-11	6.43E-12	4.23E-12	1.39E-14
1.00E+00	1.00E+00	1.00E+00	**2.38E+05**	**1.22E+06**	**4.26E+05**	**2.70E+05**	**1.23E+06**	1.89E-17	9.70E-17	3.39E-17	2.15E-17	9.81E-20
1.00E+00	1.00E+00	1.00E+00	**4.00E+00**	**2.19E+01**	**7.62E+00**	**4.76E+00**	**2.18E+01**	9.63E-15	5.27E-14	1.83E-14	1.15E-14	5.25E-17
1.00E+00	1.00E+00	1.00E+00	**7.61E+04**	**1.94E+05**	**9.61E+04**	**7.72E+04**	**1.54E+04**	1.65E-08	4.22E-08	2.09E-08	1.68E-08	3.34E-12

Recreator Peak Dose DCCs for 2-D Direct External Exposure (complete chain decay)

Exposure Route	Peak DCC for Am-241 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=10 (yrs)
External Exposure - Soil Volume	*1.40E+02*	*7.16E-03*	*7.21E-04*	*1.00E-08 - 1.00E+01*
External Exposure - Ground Plane	*2.04E+02*	*4.91E-03*	*4.95E-04*	*1.00E-08 - 1.00E+01*
External Exposure - 1cm	*2.84E+02*	*3.52E-03*	*3.55E-04*	*1.00E-08 - 1.00E+01*
External Exposure - 5cm	*1.50E+02*	*6.65E-03*	*6.71E-04*	*1.00E-08 - 1.00E+01*
External Exposure - 15cm	*1.40E+02*	*7.16E-03*	*7.21E-04*	*1.00E-08 - 1.00E+01*

Recreator DCCs for 2-D Direct External Exposure (complete chain, no decay)

Isotope	External Exposure DCF (mrem/yr per pCi/g)	External Exposure DCF (1 cm) (mrem/yr per pCi/g)	External Exposure DCF (5 cm) (mrem/yr per pCi/g)	External Exposure DCF (15 cm) (mrem/yr per pCi/g)	External Exposure DCF (Ground Plane) (mrem/yr per pCi/cm²)	Lambda (1/yr)	Half-life (years)	1000000 m² Soil Volume Area Correction Factor	1000000 m² Ground Plane Area Correction Factor	1000000 m² 1 cm Area Correction Factor	1000000 m² 5 cm Area Correction Factor	1000000 m² 15cm Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	0 cm Ground Plane Gamma Shielding Factor
U-234	3.46E-04	1.57E-04	2.91E-04	3.44E-04	6.78E-04	2.82E-06	2.46E+05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Th-230	1.11E-03	3.94E-04	8.87E-04	1.09E-03	7.49E-04	9.19E-06	7.54E+04	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ra-226	3.18E-02	7.92E-03	2.19E-02	3.10E-02	7.81E-03	4.33E-04	1.60E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Rn-222	2.13E-03	4.41E-04	1.26E-03	1.94E-03	4.35E-04	6.62E+01	1.05E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-218	9.23E-09	4.33E-09	8.11E-09	9.23E-09	7.77E-09	1.17E+05	5.90E-06	9.00E-01	9.00E-01	9.00E-01	9.00E-01	9.00E-01	1.00E+00	1.00E+00
At-218	5.57E-05	3.16E-05	4.43E-05	5.34E-05	1.46E-04	1.46E+07	4.76E-08	9.00E-01	9.00E-01	9.00E-01	9.00E-01	9.00E-01	1.00E+00	1.00E+00
Rn-218	4.26E-03	8.57E-04	2.45E-03	3.81E-03	8.46E-04	6.24E+08	1.11E-09	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pb-214	1.26E+00	2.80E-01	7.90E-01	1.17E+00	2.84E-01	1.36E+04	5.10E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Bi-214	9.13E+00	1.63E+00	4.71E+00	7.62E+00	1.66E+00	1.83E+04	3.79E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-214	4.80E-04	9.34E-05	2.67E-04	4.22E-04	9.20E-05	1.33E+11	5.21E-12	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tl-210	1.68E+01	3.06E+00	8.80E+00	1.41E+01	3.09E+00	2.80E+05	2.47E-06	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pb-210	2.09E-03	1.33E-03	2.05E-03	2.09E-03	2.54E-03	3.12E-02	2.22E+01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Bi-210	5.47E-03	3.14E-03	4.54E-03	5.36E-03	4.10E-02	5.05E+01	1.37E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Po-210	5.64E-05	1.09E-05	3.14E-05	4.93E-05	1.08E-05	1.83E+00	3.79E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Hg-206	6.13E-01	1.39E-01	3.87E-01	5.73E-01	1.74E-01	4.47E+04	1.55E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tl-206	1.28E-02	7.58E-03	1.06E-02	1.25E-02	7.15E-02	8.67E+04	7.99E-06	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Recreator DCCs for 2-D Direct External Exposure (complete chain, no decay)

0 cm 1 cm Gamma Shielding Factor	0 cm 5 cm Gamma Shielding Factor	0 cm 15 cm Gamma Shielding Factor	Soil Volume DCC DL=1.0E+00 (pCi/g)	Soil Volume @ 1cm DCC DL=1.0E+00 (pCi/g)	Soil Volume @ 5cm DCC DL=1.0E+00 (pCi/g)	Soil Volume @ 15cm DCC DL=1.0E+00 (pCi/g)	Ground Plane DCC DL=1.0E+00 (pCi/cm²)	Soil Volume DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 1cm DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 5cm DCC DL=1.0E+00 (mg/kg)	Soil Volume @ 15cm DCC DL=1.0E+00 (mg/kg)	Ground Plane DCC DL=1.0E+00 (mg/cm²)
1.00E+00	1.00E+00	1.00E+00	**1.49E+05**	**3.29E+05**	**1.77E+05**	**1.50E+05**	**7.60E+04**	2.40E+01	5.29E+01	2.84E+01	2.41E+01	1.22E-02
1.00E+00	1.00E+00	1.00E+00	**4.66E+04**	**1.31E+05**	**5.81E+04**	**4.72E+04**	**6.88E+04**	2.26E+00	6.35E+00	2.82E+00	2.29E+00	3.34E-03
1.00E+00	1.00E+00	1.00E+00	**1.62E+03**	**6.51E+03**	**2.36E+03**	**1.66E+03**	**6.60E+03**	1.64E-03	6.59E-03	2.39E-03	1.68E-03	6.68E-06
1.00E+00	1.00E+00	1.00E+00	**2.42E+04**	**1.17E+05**	**4.10E+04**	**2.65E+04**	**1.18E+05**	1.58E-07	7.61E-07	2.67E-07	1.73E-07	7.72E-10
1.00E+00	1.00E+00	1.00E+00	**6.20E+09**	**1.32E+10**	**7.06E+09**	**6.20E+09**	**7.37E+09**	2.23E-05	4.76E-05	2.54E-05	2.23E-05	2.65E-08
1.00E+00	1.00E+00	1.00E+00	**1.03E+06**	**1.81E+06**	**1.29E+06**	**1.07E+06**	**3.92E+05**	2.99E-11	5.27E-11	3.75E-11	3.11E-11	1.14E-14
1.00E+00	1.00E+00	1.00E+00	**1.21E+04**	**6.01E+04**	**2.11E+04**	**1.35E+04**	**6.09E+04**	8.20E-15	4.07E-14	1.43E-14	9.16E-15	4.12E-17
1.00E+00	1.00E+00	1.00E+00	**4.10E+01**	**1.84E+02**	**6.52E+01**	**4.39E+01**	**1.81E+02**	1.25E-12	5.62E-12	1.99E-12	1.34E-12	5.54E-15
1.00E+00	1.00E+00	1.00E+00	**5.64E+00**	**3.16E+01**	**1.09E+01**	**6.76E+00**	**3.10E+01**	1.28E-13	7.18E-13	2.48E-13	1.53E-13	7.04E-16
1.00E+00	1.00E+00	1.00E+00	**1.07E+05**	**5.52E+05**	**1.93E+05**	**1.22E+05**	**5.60E+05**	3.35E-16	1.72E-15	6.02E-16	3.81E-16	1.75E-18
1.00E+00	1.00E+00	1.00E+00	**3.07E+00**	**1.68E+01**	**5.86E+00**	**3.64E+00**	**1.67E+01**	4.47E-15	2.45E-14	8.52E-15	5.30E-15	2.43E-17
1.00E+00	1.00E+00	1.00E+00	**2.46E+04**	**3.87E+04**	**2.51E+04**	**2.46E+04**	**2.03E+04**	3.22E-04	5.06E-04	3.27E-04	3.22E-04	2.65E-07
1.00E+00	1.00E+00	1.00E+00	**9.41E+03**	**1.64E+04**	**1.14E+04**	**9.61E+03**	**1.26E+03**	7.60E-08	1.33E-07	9.17E-08	7.76E-08	1.01E-11
1.00E+00	1.00E+00	1.00E+00	**9.13E+05**	**4.71E+06**	**1.64E+06**	**1.04E+06**	**4.78E+06**	2.04E-04	1.05E-03	3.66E-04	2.33E-04	1.07E-06
1.00E+00	1.00E+00	1.00E+00	**8.41E+01**	**3.72E+02**	**1.33E+02**	**8.99E+01**	**2.96E+02**	7.52E-13	3.33E-12	1.19E-12	8.04E-13	2.65E-15
1.00E+00	1.00E+00	1.00E+00	**4.03E+03**	**6.79E+03**	**4.87E+03**	**4.14E+03**	**7.20E+02**	1.86E-11	3.13E-11	2.25E-11	1.91E-11	3.32E-15

Recreator Peak Dose DCCs for 2-D
Direct External Exposure (complete chain decay)

Exposure Route	Peak DCC for U-234 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=10 (yrs)**
External Exposure - Soil Volume	*2.83E+02*	*3.53E-03*	*3.56E-04*	*9.90E+02 - 1.00E+03* **
External Exposure - Ground Plane	*1.26E+03*	*7.94E-04*	*8.00E-05*	*9.90E+02 - 1.00E+03* **
External Exposure - 1cm	*1.50E+03*	*6.69E-04*	*6.75E-05*	*9.90E+02 - 1.00E+03* **
External Exposure - 5cm	*5.29E+02*	*1.89E-03*	*1.91E-04*	*9.90E+02 - 1.00E+03* **
External Exposure - 15cm	*3.33E+02*	*3.00E-03*	*3.03E-04*	*9.90E+02 - 1.00E+03* **

** Peak dose time has not been achieved. The maximum dose interval has been defined as the last 10 years before the user-entered time point.

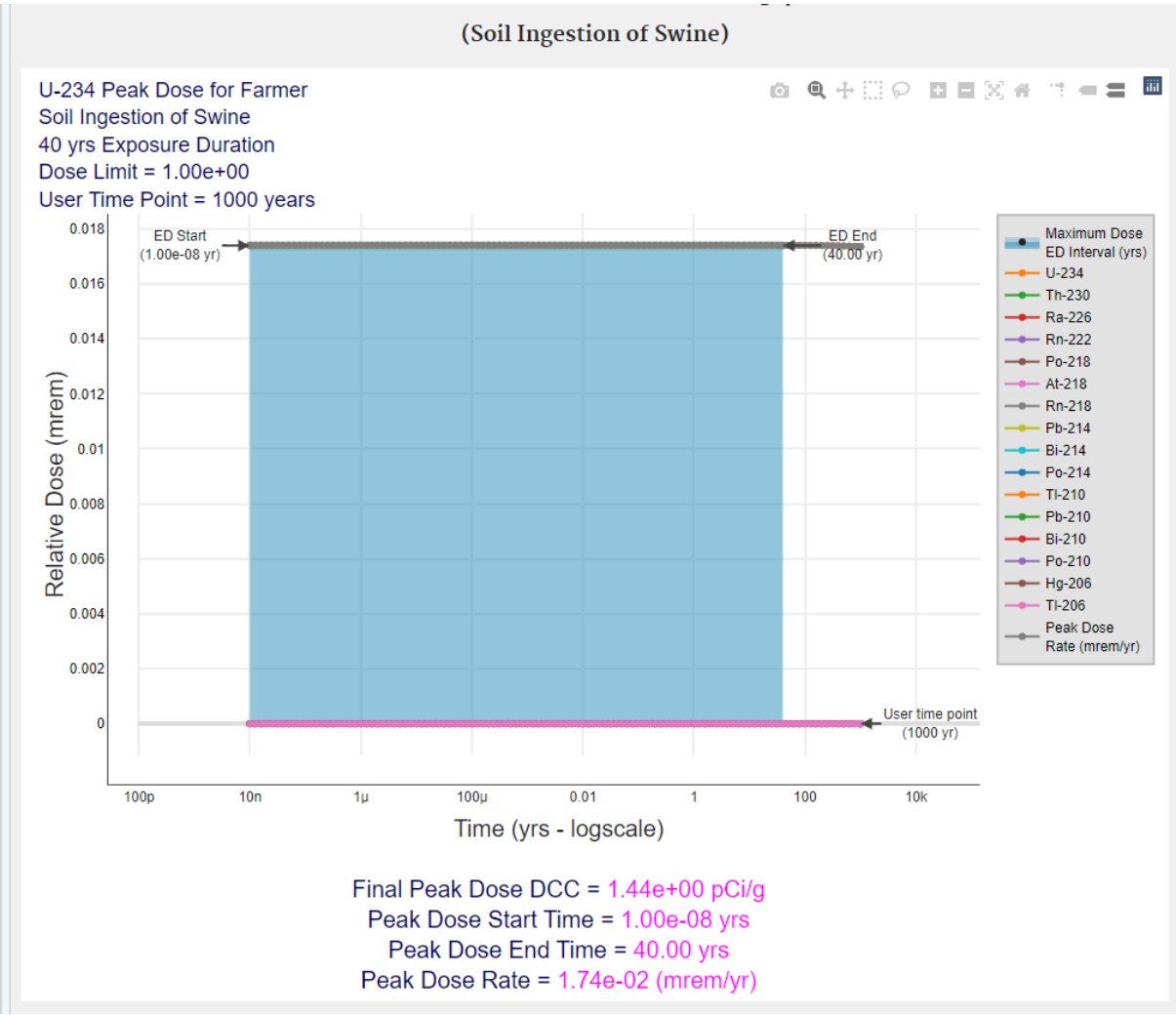
ATTACHMENT H—Summary of Farmer DCC Maximum Dose Intervals of U-234 for Swine Consumption as Compared to the Consumption of Other Agricultural Products

Farmer Peak Dose DCCs for Soil (complete chain decay)

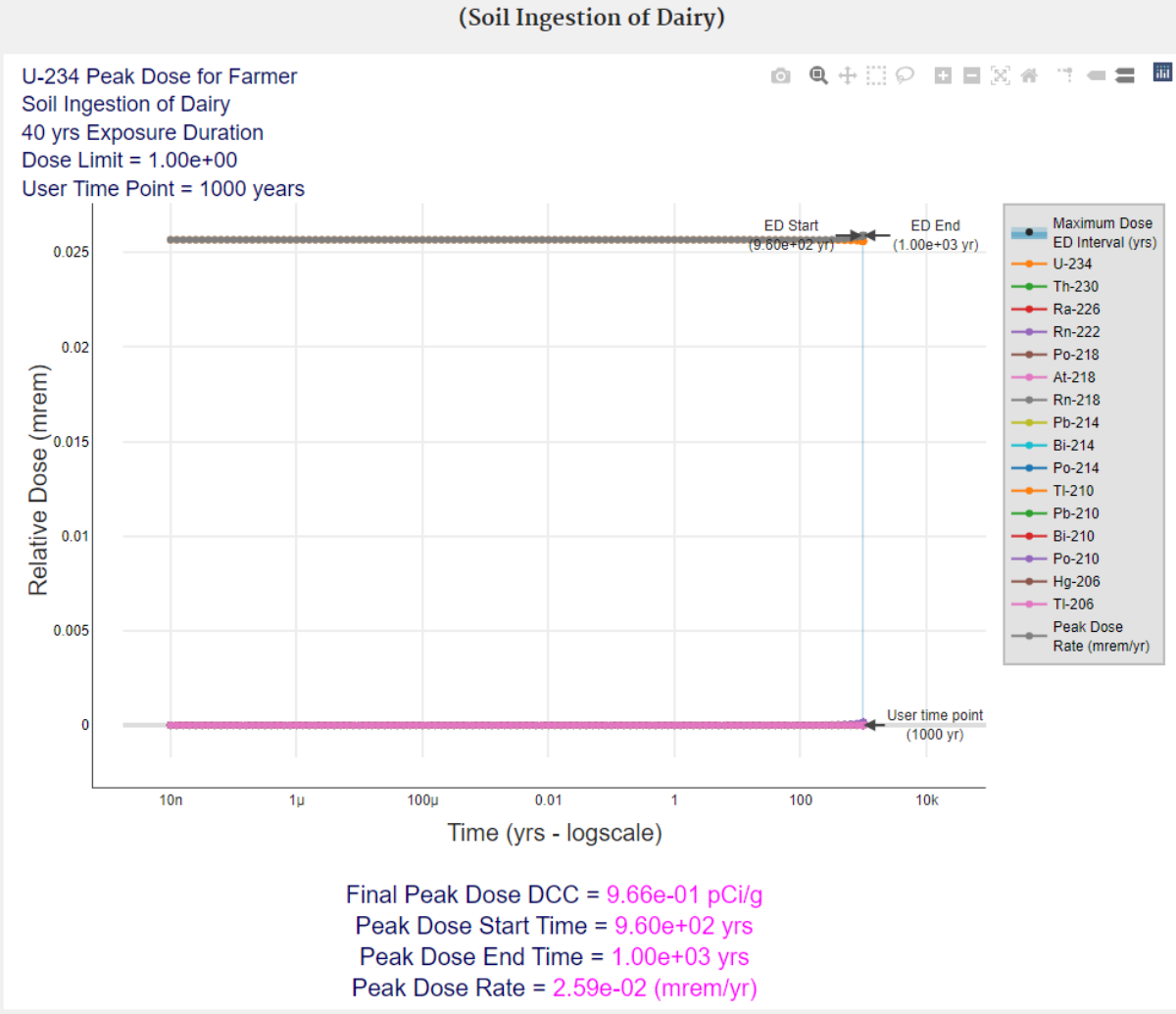
Exposure Route	Peak DCC for U-234 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=40 (yrs)**
Ingestion	*1.03E+02*	*9.72E-03*	*2.44E-04*	*9.60E+02 - 1.00E+03***
Inhalation	*5.14E+03*	*1.95E-04*	*4.87E-06*	*9.60E+02 - 1.00E+03***
External Exposure	*8.75E+01*	*1.14E-02*	*2.97E-04*	*9.60E+02 - 1.00E+03***
Finfish Consumption	*3.90E-02*	*2.56E+01*	*6.41E-01*	*9.60E+02 - 1.00E+03***
Shellfish Consumption	*1.71E-04*	*5.86E+03*	*1.47E+02*	*9.60E+02 - 1.00E+03***
Beef Consumption	*2.72E+01*	*3.67E-02*	*9.29E-04*	*9.60E+02 - 1.00E+03***
Dairy Consumption	*9.66E-01*	*1.04E+00*	*2.59E-02*	*9.60E+02 - 1.00E+03***
Swine Consumption	*1.44E+00*	*6.96E-01*	*1.74E-02*	*1.00E-08 - 4.00E+01*
Poultry Consumption	*1.35E+00*	*7.42E-01*	*1.87E-02*	*9.60E+02 - 1.00E+03***
Egg Consumption	*1.69E+00*	*5.92E-01*	*1.49E-02*	*9.60E+02 - 1.00E+03***
Total	*1.70E-04*	*5.89E+03*	*1.47E+02*	*9.60E+02 - 1.00E+03***

** Peak dose time has not been achieved. The maximum dose interval has been defined as the last 40 years before the user-entered time point.

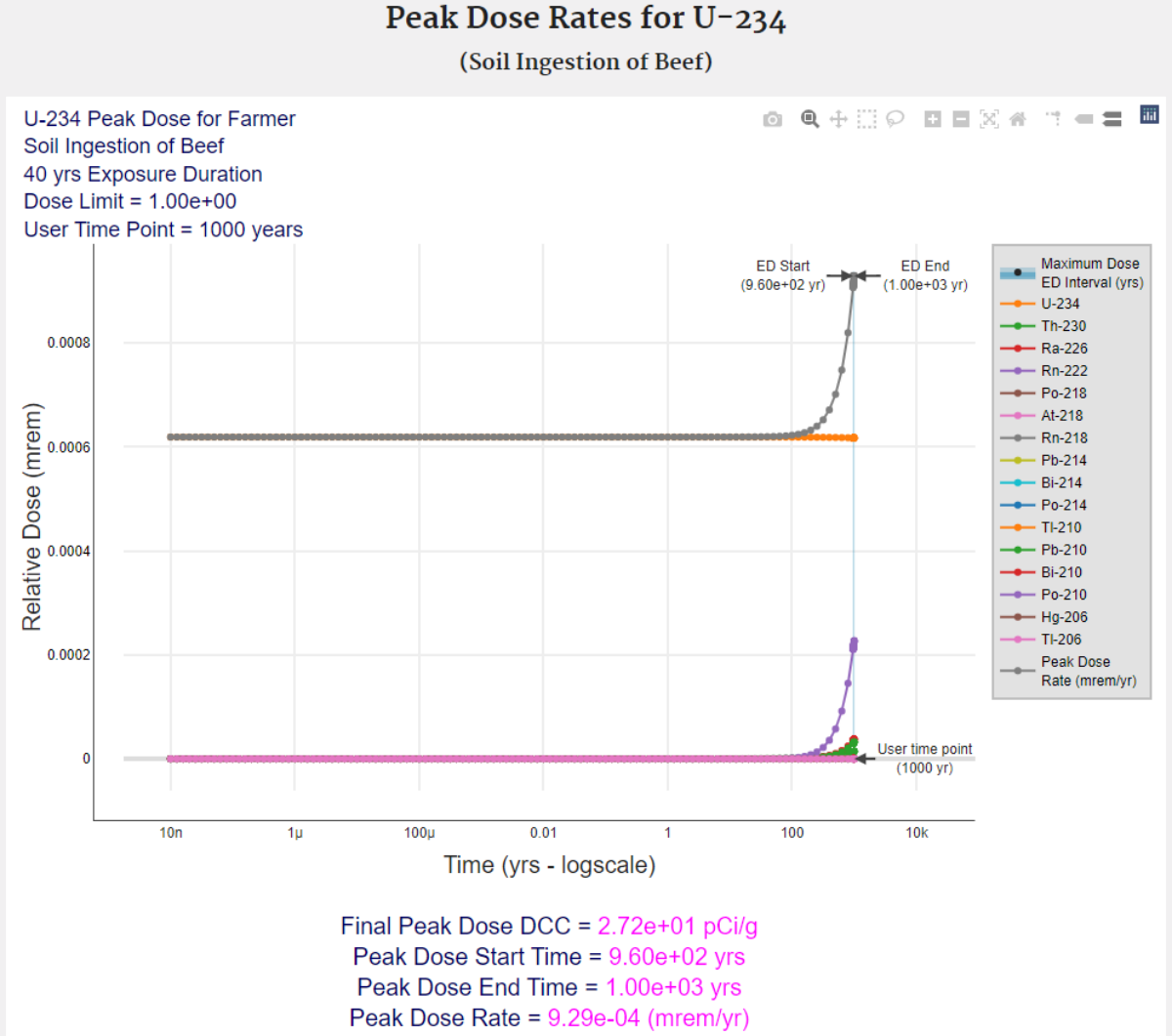
The dose rate associated with swine consumption is shown on the accompanying Graph 1 as occurring in year 0-1, then negligibly gradually decreasing for the nest 999 years. This runs counter to e.g., the ingestion of dairy (see attached Graph 2), where the dose rate negligibly gradually increases to its highest level at year 999-1,000. Also, the dose rate associated ingestion of beef increases negligibly until approximately year 100, then increases more rapidly (see attached Graph 3).



Graph 1. Ingeston of Swine Peak Dose.

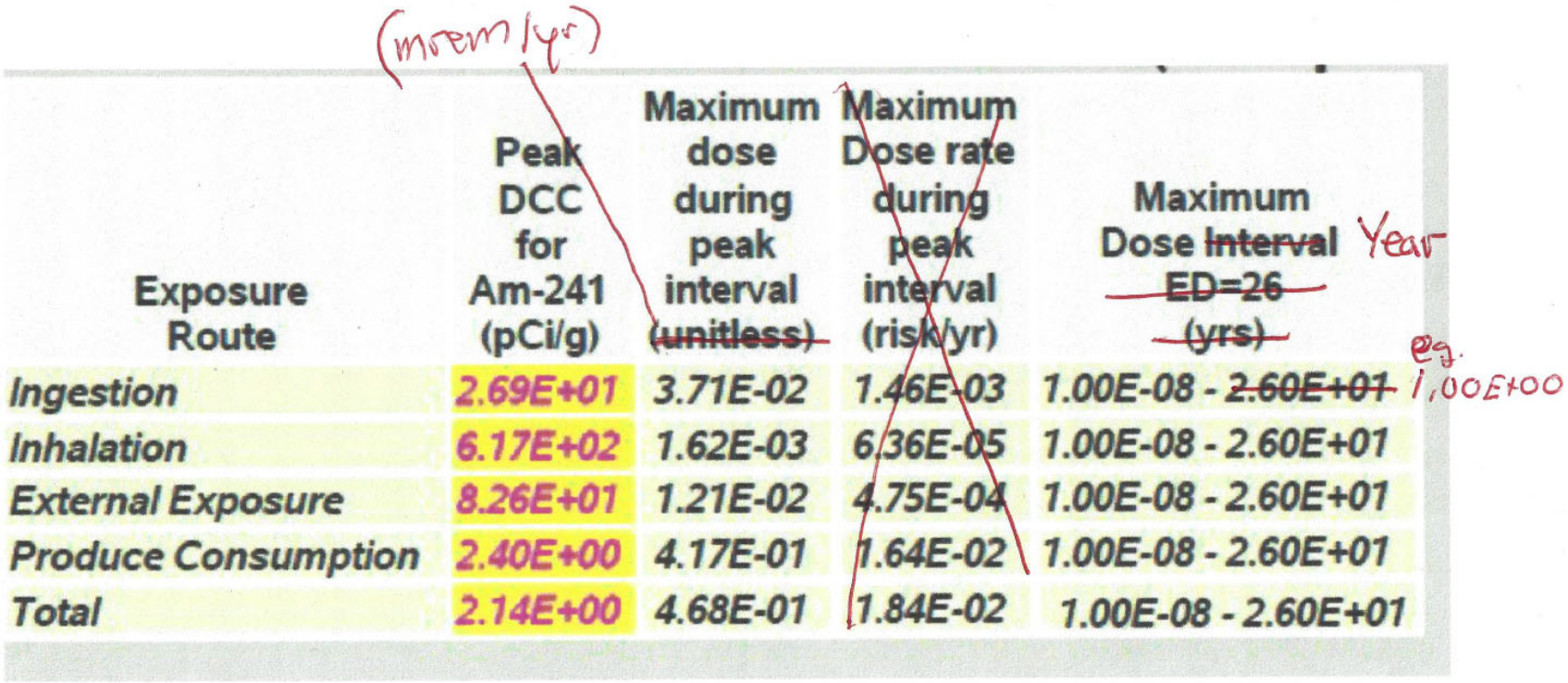


Graph 2. Ingestion of Dairy Peak Dose.



Graph 3. Ingestion of Beef Peak Dose.

ATTACHMENT I –Suggested Revisions to DCC Output Summary



Exposure Route	Peak DCC for Am-241 (pCi/g)	Maximum dose during peak interval (unitless)	Maximum Dose rate during peak interval (risk/yr)	Maximum Dose Interval ED=26 (yrs)
Ingestion	2.69E+01	3.71E-02	1.46E-03	1.00E-08 - 2.60E+01
Inhalation	6.17E+02	1.62E-03	6.36E-05	1.00E-08 - 2.60E+01
External Exposure	8.26E+01	1.21E-02	4.75E-04	1.00E-08 - 2.60E+01
Produce Consumption	2.40E+00	4.17E-01	1.64E-02	1.00E-08 - 2.60E+01
Total	2.14E+00	4.68E-01	1.84E-02	1.00E-08 - 2.60E+01

These following suggested revisions apply to all receptors/pathways: 1) The 3rd column of the output is labeled "Maximum dose during peak interval (unitless)." The calculation is 26X the maximum dose rate; thus, the units would seemingly be "mrem" over the entire exposure duration. Because ARARs are based on mrem/year, the third column should either be eliminated or an explanation should be provided as to how it is used to calculate a DCC that is based on the 1-yr period of maximum dose rate (mrem/yr). 2) The 4th column is headed "Maximum dose rate during peak interval" (risk/yr). The units should be "mrem/yr". 3) In the 5th column, “Maximum dose interval” should be replaced with a heading such as, “Maximum Dose Year.” Mention of ED should be eliminated, or an explanation should be provided as to how it is used to calculate a DCC that is based on the 1-yr period of maximum dose rate (mrem/yr). Note that the ED is (errantly) applied only to the resident, recreator and farmer receptors, whereas the t=1 values is correctly applied to the worker scenarios such that the length of the maximum dose interval is correctly shown as 1 year. The User's Guide (p. 108 of the pdf) also uses a t=1 for the resident and farmer receptors as well as for the worker scenarios; t=1 is reflected in the 5th column of the DCC output summaries for the worker scenarios rather than a multi-year ED value.

Thomas J. Siard

Senior Scientist

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KEY QUALIFICATIONS

- ★ *30 years of CERCLA and RCRA regulatory compliance experience*
- ★ *Subject matter expert in chemical/radiological human health and ecological risk assessment*
- ★ *Expertise in the development of regulatory compliance documentation including remedial investigations/feasibility studies, RCRA Facility Investigations, proposed plans, records of decision, corrective measures studies, non-time critical removal actions, action memoranda, five-year reviews and other documents*

EDUCATION

UNIVERSITY OF TENNESSEE, KNOXVILLE, TN

M.S., Environmental Toxicology, 1990

PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA

B.S., Biology, 1986

EXPERIENCE SUMMARY

Mr. Tom Siard is an environmental professional with 30 years of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) experience supporting Department of Energy (DOE), the Department of Defense (DOD), and commercial projects. He is a subject matter expert in chemical/radiological human health and ecological risk assessment and has developed numerous regulatory compliance documents. This includes risk assessment support for many remedial investigations/feasibility studies, RCRA facility investigations, proposed plans, records of decision (ROD), corrective measures studies, non-time critical removal actions, action memoranda, five-year reviews and other documents. In the performance of his work, Mr. Siard routinely interfaces with clients, regulators, and stakeholders to address the probability of adverse health effects in humans who may be exposed to chemicals in contaminated environmental media, now or in the future.

PRESENT POSITION

STRATA-G, LLC, KNOXVILLE, TN

Senior Scientist, 02/2019 – Present

- Subject matter expert in chemical/radiological human health and ecological risk assessment. Experienced in the use of RESRAD software and the EPA PRG Calculator.

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- Provided human health and ecological risk assessment evaluation and support for the Fifth Five-Year Review Report for the Rocky Flats Site to determine whether the remedy is still protective of human health and the environment for each of three areas included in the ROD. This includes evaluation of radiological and chemical contaminants. Included the use of the EPA PRG Calculator and EPA RSL Calculator using site-specific input.
- Provided human health and ecological risk assessment evaluation and support for the Sixth Five-Year Review for Monticello Mill Tailings Site (MMTS) and Sixth Five-year Review for Monticello Radioactively Contaminated Properties (MVP). The MMTS consists of three OUs, and the MVP consists of multiple areas. This review was performed to determine the protectiveness of the remedy and includes the evaluation of five separate supplemental standards that were developed as part of the remedy, consistent with 40 CFR 192.21 and 192.22. Included the use of RESRAD, the EPA PRG Calculator, and the EPA RSL Calculator
- Performed human health and ecological risk assessments for the Paducah Gaseous Diffusion Plant for Parcel A1 title transfer. Included the evaluation of exposure and associated risks/hazards to chemical and radiological contaminants in soil, groundwater, surface water, and sediment under multiple potential human exposure scenarios. Also evaluated exposure of multiple ecological receptors to contaminants in these same media for the potential of adverse effects to ecological receptors using multiple lines of evidence.
- Supported DOE Oak Ridge Environmental Management office (OREM) by preparing the data quality objective (DQO) presentation and the *Sampling and Analysis Plan / Quality Assurance Project Plan for the Waste Handling Plan for the Big Spring Water Treatment System Waste at the Y-12 National Security Complex*.
- Supported DOE OREM in developing an addendum to the *Remedial Design Report/Remedial Action Work Plan for Soils, Sediments, and Dynamic Characterization Strategy for Bethel Valley, Oak Ridge, Tennessee, (DOE/OR/01-2378&D5)* by performing a data quality assessment (DQA) of existing data for the West Bethel Valley 5 assessment unit and the exposure unit that encompasses the 7000 area of ORNL (EU 9). Data assessed included analytical data from soils/slabs, groundwater, direct survey measurements, process knowledge, and historical records. This information served as the basis for the DQO scoping packages and presentations for WBV 5 and EU 9. Performed a DQA of existing data and presented a DQO for WBV 8.

- Provided human health and ecological risk assessment support to the US Army Corps of Engineers (USACE) for Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio, which is administered under the Defense Environmental Restoration Program—Formerly Used Defense Sites (DERP-FUDS).
    - Provided technical expertise to resolve ongoing issues related to incremental sampling method results for the Ransom Road Disposal Area (RRDA) Remedial Investigation
    - Provided extensive support for the RRDA Feasibility Study including the development of risk-based remediation goals, remedial alternatives, cost estimates and project schedules. Responded to USACE and regulator comments.
    - Prepared the draft RRDA Proposed Plan and responded to USACE comments.
    - After USACE questioned the approach of another contractor during remediation, Mr. Siard provided a risk-based recommendation consistent with the remedial action objectives that resulted in limiting soil remediation and costs for the Pentolite Road Red Water Pond Area, while protecting the public and the environment
    - Provided risk assessment support for a delineation plan to address the evaluation of asbestos throughout the RRDA (consistent with 40 CFR 763.87(c)(1)) and chemicals of concern that extend slightly beyond the originally estimated decision unit boundary
- Provided human health and ecological risk assessment support to the USACE for West Virginia Ordnance Works (WVOW) National Priorities List (NPL) site in Mason County, West Virginia. This project is also administered under DERP-FUDS.
    - Developed a draft sixth Five-Year Review Report consistent with five-year review guidance for Federal Facilities (i.e., U.S. Environmental Protection Agency, 2001, Comprehensive Five-Year Review Guidance) for WVOW Operable Units 1 and 2.
    - Provide technical support and site knowledge in the preparation of a WVOW FUDS Summary Report that will document the history of USACE activities for all WVOW Sites over the past three decades.

PROFESSIONAL HISTORY

APTIM FEDERAL SERVICES (AND PREDECESSOR COMPANIES), KNOXVILLE, TN

Senior Risk Assessor / Toxicologist and Resource Manager, 06/1999 – 10/2018

- Performed and reviewed numerous human health and ecological risk assessments.
- Authored numerous CERCLA/FUDS proposed plans, RODs, and other remedy selection decision documents, with several leading to no further action (NFA).
- Provided toxicology reviews for US Environmental Protection Agency (EPA).
- Provided risk assessment support for many feasibility studies, compliance monitoring strategies, non-time critical removal actions, action memoranda, five-year reviews, and other documents.
- Prepared and presented a briefing to the Assistant Secretary to the US Army concerning groundwater contamination at an NPL Site under USACE/EPA dispute.
- Co-authored Explanation of Significant Differences (ESD), providing technical methods/justifications, coordinating with EPA and client legal counsel to reduce record of decision groundwater remediation goals by up to a factor of 500, as part of a post-record of decision optimization, which saved an estimated $8M.
- Developed streamlined screening protocol for incremental sample method evaluation.
- Evaluated radiological contamination and identified remediation goals.
- Performed statistical trend analyses.
- Led several task groups as 18-year member of interagency (USACE, EPA, and State) project partnering team, resulting in partnering team consensus agreements that expedited remediation.

TN & ASSOCIATES, INC., OAK RIDGE, TN

Risk Assessor / Toxicologist, 09/1998 – 05/1999

- Provided human health and ecological risk assessment support.
- Provided toxicology support for US EPA National Center for Environmental Assessment.
- Co-authored a paper with client on the toxicity of PCBs, dioxins, and furans in fish.
- Provided support for RCRA facility investigation work plans and reports.

PTRL ENVIRONMENTAL SERVICES, INC., OAK RIDGE, TN

Risk Assessor / Toxicologist, 04/1994 – 08/1998

- Performed human health and ecological risk assessment.
- Authored a risk assessment process manual for NASA Kennedy Space Center.
- Authored a risk assessment for an early, high-level Ohio Brownfields, which was highly commended by the Director of Ohio EPA at ribbon-cutting ceremony.
- Provided toxicology reviews for commercial clients.

- Identified inappropriate application of US EPA statistical method by regulatory agency; correction of erroneous application resulted in NFA and heavily influenced the eventual development of USEPA ProUCL software.
- Assisted in wetlands delineation and marketed wetlands banking.
- Authored environmental technology summary document for client in Japan.

PAUL C. RIZZO ASSOCIATES, INC., MONROEVILLE, PA

Senior Project Toxicologist / Risk Assessor, 06/1990 – 03/1994

- Performed human health and ecological risk assessments.
- Performed field sampling, leading a field team at an NPL site in Puerto Rico.
- Performed an ecological risk assessment, which identified the interpretation of previous university ecological study by regulator as incorrect and resulted in no action for unit at RCRA site,
- Performed risk-based closure of a RCRA operable unit.

PROFESSIONAL DEVELOPMENT / TRAINING

- Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations 40-Hour Training per 29 CFR 1910.120, June 1990
- OSHA Hazardous Waste Operations 8-Hour Refresher Training per 29 CFR 1910.120

PUBLICATIONS

- Downey, S.T., and T.J. Siard, 2010, Field Sampling for Site Characterization - Lessons Learned, The Nielsen Environmental Field School and Symposium, Tampa, Florida.
- Siard, T.J., S.T. Downey, and R.L. Meadows, 2007, Moving Forward When a Good Team Disagrees, Joint Services Environmental Management Conference, Columbus, Ohio.
- Downey, S., R. Meadows, and T. Siard, 2005, Partnering Successes for WVOW Site, Shaw Symposium 2005, Orlando, Florida.
- Downey, S., T.J. Siard, and R.L. Meadows, 2005, Partnering Successes for West Virginia Ordnance Works NPL Site, Joint Services Environmental Management Conference, Tampa, Florida.
- Cubbison, C., Eskew, D.L., Siard, T.J., Geisy, J.P., and K. Kannan, 1999, Toxicological Endpoints in Fish for Ecological Risk Assessment of Dioxins, Furans, and PCBs, Society of Toxicology and Chemistry, 20th Annual Meeting, Philadelphia, Pennsylvania.
- Zhou, D., Siard, T.J., and M.W. Petroccia, 1993, "Air Pollutant Dispersion and Risk Assessment in a Steel Mill Complex," Proceedings of the World Congress III on Engineering and Environment, Beijing, China, Volume 2 (Eds. Q. Yi, H. Jimimg, and L. Jun), pp. 705-713.
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- Siard, T.J., Katze, J.R., and W.R. Farkas, 1989, "Queuine is Incorporated into Brain Transfer RNA," Neurochemical Research, Vol. 14, No. 11, pp. 1159-1164, 1989.
- Farkas, W.R., Lifsey, B.J., and T.J. Siard, 1989, "Queuine Content of Hematopoietic and Neuronal Tissues," Nucleosides and Nucleotides, Vol. 8, pp. 1169-1173.
- Siard, T.J., 1989, Transfer RNA and Cadmium Toxicity in Drosphila melanogaster, Annual Meeting of the Southeastern Chapter for the Southeastern Section for Experimental Biology and Medicine, Johnson City, Tennessee.
- Siard, T.J., 1989, Role of Queuine in Heavy Metal Toxicity of Drosophila melanogaster, Annual Meeting of the Southeast Regional Society of Toxicology, Augusta, Georgia.

Peer Reviewer Conflict of Interest Certification

Peer Review: **Dose Compliance Concentrations (DCC) for Radionuclides at Superfund Sites Electronic Calculator**

A conflict of interest or lack of impartiality exists when the proposed participant personally (or the peer reviewer's immediate family), or his or her employer, has financial interests that may be affected by the results of the peer review; or may provide an unfair competitive advantage to the participant (or employer); or if the participant's objectivity in performing the peer review may be impaired due to other factors. When the participant knows that a reasonable person with knowledge of the facts may question the participant's impartiality or financial involvement, an apparent lack of impartiality or conflict of interest exists.

The following questions, if answered affirmatively, represent potential or apparent lack of impartiality (*any affirmative answers should be explained in an attachment*):

- Did you contribute to the development of the calculator (and associated webpages) under peer review, or were you consulted during its development, or did you offer comments or suggestions to any drafts or versions of the calculator during its development? ☑ No ☐ Yes
- Do you know of any reason that you might be unable to provide impartial advice on the matter under consideration in this peer review, or any reason that your impartiality in the matter might be questioned? ☑ No ☐ Yes
- Have you had any previous involvement with the DCC calculator under consideration? ☑ No ☐ Yes
- Have you served on previous advisory panels, committees, or subcommittees that have addressed the topic under consideration? ☑ No ☐ Yes
- Have you made any public statements (written or oral) on the issue? ☑ No ☐ Yes
- Have you made any public statements that would indicate to an observer that you have taken a position on the issue under consideration? ☑ No ☐ Yes
- Do you, your family, or your employer have any financial interest(s) in the matter or topic under peer review, or could someone with access to relevant facts reasonably conclude that you (or your family or employer) stand to benefit from a particular outcome of this peer review? ☑ No ☐ Yes

With regard to real or apparent conflicts of interest or questions of impartiality, the following provisions shall apply for the duration of this peer review:

(a) Peer Reviewer warrants, to the best of his/her knowledge and belief, that there are no relevant facts or circumstances that could give rise to an actual, apparent, or potential organizational or personal conflict of interest, or that Peer Reviewer has disclosed all such relevant information to EMS or to EPA.
(b) Peer Reviewer agrees that if an actual, apparent, or potential personal or organizational conflict of interest is identified during performance of this peer review, he/she immediately will make a full disclosure in writing to EMS. This disclosure shall include a description of actions that Peer Reviewer (or his/her employer) has taken or proposes to take after consultation with EMS to avoid, mitigate, or neutralize the actual, apparent, or potential organizational conflict of interest. Peer Reviewer shall continue performance until notified by EMS of any contrary action to be taken.

Thomas J. Siard 8·22·2022

Signature Date

☐ Check here if any explanation is attached

Thomas J. Siard

Printed Name

Strata-G LLC

Affiliation/Organization

Theodore Wentworth

Michigan Department of Environment, Great Lakes, and Energy

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Wentworth	1	Is there anything you would recommend to improve the website? In particular:	Apart from the comments in my Notes I think the website is mostly fine. I would suggest asking who the intended audience for the tool might be. As I talk about in other questions and in my Notes, I am somewhat of an outsider to many EPA concepts and I had to educate myself on some of them. One way to ease that issue is to be more consistent when defining initializations or acronyms. I encountered several instances where I found an acronym/initialization that I was unfamiliar with and the definition was not easy to find. That required me to do document searching and was not always trivial to do. I have pointed to many instances of this kind of problem in my Notes but it is not exhaustive. Generally I would say the entire website and User's Guide need a thorough editorial review to clean these issue up and make the web page and User's Guide internally consistent.
Wentworth	1a	Is the website clearly organized, described, easy to navigate, and generally "user friendly"? If not, what do you recommend?	The website is well organized generally and user friendly overall. I accessed the website through 3 different computers all using a Windows OS and Chrome browser during my evaluation. I had some performance issues occasionally. Because of the large number of operations contained in the web page, I would assume that users will have mixed results which can be somewhat frustrating. Expanding the entire User's Guide with "Open All Sections" was occasionally problematic.
Wentworth	1b	Do the online DCC calculator tools match the information provided in the User's Guide and vice versa? If not, what do you recommend?	The calculator tools generally match the user's guide. As I note in several entries of my Notes, I do not have a background in CERCLA and I needed to educate myself on some of the EPA ideas and concepts. One item that I'm still unsure about occurs in User's Guide Section 4.10.6 "TR".
Wentworth	1c	Do you have any other recommendations to improve the usability of the website?	I have no other general recommendations to improve usability other than internal consistency issues noted my other comments.
Wentworth	2	Is there anything you would recommend to improve the User's Guide? In particular:	
Wentworth	2a	Are the tool and website clearly explained?	The tool and website are clearly explained. I would emphasize again editorial consideration be given to the audience and internal consistency.
Wentworth	2b	Are the assumptions clear and reasonable? If not, what do you recommend?	Most assumptions seem to be clear and reasonable. One major exception is the default breathing rate for all occupational settings (60 m^3/day). This seems like an overly high breathing rate. Using my prior experience with NRC regulations I am familiar with the average rate used to establish Derived Air Concentrations (DACs) which uses 20 l/min (29 m^3/day) defined as light work. I'm not convinced that a worker could spend an entire shift at a breathing rate of 60 m^3/day (42 l/min).
Wentworth	2c	Is the guide well written and clearly organized? If not, what do you recommend?	The guide is well written generally apart from the specific examples I cited elsewhere or in my "Notes".
Wentworth	2d	Is the technical support documentation complete, organized and easy to follow? If not, what do you recommend?	The technical support documentation is very good. However, due to the large number of references I found many dead links to supporting material. These are identified in my attached Notes.
Wentworth	3	Are the DCC models for the following scenarios comprehensive and accurate, and do they represent the current state of knowledge? Are they supported appropriately by citations? If not, what do you recommend?	I believe the models are appropriate and comprehensive. Citations are appropriate and actually very expansive. To me, the number of citations and references are the most compelling feature of the DCC project. EPA should consider curating the bibliography used as a standalone resource for unique modelling situations. I have provided specific comments on the various scenarios in my "Notes". One issue that bothered me during the review was the confusing variable naming schemes. In particular there are cases where the variable name might be an ingestion or inhalation variable (see my "Notes"). I feel like the variable naming scheme should be analyzed and normalized overall; the variable name should be somewhat intuitive to a user.
Wentworth	3a	Resident	See Notes document.
Wentworth	3b	Indoor Worker	See Notes document.
Wentworth	3c	Outdoor Worker	See Notes document.
Wentworth	3d	Composite Worker	See Notes document.
Wentworth	3e	Construction Worker (Site-specific only)	See Notes document.
Wentworth	3f	Recreator (Site-specific only)	See Notes document.
Wentworth	3g	Farmer	See Notes document.
Wentworth	3h	Soil to Groundwater	See Notes document.
Wentworth	4	Is the choice of radionuclides and how decay chains are addressed appropriate and based on supportable reasoning? If not, what do you recommend? Are the standard recommended default factors adequately explained, sourced, and reasonable?	I believe these are stated appropriately and factors explained well.

PEER REVIEW CHARGE RESPONSES: DCC Calculator

Commenter	Charge Question No.	Charge Question	Response
Wentworth	5	Are the results of the calculator clearly explained and presented for the given scenarios? If not, what do you recommend?	One issue with the outputs that is confusing is the use of time intervals. What is the utility of nanoyears, picoyears, etc? Also, use of nano, micro, or pico for year is confusing; scientific notation is preferable instead. The tables and graphs should not be cluttered with these timeframes. I do not understand why any time less than a day should be considered for the cases relevant to the tool.
Wentworth	5a	In particular, we are interested in your review of the calculator results when selecting the DCC Output Option "Peak DCC".	I have no specific comment on the Peak DCC compared to the other 3 output frames.
Wentworth	6	Are the results appropriately described and qualified (to the extent that they may be relied upon and defended)? If not, what do you recommend?	I think the backing reference material are more than adequate to defend decisions made from the calculator. That is the strength of the tool as I see it. If anything, I would suggest more explicit narratives linking the calculator's outputs to the documents referenced. Rather than linking to a particular study, links should either go to specific tables or locations in the reference reports or sections of the reference could be quoted directly in the website. Because of the extreme technical nature of the references, more helpful citations/quotations could be helpful to the user when justifying results.
Wentworth	7	Do the results provide a defensible explanation of how they were derived, or are they the result of a "black box"? Do you recommend anything different?	The results provide defensible explanations. As I stated in question 6, more direct or explanatory material could be helpful for justifying/explaining the results.
Wentworth	8	Is there anything else you would recommend to improve the utility, accuracy, completeness, or supportability of the calculator?	No additional comments. As I've stated in other questions and in my Notes, the quality and quantity of reference reports that support this tool are very impressive. I think enhancing and curating the web page for these references would be a great resource in general.

The following are notes made while reviewing the DCC website and users guide. The notes were spontaneous and may not be perfectly formatted. For ease of review, I will attempt to make it clear as follows:

- Where I suggest specific wording changes I've quoted the website in a text box and used track changes to show what I would change.
- The user's guide comments are denoted by section number and location using bulleted hierarchy scheme.

Home Page

- Tap water pathway – from the homepage it isn't clear what this entails. Crops raised on site in the resident and farmer scenarios may not use "tap water". What is the difference between groundwater and tap water?

  Does the program distinguish between tap and ground water if both are available?

- PRG should be defined on the home page.
- OSWER is not defined anywhere on the homepage.
- CERCLA is not defined anywhere on the homepage.
- The "Introduction" section contains a dead link: The website was initially made available for use in a transmittal memo entitled "Distribution of OSWER Radionuclide ARAR Dose Compliance Concentrations (DCCs) for Superfund Electronic Calculator", January 28, 2004.

> **ARAR Dose Compliance Concentrations**
>
> Dose conversion factors (DCFs), or "dose coefficients", for a given radionuclide represent the dose equivalent per unit intake (i.e., ingestion or inhalation) or external exposure ~~of~~ from emissions of that radionuclide. These DCFs are used to convert a radionuclide concentration in soil, air, water, or foodstuffs to a radiation dose. DCFs may be specified for specific body organs or tissues of interest or as a weighted sum of individual organ dose, termed the effective dose equivalent. These DCFs may be multiplied by the total activity of each radionuclide inhaled or ingested per year, or the external exposure concentration to which a receptor may be exposed, to estimate the dose equivalent to the receptor.
>
> At this website, you will find DCCs calculated using the dose conversion factors from International Commission on Radiological Protection (ICRP) 30, ICRP 60, and ICRP 107. This website does not address the calculation of DCCs for ARARs based on ICRP 2 dose conversion factors (e.g., 40 CFR 141.66(d), 10 CFR 61.41).

- WTC, SDCC, SPRG, BDCC, BPRG are not defined in the "Related CERCLA Calculators and Guidance" paragraph.
- DCC calculator download link and Download Area links in the "Welcome" section are not active.

- Should the top graphic be presented lower on the home page or omitted altogether?
- The “Welcome” paragraph should distinguish between the PRG and DCC “fact sheet”. This could be as simple as appending DCC or PRG to fact sheet and the corresponding hyperlink.

Welcome

Welcome to the EPA's "Dose Compliance Concentrations for Radionuclides at Superfund Sites" (DCC) Download and Calculator website for demonstrating compliance with dose-based Applicable or Relevant and Appropriate Requirements (ARARs). The recommended DCCs on this website are dose levels for contaminated soil, water, and air.

This tool presents recommended DCCs calculated using suggested default input parameters and the latest dose conversion factors. In addition, you may modify the input parameters to create site-specific DCCs to meet the needs of your site. To ensure proper application of the DCCs, please see further guidance for DCC use in the User's Guide, What's New, FAQ, and Download Area links. Below is a general description of DCC use. The EPA has prepared a fact sheet for the general public that describes DCC uses, DCC calculator operation, and land uses available for assessment. Additionally, this fact sheet describes the PRG and DCC calculators in greater detail for EPA staff. The OSWER Directive~~,~~ and Superfund Radiation Risk Assessment: A Community Toolkit ~~was~~ were also developed by the EPA to help the public understand more about the risk assessment process used at Superfund sites with radioactive contamination.

The DCC calculator was largely developed based on the PRG calculator and benefited from its peer reviews~~, which may be seen here~~. The DCC calculator results were previously verified. The documentation from these may be seen on the Internal Verification and External Verification, which also ~~benefits~~ benefited from the external verification review of the PRG calculator. Several other comparison reviews that focused on describing the default parameters in various models may be found here.

User’s Guide

- Link to the pdf of user’s guide appears to be a pdf print of the web page from July 2022 and includes an ORNL server system outage message.

  The pdf of the guide should be a standalone document, not a print of the web page.
- Administrative Record is used inconsistently in the document. It is sometimes capitalized as if it is a regulatory requirement but not always.

  If this is a CERCLA concept it should be emphasized and/or explained.

  Disclaimer Section:
- Acronym definitions missing: CERCLA, WTC, SDCC, BDCC, PRG, BPRG, SPRG
- Link to **Regional Screening Levels (RSLs)** is a dead link.
- Referenced citations should match the reference section of the User’s Guide citation format. The last paragraph of the reference section cites “EPA 2000a” for site-specific

DCCs however the reference section of the User's Guide uses U.S. EPA (2000a) as the reference.

- The last paragraph of the Disclaimer section is extremely confusing it provides links to **Soil Screening Guidance for Radionuclides: Technical Background Document** twice but abbreviates it on the second occurrence while linking to the same document. It uses the phrase "this report" twice creating confusion about what "this report" is. This paragraph and the inconsistent referencing creates a lot of confusion.

1. Introduction section:

- Reference to EPA/540/1-89/002 should be changed to match the format in the Reference section
- Fourth paragraph change suggestion:
  One set of radiation standards consists of a combination of whole body and critical organ dose annual limits, generally either (1) 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other critical organ besides the thyroid or (2) 25 mrem~~/year~~ to the whole body and 75 mrem~~/year~~ to any critical organ (including the thyroid). Another set of standards consists of a single limit (e.g., 10 mrem/year). The type of dose limit used in ~~the~~ a particular standard would ~~be the~~ use the same ~~type of~~ dose methodology ~~used~~ as used for dose assessments to demonstrate ARAR compliance.
- Paragraph 5 cites "(ICRP,1959)". This document is not included in the reference section and does not use the apparent preferred format, i.e. [Organization (Year)].
- Paragraph 6: wrong formatting again for ICRP (1977) and reference not in Reference section.
- Subsequent paragraphs have additional versions of reference citations. The reference section must be updated to include all references.
- The paragraph introducing ICRP 60 states that effective dose is similar to effective dose equivalent but without details. The differences should be spelled out. Also the reference is flawed in many ways.
- ICRP publications are a special case and reference to them is chaotic throughout this whole section.
- Use of the phrase(s) "this document", "this report", "this database", etc. are poorly used. They often create confusion about the point of view or reference.
- Third to last paragraph "Likely Federal Radiation Applicable or Relevant and Appropriate (ARARs)", should not be quoted or capitalized as a title. References should be more consistent.
- DCC concentration should never be used, should be DCCs. It occurs in the penultimate paragraph.

Understanding the DCC Website Section:

2.1 General Considerations:

- DCFs are defined as Dose Coefficients. "Dose Conversion Factor" should be stated and DCF should be consistently used once defined rather than switching randomly between DCF and Dose Coefficients. Changing back and forth creates confusion.
- The link to the bookmark for Ingestion of Fish is a dead link.
- RME needs more explicit definition.

- This (last of the section) paragraph needs a lot work to explain the initializations and what they mean:

> "The DCCs are generated with standard exposure route equations using EPA DCFs and exposure parameters. A DCC calculator receptor represents a high end (RME) exposed individual, as does BDCC receptor (for person exposed to contamination indoors). Since the DCC RME is often outside and the BDCC RME is always indoors, an individual receiving both indoor and outdoor exposures at a site should be protected. For the calculation of oral dose coefficients, area correction factors, and gamma shielding factors, a standard soil density of 1.6 g/cm^3 has been used".

2.2 DCC Output Options:

- 2.2.1 "The DCC provided in the output is the inverse sum of the reciprocal DCCs of the parent and all the progeny present at the period of peak dose." This is difficult to understand.
- 2.2.1.1 The Bateman and ORNL Technical Memorandum are dead links.
- 2.2.1.2

> The user may also select a defined time period to search for the period of peak dose. This option operates just like the infinite time option but stops searching for the period of peak dose at a user-defined time in the future. Predefined time points of 10,000, 1,000, and 100 years are offered as well as the option for the user to enter a specific time period between 70 and one trillion years. These options are only offered for use in certain situations where a regulatory agency is concerned with dose at certain time points in the future. If a peak hasn't been resolved in the entered time period, as is the case when progeny are still ingrowing, the dose interval will be calculated for the last exposure duration span. For instance, if the time period of 100 years is selected for default resident soil for U-238 (ED of 1 year), year 100 will be selected by default, because U-238 peak 0 dose isn't until year 3,981,072.

This paragraph is very confusing, especially the last two sentences. I think I understand the intent but I am not certain. This should be reworded.

- **2.2.1.2 Tutorial graphs comments:**
  Don't use esoteric time units on the x-axis of the graph, nanoyears and microyears are of little value for the graphs. Perhaps years in powers of 10 years?

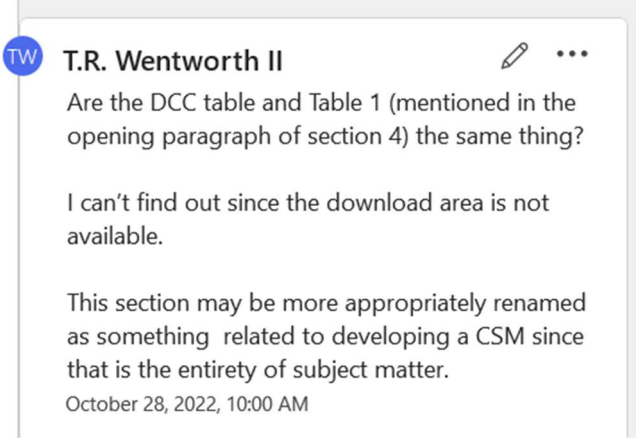
- **2.2.2**
  I would recommend not using FC to indicate fractional contribution in the narrative. Although FC is used as a variable in the equations, it does not need to be abbreviated in the descriptive text. It saves no time and creates a new initialization without value.

- **2.2.5:**
  - Don't use esoteric time units on the x-axis of the graph, nanoyears and microyears are of

little value for the graphs. Perhaps years in powers of 10?
- In the section describing the 6 categories of common superfund radionuclides – don't abbreviate "exposure duration" as ED. It's confusing and unnecessary. In health physics contexts ED is frequently used to abbreviate Effective Dose.
- The footnote at the bottom of the table comparing the 6 superfund radionuclides stating "DL=1.0" causes confusion and requires the reader figure out what "DL" means. Also, the explanatory category introducing the table states a risk coefficient of 1E-06 which I assume corresponds to the default calculation parameter of DL=1.0 making the footnote unnecessary.

- **2.3.2 ICRP 60**
  The link to European Council Directive 96/29 in paragraph 3 is a dead link.
- **2.4.1 Sources**
  The link to the spreadsheet downloads from IAEA TRS 472 and the UK Environment Agency are dead links.
- **2.4.2 Hierarchy by Parameter**
  Use of day and d (pCi/day versus pCi/d) should be normalized throughout this section, there are multiple instances in this section. I would recommend use of "day" in all instances.
- **2.5.1 Produce Modeling**
  Exposure Factors Handbook (EFH) – A link to this document/web page would be helpful.
- **2.5.1.1 Intake Rates (g/day)**
  In the second paragraph, the link Guidance for Conducting Fish and Wildlife Consumption Surveys is dead.
- **2.5.1.2 Soil-to-Plant Transfer Factors (Bvwet)**
  1. There seems to be a missing image in the Climate Zones paragraph associated with the link to the USA Koeppen-Geiger county map.
  2. There seems to be a missing flow chart image and link preceding the last paragraph of this section.
- **2.5.2.1 Intake Rates (g/day)**
  1. The link Guidance for Conducting Fish and Wildlife Consumption Surveys is a dead link.
- **2.5.2.2 Animal Transfer Factors (TF)**
  Clicking on the flow chart does not provide a larger image.
- **2.5.3 Mass Loading Factor**
  The reference column in table Table 2.4.3-A does not provide a link to the reference for the dry weight plants.
- **2.9.1 Postprocessing Calculator Results to Incorporate Site-Specific MCNP Factors**
  1. The first paragraph introduces ACF without defining what it means.
  2. What is "resident GSF_o" in the second bullet of considerations (third paragraph)?
  3. GSF is used extensively in this section. It appears to be defined for the first time in "4.10.5 Gamma Shielding Factor".

3. Using the DCC Table



Download area is unavailable

- **3.1 Developing a Conceptual Site Model**

  1. The link location in the last sentence in paragraph 1 is in an odd location.
  "A separate CSM for ecological receptors can be useful. Part 2 and Attachment A of the Soil Screening Guidance for Radionuclides: Users Guide (EPA 2000a) contain the steps for developing a CSM. A site-specific CSM may not include all of the land uses presented in this calculator."
  The link emphasizes Part 2 and Attachment A in the sentence while the link itself directs the user to the entire document and summary description.

4. Land Use Descriptions, Equations, and Technical Documentation

4.1.1 Resident Soil

1. The sentence in paragraph 1 should be changed:
Adults and children exhibit different ingestion rates for soil and produce. For example, the child resident is assumed to ingest 200 mg **of soil** per day while the adult ingests 100 mg per day.
2. BDCC in the second to last sentence is a dead link.

4.1.1 Resident Soil - DCC Equations

1. It is not helpful that the discussion of 6 years and 26 years used in the soil ingestion and inhalation is presented at the end of this section, many lines (about a page?) below the equations. Presenting it earlier would allow the user to understand the terms in the equations.
2. It is confusing to have some variables in the equations shown with parenthetical values without declaring that these are the intended values for those variables. A note on presentation would be helpful.
3. DCF subscripts need to be better defined in definition/units column of Table 1. For example, the user has to infer that $DCF_{ext\text{-}sv}$ is for external soil volume searching for other instances of sv in the table. Does the sv subscript denote an infinite underlying volume given the other options are 1 cm, 5 cm, 15 cm?

4. The link Exposure Factors Handbook in the “consumption of fruits and vegetables” equation description is a dead link.
5. The link to Table 1 at the end of this section goes to a bookmark on the web page which opens the entire users guide and requires the user to scroll to the end of the guide in order to view the table. You should create a standalone web page with just Table 1 for ease of access.
6. The stated assumptions (first sentence: “This receptor spends most, if not all, of the day at home except for the hours spent at work.”) for the receptor include being at home all the time except for going to work. The time away from home for work is not stated. What are the time assumptions for work in the ingestion and inhalation pathways? For a full time worker, one might assume a minimum of 4000 hours away from the residence (not including commute time or other factors) or 167 days per year.
7. The equations use 350 days per year. Are 15 days taken for vacation? These assumptions should be stated. Is the child at the residence full time?

4.1.2 Resident Soil 2-D External Exposure

4.1.2 Resident Soil 2-D External Exposure - DCC Equations

General comment 1 - This applies to the equations in all parts of this user guide and especially to the table: Exposure Times (ETs) are given in 4 or more digits based on 50th percentile averages of US citizen behaviors (i.e. 1.752 hours outdoors and 16.416 hours indoors at home per day); yet hours in a day are still specified in two digit numbers (i.e. 24 in a day). Why not round these 50th percentile values? Please tighten or otherwise use a standard number of digits as excess digits are wasted space and clutter the concepts.

General comment 2 - This applies to this and all parts of this user guide: I am personally not familiar with the use of Chronic Daily Intake (CDI). I do not understand the utility of presenting a series of equations for DCCs followed by CDIs. The relationship between CDI and DCC are obvious. I would recommend eliminating the CDI portions of the user guide to save space/memory and potential editing errors.

General comment 3 - This applies to this and all parts of this user guide: Use of IF* is extremely confusing. IFA (with various subscripts) refers to inhalation fraction in cubic meters per year but all other occurrences of IF* refer to ingestion fractions. Please establish a distinction between inhalation fractions and ingestion fractions.

4.1.4 Resident Tap Water - DCC Equations

1. For the inhalation equation, a discussion of the Andelman Volatilization Factor would be helpful.

2. Regarding the immersion equation, Table 1 has ETevent-res-c occurs twice. One of these should be labelled ETevent-res-a. It would also be helpful to know what is being modelled here, is this a bath/shower/swimming event and why is the child duration assumed to be 0.54 hr compared to the adult 0.71 hr.

3. DFAres-adj from the immersion equation does not occur in the table.

4. The link to Exposure Factors Handbook in the consumption of fruits and vegetables equation is dead.

4.3.1 Outdoor Worker Soil – DCC Equations

1. What is the explanation for EF to go from 250 days/yr in the composite worker condition to 225 days/yr for the outdoor worker? This would be helpful to know.

General comment 1 - This applies to the equations in all parts of this user guide. In the inhalation pathways, each of these equation sets includes an inhalation fraction of "particulates emitted from soil". The language should be modified since particulates are not "emitted" from the soil (or water source). The particulates are in the air as a result of some kind of kinetic suspension (resuspension) process not from being emitted.

4.4.1 Indoor Worker Soil – DCC Equations

General comment 1 - This applies to the equations in all parts of this user guide. The use of a breathing rate of 60 m^3 per day for all occupational settings seems extremely high. The Resident and Farmer scenarios use 20 m^3. This converts to 42 l/min and 14 l/min respectively. NRC regulations in 10 CFR 20 DAC calculations use a breathing rate of 20 l/min for "light work", which equates to 29 m^3 per day. Why is such a high breathing rate for the entire duration of in all occupational scenarios? This seems like an excessively conservative rate.

4.10 Supporting Equations and Parameter Discussion

General comment 1 - This applies to the User Guide generally: when clicking on a redirect link that goes to another part of the User Guide or DCC website, the back page button should go back to the html location where we started. Currently, using the back button (for most) links returns the user to the DCC homepage requiring the user to find the location they were previously looking at. **This issue may be browsers/operating systems specific.**

4.10.5 Gamma Shielding Factor

1. It is not completely clear that a structure built on a contaminated slab will have the same soil cover depth as a receptor walking on top of an undisturbed part of the zone. It's not clear whether this concept has been included in the various models.

4.10.6 Using the Combined Biota, Soil, and Water Interactive Graph

1. What is TR in this paragraph (occurs just before the graph):
"The x-intercept (coordinate x,0) shows where the water DCC = TR and soil concentration must equal 0. The y-intercept (coordinate 0,y) shows where the soil DCC = TR and the water concentration must equal 0. Any point between (x,0) and (0,y) shows a separate DCC for water and soil that will meet the TR. Hovering the mouse over the graph will display moving lines that follow

the mouse based on the x-coordinate (water DCC). Click anywhere on the graph to stop the lines from moving and to display the soil and water DCCs associated with that specific x-coordinate."

Radionuclide Decay Chain

https://epa-prgs.ornl.gov/cgi-bin/radionuclides/chain.pl

The description narrative paragraphs are terrible. These are barely passable as basic public health level science and are linked from the DCC framework which requires a high level of scientific understanding in multiple disciplines (i.e. bateman equations, matrices for solving a system of linear differential equations).

The EPA should edit this page and the source pages regardless of the DCC project.

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Employment History

State of Michigan, Department of Environment, Great Lakes, and Energy, Lansing, Michigan

Manager, Radiological Protection Section
March 2020 to Present

Job Duties

- Provide leadership and guidance for the two units in the Section.
- Serve as the State Liaison Officer for Michigan, representing the State's Executive in matters pertaining to the U.S. Nuclear Regulatory Commission.
- Provide technical guidance and final review of technical documents related to the cleanup and disposal of radioactive material in Michigan.
- Provide staff the necessary resources and technical advice to solve problems related to the use and control of radiation and radioactive material.
- Advise and approve purchases of equipment and training to support the mission of the Section.

State of Michigan, Department of Environment, Great Lakes, and Energy, Lansing, Michigan

Supervisor, Radioactive Materials Unit
December 2018 to March 2020

Job Duties

- Supervise the activities of the Radioactive Materials Unit. The Unit is responsible for regulating radioactive material in the environment, education and outreach through the Michigan Indoor Radon Program, and testing environmental samples in the Radiological Protection Laboratory.
- Develop training plans for technical staff in the Unit.
- Provide staff the necessary resources and technical advice to solve problems.
- Review and approve purchases for the Unit.
- Provide technical expertise in the review of safe handling and disposal of technologically enhanced radioactive material (TENORM).
- Develop revisions to Michigan's Ionizing Radiation Rules.
- Maintain the contracts for sample collection in the vicinity of the three nuclear power stations in the state.

State of Michigan, Department of Licensing and Regulatory Affairs
Lansing, Michigan

Health Physicist - Rules Specialist
June 2009 to December 2018

Job Duties

- Perform radiation safety inspections of x-ray registrants.
- Measure radiation levels to quantify exposures to employees working with x-ray equipment and exposures to patients undergoing diagnostic x-ray procedures.
- Maintain qualifications as a certified inspector under the U.S. Food and Drug Administration Mammography Quality Standards Act.
- Revise of the program's rule set to meet the evolving guidance and radiation protection standards of the federal agencies and other states.
- Participate in the state's radiological emergency response program for nuclear power plant incidents.
- Maintain the web page for the program.

State of Michigan, Department of Environmental Quality
Lansing, Michigan

Health Physicist
August 2001 to May 2009

Job Duties

- Perform health physics review of the use and management of radioactive materials.
- Inspect and register radioactive material users for compliance with state and federal regulations.
- Survey for radiation levels and radioactive contamination at registrant facilities and incident locations.
- Calibrate radiation detection instruments.
- Respond to incidents involving lost sources of radioactive material.
- Review radiation-shielding plans for radioactive materials.
- Assist in the development of draft rules in the state's development of an agreement state program.
- Participate in the state's radiological emergency response program for nuclear power plant incidents.

Education

Michigan State University
Bachelor of Science in Physics, 1993

Professional Training

3/3/2008 - 3/7/2008	U.S. Nuclear Regulatory Commission *"Licensing Practices and Procedures Course (G-109)"*
4/14/2008 - 4/18/2008	U.S. Nuclear Regulatory Commission *"Inspection Procedures Course (G-108)"*
7/28/2008 - 8/1/2008	U.S. Nuclear Regulatory Commission *"Diagnostic and Therapeutic Nuclear Medicine (H-304)"*
2/23/2009 - 2/24/2009	Midwest Environmental Enforcement Association *"Communication Skills for Regulatory Inspectors"*
4/13/2009 - 4/17/2009	U.S. Department of Homeland Security, Domestic Nuclear Detection Office *"State Reachback Spectroscopy Course"*
1/20/2010	U.S. Food and Drug Administration *"Full Field Digital Mammography and the Systems Approach to FFDM Inspections"*
5/15/2010	Medical Technology Management Institute *"Digital and Computed Radiography"*
7/10/2010	Medical Technology Management Institute *"Understanding CT Technology"*
12/13/2012	Medical Technology Management Institute *"The New ACR CT Quality Control Manual: Role of the Medical Physicist"*
1/7/2019 - 1/11/2019	U.S. Department of Homeland Security *"Radiological Accident Assessment Concepts Course (PER-316)"*
1/11/2021 - 1/15/2021	Argonne National Laboratory "*RESRAD-ONSITE, RESRAD-OFFSITE, and RESRAD-BUILD Training Workshop*"
1/12/2022	U.S. Department of Homeland Security "*Introduction to IND Effects and Response Strategies (PER-307-W)*"
2/7/2022 – 2/10/2022	U.S. Department of Homeland Security *"Radiological Operations Support Specialist (ROSS) Training (PER-388)"*

Peer Reviewer Conflict of Interest Certification

Peer Review: **Dose Compliance Concentrations (DCC) for Radionuclides at Superfund Sites Electronic Calculator**

A conflict of interest or lack of impartiality exists when the proposed participant personally (or the peer reviewer's immediate family), or his or her employer, has financial interests that may be affected by the results of the peer review; or may provide an unfair competitive advantage to the participant (or employer); or if the participant's objectivity in performing the peer review may be impaired due to other factors. When the participant knows that a reasonable person with knowledge of the facts may question the participant's impartiality or financial involvement, an apparent lack of impartiality or conflict of interest exists.

The following questions, if answered affirmatively, represent potential or apparent lack of impartiality (*any affirmative answers should be explained in an attachment*):

- Did you contribute to the development of the calculator (and associated webpages) under peer review, or were you consulted during its development, or did you offer comments or suggestions to any drafts or versions of the calculator during its development? ☒ No ☐ Yes
- Do you know of any reason that you might be unable to provide impartial advice on the matter under consideration in this peer review, or any reason that your impartiality in the matter might be questioned? ☒ No ☐ Yes
- Have you had any previous involvement with the DCC calculator under consideration? ☒ No ☐ Yes
- Have you served on previous advisory panels, committees, or subcommittees that have addressed the topic under consideration? ☒ No ☐ Yes
- Have you made any public statements (written or oral) on the issue? ☒ No ☐ Yes
- Have you made any public statements that would indicate to an observer that you have taken a position on the issue under consideration? ☒ No ☐ Yes
- Do you, your family, or your employer have any financial interest(s) in the matter or topic under peer review, or could someone with access to relevant facts reasonably conclude that you (or your family or employer) stand to benefit from a particular outcome of this peer review? ☒ No ☐ Yes

With regard to real or apparent conflicts of interest or questions of impartiality, the following provisions shall apply for the duration of this peer review:

(a) Peer Reviewer warrants, to the best of his/her knowledge and belief, that there are no relevant facts or circumstances that could give rise to an actual, apparent, or potential organizational or personal conflict of interest, or that Peer Reviewer has disclosed all such relevant information to EMS or to EPA.
(b) Peer Reviewer agrees that if an actual, apparent, or potential personal or organizational conflict of interest is identified during performance of this peer review, he/she immediately will make a full disclosure in writing to EMS. This disclosure shall include a description of actions that Peer Reviewer (or his/her employer) has taken or proposes to take after consultation with EMS to avoid, mitigate, or neutralize the actual, apparent, or potential organizational conflict of interest. Peer Reviewer shall continue performance until notified by EMS of any contrary action to be taken.

T.R. Wentworth II 09/02/2022

Signature Date

☐ Check here if any explanation is attached

Theodore Wentworth II

Printed Name

State of Michigan - Department of Environment, Great Lakes & Energy

Affiliation/Organization