APPENDIX H
Peer Review Comments

JUNE 26, 2006
HEALTH CANADA COMMENTS:
FACT-FINDING TASK 3A-2: HUMAN HEALTH RISK ASSESSMENT FOR CURRENT EXPOSURES TO HERBICIDES AND HERBICIDE-RELATED CHEMICALS AT CFB GAGETOWN, OROMOCTO, NEW BRUNSWICK (DRAFT REPORT)
PREPARED BY: DILLON CONSULTING LIMITED, JUNE 2, 2006

GENERAL COMMENTS:

Overall, the report is consistent with general practice for risk assessments of contaminated sites. The information was presented in a logical manner, and it was generally easy to locate the information within the document. However, there are a number of areas where this document could be improved, as noted below.

Exposure Concentrations of Chemicals in Various Media

The authors did not present a strong rationale for the statistical approach used to determine the appropriate value for exposure point concentrations for use at each subject area assessed in the report. The report indicates that either the 95% UCLM (Upper Confidence Limit of the Arithmetic Mean) or the maximum concentration was used, whichever value was lower. It is unclear whether the data were adequate in all subject areas to derive a 95% UCLM and whether it was justified in each subject area, given the site use and the historical spraying activities. Specific comments are provided below:

- The number of samples appears to be too small to fit a distribution in some of the subject areas. Please confirm whether the maximum value would be more appropriate in some of the subject areas.
- Four different types of distribution were assigned to the subject areas. These are the gamma distribution, the non-parametric distribution, the log-normal distribution and the normal distribution. Insufficient rationale was provided in the report to justify the use of the different distributions, especially in the case of small sample sizes. Please verify the applicability of the distributions used to describe environmental contaminant concentrations

It is unclear if the data on chemical concentrations are reported on a dry-weight or a wet-weight basis. Please clarify.

Please ensure that the information in the final report is consistent with the final Environmental Site Assessment prepared by Jacques Whitford (2006), as it is recognized that only the draft Environmental Site Assessment was available at the time of preparation of this draft report.

Risk Characterization

In the risk characterization section, the report would benefit from a clear discussion of whether the risk values provided include background Estimated Daily Intake (EDI) or

just the site exposures. As the report indicates, Health Canada Preliminary Quantitative Risk Assessment (PQRA) guidance identifies that it is acceptable to use a target Hazard Index (HI) of 0.2 if the background EDI is not considered, but that a target HI of 1 applies when the background EDI is considered. The report provides a background EDI for dioxins and provides a discussion of how the values compare to both an HQ of 0.2 and of 1. It is apparent from the document that, with the exception of fish ingestion, the exposures from the site are less than 1% of the background EDI. It is noted that the EDI exceeds the Tolerable Daily Intake (TDI) for some age groups, which means that even without site exposure, some age groups have a background HI of over 1. The results would not change and the report would be easier to understand if only a target HI of 1.0 was used, as the use of two different target HIs may be confusing and is unnecessary for the risk characterization.

Toxicological Reference Value (TRV)

Toxicological Reference Values (TRVs) for polychlorinated dibenzodioxin (PCDD) Toxic Equivalents (TEQ) are inconsistent throughout the report. Table 5-1 and Appendix G and show a value of 2.0 pg TEQ/kg-day. However, Section 6 and Appendix E provide a TRV of 2.3 pg TEQ/kg-day. Please ensure that the correct TRV is used throughout the report.

Estimated Daily Intake (EDI)

Please provide the background information for the estimated daily intake for PCDD TEQ.

Exposure Amortization

Page 46, Section 7.2, para 1: The rationale for amortization of short-term exposure over the course of a year (e.g., amortize 5 days exposure over 365 days and compare that exposure estimate to the TRV) does not appear to be consistent with the intent of the TRV. As the toxicity reference value for dioxins is provided as a tolerable monthly intake, it would be more accurate to amortize an exposure of less than one month (e.g., 5 days) over the period of one month and compare that to the tolerable monthly intake provided by WHO. The report did not identify whether the acute/subchronic TRV identified in the Cantox (2006) report would be adequate for this purpose.

Receptor Characteristics

Page 31, Section 4.4: Please clarify why soldiers are considered to have much greater exposure to soil via incidental ingestion than other people considered in the report. An ingestion rate of 100 mg per day was assumed for soldiers which is consistent with construction workers rather than the typical value for adults. It is not apparent from the report that soldiers are involved in activities similar to those of construction workers in general or in all subject areas.

SPECIFIC CLARIFICATIONS IN REPORT

Page i, Executive Summary, 1 para, lines 5-6: These statements suggest that only PCDD/F exposure was addressed. It should be noted that all the residuals of herbicides and herbicide-related chemicals were also evaluated; but were screened out in the chemical screening.

Page 1, Section 1.1, 3 para, line 4: typographical error "use of herbicides….chemicals used at CFB…"

Page 3, Section 1.2, 7 para (Discussion of Uncertainties), line 3: typographical error for the word "Uncertainty".

Page 3, Section 1.2, 7 para (Discussion of Uncertainties), line 5: typographical error "considerations which reflect…".

Page 6, Section 2.1, para 5, line 1: typographical error "There are a minimum of two…"

Page 10, Section 2.2.3 – Murphy Bivouac: if using data from the entire APEC 16, the subject area should be called *Bivouac Sites with no Water Source* and not Murphy Bivouac. Please re-word throughout report where relevant. Also, soldiers were assessed for this area, but not identified in this paragraph.

Page 10, Section 2.2.3 – Clones Bivouac: if using data from the entire APEC 15, the subject area should be called *Bivouac Sites with Potable Water* and not Clones Bivouac. Please re-word throughout report where relevant.

Page 12, Section 2.3, para 2: The sampling and compositing procedure described in this paragraph does not apply to APEC 15 to 22.

Page 12, Section 2.3, para 3, lines 5 and 6: Please verify that the number of samples corresponds to the number of analysed samples available in the database *CFB Gagetown Task 2B-3 Field Program Analytical Results*

Page 13, Section 2.3, para 4, line 1: "…from ~~there~~ background…"

Page 13, Section 2.3, summary table: Please confirm this is consistent with the final ESA report. It is not clear in the title of the table that the values correspond to the number of analyzed samples.

Page 13, Section 2.3, para 6: Please provide additional rationale regarding the treatment of composite and discrete samples as individual values and comment on whether this is considered to be a conservative estimate of exposure concentrations.

Page 14, Section 2.4, para 2, line 4: typographic error "PCDD/PCFCs"

Page 17, Section 3.1, para 3, line 3: please provide the correct reference for the ESA reports (Jacques Whitford is the author) and please change throughout the report where relevant as well as in the reference section. Also, "Stage 3 (ESA 2005A, ESA ~~205B~~ *2005B*, ESA 2006)…"

Page 20, Section 3.1.3, para 3, line 1: Please confirm whether the chemicals were screened against soil and sediment screening criteria, the tables appear to screen against soil values only.

Page 20, Section 3.1.3, table: It is unclear why SA6, which also includes data on sediments (from APEC 8), was not included in this table.

Page 21, Section 3.1.4: The report indicates that the surface water samples were screened against potable water values; however, some of the surface water samples were identified as puddles. Please confirm.

Page 22, Section 3.2.1, para 2, line 6: missing word "soldiers would not camp…"

Page 23, Section 3.2.2, para 1, line 4: "it is ~~closed~~ restricted to the general public…"

Page 27, Section 3.2.9, 3.2.10, 3.2.11: please identify the number of days that the receptors are expected to eat fish, game, and berries from the site. Also, please identify whether the families of the anglers and hunters are expected to consume fish, game, and berries from the site. This is discussed in the appendices but not summarized in the main report. Also, please identify why fish was the only aquatic life considered to be consumed from the site.

Page 29, Section 3.3, table: Please provide the rationale for excluding/including exposure pathways or provide a footnote indicating where this may be found in the report.

Page 31, Section 4.4 and 4.5, Tables: There is a typographic error in the description of ET1. Change "xposure" to "exposure".

Page 31, Section 4.4, Eq 4-1: it is noted that the units are not the same in the equation summary as in the sample exposure calculation. Also, the equation shows AG_{GIT} while the explanation shows AF_{GIT}

Page 33, Section 4.5, para 3: There is inconsistency in the report with regard to the dermal absorption factor used. In section 4.5, an absorption factor of 0.03 is recommended by the USEPA. This absorption factor is used in the calculation of EDI_{dc}. However, in Appendix G, section 3.1.3, para 3, a dermal absorption factor of 0.01 was identified to represent the fraction absorbed through skin from soil for human exposure. Table 5-1 appears to have a value of 1.0 for dermal absorption. Please confirm which value is correct and which value was used in the calculations and edit report as required.

Page 33, Section 4.6, Eq 4-3: The units in the equation summary are not consistent with the sample equation. The units for inhalation rate should be m^3/h rather than m^3/day. Please ensure that the equation, sample calculation and the data are done correctly. The sample calculation appears to be correct, but the description of the equation is not.

Page 34, Section 4.6 (Inadvertent Ingestion of Groundwater and/or Surface Water), Eq 4-4: Please note that there are two Section 4.6s. Also, the equation 4-4 does not have ET2.

Page 35, Section 4.7, Table: Change the description for C_W from "Chemical concentration in soil" to "Chemical concentration in water", and remove AF_{inhal} from the table since it belongs to Equation 4-3.

Page 36, Section 4.8: the units are incorrect in equation 4-6 and are not consistent with the sample equation. Also, please note that Section 4.8 states that calculations for exposure due to fish consumption are provided in Table 4-24 and detailed calcs of exposure to PCDD/Fs through fish are in Appendix E. Please confirm whether the reference to Appendix E should be Appendix F.

Section 5: A copy of the comments provided to Cantox with regard to the Toxicological reference value will be provided separately. Please ensure that all references are in the reference list.

Page 46, Section 7.3: The title indicates APEC 15, but the text refers to APEC 16. As noted above, the reference should be to Bivouacs with Potable Water use rather than "Clones". Please revise as appropriate.

Page 48, Section 7.6, para 2, line 1: please confirm that this sentence should indicate that the consumption rates "are expected to" overpredict the actual rates.

Page 48, Section 7.7: The uncertainty section does not address whether the fish consumption assumptions are over or underestimates of consumption. Please clarify.

Page 49, Section 7.8, para 1, last sentence: The last sentence refers to recreation and training although the calculations in this section do not address these exposure pathways. Please clarify.

Page 49, Section 7.9: This section provides information regarding consumption of country foods by the families, where the toddler is the most sensitive receptor. It is appropriate to consider a toddler receptor for this assessment. However, it is suggested that the ingestion rate of these foods be used for the toddler rather than using a body weight to food ingestion rate for the adult. No scientific rationale was provided for the methodology used in this section.

Tables:

Table 2-1: Some of the sample numbers could not be located in the ESA field program analytical results database, or in the ESA report. Some examples from SA-1 include: A1-C2 level 4 DUP, A1-S1-SS3 Level 4 DUP, A1-S2-SS2 DUP, A1-S2-SS5 Level 4 DUP and A1-S3-SS3 DUP. Please provide a reference for this information.

Tables 3-1 to 3-17: the constituent "bromoxynil" was part of the analytical package E&F and "bromacil" was part of package C. Please make the appropriate changes.

Please reference the source of the analytical data, i.e., the electronic database for ease of review.

Please provide the full references for CCME 2004 criteria, MOE 2004 Table 2 criteria, USEPA 2006 Region 3 RBCs, surrogate criteria and Interim Screening Criteria.

Table 3-1 to 3-11: "Screening Values" column: the screening values highlighted in orange do not match the US EPA Region 3 RBCs (2006) since the values were changed to reflect 20% of the TRV. Please provide a footnote for this.

Table 3-2: The maximum detected value for dioxins is not consistent with that in Table 4-1. It is not clear how this value was calculated (a footnote would be useful). Please confirm the correct values for SA-2 and SA-11 in table 4-1 and tables 3-2 and 3-11, respectively and ensure that the correct value was used in the calculations.

Table 3-10 (Summary of Analytical Data for Soil from SA-10): the maximum detected concentration of PCDD/F (41.994 pg TEQ/g) is A22-SCL2-SD1 which is a sediment sample and it is not clear why it is in this table. The report indicated that sediment was treated as soil for the purpose of the human health risk assessment, and a footnote in the table would be useful for clarification and ease of review.

Table 3-11: Same comment as for Table 3-2.

Table 3-13 (Summary of Analytical Data for Sediment from SA-9): the maximum detected concentration of PCDD/F TEQ (1.510 pg/g) references A21-NR2-SW1 which is a surface water sample. Please confirm that the appropriate data are in the table.

Table 3-14 (Summary of Analytical Data for Sediment from SA-10): the maximum detected concentration of PCDD/F TEQ (1.232 pg/g) references A22-SCL4-SW1 which is a surface water sample. Please confirm that the appropriate data are in the table.

Table 4-1: Exposure point concentrations for PCDD in soils provides maximum detected values for SA-2 and SA-11 that are different from tables 3-2 and 3-11, respectively. Please confirm the correct value and ensure that the correct value was used in the calculations.

Table 4-5: Exposure point concentrations for vegetation does not provide information regarding dry weight or wet weight for the sample data. This information is also not provided in the appendices. There is no summary for SA2 vegetation data or background vegetation data (which are provided in Appendix A, Table 17). Please identify which data were used in the modelling for moose/deer intake and whether it was dry weight or wet weight.

Table 4-6, 4-7, 4-8: The exposure point concentrations that are modelled are not clearly identified in the titles. The footnote indicates that modelling information is provided in Appendix D, however this information is not in Appendix D.

Table 4-8: Modelling for berries does not appear to be presented in the report, please provide this information. Also, please provide rationale regarding why the modelled berry concentration is one to two orders of magnitude lower than the concentrations measured in leaves/stems. It is recognized that chemicals partition differently in plants, but a discussion of the variability would be useful, as well as an indication of uncertainty associated with the modelling.

Table 4-10 (continued): Please footnote why the exposure term for the angler (SA-9, SA-10) is 70. According the table *Summary of Receptor Group Activity Patterns* presented in Section 4.3 of the report, the exposure term is 50 days/year for SA-9 and SA-10 (This also applies to Tables 4-16, 4-19 and 4-22). Please verify what values were used and ensure that the appropriate values were used in the calculations.

Table 4-12 (Summary Table for Inadvertent Soil Ingestion): Please verify the value for the Recreational Teen receptor from Subject Area 5. Please confirm calculations for anglers with an exposure term of 50/365 if the comment for Table 4-10 is correct (This also applies to Tables 4-17, 4-20 and 4-23).

Table 4-13 (Factors and Equations Used to Estimate Dose: Dermal Contact With Soil): Please verify that the values used in the calculations were accurate. For instance, for the recreational adult, the values for soil loading to exposed skin in table 4-13 are 0.000195 g/cm^2/day, while in table 4-9 the average loading was identified as 1.9E-5 g/cm^2 for recreational adults. Please verify that all values used in calculations are correct and ensure that the document reflects the values that were used.

Table 4-16 (Factors and Equations Used to Estimate Dose: Inhalation of Soil Particulates): Please verify the number for *Particulate Emission Factor*. The table indicates a value of 7.6E-7 kg/m^3 was used, however, Section 4.6 of the report indicates that a value of 7.6E-10 kg/m^3 was used. Please ensure that the calculations are provided using the correct value.

Soldiers: According to Section 3.2.2 of the report, soldiers have a daily exposure time of 6 hours per day in SA2, but this table indicates 8 hours per day. Please ensure that the calculations are provided using the correct value.

Table 4-17 (Summary Table for Soil Particulate Inhalation): Please see comments for Table 4-16.

Table 5-1: The TRV and dermal absorption factor in this table are inconsistent with the rest of the report.

Table 6-1: The Hazard indices tables should indicate that this is for site exposures only, the EDI is not included.

Table 6-32: typographical error in "Total"

Appendix A:

In some tables from Appendix A, it is unclear where the data for the PCDD/PCDF congeners were obtained. For example, the data from sample A22-SCL1-C1 in Table 10, do not correspond to the data in Table G-2 of the ESA; however, in most cases (not always) the TEQ values do match. Please provide an explanation for these discrepancies and verify data contained in tables from Appendix A. When verifying the data, please use the final ESA report.

The data are reported inconsistently through Appendix A, i.e., when the raw laboratory data were not detected or when the lab blank subtracted value was a negative number, the value substituted sometimes corresponds to half the detection limit, and other times, to the full detection limit. For example, in Table 1, the substituted values correspond to half the detection limit, whereas in Table 14 the substituted values correspond to the full detection limit. Please correct these inconsistencies and clearly indicate which one is being used.

It is unclear how the PCDD/PCDF TEQ values for the vegetation samples (Table 17) were calculated; calculations could not be replicated. Please verify these calculations.

In Table 17, 2,3,4,6,7,8-HxCDF is listed twice. Please verify whether the second should be OCDD.

Appendix D:

Please include a section to justify the use of a potable water ingestion rate of 0.05 L/day used in the calculation of EDI from ingestion of groundwater and/or surface water (2nd section 4.6 of the report). A paragraph justifying the choice of a daily exposure time for dermal contact with potable water of 0.167 hrs/day, and the use of a dermal permeability coefficient of 0.81 cm/h in the calculation of EDI from dermal contact with groundwater and/or surface water (section 4.7 of the report) would be useful.

Section 7 (Consumption of Game): Values of game ingestion rate should also be provided for toddler, child and teen since an assessment of risks engendered by

consumption of game is also required for the hunter's family members, who will also be consuming the food.

Section 8 (Consumption of Fish): It is unclear why data from Health Canada's guidance on Human Health Preliminary Quantitative Risk Assessment Part I (PQRA Part I) was not used. Apart from the data on the First Nations populations that are discussed in Section 8, HC's guidance also provide data on fish consumption for the Canadian general population.

The equation presented in section 8 for the calculation of the yearly averaged daily sport fish consumption does not provide rationale to assume that consumption is linearly proportional to body weight and this is better illustrated by looking at the food ingestion data from the PQRA Part I guidance.

Please provide a discussion of whether it is conservative to assume that all fish consumption will come from the Base.

Section 9 (Consumption of Blueberries): Please describe the uncertainty/limitations associated with using blueberry consumption rates from a Canadian food survey compared to the actual blueberry consumption from people collecting wild berries at CFB Gagetown.

Appendix F

Some items concerning the modelling of chemical residues in wild game remain unclear after the discussion presented in Appendix E. For example, it is unclear how a method was selected over another, and how the diet composition was determined for moose. Each IR, Ba, BW and F value (Gagetown Appendix F-3 BCF – Moose and Deer.xls) should be properly referenced and justified and if they were calculated based on more than one study, calculations should be provided.

Please explain why the dioxin concentration measured in vegetation collected at Gagetown did not appear to be used as C_{TP} in the equation to calculate deer and moose tissue residue concentration (Gagetown Appendix F-1 BAFs – Deer.xls, Gagetown Appendix F-2 BAFs – Moose.xls). Instead, dioxin concentration in terrestrial plants appears to have been taken from US EPA Region 6 (1999).

In the accompanying spreadsheet, Gagetown Appendix F-2 BAFs – Moose.xls, please verify whether F_{TA} should be changed to F_{AV} (second box, *Diet Composition*) so that it is the same as in the equation presented on the same sheet.

According to Table 4-6, values for surface water and modelled fish concentrations are:
SA-9: surf water EPC = 1.216 pg/L, fish EPC = 5.17 pg/g
SA-10: surf water EPC = 1.199 pg/L, fish EPC = 4.17 pg/g
The footnote to the table indicates that details of uptake modeling are provided in Appendix D -- but this appears to be Appendix F. According to Appendix F: page F-2

indicates that for fish, a BAF of 4235 was used to estimate concentrations in fish based on water concentrations. According to worksheet "text\Appendix F\Dioxin Bioaccummulation Appendix Attachment.xls": in the sheet "Direct BAFs", the calculation for fish concentration is: 1.2E-09 * 4235 = 5.08E-06 mg/kg where 1.2E-09 is the water concentration in mg/L. This value (1.20 pg/L) does not match either of the area-specific water concentrations in Table 4-6 and consequently, the fish concentration in the detailed calculations (5.08 pg/g) does not match the EPCs in report Table 4-6 (5.17 pg/g and 4.17 pg/g). Please verify the correct values and ensure that the text in the main report matches that in the appendices.

HUMAN HEALTH RISK ASSESSMENT FOR CURRENT EXPOSURES TO HERBICIDES & HERBICIDE RELATED CHEMICALS CFB GAGETOWN, OROMOCTO, NEW BRUNSWICK

Prepared by Dillon Consulting Limited

Dillon Consulting Limited Project No. 05-4212-0800

Consensus Report of the Peer Review Panel for Task 3A-2

Anthony L. Knafla, Equilibrium Environmental Inc.
Leonard Ritter, University of Guelph (Chair of the Panel)
Reidar Zapf-Gilje, RZG Consulting

June 23, 2006

This review was conducted at the request, and for the exclusive use, of Health Canada. The report is intended to provide a technical review and opinion of information included in the documents provided to the Peer Review Panel for Task 3A-2, "Human Health Risk Assessment for Current Exposures to Herbicides and Herbicide Related Chemicals at CFB Gagetown, Oromocto, New Brunswick", prepared by Dillon Consulting. This report is not meant to represent a warranty, or a legal opinion regarding compliance with applicable laws. The Peer Review Panel makes no other representation or warranty as to the accuracy or completeness of the information provided.

The review conclusions and opinions are entirely based on the information provided. The Peer Review Panel has relied on the accuracy and completeness of the background materials upon which the reported information was based, and is not responsible for errors and omissions in such background materials.

Any use of this report by a third party, or any reliance on or decisions to be made based on it are the responsibility of such third parties. The Peer Review Panel accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

1.0 INTRODUCTION

The Peer Review Panel (PRP) for Task 3A-2 was requested to carry out a peer review of a risk assessment carried out by Dillon Consulting (in collaboration with RBR Consulting, Inc). Dillon was required to carry out an independent human health risk assessment by: consulting the systematic review of the literature completed through Fact Finding Task 3a-1, and where necessary augment that literature review, to estimate exposures, characterize potential risks, and determine in an objective manner whether current environmental contamination detected at CFB Gagetown, and assumed to have resulted from the application of herbicides and herbicide-related contaminants at CFB Gagetown from 1952 to the present, may be associated with potential health risks and to describe the specific health risks of concern. The contractor was also required to determine whether estimated exposures are sufficient to exceed no-effect levels as determined from the toxicological literature, environmental health regulatory agencies and/or other information and sources. Contaminant levels in relevant environmental media (may include soil, groundwater, vegetation, fish, game, etc.) and identification of contaminants of potential concern were determined in Fact Finding Task #2b (Environmental Site Investigation). The assessment should also include consideration of background (not impacted by herbicide spraying at CFB Gagetown) exposures.

The report includes a number of key assumptions, which have relevance and impact for the risk assessment carried out by Dillon. These assumptions, and their implication for the risk assessment, are discussed in detail in the report that follows.

2. REVIEW CRITERIA

As noted in the instructions provided by Health Canada to the peer reviewers, the PRP is asked to provide an overall assessment, including comments, on the risk assessment report prepared by Dillon Consulting Limited. The overall assessment will be presented as one of the following:

Acceptable as is;
Acceptable with minor revision (as indicated);
Acceptable with major revision (as outlined); or
Not acceptable under any circumstance (as outlined)

Health Canada requested that peer reviewers use the following questions as a guide in completing their peer review of the toxicological risk assessment report:

1. Is the selected team of specialists that contributed and produced the report appropriate?

2. Is the material in the report presented in a clear, logical and concise manner? Is the report comprehensive? Please explain fully.

3. In your opinion, does the report meet the overall objective as outlined in the SOW for the Contaminated Site Human Health Risk Assessment? Please explain fully.

4. Are the assumptions, strategies, data sets and scope of review appropriate? Please explain fully.

5. Is the overall approach to conducting the risk assessment technically acceptable? Please explain fully.

6. Is each component (i.e. problem formulation, hazard assessment and toxicokinetics, exposure assessment, estimated background daily intakes, risk calculation and characterization) of the risk assessment technically acceptable? Please explain fully.

7. Does the work conducted (i.e. contaminated site human health risk assessment) yield scientifically credible conclusions?

8. In your opinion, what are the weakest and the strongest aspects of the report to address the risks associated with the current contamination in soil and ground water at CFB Gagetown? Please make suggestions on how the weakest parts can be strengthened.

9. Are there any elements missing from the report which you think need to be included or which would strengthen the document? Please explain fully.

10. Are you aware of any other significant data/studies that are relevant and should be included or referenced in the report? Please explain fully.

11. Are the stated goals realistic? Are the stated objectives adequately met? Please explain fully.

3. GENERAL COMMENTS AND REVIEW

3.1 Is the selected team of specialists that contributed and produced the report and database appropriate?

The PRP was provided with a detailed description of the team assembled by Dillon to conduct the subject risk assessment. From the detailed information provided by Health Canada to the PRP, it was possible to assess the suitability of the Dillon team in the context of the Statement of Work provided by Health Canada.

The PRP is satisfied that the Dillon team was experienced and fully competent to complete the risk assessment.

3.2 Is the material in the report presented in a clear, logical and concise manner? Is the report comprehensive? Please explain fully

Overall, the organization and presentation of findings in the report is well done. The approach taken by Dillon is to first define the scope and objectives of the project and to then lay out an organizational approach that the report will follow. This introduction, while brief, is very useful to the reader in understanding how, and why, various aspects were undertaken and the contribution of these aspects to the overall risk assessment process. The information, data, tables, etc are presented in a rather clear, easy to follow manner, with tables and appendices arranged in a logical sequence.

The issue of comprehensiveness can be interpreted in several different ways, and several of the other questions that have guided the work of the PRP will also speak to and address the issue of comprehensiveness. In the present context, comprehensiveness can be interpreted to raise the issue of possible omissions in the assessment that are of a nature that may have influenced the outcome of the analysis and, hence, the interpretation and conclusions drawn by Dillon. A wide diversity of receptors has been considered in addition to a number of relevant exposure pathways. There was however a tendency to rely on modeled uptake of PCDD/PCDF into various biological media that are consumed by humans and wildlife (*e.g.*, moose) even though measured data were available (*i.e.*, vegetation concentrations), which introduces considerably uncertainty (and not necessarily over-conservatism) into the risk assessment process. In addition, little data are available regarding behavioral characteristics of the local population that are used in exposure calculations (*e.g.*, frequency of hunting and fishing events, consumption of berries by youth campers). The incorporation of local stakeholders into the risk assessment process at an earlier stage would have contributed significantly towards the derivation of more relevant exposure characteristics.

The main report (pg 13) includes a summary of composite and discrete soil samples, by subject area. A total number of 295 soil samples were collected, including composite and

discrete samples from an area that is described on page (i) as being 110,000 hectares; similarly, a relatively small number of samples were also collected from the various other media, including water (potable and surface) and vegetation (leaves, roots and stems) that were included in the present study. It is evident that the validity of the risk assessment conducted by Dillon is very much dependent on the adequacy of the samples collected to reliably describe the concentration of various herbicides and contaminants in the media that were assessed as possible sources of exposure to various population subsets included in the present assessment. Despite the relatively small number of samples that were collected to represent the Camp Gagetown universe, the adequacy of the sampling is not described or discussed as a source of uncertainty in section 7.0 (pg 45) , "Discussion of Uncertainties", yet may be a very important source of uncertainty in the Dillon risk assessment. This aspect should be discussed in this section, including some rational and/or justification for the sampling protocol that was utilized, and the possible implications (if any) of the sample size to adequately represent potential sources, and magnitude, of exposure. It appears that Dillon is working from analytical/modeled data that had been collected pursuant to another Task, and was thus not directly responsible for selection of samples. Having said this, the risk assessment conducted by Dillon needs to include a discussion of the validity of the sampling in so far as it supports the validity of the risk assessment.

Similarly, Dillon concludes that of all of the population subsets that were included in their assessment, only the (adult) anglers may experience exposures that exceed an acceptable threshold, and only for PCDDS/PCDFs. The report does not consider that some anglers may bring children with them and that these children may also be fish consumers. Children may be at greater relative risk than adults due to: 1) greater general background exposures to PCDD/PCDFs compared to the adult on a per kilogram body weight basis (Dillon 2006, page 43) and associated smaller residual tolerable daily intake; and, 2) greater relative consumption rate of fish, compared to adults, on a per kilogram body weight basis. Discussions with stakeholders (*i.e.*, local residents) could determine whether this receptor is valid and applicable for the Gagetown site.

The Dillon assessment models an estimate of exposure from fish on the basis of a US EPA published model, rather than on direct analytical data. Moreover, the report suggests that this estimate is invariably an overestimate and that sampling of fish should be considered in order to reduce or eliminate the uncertainty inherent in the use of modeled data.

The PRP was aware that the SOW which guided Dillon's assessment indicated that "…..to assess the potential effects on human health of all contaminants of potential concern identified in environmental media (may include soil, groundwater, vegetation, fish, game, and/or other media) sampled and analyzed at CFB Gagetown through completion of Fact Finding Task 2b (Environmental Site Investigation)…" It would seem that the data utilized by Dillon was generated through Task 2b. It also seems likely that sampling of fish was not conducted under Task 2b, and hence these analytical data would thus not have been available to Dillon for their use in conducting their risk assessment.

3.3 In your opinion, does the report meet the overall objective as outlined in the SOW for the Contaminated Site Human Health Risk Assessment? Please explain fully.

Noting several specific comments and concerns of the PRP discussed in this review, the report does, generally, meet the objectives as outlined in the SOW.

As noted in (2) above, fish were identified as the only possible medium in which concentrations of PCDDs/PCDFs could result in human exposures that exceed acceptable thresholds. It is evident that Dillon was working from analyses that were performed pursuant to task 2b, and that presumably these analyses did not include direct sampling of fish which would have allowed Dillon to utilize analytical, rather than modeled, data in their risk assessment. The SOW intimates that Dillon was not required to carry out independent analysis, but rather to rely on analyses conducted under task 2b and to augment, where necessary, literature reviews that would be used to model potential sources of exposure originating from various environmental media. The PRP was also concerned that in a number of instances, there was a tendency to rely on modeled uptake of PCDD/PCDF into various biological media that are consumed by humans/wildlife even though measured data were available (*i.e.*, vegetation concentrations).

A further area of concern for the PRP was the assessment of potential future risks as required by the SOW. It would appear that risks under the current situation were assumed to project into the future and that use of the land would not change. Stakeholder input could be used to determine potential future land use changes and associated changes to the assumptions and parameters used to estimate risks. This issue should be addressed in the risk assessment report.

3.4 Are the assumptions, strategies, data sets and scope of review appropriate? Please explain fully.

The assumptions, strategies, data sets and scope of the review are not entirely appropriate.

The PRP was aware that data sets made available for the risk assessment conducted by Dillon were not entirely within the control of Dillon in that these data had been generated (either analytically or from literature sources) through other tasks of the larger Gagetown undertaking. Having said this, Dillon was expected, pursuant to the terms of the SOW, to augment the literature, as necessary. The PRP did express some concerns with regard to several assumptions and data sets included in the Dillon assessment.

The PRP was concerned with the Dillon approach to “amortize” the annual exposure to the putative contaminants from an estimate of daily intake (essentially this is tantamount to assuming that the annual total exposure can be considered to have occurred on an

average daily basis). While this approach is not uncommon, the underlying biological justification, and appropriateness, is not clear. It is well understood that the magnitude of a single dose, rather than the total dose, can be very important in defining threshold toxicological outcomes, especially so for effects that require only a brief period of exposure at a specified level (ie, teratogens). In the case of the risk assessment for contaminated fish for which Dillon has suggested that exposures to certain population subsets may exceed an acceptable threshold, it is noteworthy that the model described in Table 4-9 is based on a daily dietary intake of only a few grams. It will be apparent that consumption of fish, contaminated or otherwise, by humans is more typically characterized by intake of relatively large amounts over very brief periods, such as in a single meal; all this to say that typical exposure in humans is more likely to result from ingestion of several hundred grams of contaminated fish at a single meal, which may recur several times per month or, in the case of some fish eaters, several times per week. Similarly, on page App D-7, a statement is made that "It is reasonable to assume that consumption is proportional to body weight and that smaller adults and children will eat proportionally less fish than larger adults". This statement is in direct contradiction to the data reported on the previous page citing Richardson (1997) where children would be expected to consume more fish than adults when including body weight in the analysis. In this section, Dillon appear to have corrected fish consumption rates for toddlers, children, and teens based on a body weight scaling factor and the consumption data provided for adults by Kearney *et al.* (1995). This approach is not well defended and given the data provided by Richardson (1997) for differences in consumption rates between age groups, the approach taken may lead to an underestimation of fish-related exposures for toddlers, children, and teens.

It is also important to note that the various default intake values that were utilized by Dillon in its assessment typically reflect "average" consumption and would not, for example, accommodate vegetarians and other possible dietary variants; the potential impact of altering intake values from those typical default values, in order to accommodate potentially highly exposed population subsets is unclear in the present assessment.

It is important to note that the impact of the application of various amortization models is not well understood. Dillon did make an attempt to address this area of uncertainty in section 7.2 (pg 46) of the main report. In this section Dillon carried out two calculations to describe exposure to contaminants in soil from ingestion, dermal contact and inhalation; one applying classical amortization models and the other with essentially no amortization. In this particular instance, Dillon concluded that application of the amortization concept does substantially increase the apparent risk (by increasing the Hazard Index (HI) estimate by 73 fold), but that it still fell well below the acceptable threshold. In contrast, one can alternatively conclude that the absence of amortization can substantially increase the HI, and thereby the apparent risk, and one can only speculate as to the impact of amortization when applied across all of the various exposure scenarios in the Dillon risk assessment.

As noted, Dillon has recognized and attempted to address issue of potential impact of exposure amortization on the overall risk assessment. In view, however, of the importance of this assumption in the overall conclusions of the risk assessment, Dillon should be encouraged to elaborate the potential impact for several other exposure scenarios.

In its Executive Summary (pg (i), main report) Dillon noted that the present assessment, Task 3A-2, evaluates "…. Potential human exposures to current levels of herbicides and herbicide related chemicals for people who could be expected to be on the site currently or in the future." As discussed in (3) above, it would appear that risks under the current situation were assumed by Dillon to project into the future and that use of the land would not change. Stakeholder input could be used to determine potential future land use changes and associated changes to the assumptions and parameters used to estimate risks. This issue should be addressed in the risk assessment report.

Dillon presented little data regarding behavioral characteristics of the local population that are used in exposure calculations (*e.g.*, frequency of hunting and fishing events, consumption of berries by youth campers). The incorporation of local stakeholders into the risk assessment process at an earlier stage can contribute significantly towards the derivation of more relevant exposure characteristics.

The concerns of the PRP regarding the sample data set for soil and other media have been discussed in (2) above.

Overall, the PRP considers that while many assumptions, data sets and strategies are acceptable, others either need further supporting rationale or revision. In cases where assumptions are based on limited data, a more conservative selection of approach or measured values for exposure assessment may be warranted, as outlined in the attachment.

3.5 Is the overall approach to conducting the risk assessment technically acceptable? Please explain fully

The approach adopted by Dillon is in general accordance with standard practice for risk assessment. The Dillon approach includes a site characterization which provides an overview of the environmental sampling; a problem formulation component that identifies the chemicals of concern, based on the information included in the site characterization; an exposure assessment that describes the potential exposure (based on analytical data or modeled data) for each of several population subsets; a toxicity assessment that summarizes the likely toxicological effects of the chemicals of concern; a risk characterization which is essentially the product of the quantitative risk assessment and which estimates the risks to various population subsets resulting from exposure to various contaminated media; and a discussion of uncertainties which, while cast in a context specific to this particular risk assessment, are inherent to the risk assessment process.

As noted elsewhere in this review, reliance on assumptions and default values introduces inherent uncertainty in the risk assessment process, including the one conducted by Dillon. The PRP was of the view that the approach utilized by Dillon in the present risk assessment generally complies with accepted practice for assessments of this type; hence, the risk assessment is technically acceptable. The validity of at least some of the assumptions included in the Dillon assessment can be debated (assumptions in risk assessments are *always* debated), and the PRP is of the view that several of the key assumptions included in the Dillon assessment are not inherently conservative, as stated by Dillon, and do not indicate an overestimation of risk. The nature of some of these assumptions, and their potential impact, are subject to interpretation and modifying some of the assumptions may have yielded an outcome that would have resulted in a risk assessment interpretation different than that concluded by Dillon.

Finally, residual tolerable daily intakes (rTDIs) do not appear to have been calculated in accordance with methods put forth by the Canadian Council for Ministers of the Environment. Instead, Gagetown-related risks were compared against background exposures. The purpose of a rTDI is to determine acceptable intakes that can occur when added to background exposures that will not lead to an exceedence of the tolerable daily intake (TDI). Substantial datasets are available regarding background PCDD/PCDF exposures and values were recently provided for a Canadian population by CanTox (as cited by Dillon). Greater Hazard Indices may be calculated following a rTDI approach compared an evaluation of site-related exposures against a TDI value. The rTDI approach can be particularly important in situations where background exposures may be approaching exposure limits (tolerable daily intakes) that are used to predict potential risks to humans. Dillon alternately evaluated risks based on a Hazard Index of 0.2, which essentially indicates that 20% of the TDI can come from site-related exposures, a method that has been endorsed by several regulatory agencies in Canada. However, this approach is intended for evaluating exposures from a single contaminated environmental media (e.g., soil, water, **or** air) and has less relevance for a multi-media exposure setting such as Gagetown. A defensible rationale should be provided to address why a rTDI approach has not been adopted particularly when Canada-specific data are available that could be readily incorporated into the risk assessment.

3.6 Is each component (i.e. problem formulation, hazard assessment and toxicokinetics, exposure assessment, estimated background daily intakes, risk calculation and characterization) of the risk assessment technically acceptable? Please explain fully.

The problem formulation and hazard assessment components have been assessed in an acceptable fashion. The approach to exposure assessment utilized by Dillon, as discussed elsewhere in this report, does raise several questions.

In some cases, actual analytical data were utilized to estimate exposures (as in the case of soil and water samples) while in other cases, such as for contaminants in fish and berries, modeled data, sometimes employing complex BAF models, to estimate likely human

exposure. In addition daily intake of various food sources, such as fish and berries, were assumed to adhere to general published default values. Dillon does not appear to have verified the validity of these default assumptions for the specific subpopulations included in their assessment and, in this context, it would appear that potentially more highly exposed subpopulations (vegetarians, fish eaters) may be underestimated in terms of their estimated dietary intake from certain food sources.

In addition, as discussed elsewhere in this review, the exposure assessment included amortization models which may, or may not reliably predict daily exposure from contaminated environments (soil) and foods. These concerns are elaborated elsewhere in this review. Similarly, Dillon noted on pg 49 of the main report (section 7.8) that concomitant exposures to fish, game and berries are unlikely, but not impossible. In order to address this possibility, however, Dillon then develops a HI calculation to estimate concomitant exposure from game and berries but, curiously, does not include fish in this concomitant exposure model. In this particular instance, Dillon has not offered any rational for their view that concomitant exposure to fish, game and berries is unlikely; nor have they explained why they omitted fish when they assessed exposure from their assessment of possible combined exposure.

An issue also exists as to whether amortization of exposure is at all relevant given the nature of PCDD/PCDF toxicity and the animal studies from which the tolerable daily intake has been derived. Greater laboratory animal exposures relative to those experienced by humans may lead to lower relative body burdens, particularly when considering intermittent exposures due to differences in elimination half life, which is considerably greater for humans (as summarized in the Dillon report). The induction of liver enzymes results in a sequestration of TCDD in the liver which may underestimate the distribution of TCDD to other tissues at lower doses where less induction may be observed. Therefore, straightforward amortization may not be appropriate for assessing chronic risks to humans based on studies with laboratory rodents.

Due to this uncertainty, and the persistence of PCDD/PCDFs in biological tissues (that is greater in humans compared to rodents), amortization of exposure to the degree conducted in the Dillon risk assessment may not be a conservative or defensible approach. A greater persistence in humans versus rodents can lead to greater steady state chronic blood concentrations (as well as concentrations in target tissues), which could lead to a greater risk of the development of an adverse effect particularly following intermittent exposure. Body burdens in rodents will decrease more rapidly than in humans due to differences in half life, and thus on a relative basis humans will be at greater risk for the development of an adverse effect, compared to rodents, following intermittent exposures. A more conservative approach would be to use the default exposure terms provided by Health Canada that are also more comparable to the exposure frequency used in animal studies to derive the exposure limit.

Further to this comment, and given that exposure limits have been provided by regulatory agencies on a weekly or monthly basis (Page G-11 to G-13, Appendix G in the Dillon report) why were risks for potentially sensitive risk situations that may occur over a

shorter interval of a particularly year (*e.g.*, weekly or monthly basis for prolonged hunting or fishing trips) not compared with weekly or monthly exposure limits? This may be a more defensible approach than amortizing over a year both the exposure limit and exposure doses calculated in the risk assessment, particularly given differences in toxicokinetics between exposed humans and the laboratory animals from which exposure limits were derived.

The statement that differences in blueberry consumption rates between 1970 and 1972 and present day are expected to be relatively similar is based on conjecture and no defensible explanation has been provided. A more detailed explanation should be provided.

On page App D8, it was stated that individuals may inadvertently ingest water while wading or swimming. A value of 50 ml/hour was cited. The values cited under various sections in Appendix E and used to calculate exposure via this pathway was 50 ml/day (0.05 L/day). This suggests either an error in reporting or an error in the data used to calculate risks given that the exposure duration was 2 hours for the angler receptor.

Hunter exposures to PCDD/PCDF were determined by averaging measured soil concentrations over the entire CFB Gagetown area (110,000 hectares), defined as SA 11. The rationale given for this is that hunters can be expected to range over a considerable area during their hunting activities. Under Section 2.2.11, it is stated that assessing hunter exposures to chemicals in soil on an area by area basis will "greatly overestimate potential exposures for this receptor group". This was the basis for the establishment of area SA 11. On what basis does Dillon assume that hunters will travel over an area of 110,000 hectares to hunt moose and/or deer over a 27 day period, the duration assumed by Dillon that hunters will be on the base per year.

Are there data available regarding the typical area over which hunters may travel during a particular hunting year? Have stakeholders been consulted to provide more site-specific information? Does the possibility not exist that hunters could have relatively smaller preferential hunting areas (where successful hunting ventures have occurred in the past and therefore may be expected to occur in the future due to favorable habitat for the frequenting of a moose or deer population)? These issues should be addressed in the report and/or stakeholders consulted to determine more relevant data from which to derive exposure calculations results.

Concentrations of PCDD/PCDF have been detected in vegetation samples collected at CFB Gagetown, but not in background locations. Were these data used to calculate uptake into game tissues? From Appendix F it would appear that mathematical models were used to calculate plant concentrations. Would the use of measured plant concentration data not result in more accurate estimates of plant concentrations than those predicted using mathematical models? These concentrations could readily be applied with biotransfer factors for the various PCDD/PCDF congeners detected in plant tissue (such as the hexa- and hepta-chlorinated congeners – Table 17).

Has the typical range area of a moose or deer been considered? In other words, would the areas over which concentrations are combined be better defined, for calculating uptake into moose tissue, based on range area rather than the total area of CFB Gagetown? In the spreadsheet calculations under Appendix F, a Time On-Site unitless factor of 1 was assumed.

Therefore, range area has not been considered in the calculation of uptake and instead soil concentration data from then entire CFB Gagetown area were used. The Range area reported in Appendix F for White-tailed Deer was 100 ha compared to the entire Gagetown area of 100,000 ha. Thus it is plausible that wildlife may spend all of their time in smaller areas of the site (*e.g.*, SA 1 and SA 2) where greater concentrations of PCDD/PCDF have been detected, suggesting the assumptions used are under-conservative in terms of estimating uptake into wildlife. It is recommended that range area be considered in these calculations to provide a more realistic estimate of uptake over smaller areas of CFB Gagetown where localized areas of higher soil concentrations have been measured and where detectable concentrations of PCDD/PCDF isomers in plant tissue has been observed.

Appendix F provides a detailed discussion on the methods used to calculate uptake of PCDD/PCDF into fish. The Dillon report indicates that they used relevant bioaccumulation factors (BAFs) provided by the US EPA (1999) for 7 PCDD/PCDF congeners. These BAFs were applied to the concentration of 2,3,7,8-TCDD detected in surface water. Why were the concentrations of other PCDD/PCDF isomers not used for these calculations particularly given that 2,3,7,8-TCDD was never detected at concentrations above the detection limit in surface water samples from SA 6 and SA 9? Were the BAFs for various congeners used in combination with the respective concentrations of those congeners in surface water to calculate a fish PCDD/PCDF TEQ concentration? What approach was taken for those congeners detected in surface water for which BAF factors were not available? Some of the higher molecular weight congeners were detected in surface water (*e.g.*, OCDD), which will have relatively larger BAFs compared to 2,3,7,8-TCDD. A more detailed and specific discussion is required for the calculation of fish concentrations. As mentioned previously, a well designed study for the collection of fish from relevant surface water features and subsequent analysis for PCDD/PCDF congeners would substantially strengthen predictions of risk.

The statement on page App F2 that “It is generally accepted that the predicted whole-body tissue residues provide a conservative estimate of what would be present in the edible tissues” is not applicable in all cases for all chemicals and should be modified to reflect those specific situations where this statement is valid.

Although water to fish BAFs are available, many species of sports fish (*e.g.*, Rainbow Trout, Lake Trout) may also receive significant exposure via the consumption of benthic invertebrates that have in turn accumulated chemicals from pore water and sediment. These accumulation pathways were not considered in the risk assessment. The use of laboratory derived BAFs provided by the US EPA (1999) and cited by Dillon for water to fish transfer will not account for these alternate accumulation pathways, which highlight

the importance of obtaining fish from relevant surface water features and analyzing for concentrations of PCDD/PCDF. The PRP is of the view that the calculation of fish concentrations was not necessarily a conservative approach.

In Appendix G (page G-3), it is stated that an oral bioavailability of 50% was chosen to represent oral exposures via the ingestion of soil. On page 32 of the Main Report, the sample exposure calculation for the inadvertent ingestion of soil/sediment for the soldier in area SA 1 presents an absorption fraction of 100%. This discrepancy should be addressed.

A similar discrepancy exists for dermal exposures where on page G-4 (Appendix G) a dermal bioavailability via soil contact of 1% was reported, whereas the sample calculation on page 33 (Main Report) was based on a value of 3%. This discrepancy should also be addressed.

The PRP also noted that overall, the risk calculations carried out by Dillon, in general, appear to be focused on single media exposure (perhaps with the exception of the game/berries calculation described above), without due consideration of the possibility that human population subsets could be simultaneously exposed to multiple contaminated sources (ie, water, food – berries/game/fish- , soil). The approach of multi media exposure assessment is now widely practiced; the US EPA, for example, has adopted this latter approach for estimating multimedia pesticide exposure from the totality of all possible sources. The PRP is also of the opinion that in the absence of a large data set that could support a probabilistic assessment, Dillon should consider the use of maximum concentrations, or percentiles (*e.g.,* 90^{th} or 95^{th} percentile), as a means of conservatively estimating human exposure.

3.7 Does the work conducted (i.e. contaminated site human health risk assessment) yield scientifically credible conclusions?

Generally, yes, although the scientific credibility is challenged by some of the assumptions made and related unsupported statements of the inherent conservatism in the risk assessment. As noted above, the risk assessment conducted by Dillon is in general accordance with standard practice for assessments of this type. A number of assumptions on which Dillon has relied do impact the final outcome. In general, the risk assessment process does, typically, rely on various assumptions and default values to arrive at interpretations and conclusions. Some of these assumptions, such as the exposure amortization process discussed elsewhere in this report are not universal and could be assigned different values. In particular, the amortization process used does not follow recent developments for compounds such as PCDD/PCDF and may lead to a significant underestimation of the potential for health risks. Having said this, the majority of the assumptions included by Dillon in its work are consistent with those typically adopted in assessments. It is, however, difficult to predict the impact of some of these assumptions on the final outcome of the Dillon risk assessment. For example, it is noteworthy, as discussed above, that the total number of samples for the geographic area included in the present assessment is relatively small. While it is appreciated that Dillon's work began

where the site assessment work concluded, the potential impact of the relatively small sample size does deserve some discussion and assessment by Dillon in their report. The calculation of residual tolerable daily intakes was not considered in the risk assessment, which may be important for compounds (such as PCDD/PCDFs) for which there is significant human background exposure and that are toxic at relatively low doses. Sufficient Canadian background data are available for calculating a rTDI. Otherwise, in general terms, the risk assessment conducted by Dillon complies with the guidelines and philosophy published by Health Canada for human health risk assessment for contaminated sites.

3.8 In your opinion, what are the weakest and the strongest aspects of the report to address the risks associated with the current contamination in soil and ground water at CFB Gagetown? Please make suggestions on how the weakest parts can be strengthened

There are several "weaknesses" that should be addressed in order to strengthen the value of the Dillon report. The primary expectation of the Dillon risk assessment was to provide the Government of Canada with a robust, objective and comprehensive risk assessment related to the use of herbicides at Camp Gagetown. It will be obvious that the perceived objectivity of the work is absolutely paramount to acceptance of the findings by the various interests that will read and utilize the risk assessment report. An important "weakness" of the report is various statements that appear to minimize possible adverse outcome. Statements such as "The results indicate……. clearly do not and will not represent a potential concern for human health at CFB Gagetown." (concluding statement, pg (iv), main report) does not support the expected objectivity of such a the report. Statements of this type are not required as a component of the SOW and of questionable validity given the inherent uncertainty in the risk assessment process and the substantial dependence on various assumptions and default values, as discussed above. It is recommended that statements of this type be removed and that comments and conclusions focus on risk assessment *per se*, and leave the implication of its assessment to the discretion of the reader and end users of its risk assessment.

Another important weakness is the reliance of the report on modeled data (ie, contaminated fish), in some instances even where analytical data were available (i.e., vegetation), and where such modeling yields, in Dillon's opinion, outcomes of questionable validity. Dillon correctly notes that the only practical means to reduce uncertainty is through the generation of data, and inherent uncertainty that is attributable to the lack of data deters from the validity of the report and its value to subsequent users of its findings.

Clearly, an important strength of the report is its compliance with internationally accepted practice for work of this kind and its adherence to the general guidelines and principles articulated in the Health Canada guidance for contaminated site risk assessment.

3.9 Are there any elements missing from the report which you think need to be included or which would strengthen the document? Please explain fully.

As noted in (4) above, some discussion of the context and meaning of the term "future" is warranted to ensure that a population at potential risk has not been omitted from the Dillon report. Similarly, as noted elsewhere, some discussion of the impact of sample size would also strengthen the report in that it would re-assure (or raise concern) the reader that the sampling protocol could reliably support the risk assessment outcome. Finally, as noted above, is the implied risk associated with consumption of contaminated fish, and the apparent minimizing of the importance of this outcome by Dillon due to its reliance on "reportedly" conservative modelled data. A stonger statement of the uncertainties in the modelled results and the need to confirm the modelled potential risk with analytical tissue data should be included in the main body and conclusion of the report.

3.10 Are you aware of any other significant data/studies that are relevant and should be included or referenced in the report? Please explain fully.

As noted elsewhere in these comments, the assessment prepared by Dillon report considers the key aspects described in the Health Canada risk assessment guidance documents, as well as those described by other major regulatory jurisdictions. A review of the bibliography included in the Dillon report reveals that a number of citations are inadequately or incompletely cited, and users of this assessment would have some difficulty retrieving some references on the basis of the citation information included. For example, while the URL for the Health Canada dioxins and furans report published in 2005 is cited, the Health Canada contaminated site risk assessment guidance document does not include a web accessible citation. In general, many of the citations included in the bibliography are web accessible, and Dillon should be encouraged to provide comprehensive citation information in order to facilitate use of this report by the broadest possible audience.

It is also noteworthy that the US government has had a similar interest to that being expressed by the Government of Canada in the present Gagetown review. While the US government studies have been motivated by concerns of adverse effects in US veterans who may have been exposed to various herbicides utilized by the US military in Vietnam, the chemicals and contaminants involved may be similar, and in some instances identical, to those that are being considered in the present context. The US National Academy of Science (NAS), Institute of Medicine, Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides, has undertaken several reviews of US veterans and Agent Orange, the most recent of which was issued by the Academy as a 2004 update (http://fermat.nap.edu/catalog/11242.html). The update, the sixth in the series, is some 650 pages in length and includes a very comprehensive synopsis of published information on all aspects of the herbicides in question. The update provides a

comprehensive overview of the literature on herbicides and associated contaminants, including at least some of those considered by Dillon in its assessment and report. The update could be particularly useful in several areas of the Dillon risk assessment. As this publication is not cited by Dillon, it appears that Dillon was not aware of this major US initiative and may wish to consult the NAS document in finalizing its own report.

3.11 Are the stated goals realistic? Are the stated objectives adequately met? Please explain fully.

The goals of the assessment, as stated in the SOW as well as in the introduction to the Dillon report, are entirely realistic. Noting several limitations described in the comments above, some re-consideration by Dillon will be required in order to conclude that the objectives have been adequately met.

4.0 SPECIFIC RECOMMENDATIONS

1. It would be useful to have an introductory section that includes a brief glossary of terms and common definitions that are utilized in the report. For example, the terms hazard and risk are used virtually interchangeably, yet the common use of these terms in risk assessment is often meant to imply different things. Dillon should adopt an accepted definition, and amend the report accordingly. Similarly, it would be very useful to the reader if the report could also include a description of the main assumptions that formed the basis for the risk assessment.

2. The RA should include an analysis of the potential impact of the relatively small number of samples, and the associated uncertainty.

3. The RA should consider alternate approaches, as discussed in this report, to the amortization models used for estimating exposure in human populations.

4. The range area for wildlife (i.e., moose/deer) should be considered for calculating uptake since the possibility exists for higher PCDD/PCDF tissue burdens in wildlife inhabiting areas with greater PCDD/PCDF concentrations. Concentrations measured in vegetation should also be used to calculate uptake by herbivorous wildlife.

5. The RA should include an assessment of concomitant, multimedia exposure.

6. A residual tolerable daily intake approach should be considered given the availability of Canada-specific data and detailed estimates of estimated daily intakes.

7. The RA should consider several apparent discrepancies in various calculations and alternate approaches/assumptions for estimating PCDD/PCDF concentrations

in various media (including biota), as well as alternate approaches for estimating exposure, as discussed in the present report

8. The RA needs to clarify what had been intended by use of the term “future” uses of CFB Gagetown, and amend the conclusions of the RA in accordance with this understanding.

9. The RA report should include comprehensive bibliographic citation information to facilitate use of this report by the broadest possible audience. A number of bibliographic citations are inadequate to allow retrieval.

10. The RA report should be amended to reflect a more neutral tone. In view of the large number of assumptions, use of default values and exposure amortization models and lack of multimedia exposure assessment, the repeated reference to what Dillon has interpreted as conservatism is not supported by the data and detracts from the quality of the report.

11. The boundaries of the SA need to be better defined and explained in both the figures and text (for example, the legend to Figure 2-3 cannot be read, even when digitally enlarged)

12. The exposure point concentrations were based on the 95% UCLM. Subject Areas where the 95% UCLM did not exceed the CCME guideline (6) did not require a human health risk assessment (HHRA) to be conducted, if one assumes the level of site investigation is sufficient. Alternatively, if the site investigation scope is considered to be limited, then the max concentrations should be used; or the 90^{th} percentile if the sampling coverage is marginally limited.

13. Hot-zone identification: The large range in concentrations and the use of non-parametric statistics for SA2 - Rippon Road may indicate that this data set may represent more than one statistical population. Therefore, it is possible that the highest concentrations represent “hot zones” which should be confirmed and delineated. In-lieu of this information, the maximum concentrations should be used for the entire Subject Area. The same is true for SA3 - Murphy Bivouac, and SA6 – Static Range Impact Area.

14. SA11 - CFB Gagetown covers the entire base; and the statistics are for based on the total number of samples collected. It may be more useful if the base area was divided into probable hunting areas based on habitat and usage. For example, are the firing ranges accessible to hunters? Where are the likely moose and deer habitat and hunting areas? The rationale for using the 95% UCLM for the entire base for the hunter exposure scenario is weak; and it is hard to determine whether this value of 15 pg/g would be conservative or not.

15. Adjustment of Raw Data (for most media): Usually blanks are used to check data quality and not for adjusting the data. The practice may not affect the overall results significantly, but should either be revised, or based on a defensible rationale. This is especially relevant as many blanks had significant concentrations compared to those of the samples.

16. Discrete versus Composite Samples: While the use of composites is accepted practice, especially when the discrete samples are stored for follow-up analyses where elevated concentrations are found in the composite sample. Often, the trigger limit for selecting the discrete samples for analysis is based on the guideline value divided by the number of discrete samples used to make up the composite (in this case 6). However, as the CCME guideline value is sufficiently protective (based on background concentrations); Dillon approach of using the guideline value as a trigger may be reasonable (although justification for this should be provided in the report). However, the discrete samples are <u>not</u> independent of the composites, which is a requirement for classical statistical analysis. In fact, they represent the very same soil; which leads to a bias in the statistical analysis. Options to remove the bias include:
    - Not include the discrete samples (except for estimates of max conc.)
    - Include the discrete calculating a "numerical composite" which would then be used to estimate the average composite value for the sector.
    - Separate statistics can also be used for the discrete samples to compare the variability of the composites and the discrete samples. Statistical analysis on composite samples underestimates the true variability; which could be adjusted based on the results from the discrete samples.
    - The inclusion of the discrete samples is conservative as the sectors with higher concentrations are biasing the results (double counting of results). However, the use of composites leads to underestimation of the variability, which affects the 95%UCLM.

17. Predicting tissue concentration based on models using literature values for input parameters can result in large uncertainties in the predicted values, especially for higher trophic levels. Given that the potential risk for fish ingestion is estimated to be unacceptable; it is necessary to collect tissue data from the site. As stated by Dillon in Section 7.7, direct measurement of PCDDs/PCDFs in fish tissue is the

most scientifically meaningful aproach to resolve the issue. The approach taken for calculating uptake into various biota was not necessarily conservative.

18. Background Data: Soil, sediment, surface water and sediment samples were collected from 3 background locations on CFB Gagetown. The concentrations in soil for many of the samples are similar to those obtained in some of the SA. A comparison to what may be considered to be "normal" background" concentrations in Eastern Canada, or in North America, would be useful.

19. Exposure Scenario Assumptions: As noted in (5) and (8) above, potential exposure in populations that partake in multiple activities, concomitantly, should be considered. For example, soldiers who live and work on the base may also hunt, fish and eat local berries. The hunting exposure scenario may not be conservative as an individual hunter may not cover the whole base but rather may have favorite spots.

20. Groundwater (potable water) is used for washing and showering but not drinking. The term potable water, as used throughout the report, is misleading if the water is not considered safe for drinking, and not used for drinking. Clarification of the actions DND has taken to prevent exposure to drinking piped water used for washing and showering would be useful.

OVERALL ASSESSMENT

The Peer Review Panel has concluded that the risk assessment prepared by Dillon Consulting is acceptable, with major revisions, as described in this review.

APPENDIX

Additional Comments and questions for consideration when finalizing the report.

1. *Hazards and/or risks seem to be used almost interchangeably, which we believe is incorrect. The terms need to be defined and used in a consistent manner. The most common definition of 'hazard" in the context of contamination or chemical concentrations does not consider exposure; only the substance type and concentration*

2. *Evaluate potential exposures for Military personnel currently on CFB Gagetown (residential and military activities). Comment: The work "currently" is misleading as used. Is it meant to refer to the current military uses (scenario), and not the individual personnel.*

3. *Evaluate potential hazards/risks for each group of people. Based on the definition defined above, "hazard" is independent of exposure; hence the correct term should be "risk"*

4. *Identify areas where hazards related to exposure to H/HRC may be unacceptable. Same as above.*

5. *Subject Areas (SA) represent areas across the base which reflects distinct exposure zones (in terms of source, pathway and receptor). The SA are shown in Figure 2-3. The legend appears to be incomplete (and hard to read as the text is too small). It is not clear why the boundaries of the SA do not correspond to the apparent boundaries of the base. =*

6. *SA1 - 1966 Testing area:*

    - *It is not clear what the two "snaking" lines refer to in Figure 2-3. Also the red line indicating the extent of the SA appears to be arbitrarily drawn.*

Further explanation of the exact extent of the area and how it was determined would be useful.

- *The SA was selected based on one sample (of 24 [28 indicated in Table 2-1] for 10 km2 area) exceeding the TEQ CCME guideline (4.34 compared to the guideline of 4 pg/g). The exposure point calculation was assumed to be 1.28 (Table 4-1). Given that the 95% UCLM does not exceed the guideline, and assuming the level of site investigation is sufficient, no risk assessment is required for this area, at least not in terms of the soil concentrations. Alternatively, if the site investigation scope is considered to be limited, then the max (or 90th percentile if the sampling coverage is considered to be in only somewhat limited).*

7. *SA2 - Rippon Road (1967 Trial Area): 43 TEQ samples for 3 km2 area*

    - *Same as comment first bullet above*

    - *The number of samples and the max conc. are different for Table 3-2 and Table 4-1. Why?*

    - *The large in concentrations and the use of non-parametric statistics may indicate that this data set may represent more than one statistical population (as discussed later). Therefore, it is possible that the highest concentrations represent "hot zones" which should be confirmed and delineated. In-lieu of this information it is not conservative to use the 95% UCLM of 84.9 pg/g.*

8. *SA3 - Murphy Bivouac (distinct because of use by youth groups, and crossing by local residents to access summer cottages):*

    - *This SA appears to be outside the base boundary. The SA was selected based on one TEQ sample (of 22 for 1 km2 area) exceeding the TEQ CCME guideline (29.5 compared to the guideline of 4 pg/g). The exposure point calculation was assumed to be 6.29 (Table 4-1). However, as discussed later, given the small data set consideration should be given to:*

        i. *Using the max conc. for the risk assessment*

        ii. *Conducting step-out samples around the location with the max conc. to assess the potential for a "hot-zone" to exist*

9. *SA4 - Clones Bivouac (distinct because of specific use as a bivouac for manoeuvres):*

    - *Sample size of 19 (1.5 km2 area))*
    - *As above, the rationale and exact boundaries are not provided*
    - *As above, depending on the confidence in the sampling coverage; the use of the 95% UCLM may not be conservative. In this SA, the max conc. was only about 2 times the guideline; hence hot zone determination is not necessary.*

10. *SA5- Base administration and park (base personnel use and family recreational use)*

    - *The boundaries appear to exclude adjacent developed area (as shown on Figure 2-3). Why?*
    - *Sample size of 29 for an area of 10 km2*
    - *The max conc. was only marginally over the guideline. Hence, if the sampling coverage is considered to be acceptable, then no risk assessment is required wrt to soil. If the coverage is considered to be limited then the max conc. should be used.*

11. *SA6 - Static range impact area (distinct because of limited access by soldiers and limited potential for contact with soil while on training)*

    - *38 samples for 250 km2 area*
    - *The max conc. is about 10 times the guideline. Non-parametric statistics were used. The comments as provided for SA2 and SA3 apply wrt exposure point conc. and hot zones.*

12. *SA7 - General Manoeuvres (remainder of base area east of Hwy 7 [which is not visible on Figure 2-3, but presumed to run along SA8's eastern boundary])*

    - *12 TEQ samples for 100 km2 area*
    - *Dillon states that the HHRA is limited to the (numbered) areas sampled as shown on Figure 2-3. The other areas (between SA8 and SA6) where not*

included because the ESA identified no APEC either due to lack of H applications or very limited indications of H application.

- *The max conc. is about 3 times the guideline. Non-parametric statistics were used. The sampling coverage appears extremely limited in this SA, and requires a stronger rationale for selecting the exposure point conc. It is possible that not even the max conc. would be sufficiently conservative for this SA*

13. *SA8 - Base perimeter and fire breaks (distinct because this land has the greatest access by the public for recreation).*

    - *66 TEQ samples for about 400 km2*

    - *Max conc. = 4.71. The data range is small, and the distribution was determined to be lognormal. If sampling coverage is considered adequate, then it is not necessary to conduct HHRA; based on the 95% UCLM or the 90th percentile. If the sampling is considered to be somewhat limited, then the max conc. should be used (or more site investigation conducted).*

14. *SA9- Nerepis River (distinct because of fishing access by the public, and because it is the only river area with sampling results for surface water and sediment).*

    - *Discrepancies in number of soil samples:*

        iii. *The number of total samples indicated in Table 2-1: 6 soil, 10 sediment*

        iv. *Table 3-1 refers to 15 soil samples for TEQ*

        v. *Table 4-1 refers to 6 TEQ soil samples*

    - *Soil characterized by 6 samples within 100 m of the river bank (the boundary on Figure 2-3 indicates 1 km on either side), an area of about 1 km2.*

        vi. *Does this data set represent the TEQ concentrations along the river, or would it be better to include more data from the nearby areas?*

vii. *The max conc. shown in Table 4-1, indicate no exceedance of the guideline (no HHRA required for soil, unless including additional data). If data from SA8 is included, then the max conc. would be 4.7 pg/g.*

- *What screening criterion was used for sediment?*

- *What about other fish bearing streams and rivers? Were they not included because of no fishing, or no data?*

15. *SA10 - Swan Creek Lake (distinct because of fishing access by the public?, and because it is the only lake area with sampling results for surface water and sediment)*

    - *Discrepancies in number of soil samples:*

        viii. *The number of total samples indicated in Table 2-1: 6 soil, 6 sediment*

        ix. *Table 3-10 refers to 12 soil samples for TEQ*

        x. *Table 4-1 refers to 6 TEQ soil samples*

    - *Soil characterized by 6 samples within an unspecified distance from the lake shore (the boundary on Figure 2-3 indicates 1 km on either side).*

        xi. *Does this data set represent the TEQ concentrations along the lake shoreline, or would it be better to include more data from the nearby areas?*

        xii. *The max conc. shown in Table 4-1, indicate no exceedance of the guideline (no HHRA required for soil, unless including additional data).*

    - *What about other fish bearing or recreational lakes? Where they not included because of no fishing, or no data?*

16. *SA11 - CFB Gagetown (distinct SA to reflect potential exposures for hunters of moose and deer, the only animals actively hunted)*

- *SA11 covers the entire base, as we understand it; and the statistics are for the total number of samples collected. It may be more useful if the base area was divided into probable hunting areas based on habitat and usage. For example, are the firing ranges accessible to hunters? Where are the likely moose and deer habitat and hunting areas? The rationale for using the 95% UCLM for the entire base for the hunter exposure scenario is weak; and it is hard to determine whether this value of 15 pg/g would be conservative or not.*

17. *Overlay of HHRA SA with ESA APEC: From the table is appears that about half of the SA corresponded to equivalent APEC. The other SA included more than one APEC. This is important in terms of statistical populations. An alternative to using "central" (95%UCLM) or "tail" (max or 90th percentile) statistics, would be to use sub area exposure; i.e. exposure duration within each APEC. This of course would be identical to the method used if the exposure scenario was identical in each APEC; which is what was assumed.*

18. *Most APEC was divided into 6 sectors, with 6 randomly selected sampling locations. APEC 15 had 16 composites; APEC 15 had 12 (one for each of the bivouac areas); APEC 17, 18, 19 had 10. The discrete samples were used to form a composite for each sector. The process was repeated <u>six times</u> to for each APEC. Does this mean 6 replicates for each sector; or does it refer one composite for each of the 6 sectors referred to in the first bullet?*

19. Groundwater data is only available for SA4 (term is used interchangeably with potable water). The results of the blanks were subtracted from sample result. *Usually blanks are used to check data quality and not for adjusting the data. Dillon should add some discussion wrt to the rationale and the implication. It is not expected that it would have changed the results much, but a discussion to that effect would be useful. Also, subtracting the blank values is not conservative. The subtracting resulted in some negative values in the table. Negative values are impossible and should be replaced with the DL. Some samples had very high negative values. In fact these values were higher than the concentrations reported in the actual sample (f.ex. A15-HEA-GW1: OCDF and OCDD). This would suggest some QA problems.*

20. *Sediment data is available for SA9 and SA10. The comment made for soil and groundwater wrt to subtracting the blank values is also true for sediment. For example, sample A21NR6-SD1 seems to have significant concentrations in the blank.*

21. *Surface water data is available for SA6, SA9 and SA10. Same comment as above*

22. Vegetation data is available for SA1, SA2 and SA10. *Dillon states that the data was corrected based on the blank results, as samples for the other media. However, this does not appear to be the case, according to the information shown in Table 17 (Appendix A).*

23. *Dillon states (on top of page 18) that "Chemicals that are listed in the ESA but for which analyses have not been reported have not been including in the screening tables" Appendix B presents the selection of screening criteria; either from published standards or guidelines, or developed by Dillon. For vegetation, the chemicals screened "in" for other media were included in the HHRA.*

    - *What does the above statement refer to? Were the chemicals not considered to be COC?*

    - *What sediment criterion was used for screening? In the tables, it appears that it is the same as the one used for soil. Is this because it is a HHRA? In BC, a criterion of 130 pg/g is used for sensitive sites.*

    - *The units for soil screening criterion for TEQ shown in Section 2.4 of Appendix B should be pg/g instead of ug/g. The CCME guideline is shown as 4 pg/g in Table 4-1. In BC, for example, the standard for human health is 350 pg/g. It is likely that the large discrepancy is because CCME has based the guideline on typical background concentrations in media, as the EDI for a toddler is higher than the TDI. This is not the case in BC.*

24. *Comment: Dillon states that SA1 is not used for bivouac, and therefore that soldiers would camp in the area. Was it meant to say "would NOT camp"*

25. *SA3 is used as housing for training exercises. It also used as a youth camp, and as an access point for several residences on Murphy Lake.We understand that the testing did not include Murphy Lake, but is there likely to be any contamination there?*

26. SA5 – Base Administration and Parks: The receptors include soldiers and other base personnel, as well as people who live in the nearby community. *If the soil at the base has D&F contamination, is it possible that this contamination also may be present in the adjacent community?*

27. *As already mentioned, an individual hunter is more likely to favour parts of the site, and would not hunt all across the area. More detailed analysis of areas that would be more frequented for hunting would be useful. Or alternatively, the HHRA may include a worst case scenario of hunting in the SA with the highest concentration. The same may be true for assessing the habitat for the deer and moose. Dillon mentions that according to base personnel, only deer and moose are hunted. Is there no hunting of smaller mammals or fowl?*

28. *A statement regarding the expected D&F concentrations in areas not tested (adjacent land, other lakes and rivers) should be provided in order to support not including potential exposure in these areas (i.e. off-site contamination).*

29. *Exposure Point Concentrations: An expanded discussion on the rationale and methods for the use of statistics is required.. The terms UCL was not defined in the text, but from Appendix C it is clear that it refers to the UCLM (or upper confidence limit of the mean), which is a measure of the central characteristics of the population. The following is a brief summary of points to consider:*

    - *Population: Many of the data sets are highly skewed indicating that the data may belong to more than one population. Estimating a UCLM for such data set will "numerically composite", or be averaging the data. Common practice is to investigate whether a subset of the data belongs to a "hot-zone" (through step-out sampling); and if so conduct separate statistics for the two populations. It is also common to use estimates of upper-end (or tail) characteristics of the population using percentiles or the max conc. In other words, using the 95% UCLM in the HHRA may not be conservative for most or all of the SA. Other statistics should be considered on a site by site basis.*

    - *SA11: As discussed earlier, SA11 is unique in that it includes the whole base. The points made in #1 above are particularly relevant to SA11. In addition, the exposure assumption that individual people may use the whole base for hunting, and therefore be exposed to an estimate of the mean concentration, is not conservative.*

30. *Exposure Assumptions: The exposure assessment follows recommended receptor characteristics mainly from Health Canada and the US EPA.*

    - *Dermal Contact with Sediment: Dillon estimated exposure through dermal contact with sediment using the same assumptions as those of soil exposure. Given the lack of a dermal absorption factor for sediment, it*

reasonable to use the EPA value for soil. However, this may not be conservative which should be addressed in the uncertainty section.

- *Game and Fish Consumption: Dillon used an ingestion rate of 270 g/day for game (adults only) and 5 to 21 g/day for fish (toddler to adult). While the ingestion rate for game may be conservative, the one for sport fish consumption is low, as it is averaged over a year. As consumption of fish is the only exposure that indicates a potential unacceptable risk; further discussion of the uncertainty around the assumptions made is important (it is currently not discussed in the Section 7 of the report).*

31. *Dillon provided a comparison to background exposures in Table 6.32 (spelling error in table heading). For all SA except SA0 and SA10, the contribution to total exposure from activities on the base was less than 1 %. For SA 9 and SA10, the contribution to total exposure was about 55%; due to fish ingestion.*

32. *The general discussion of uncertainties, in the first 3 paragraphs of Section 7, is generic and should be revised to reflect the many sources of uncertainties in a HHRA of this scale and complexity.*

33. *The interpretation of the site characterization data produced under a different task (not by Dillon) should be re-considered. The interpretation included some non-conservative assumptions, which affect the risk estimates.*