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RESPONSES TO COMMENTS ON THE SURFACE WATER FLOW AND INFILTRATION MODEL SUMMARY REPORT

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Response to Comments on the Surface Water Flow and Infiltration Model Summary Report

General Comment

1. Comment: The U.S. Department of Energy's (U.S. DOE) approach to this modeling effort, as well as others completed for the Fernald Environmental Management Project (FEMP), attempts to estimate the future concentration of contaminants in a medium which will always be greater than the actual future concentration, rather then attempting to estimate the actual concentration of contaminants which may be lower than those observed in the future. U.S. DOE's approach is designed to determine results as a conservative estimate of the future potential risk to receptors. To be consistent with this approach, U.S. DOE should assume that 100 percent of the contaminated runoff from the "representative storm event" infiltrates to the Great Miami Aquifer (GMA), not 37 percent of the contaminated runoff, as predicted in the report.

Response: The suggested assumption that 100% of the contaminated runoff infiltrates into the GMA is a simple approach which also implies that no infiltration modeling is really necessary. However, using averaged total infiltration rate over the entire Paddys Run and the Storm Sewer Outfall Ditch (SSOD), where infiltration can occur, is not conservative because most of the contaminated runoff infiltrates into the GMA close to the points of discharge. Local contaminant loading rates and groundwater concentrations along the discharge points will be underestimated if no infiltration modeling is performed so that only the total annual runoff is available and averaged infiltration is uniformly applied. Therefore, distribution of the infiltration along the Paddys Run and SSOD needs to be adequately defined by infiltration modeling. For this purpose, a representative storm event was simulated to estimate the infiltration pattern along the Paddys Run and the SSOD. The calculated infiltration pattern made it possible to estimate the distribution of the contaminant loading to the GMA for use in the groundwater solute transport model. The distributed contaminant loading then allowed for a more accurate simulation of contaminant transport in the GMA by the groundwater model.

The Surface Water Flow and Infiltration Model Summary Report uses two types of rainfall events to simulate the rainfall and flow characteristics that occur at the FEMP over the course of a year. The first is the representative storm event (a single storm event) to determine the pattern of the runoff and infiltration at the FEMP; the second simulates all other storm events of the year by estimating annual

totals of rainfall and runoff. The annual loading to the groundwater from the Paddys Run and the SSOD is calculated as a combination of these two types of rainfall events. The attached Figure 1 presents the annual loading pattern indicating the combination of the two types of rainfall events used in the surface water model.

Very conservative assumptions regarding the overall annual runoff and infiltration volumes were made when estimating the annual contaminant mass loading rates into the GMA. As a result, more than 96% (not the 37%) of the contaminated annual runoff will be loaded into the GMA along Paddys Run and SSOD. This contaminant mass in the runoff will be loaded into the GMA based on the distribution pattern of infiltration obtained from simulating the representative storm event. With all the conservative assumptions for estimating the annual contaminant mass loading, it is logical to say that the objective and the most important result of this infiltration modeling is the distribution or pattern of the infiltration not the actual volume of infiltration from the simulated single storm event (i.e., 37% of the runoff volume). The attached Figure 2 presents a schematic representation of the infiltration pattern in Paddys Run and the SSOD. The attached Figure 3 presents an example of a contaminant loading pattern to the GMA. Figure 3 is based on the loading of U-238 using current site source concentrations and assuming that there are no storm water controls on the site. The loading pattern for each constituent will change because each constituent has a different areal distribution of contamination. Sensitivity analysis of this modeling task was also conducted and presented accordingly.

The approach for the annual contaminant loading to the GMA conservatively assumed that 100 percent of the contaminated runoff for all storms during the year other than the representative storm event infiltrates and reaches the GMA. The representative storm event accounts for approximately 6 percent of the total annual runoff. The amount of annual runoff is calculated by assuming the ratio of annual precipitation to annual runoff is the same as the ratio of representative storm precipitation to runoff from the representative storm. This yields a conservative (high) estimate of annual runoff because most storm events during the year normally will be smaller than the representative storm event and have a higher percent of precipitation that directly infiltrates into the ground surface or is intercepted by vegetation rather than becoming runoff. Since the estimate of annual runoff is conservatively high it should also produce a conservatively high estimation of contaminants reaching the GMA by infiltration of runoff through the streambeds of Paddys Run and the SSOD.

Approximately 37 percent of the contaminated runoff from the representative storm event was estimated to infiltrate, accounting for approximately two percent of the estimated yearly total runoff. More than 96 percent of the total yearly contaminated runoff is predicted to infiltrate (see the attached Figure 4). This approach should yield conservative results consistent with the rest of the modeling efforts at the FEMP.

Action: The Surface Water Flow and Infiltration Model Summary Report will be revised and resubmitted. The revisions to the Surface water Flow and Infiltration Model Summary Report will clarify the relative importance of the representative storm event, the infiltration pattern, and will include additional sensitivity analyses but will not assume that 100 percent of the runoff volume from the representative storm event infiltrates.

Specific Comments

1. <u>Section 3.2.4. Page 3-7, Paragraph 2</u>

Comment: Table 3-2 presents the Soil Conservation Service (SCS) curve number for each subbasin. However, there are two average SCS curve numbers for some of the subbasins. U.S. DOE should explain why there are two numbers and which number was used in the model. In addition, the average SCS numbers listed in the last column of the table do not represent the average of the Weighted SCS Curve numbers in the next to the last column. U.S. DOE should explain how the average was derived or should correct the table. If the average SCS curve numbers are in error, U.S. DOE should discuss the effect this has on the results of the model.

Response: Table 3-2 and the explanation of the information contained within it does require some clarification although the values presented in it are correctly calculated. In some instances two curve numbers are input into the HEC-1 model for a single subbasin. For subbasins with significant amounts of paved or developed areas, a separate curve number and overland flow path parameters can be input into the model rather than overall average parameters for the subbasin. Use of two curve numbers for a single subbasin allows the model to more closely simulate subbasins which are not homogenous. This method was used for several subbasins (i.e., 70, 75, and 80) in the HEC-1 model used for infiltration calculations to represent the developed portions of the FEMP. When the subbasins were further subdivided for the contaminant calculations, the smaller subbasins were

sufficiently homogenous to only require one SCS curve number per subbasin.

For every subbasin, the last column in Table 3-2 labeled "Average SCS Number" represents a weighted average of the SCS curve numbers for each land use type. That is, a weighted curve number was calculated for each land use type (woods, meadow, or hard surface) based on the hydrologic soil group. This calculation is presented in the next to last column (labeled " Weighted SCS Number") of Table 3-2. The overall curve number for the subbasin was then calculated by averaging the curve numbers for each land use type weighted by the percent of the subbasin covered by each land use as indicated in the second column (labeled "Land Cover"). The results of this second weighted average (the overall curve numbers input into the HEC-1 model) are then presented in the last column of Table 3-2.

Action: The revised Surface Water Flow and Infiltration Model Summary Report submitted will contain additional text to clarify the contents of Table 3-2.

2. <u>Section 3.4.5. Page 3-39, Paragraph 4</u>

Comment: The report concludes that the model compares favorably to measured increases in the river stage of Paddys Run and the elevation of the groundwater in response to an observed precipitation event. The report also presents a reasonable explanation for the error associated with the increase in the groundwater levels. While these statements are qualitatively correct, the quantitative comparison indicated a potential for significant error. For example, the modeled river stage of Paddys Run rose only one-half the height of what was observed. Assuming that U.S. DOE's explanation of why the modeled groundwater elevation rose only 1.65 feet is correct, the modeled rise in the river stage of Paddys Run should have been much greater than what was reported. U.S. DOE should explain why the river stage did not increase as much as it should have. In addition, U.S. DOE should collect more field data to further verify the model.

Response: This comment raises two issues with the performance of the surface water model. The first is concerned with the predicted amount of infiltration and the response of the groundwater table to the representative storm event. The second is the comparison of the predicted rise in water surface elevation and the measured rise in water surface elevation in Paddys Run. As was discussed in the response to the first general comment, the infiltration model is very conservative in its estimation of

the annual percent of contaminated runoff which infiltrates into the GMA, so that the distribution of the infiltration determined from the representative storm event is more important than the actual volume of infiltration from that storm event. The infiltration distribution is then applied to the annual infiltration and in turn the contaminant loading. In addition, the differences in the initial conditions of the modeled event and the measured event make a true quantitative comparison difficult although qualitatively the general aquifer response was similar.

It is difficult to quantitatively compare the output from the model for the representative storm to actual field data because of the differences in the initial conditions of the ground surface and the streambeds, the duration of the storm event and the variation of intensity of the rainfall with time (hyetograph), and differences in the shape of the stream cross sections where the stage measurements and calculations were made. The Surface Water Flow and Infiltration Model Summary Report qualitatively compares the results from the model of the representative storm event to a rainfall event occurring in April of 1989 (note the report incorrectly indicates that the date of the rainfall event; it should have been reported as April 28-29). The curve numbers used for the HEC-1 model of the representative storm event are based on an Antecedent Moisture Condition-II (AMC-II) which represents an average moisture content in the surface soils prior to the storm rainfall event. AMC-I condition represents a dryer than average initial soil condition and AMC-III represents a wetter than average soil condition. The AMC-II curve numbers are primarily used for design (SCS, Technical Release 55, June 1986). The SCS curve numbers presented for use in the Superfund Exposure Assessment Manual (EPA, 1988) do not specifically indicate what AMC they are for, but they do match the curve numbers given for the same land use and soil type for AMC-II conditions in the SCS's Technical Release 55 (SCS 1986). Since AMC-II is most commonly used in design and because of the curve number presented in the Superfund Exposure Assessment Manual, AMC-II Curve numbers were also used in the HEC-1 model of the representative storm event. In order to better evaluate the performance of the runoff model, actual rainfall data from the FEMP from two storm events (the April 28-29 event and another one on April 3-4 1989) and SCS curve numbers that represent actual soil conditions during an abnormally wet season were input into the HEC-1 model. The input and results for these modeled conditions are discussed below.

The rainfall in the spring of 1989 was above average (DOE, 1993 Groundwater Modeling Report Summary of Model Development) indicating that the ground surface could have been saturated prior

to the storm event which would cause a larger amount of runoff (and deeper depth in Paddys Run) than if the ground surface is unsaturated. If the ground surface is saturated prior to the storm event, a greater percentage of the rainfall will become runoff (than if the ground is unsaturated) since the ground surface does not have unsaturated pore spaces available to capture the rainfall. Storm water runoff is the only major source of flow in Paddys Run since flow from groundwater would only represent a small portion of the total flow during a fairly large storm event. The total amount of precipitation as measured at the Greater Cincinnati Airport by the National Weather Service (NWS) was 5.19 inches during April 1989. The average monthly rainfall of April for the years 1958 through 1992 also at the Greater Cincinnati Airport is 3.53 inches. The rain gauge information at the FEMP reported 6.09 inches of rainfall in the month of April 1989 before it stopped recording during the rainfall event on April 28. If the site rainfall data is supplemented with rainfall data from the Greater Cincinnati Airport to replace the missing data, a total of 7.48 inches of rain would have fallen on the FEMP in April 1989.

Storm events occurring on April 3-4 and 28-29, 1989 were simulated with the surface water model. Hourly precipitation data from the FEMP supplemented with data from the Greater Cincinnati Airport was input into the HEC-1 model with the curve number modified to represent an AMC-III initial moisture condition. The FEMP precipitation data was supplemented with data from the Greater Cincinnati Airport to replace several missing data points from the FEMP rain gauge. This data was used because it was the best information available for the missing data points in question. The SCS National Engineering Handbook, Section 4, Hydrology (NEH-4 [SCS 1985]) recommends that if more than 1.1 inches of precipitation falls during the five days before the storm event being modeled that a AMC-III should be used. Approximately, 1.3 inches of rain fell in the five days prior to the storm event on April 28-29, 1989. Since this was in the range for AMC-III recommended in NEH-4 an AMC-III was used to simulate this storm. An AMC-III was also used for the simulation of the April 3-4 storm since this storm occurred four days after a storm event on March 31, 1989 which caused the Storm Water Retention Basin to overflow. The site precipitation data was not readily available for the March 31 storm, but it is valid to assume that such a event would create AMC-III soil conditions for the April 3-4 event.

A comparison of the modeled and measured rise in flow depth of Paddys run is presented in the attached Table 1. The measured rise in water surface elevation was measured at two location along

Paddys Run in April of 1989; stilling well 9 (near cross section location C-C) and stilling well 14 (near cross section location E-E). The measured and modeled rises in stream elevation for the April 3-4 storm were within three percent of each other at both measuring locations on Paddys Run. The modeled rise in stream depth for the April 28-29 storm did not match as well although the differences between the modeled and the measured elevation rises are less than 10 inches. The second storm event may not match as well because the site rainfall data for this event had to be supplemented with rainfall data from the Greater Cincinnati Airport approximately 17 miles to the south. Based on the simulated actual storm events, it is determined that the surface water model is predicting the water surface elevations with acceptable accuracy so that additional field data is not required to verify the model.

Changing parameters in the HEC-1 model of the representative storm event to match the changes in the simulation of actual storm events discussed above (curve numbers based on AMC-III) is not necessary for the following reasons. An average Antecedent Moisture Condition (AMC-II) is usually used for designs and match values given in U.S. EPA documents. As was discussed in the response to the general comment, the representative storm event runoff is used to estimate the annual runoff. Using an AMC-II (average moisture condition) for the representative storm event would provide more realistic results to base the annual calculations on. An AMC-III initial moisture content will tend to increase the overall discharge from the basin, however, the amount of contaminant released in the dissolved phase is directly proportional to the amount of runoff from a subbasin so that the concentration should not change. The predicted mass of contaminant loaded to the GMA could increase for the simulated representative storm event. The single representative storm event will not have a significant effect on the annual loading to the GMA since the representative storm event only accounts for 6% of the annual runoff. The annual runoff is based on average moisture conditions since it is used to represent all of the different storms that occur during the year. In addition, the surface water model already is conservatively overestimating the annual loadings to the GMA. Modeled simulations performed for the Draft Remedial Investigation Report for Operable Unit 5 submitted for internal review at the U.S. Department of Energy (U.S. DOE) illustrated the conservativeness of the predicted loadings to the GMA. The surface water model was set up to predict the total amount of uranium-238 released to the GMA through the streambeds of Paddys Run and the SSOD. The predicted amount ranged from 6200 kg to 12300 kg. Out of the total estimated mass of 4800 kg of uranium within the plume of significant concentration in the GMA, 1860 kgs are

located along the SSOD and Paddys Run south of the SSOD in the GMA. The 1860 kg of uranium is believed to originate primarily from the surface water loading.

Action: Actual storm rainfall was put into the HEC-1 model to compare the modeled rise in stream depth to the measured rise in stream depth. As was discussed in the Response to this comment, the model compared well with the measured data so that the collection of additional field data is not necessary. The comparison between the model output and measured data will be included in the revised Surface Water Flow and Infiltration Model Summary Report.

3. <u>Section 3.4.5, Page 3-41, Paragraph 1.</u>

Comment: U.S. DOE attempted to validate the model by conducting two types of volume calculations. The results of the two methods differed significantly but U.S. DOE stated that because the results of the two methods are within one order of magnitude, the results are therefore reasonable. An order of magnitude estimation of surface water infiltration does not appear to be accurate. Because the amount of water infiltrating into the GMA will affect the mass of contaminants entering the GMA and ultimately the concentration of contaminants in the GMA, U.S. DOE should provide additional documentation on the accuracy of its infiltration estimate.

Response: The response to the general comment discusses the relative importance of the predicted infiltration volume resulting from the representative storm event. Because of the conservative assumptions used in the method of predicting the contaminant loading (96 percent of the annual dissolved contaminant released is predicted to reach the GMA) the distribution of the infiltration amount along Paddys Run and the SSOD is more important than the actual infiltration volume.

The Surface Water Flow and Infiltration Model (SWF&IM) Summary Report in actuality only attempted to estimate the volume of infiltration with the VS2DT model. The other method discussed in the report (described as the verification infiltration volume calculation in the SWF&IM report) which simply involved the calculation of the unsaturated pore space beneath the streambed was only intended to be used as a general reference to check the range of the infiltration volume predicted with VS2DT. It was understood that the calculation of the unsaturated pore space beneath the streambed would yield results that are lower than actual infiltration volumes because it did not account for lateral movement of water in the unsaturated zone away from the streambed and it did not account for

infiltration into the streambed once it was saturated.

Action: The Surface Water Flow and Infiltration Model Summary Report will be revised and resubmitted. The revisions to the Surface water Flow and Infiltration Model Summary Report will clarify the relative importance of the representative storm event and the infiltration volume as compared to the infiltration pattern, and method used to calculate the infiltration volume.

4. Section 4.1.2, Page 4-5, Paragraph 1.

Comment: To calculate the concentration of a contaminant in the surface water runoff, U.S. DOE needs to establish the following factors: the concentration of the contaminants, the extent of the contaminated area, and the volume of the contaminated material. U.S. DOE should present the methods it will use in determining these critical factors.

Response: The Surface Water Flow and Infiltration Model Summary Report's main purpose was to present hydrologic and hydraulic data and to present the approach to be used for the contaminant transport calculations in the surface water pathway. The extent, concentration, and volume of contaminated soils used as source terms are needed to complete the modeling for the Remedial Investigation but were not required for the purpose of the Surface Water Flow and Infiltration Summary Report. The procedures used to determine the extent, concentration, and volume of contaminated soils will be presented in the Operable Unit 5 Remedial Investigation report and are summarized in the following paragraphs.

Three sets of source terms are developed for the Remedial Investigation modeling in the surface water pathway; baseline, future, and current. The baseline conditions corresponds to scenario 2 and the future conditions corresponds to scenario 1 presented in the Surface Water Flow and Infiltration Model Summary Report.

The baseline conditions modeled for Operable Unit 5 at the FEMP assume that the other Operable Units (1,2,3, and 4) have been remediated. For Operable Units 1,2, and 4 it is assumed that all major source loadings in the surface water pathway to Paddys Run and the GMA have been terminated. Only minor uncapped residual contaminated soils remain in place around the capped areas. For Operable Unit 3 it is assumed that all the above-ground and under-ground buildings and

structures in the former production area not related to waste water treatment have been removed. With the removal of the buildings in Operable Unit 3, all of the contaminated soils under these building become exposed for the baseline conditions.

Currently the runoff from the former production area and the waste pit area is collected in the existing retention basins, treated, and discharged to the Great Miami River (GMR) under the NPDES permit. The baseline condition assumes that these surface water controls remain in operation for 70 years. The future conditions assume that the surface runoff currently collected in the storm water retention basins return to its natural drainage patterns (e. g., to the SSOD and Paddys Run) without treatment after the first 70 years. No surface water runoff is then discharged to the GMR via the main effluent line.

The current condition source terms attempt to reflect the contamination at the site as it is now before remediation of the other operable units. These concentrations are used to evaluate the performance of the surface water model by comparing predicted concentrations in the sediments, surface water, and groundwater with sample data.

The sources of contamination in the surface water pathway used for modeling are assumed to be the surface soils in and around the FEMP. The surface water model assumes a uniform concentration within a source area. The drainage subbasins from the HEC-1 model are relatively large and contain a significant areal variation in contaminant concentrations in the surface soils. To account for this variation, the drainage subbasins were then further subdivided based on contaminant concentrations. The assumption of uniform concentrations used in the surface water model is more applicable for the smaller areas delineated based on soil concentrations. Source areas which were defined and modeled in other Operable Unit studies were first broken out from the HEC-1 drainage areas and made separate source areas. Further delineation of source areas were based on the concentration of uranium in the surface soils. It was assumed that the surface concentrations (and therefore the source areas) for other contaminants would generally follow the same pattern of contamination as the uranium. The uranium concentrations were plotted on a map of the FEMP and then contoured. Based on the uranium contours, the drainage areas were roughly broken into low, medium, and high contamination areas. The low range included values from background to 10 pCi/g of Uranium, the medium from 10 to 50 pCi/g , and the high range of 50 pCi/g or higher. The 10 and 50 pCi/g limits

were chosen for convenience. The contours levels used to determine the ranges should not significantly effect the results since every area within each drainage subbasin is assigned a source concentration. No valid surface soil sample results were excluded from the calculation of the source concentrations because of the source area delineation. The source areas were only used to group the data so that the concentration within each source area would be more uniform and more closely match the model assumption of uniform concentration within an area. Within the production area, the delineation of the source areas did not strictly follow uranium concentration contours but also took into account locations of buildings, and the historical use and purpose of various facilities within the production area. The subbasins surrounding the FEMP are delineated into 33 source areas for surface water modeling.

To account for the termination of contaminant releases when determining source concentrations for Operable Units 1,2,and 4, background soil concentrations are assigned to these operable units. The assumption is that these areas will be capped with the top layer being clean soil, which would contain background levels of contamination.

For each of the remaining source areas, surface soil samples in the top 1.5 feet are statistically analyzed to determine a representative concentration for each contaminant in each source area. If a contaminant is detected above background in any source area, a concentration is required for all of the source areas to be able to evaluate the cumulative effects of all of the source areas. For the areas in which a contaminant concentration was detected above background, the representative concentration from the statistical analysis was used as the source concentration. If a contaminant is analyzed for in a source area but is not detected, the background concentration is assigned to that source area. If a contaminant is not analyzed for in a particular source area and the contaminant was detected above background in another source area (therefore a concentration is required for every source area in the model), a concentration is "borrowed" from an adjacent area or an area that was likely to contain similar levels of contamination. Two to four source areas are grouped together in which concentrations could be borrowed between each other. The borrowing process can best be illustrated with a short example. For instance, three source areas (A,B, and C) are grouped together because they are suspected of having similar levels of contamination, in addition no samples were analyzed for a particular constituent in area B. The representative concentration of either area A or C could be assigned to area B. If only one of areas, A or C, is immediately adjacent to area B, then

that area's concentration is borrowed. If both areas A and C are adjacent to area B, then the higher of the representative concentration for the areas, A or C, is assigned to area B. In some instances, entire groups of source areas require borrowed concentrations. When this happens the concentration are borrowed from another group of source areas or depending on the area and the expected amount of contamination, background levels could be assigned.

The source concentrations used for future conditions are adjusted to account for radioactive decay and biodegradation of the contaminants in the 70 years from the beginning of the baseline conditions.

As in the baseline and future conditions, the source terms for the current conditions are based on surface soil sample data. The source terms for the baseline and future conditions are based on the Upper Confidence Limit (UCL) on the mean or median depending on the number of sample data points in each source area. The UCL provides a conservative source concentration to be used in predicting concentrations for risk assessment purposes. To evaluate the model, the average of the sample data provided a less conservative but a more realistic source concentration when comparing the model output to sample data. The current source term concentrations are then based on the average of the surface soil sample data. For current conditions, the other operable units are not completely remediated, therefore the source concentration used in the other operable unit studies are taken from the other operable unit Remedial Investigation reports.

To simulate the current conditions, two sets of source terms were developed to provide a range of values to compare to the sample data. The first set of source terms included all of the samples taken under the buildings in the production area (as in the baseline and future conditions). The second set of source terms excludes the samples under the buildings. The samples under the buildings are excluded since the rainfall can not directly come in contact with these soils and become runoff while the building are still intact.

Action: The method used to establish the concentration, extent, and the volume of contaminated material will be presented in the Operable Unit 5 Remedial Investigation Report and will contain information similar to that presented in the response to this comment.

5. <u>**Section 4.2.1 Page 4-15, Paragraph 1**</u>

Comment: This section references a U.S. Environmental Protection Agency (U.S. EPA) Region 3 memorandum as its justification for the screening of contaminants of concern. This reference should be provided to U.S. EPA to determine if the justification is applicable in U.S. EPA Region 5.

Response: Based on comments by U.S. EPA Region V, the method used to determine the screening levels for the contaminants of concern will be revised and the Region III memorandum not used. The screening levels will be calculated with the methodology presented in the Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, "Development of Risk-Based Preliminary Remediation Goals", (RAGS, Part B), United States Environmental Protection Agency, December, 1991. As was indicated in the Surface Water Flow and Infiltration Model Summary Report, the screening procedure will still be based on 10^{-7} risk-based concentrations for carcinogens or 0.1 Hazard Quotient concentration for noncarcinogens.

Action: The methodology presented in the U.S. EPA Region 3 memorandum will not be used in determining the screening levels for the surface water model. The procedures presented in the Risk Assessment Guidance for Superfund, as described in the response to this comment, will be used for the surface water model.

6. <u>Section 4.5, Page 4-31, Paragraph 2.</u>

Comment: The report states that the first scenario assumes the failure of the storm water management system will occur after 70 years. U.S. DOE should also include the assumptions made about remediation during this 70-year period. As the text is currently written, it is U.S. EPA's understanding that this scenario will not include any remediation.

Response: As was discussed in the response to comment 4, the baseline and future conditions used in the surface water model assume remediation of the other operable units at the FEMP, but not Operable Unit 5. It is our understanding that the intent of the Remedial Investigation is to evaluate the site conditions without remediation of the operable unit. The various remediation scenarios for Operable Unit 5 will be evaluated with input from the surface water model during the Feasibility Study.

Action: The definition of the various scenarios used in surface water modeling for the Remedial

Investigation and the type of scenarios to be modeled for the Feasibility Study will be clarified in the Remedial Investigation Report for Operable Unit 5.

7. **Section 4.6 Page 4-31, Paragraph 4.**

Comment: This section presents available data for evaluating model performance but provides no discussion of how model performance will be evaluated. This section should discuss the following: (1) how the modeled results will be compared to the field data, and (2) what calibration criteria will be used to evaluate the acceptability of the model predictions.

Response: To evaluate the performance of the surface water model the current site conditions as described in response to comment 4 are modeled and compared to sample data. The evaluation of the model is focused primarily on U-238 since this appears to be the most prevalent contaminant at the FEMP and the contaminant for which the most sample data is available for comparison. The predicted concentrations in the surface water, sediments, and in the GMA near the Paddys Run and the SSOD are compared to the sample data in these environmental media. In addition, the predicted contaminant loadings to the GMA and Paddys Run are compared to estimates from other studies conducted at the FEMP.

As was briefly discussed in the response to comment 4, two sets of source terms are modeled for current conditions to provide a range of predicted values for U-238 to compare to sample results. These two sets of source terms correspond to including and not including sample results from samples taken under buildings at the FEMP. The range of predicted concentrations are compared to the range of sample results at various locations in and around the FEMP in the environmental media. The model results are primarily compared to data from RI/FS data base, however in some instances the comparison is supplemented with data from the Routine Environmental Monitoring (REM) program.

The Draft Remedial Investigation Report submitted for internal review at the U.S. DOE presented a comparison of modeled and samples results to evaluate the model performance. Based on this comparison, the model performance was judged to be acceptable. The method used to evaluate the model is presented in the following paragraphs. The final model performance evaluation will be presented in the Remedial Investigation Report for Operable Unit 5 submitted to the U.S. EPA.

In evaluating the model's performance, the model is judged acceptable if the predicted results are in agreement with samples results or if the model conservatively overestimates the concentrations and mass of contaminant released. The model is still acceptable if it overestimates the concentrations because it is the intent of the modeling approach to be conservative in its assumptions to predict conservative results. If the predicted results fall within the range of samples results or fall outside the range but can be accounted for, the model is judged acceptable. The model results for current conditions are also compared to the estimated total amount of uranium released to Paddys Run by the Fernald Dosimetry Reconstruction Project (RAC 1993) for the years that the plant was in operation. The total amount of uranium released to the GMA is estimated with the surface water model for the years from the opening of the plant in 1951 to 1993 and compared to the estimated total amount of uranium in the GMA based on sample results as was discussed in response to comment 2.

Action: The Remedial Investigation report for Operable Unit 5 will include a section describing the model performance evaluation conducted on the surface water model. This Section will contain information similar to the information presented in the Response to this comment.

8. <u>Section 4.6. Page 4-31, Paragraph 4.</u>

Comment: The majority of the data presented in the subsections of this section is from the Routine Environmental Monitoring (REM) program. This data is considered analytical support level (ASL) B. Because the results of the model will be used to complete a portion of the risk assessment, U.S. DOE should justify the use of ASL B data for this purpose. In addition U.S. DOE should provide a description of the type and level of quality assurance and quality control (QA/QC) associated with these analytical results.

Response: The contaminant source terms for the surface water model are developed using only the RI/FS data. The contaminant source terms will be presented in the Remedial Investigation report. The use of Routine Environmental Monitoring data will only be used to supplement the model performance evaluation and as such will not be used directly to evaluate the risks. In addition, the RI/FS data will still be the primary source of data to evaluate the model performance.

Action: Routine Environmental Monitoring data will only be used to supplement the model performance evaluation. The REM data will not be used directly in the risk assessment or to

determine the source concentration terms for the surface water model.

9. <u>Section 4.6. Page 4-31, Paragraph 5.</u>

Comment: This section presents the available analytical data for sediment and surface water samples. In addition to this data, the data on surface soils is critical to the estimation of contaminant concentration in surface runoff. Therefore, this section should also include the available data for surface soils.

Response: The Operable Unit 5 Remedial Investigation report will discuss the surface soil data available for use in determining the source concentration for surface water modeling. The data which was used came exclusively from the RI/FS data base for soil samples in the top 1.5 feet of the soil. For each chemical detected above background levels in the top 1.5 feet of soil, a statistical analysis was performed for each of the 33 source areas in the surface water model. For risk assessment purposes, the statistical analysis was used to determine the upper confidence limit (UCL) on the mean or median depending on the number of sample results in that source area.

Action: The Operable Unit 5 Remedial Investigation Report will include a discussion of the soil data used to determine the source concentrations terms for the surface water model.

10. <u>Section 4.6.1, Page 4-31, Paragraph 5.</u>

Comment: The available analytical data for sediment samples is limited and suspect for the following reasons: (1) only three sediment samples were collected in the storm sewer outfall ditch (SSOD) and only one sediment sample was collected from Paddys Run, and (2) the REM data does not compare well to the remedial investigation/feasibility study (RI/FS) data--the REM data indicates significantly higher levels of contamination than the RI/FS data. U.S. DOE should discuss the uncertainties associated with such a limited database and how it will use this limited database in its modeling efforts.

Response: The data presented in the Surface Water Flow and Infiltration Model Summary Report was only intended to present the types of data to be used for model performance evaluation. At the time of submission of the report in November 1993 the RI/FS data base was still incomplete and

being checked for errors and/or omissions. The amount of data presented in the Surface Water Flow and Infiltration Model Summary Report does not reflect the total amount of data that is available to evaluate the model performance. The attached Table 2 presents the sample data that the predicted sediment results will be compared to. The table used only data from the RI/FS data base. The values in the table are based on 22 sample results. The RI/FS database is still undergoing minor revisions so it is still possible that the values in the attached Table 2 could change slightly from the final one to be presented in the Remedial Investigation report.

Action: The Remedial Investigation Report for Operable Unit 5 will contain more sample data to be used in the model performance evaluation.

11. Section 4.6.2, Page 4-31, Paragraph 6.

Comment: The available analytical data for surface water samples is limited and suspect for the following reasons: (1) only one surface water sample was collected from Paddys Run and only three surface water samples were collected from the SSOD as part of the RI/FS, (2) only three surface water samples were collected from the SSOD and no samples were collected from Paddys Run as part of the REM program, (3) the unit of measure listed in Figure 4-10 is micrograms per gram (ug/g) which is not typically used for water samples, and (4) the concentrations listed in Figure 4-11 appear to be extremely low. For example, there are numerous reported concentrations below 1 microgram per liter (ug/L) which does not appear to be correct. U.S. DOE should discuss the uncertainties with such as limited database and how it will use this limited database in its modeling effort.

Response: As described in the response to Comment 10 the data presented in the Surface Water Flow and Infiltration Model report did not represent the total amount of data that is available to evaluate the model performance but was only presented to indicate the type of data to be used. The attached Table 3 lists the range of sample results that the predicted model results will be compared to. The values in the table are based on 45 sample results.

The unit on Figure 4-10 in the Surface Water Flow and Infiltration Model Summary Report were incorrectly reported and should have been microgram per liter (ug/l). Some of the values on Figure 4-11 are incorrectly reported in milligram per liter (mg/l) instead of microgram per liter (ug/l). These problems have been corrected.

Action: The Remedial Investigation Report for Operable Unit 5 will contain additional sample data to be used in the model performance evaluation. The next submittal of the Surface Water Flow and Infiltration Model Summary report will contain updated and corrected the tables and figures indicating the type of data to be used for the model performance evaluation.

12. Section 4.6.3, Page 4-40, Paragraph 2.

Comment: Many of the wells listed in this section have received contamination from sources other than the SSOD or Paddys Run. These other sources include, but are not limited to, the source areas associated with Operable Unit (OU) 2. U.S. DOE should present a method for determining the relative contribution of contamination present in some of the monitoring wells.

Response: The surface water model has the capability to evaluate a single source area or many source areas together. If the loading due to a single source area, such as the waste pit area is required, the source concentrations for the other source areas are set to zero and the model run. The results of the model will then be due to that single source area or operable unit. In this way any combination of source areas can be evaluated to determine the relative contribution of contamination from individual source areas present in the surface water, sediments or in contaminant loadings to the GMA.

The concentration of contaminants in the sample results for the monitoring wells near Paddys Run and the SSOD are due to loadings from both contaminated surface water infiltrating into the streambeds and from the vertical migration of contaminants caused by water infiltrating directly through the source soils. The surface water model only attempts to predict the amount of contaminant reaching the GMA by infiltration through the streambeds. Therefore the concentrations predicted with the model should be less than the measured concentrations. By comparing the model output with sample results which should be higher because of loadings from other contaminant migration pathways, it will insure that the model produces conservative results.

The portion of measured contamination in a particular location in the GMA attributed to different operable units can be estimated by taking the ratio of predicted loadings presented in one Operable Unit RI to the predicted loading from the other Operable Unit RI. While this can be accomplished,

it is not the main focus of the surface water modeling efforts. The primary purpose of modeling for Operable Unit 5 is to estimate future concentrations at which time the loadings from the other operable units are assumed to have been terminated.

Action: The model performance evaluation in the Operable Unit 5 Remedial Investigation Report will include a discussion of the likely contribution of the various sources of contamination in the monitoring wells along Paddys Run and the SSOD. This relative contribution will be discussed when comparing the model output to the sample results from the monitoring wells.

13. <u>Section 5.1, Page 5-1, Paragraph 2.</u>

Comment: The results of the sensitivity analysis indicate that a 10 percent increase in the SCS curve number results in a 100 percent increase in storm water runoff. This indicates that the model is very sensitive to the SCS curve number. Because the model is very sensitive to the SCS curve number, U.S. DOE should conduct field tests to validate the accuracy of its estimates of the SCS curve number.

Response: It is acknowledged that the volume of runoff from a single storm event is very sensitive to the SCS curve number, however, this increase does not have as significant effect on the average concentration of contaminants in the surface water and sediments which are the final result of the modeling task. The predicted contaminant loadings to the GMA due to a single storm event will increase with increasing runoff, however the model is already overestimating the annual contaminant loadings to the GMA by approximately 3 time as was discussed in the response to comment 2. The annual runoff, and consequently the annual contaminant loading to the GMA, is based on the runoff volume from the representative storm event (see Response to Comment 2). It is logical to use curve numbers which represent the average runoff condition to provide the basis for calculating a average yearly runoff volume since these curve numbers account for soil conditions that are both dryer and wetter than normal that occur during the year. Because of the conservative approach used to determine the annual loading, ninety-four percent of the annual loading is from direct use of the total annual runoff (see Response to comment 2) so that runoff volume from the single storm event will not greatly affect the annual loading to the GMA. The sensitivity analysis of the effect of the curve number on the final contaminant concentrations in surface water and the GMA caused by a single storm event will be discussed in responses to comments 14 and 17 as well as was briefly discussed in

response to comment 2.

The comparison of the model to the actual storm events discussed in response to comment 2 provided a good match (within 3 percent) between the modeled and measured rise in depth of flow in Paddys Run for the storm event in which all of the site precipitation data was available. The comparison of modeled to measured rise in stream depth was made for initial conditions when the ground surface was saturated (AMC-III). Because of the insensitivity of the annual loading to a single storm event and the contaminant concentration results and the good match between modeled and measured data, additional field tests are not required at this time. The model conditions used to develop the representative infiltration pattern used average moisture conditions in the surface soils since over the length of a year the average condition is a more rational assumption. The representative storm event simulated only accounts for approximately 2 percent of the annual loading.

Action: As discussed above, additional field data is not required based on the sensitivity analysis and the match between measured and modeled data. The results of this additional sensitivity analysis will be presented in the revised Surface Water Flow and Infiltration Model Summary Report.

14. <u>Section 5.1, Page 5-1, Paragraph 2.</u>

Comment: The results of the sensitivity analysis indicate that a 10 percent increase in the SCS curve number results in a 100 percent increase in storm water runoff. The report implies that this significant increase in runoff has only a minor effect on infiltration. While this may be accurate, the 100 percent increase in runoff will significantly affect the following: (1) sediment production, (2) the mass of contaminant loading to surface water bodies, (3) the concentration of contaminants in the runoff, and (4) the amount of runoff available from upgradient reaches and uncontaminated areas that is available to dilute the concentration of contaminants in the surface water runoff, SSOD, and Paddys Run. U.S. DOE should discuss how it will account for the effect that a 100 percent increase in runoff will have on the uncertainty in the model.

Response: In order to verify the affect that the SCS curve number has on the surface water model output, a sensitivity analysis was conducted. The SCS curve numbers used in the Surface Water Flow and Infiltration Model Summary Report were modified and HEC-1, VS2DT, and the contaminant transport calculations rerun. Three modifications to the original SCS curve numbers were run. These

modifications were to decrease the curve numbers by 10 percent, increase the curve numbers by 10 percent, and modify the curve numbers to reflect Antecedent Moisture Conditions III (see response to comment 2). The results of the sensitivity analysis are discussed in the following paragraphs.

The concentration of contaminants in the runoff and in the sediments coming from an individual subbasin does not change appreciably with changes in the SCS curve number, however as the flow from each individual subbasin combines with others and mixes with uncontaminated flow from upstream, the concentrations of contaminants in the sediments and in the surface water decrease as the runoff volume (and curve number) increases in Paddys Run and in the SSOD (see attached Table 4). This is due to the general result that the peak runoff from uncontaminated upstream areas occurs closer in time to the peak discharges coming from the site as the runoff volume increases. Because of the timing of the peak discharges, there is generally more water available in the Paddys Run and the SSOD as the runoff volume increases to dilute the contaminated runoff from the site when the peak discharge from the site occurs. The use of higher curve numbers will actually result in less conservative results with respect to the concentration of contaminants in the surface water and the sediments in Paddys Run and the SSOD.

The effect of varying the SCS curve number on the infiltration amounts estimated with VS2DT was tested with the channel reach in Paddys Run between cross sections D-D and E-E for each of the SCS Curve number variations mentioned above. The channel reach D-D to E-E was chosen for the sensitivity analysis because it is the channel reach that is positioned in the center of the length of Paddys Run in which the infiltration calculation were conducted. Analysis of this channel reach would yield representative results for the entire infiltration calculations. The sensitivity analysis on the curve numbers verified the conclusions in the Surface Water Flow and Infiltration Model Summary Report that the infiltration amount is not very sensitive to the flow volume in the channel. The flow volume for the entire Paddys Run drainage basin increases by approximately 3 times (11 million to 33 million cubic feet) using AMC-III curve numbers, however, the increase in the infiltration volume between cross sections D-D and E-E was less than 6 percent (see attached Table 5). The infiltration volume is fairly insensitive to the runoff volume since only a small amount of additional water can infiltrate after the initial pore volume in the soil is filled. This is demonstrated in the model results by the infiltration rate being relatively high until the unsaturated pore space beneath the stream bed fills then the infiltration rate becoming slower. Since the volume of

infiltration is fairly insensitive to SCS curve numbers and the concentration of dissolved contaminants from each subbasin is also insensitive to the SCS curve number, the loading to the GMA from the representative storm event will also be insensitive (the loading is calculated by multiplying the infiltration volume attributed to a subbasin by the concentration in the runoff from that subbasin).

Action: The results from the additional sensitivity analysis discussed in the response to this comment will be presented in the revised Surface Water Flow and Infiltration Model Summary Report and briefly summarized in the Remedial Investigation.

15. Section 5.1, Page 5-1, Paragraph 2.

Comment: The report states that the total increase in infiltration volume at cross section D-D is 9-cubic-feet per foot of channel. The estimated increase should be expressed in total cubic feet so that the increase can be easily compared to the estimates presented in Sections 3.4.4.2 and 3.4.4.3.

Response: The increased infiltration volume will be converted to a total cubic feet measurement to facilitate the comparison with estimates presented in Sections 3.4.4.2 and 3.4.4.3.

Action: The converted infiltration volume will be presented in the revised Surface Water Flow and Infiltration Model Summary Report.

16. Section 5.3, Page 5-2, Paragraph 1.

Comment: The report states that the total decrease in infiltration volume at cross section C-C is 126-cubic-feet per foot of channel. The estimated increase should be expressed in total cubic feet so that the increase can be easily compared to the estimates presented in Sections 3.4.4.2 and 3.4.4.3.

Response: The decreased infiltration volume will be converted to a total cubic feet measurement to facilitate the comparison with estimates presented in Sections 3.4.4.2 and 3.4.4.3.

Action: The converted infiltration volume will be presented in the revised Surface Water Flow and Infiltration Model Summary Report.

17. Section 5.5, Page 5-2, Paragraph 3.

Comment: The sensitivity analysis focused on the possible error associated with the infiltration rate. The sensitivity analysis should also include an analysis of the possible error in the mass of contaminant loading and the concentration of contaminants in storm water runoff, surface water, and the GMA. U.S. DOE should list the parameters for which each of these items is sensitive, and should provide a discussion on each.

Response: As was discussed in the responses to comments 2, 13, and 14, the runoff volume from a single storm event predicted with HEC-1 is very sensitive to the SCS curve number, however the concentration of contaminants in sediments and surface water from each subbasin is insensitive to the runoff volume. Also the loading to the GMA is insensitive to the runoff volume. In addition, the model is already conservatively overestimating the annual contaminant loading to the Great Miami Aquifer as was discussed in the response to comment 2.

The concentrations of contaminants in Paddys Run and the SSOD decrease as the runoff flow volume increases and increase as the runoff flow volume decreases (see response to Comment 14). An additional sensitivity analysis was conducted on the precipitation amount used for the representative storm event. The precipitation amount was increased by 20 percent and decreased by 20 percent. The 20 percent decrease in precipitation resulted in approximately a 50 percent decrease in runoff volume. The 20 percent increase in precipitation resulted in approximately a 70 percent increase in runoff volume. As with the SCS curve number the changes in the runoff volume had a comparatively small effect on the concentration of contaminants and the contaminant loading to the Great Miami Aquifer. The attached Tables 4 and 5 present a summary of the sensitivity analysis results.

Action: The results from the additional sensitivity analysis discussed in the response to this comment will be presented in the revised Surface Water Flow and Infiltration Model Summary Report.