



# **Imazapic – WordPerfect Worksheets for Human Health and Ecological Risk Assessments**

Worksheet Version 2.04b

Prepared for:

## **USDA, Forest Service Forest Health Protection**



GSA Contract No. **GS-10F-0082F**  
USDA Forest Service BPA: **WO-01-3187-0150**  
Requisition No.: **43-3187-3-0716**  
Task No. **17**

Submitted to:

**Dave Thomas**, COTR  
Forest Health Protection Staff  
USDA Forest Service  
Rosslyn Plaza Building C, Room 7129C  
1601 North Kent Street  
Arlington, VA 22209

Prepared by:

Patrick R. Durkin  
**Syracuse Environmental Research Associates, Inc.**  
5100 Highbridge St., 42C  
Fayetteville, New York 13066-0950  
Telephone: (315) 637-9560  
Fax: (315) 637-0445  
E-Mail: [SERA\\_INC@msn.com](mailto:SERA_INC@msn.com)  
Home Page: [www.sera-inc.com](http://www.sera-inc.com)

December 22, 2004

## GENERAL NOTES

The worksheets included in this document are based on Worksheet Version 2.04b. See SERA WSD 01-2.04b, Documentation for Worksheets Version 2.04b - Human Health and Ecological Risk Assessments, dated June 22, 2003. These worksheets are slightly modified from the original Version 2.04 by the additional of Worksheet F15, *Potential exposures of non-target plants through the use of contaminated irrigation water*, Worksheets F14a and F14b (*Consumption of contaminated insects by a small mammal and a small bird, acute exposure scenarios*), and F16a and F16b (*Consumption of contaminated small mammal by a carnivorous mammal and a carnivorous bird, acute exposure scenarios*). This specific version of the worksheets has been modified to include drift after aerial applications. Values from AgDrift are now included in Worksheet A06 and are used in Worksheet G05b.

These worksheets are arranged in the following order:

|          |                            |
|----------|----------------------------|
|          | Table of Contents          |
| Series A | General values and models  |
| Series B | Chemical specific data     |
| Series C | Worker exposures           |
| Series D | General public exposures   |
| Series E | HHRA Summary Tables        |
| Series F | ERA Exposures              |
| Series G | ERA Summary Tables         |
|          | List of general references |

Most worksheets are designated by a simple alphanumeric code. For example, Worksheet D03 is the third worksheet in Series D. Some closely related worksheets are designated by an additional alphabetic sub-code. For example, Worksheets D01a and D01b are the direct spray scenarios for a child and a woman, respectively.

The worksheets in Series A and B also have short descriptive synonyms, as indicated in the table of contents. For example, Worksheet A03 contains the general assumptions used in exposure assessments for the general public and is designated as **PUBL**.

The WordPerfect worksheets contain a much more detailed set of Series A and B worksheets than do the EXCEL worksheets. As noted in the documentation, the primary use of the EXCEL worksheets at this stage is to check rather than replace the WordPerfect worksheets. As the worksheets develop further, additional functionality will probably be added to the EXCEL worksheets to make them easier to manipulate and maintain.

It should be noted that all estimates of drift for chronic exposures for the off-site consumption of contaminated vegetation (Worksheets F04b, F11b, and F13b) all based on low-boom ground applications. These will need to be changed for high-boom or air-blast applications. For aerial applications, estimates specific to the program should be based on AGDRIFT.

### **CHEMICAL SPECIFIC NOTES**

Information in these worksheets is taken from SERA TR 03-43-17-04b, Imazapic - Human Health and Ecological Risk Assessment, Final Report, dated December 23, 2004. All section numbers cited in these worksheets refer to this report.

Note that the application rate is set at the typical rate given in the program description and no range is used. The consequences of varying application rates is considered in the risk characterization for human health (Section 3.4) and ecological effects (Section 4.4).

One “non-standard” feature is the number of acres treated per hour in ground broadcast applications in Worksheet C01b. For these applications, values of 2 to 6 acres per hour, with the low end of this range representative of a four-wheel drive vehicle in tall grass and the upper end of the range representative of a large bulldozer. This rate of treatment is substantially lower than the typical rates used in herbicide applications - i.e., 11 to 21 acres/hour (USDA 1989b, p 2-9 to 2-10) with a central estimate of 16 acres per hour – that is typically used in Worksheet C01b.

There are no other “non-standard” features in these worksheets.

### **REVISION HISTORY**

These worksheets were revised in December 2004 in response to internal and peer review. Other than some numeric formatting, the changes were not substantial. None of the HQ's or dose estimates have been changed. Note that the corresponding EXCEL worksheets were corrected to reflect the lower treatment rates of 2 to 6 acres per hour for ground broadcast applications.

**WORKSHEETS FOR**  
**Imazapic**  
**WS Version 2.04d**

## Worksheet Table of Contents

| Section/Title   | Page No. |
|---|----------|
| <b>GENERAL ASSUMPTIONS, VALUES, and MODELS</b>  |          |
| <b>Worksheet A01[CONST]:</b> Constants and conversion factors used in calculations  | WS-5     |
| <b>Worksheet A02 [STD]:</b> General Assumptions Used in Worker Exposure Assessments   | WS-5     |
| <b>Worksheet A03 [PUBL]:</b> General Assumptions Used in Exposure Assessments for the General Public  | WS-6     |
| <b>Worksheet A04 [HK]:</b> Estimated concentrations of pesticides on various types of vegetation immediately after application at 1 lb/acre | WS-9     |
| <b>Worksheet A05 [FRUIT]:</b> Concentrations of chemical on spheres (berries) at the specified application rate.                            | WS-9     |
| <b>Worksheet A06 [OFFSITE]:</b> Central estimates of off-site drift associated with the ground application of pesticides                    | WS-9     |
| <b>Worksheet A07a [KAMODEL]:</b> Estimate of first-order absorption rate ( $k_a$ in hour <sup>-1</sup> ) and 95% confidence intervals       | WS-10    |
| <b>Worksheet A07b [KPMODEL]:</b> Estimate of dermal permeability ( $K_p$ in cm/hr) and 95% confidence intervals                             | WS-12    |
| <b>CHEMICAL SPECIFIC VALUES and ESTIMATES</b>   |          |
| <b>Worksheet B01 [APPL]:</b> Anticipated Application and Dilution Rates.  | WS-13    |
| <b>Worksheet B02 [CHEM]:</b> Chemical specific values used in exposure assessment worksheets.   | WS-14    |
| <b>Worksheet B03 [KA_CHEM]:</b> Calculation of first-order dermal absorption rate ( $k_a$ ).  | WS-15    |
| <b>Worksheet B04 [KP_CHEM]:</b> Calculation of dermal permeability rate ( $K_p$ ) in cm/hour.   | WS-16    |
| <b>Worksheet B05 [DERM]:</b> Summary of chemical specific dermal absorption values.   | WS-17    |
| <b>Worksheet B06 [AMBWAT]:</b> Estimates of the concentration in ambient water per lb applied per acre based on monitoring data.            | WS-17    |
| <b>EXPOSURE ASSESSMENTS for WORKERS</b>   |          |
| <b>Worksheet C01a:</b> Worker exposure estimates for directed foliar (backpack) applications  | WS-18    |
| <b>Worksheet C01b:</b> Worker exposure estimates for boom spray (hydraulic ground spray) applications                                       | WS-19    |
| <b>Worksheet C01c:</b> Worker exposure estimates for aerial applications  | WS-20    |
| <b>Worksheet C02a:</b> Workers: Dermal Exposure Assessments Using Zero-Order Absorption for one minute.                                     | WS-21    |
| <b>Worksheet C02b:</b> Workers: Dermal Exposure Assessments Using Zero-Order Absorption for one hour.                                       | WS-22    |
| <b>Worksheet C03a:</b> Accidental Spill onto the Hands for 1 Hour Based on the Assumption of First-Order Absorption                         | WS-23    |
| <b>Worksheet C03b:</b> Accidental Spill onto the Lower Legs for 1 Hour Based on the Assumption of First-Order Absorption                    | WS-24    |
| <b>EXPOSURE ASSESSMENTS for the GENERAL PUBLIC</b>  |          |
| <b>Worksheet D01a:</b> Direct spray of child.   | WS-25    |
| <b>Worksheet D01b:</b> Direct spray of woman.   | WS-26    |
| <b>Worksheet D02:</b> Dermal contact with contaminated vegetation, acute exposure scenario.   | WS-27    |
| <b>Worksheet D03:</b> Consumption of contaminated fruit, acute exposure scenario.   | WS-28    |

## Worksheet Table of Contents

| Section/Title  | Page No. |
|--|----------|
| <b>Worksheet D04:</b> Consumption of contaminated fruit, chronic exposure scenario.                                      | WS-29    |
| <b>Worksheet D05:</b> Consumption of contaminated water following an accidental spill, acute exposure scenario.          | WS-31    |
| <b>Worksheet D06:</b> Consumption of water from a stream contaminated by runoff or percolation, acute exposure scenario. | WS-32    |
| <b>Worksheet D07:</b> Consumption of contaminated water, chronic exposure scenario.                                      | WS-33    |
| <b>Worksheet D08a:</b> Consumption of contaminated fish, acute exposure scenarios for recreational fisherman.            | WS-34    |
| <b>Worksheet D08b:</b> Consumption of contaminated fish, acute exposure scenarios for subsistence populations.           | WS-35    |
| <b>Worksheet D09a:</b> Consumption of contaminated fish, chronic exposure scenario for recreational fisherman..          | WS-36    |
| <b>Worksheet D09b:</b> Consumption of contaminated fish, chronic exposure scenario for subsistence populations.          | WS-37    |

### HUMAN HEALTH EFFECTS SUMMARY TABLES

|   |       |
|---|-------|
| <b>Worksheet E01:</b> Summary of worker exposure scenarios                    | WS-38 |
| <b>Worksheet E02:</b> Summary of risk characterization for workers            | WS-39 |
| <b>Worksheet E03:</b> Summary of exposure scenarios for the general public    | WS-40 |
| <b>Worksheet E04:</b> Summary of risk characterization for the general public | WS-41 |

### EXPOSURE ASSESSMENTS FOR TERRESTRIAL SPECIES

|   |       |
|---|-------|
| <b>Worksheet F01:</b> Direct spray of small mammal assuming first order absorption kinetics.  | WS-42 |
| <b>Worksheet F02a:</b> Direct spray of small mammal assuming 100% absorption over the first 24 hour period.                                 | WS-43 |
| <b>Worksheet F02b:</b> Direct spray of bee assuming 100% absorption over the first 24 hour period.  | WS-44 |
| <b>Worksheet F03:</b> Consumption of contaminated fruit by a small mammal, acute exposure scenario.   | WS-45 |
| <b>Worksheet F04a:</b> Consumption of contaminated fruit by a small mammal, chronic exposure scenario at application site.                  | WS-46 |
| <b>Worksheet F04b:</b> Consumption of contaminated fruit by a small mammal, chronic exposure scenario off-site.                             | WS-48 |
| <b>Worksheet F05:</b> Consumption of contaminated water by a small mammal, acute exposure scenario for an accidental spill.                 | WS-50 |
| <b>Worksheet F06:</b> Consumption of contaminated water by a small mammal, acute exposure scenario for runoff or percolation into a stream. | WS-51 |
| <b>Worksheet F07:</b> Consumption of contaminated water by a small mammal, chronic exposure scenario.                                       | WS-52 |
| <b>Worksheet F08:</b> Consumption of contaminated fish by bird, acute exposure scenario.  | WS-53 |
| <b>Worksheet F09:</b> Consumption of contaminated fish by bird, chronic exposure scenario.  | WS-54 |
| <b>Worksheet F10:</b> Consumption of contaminated vegetation by a large mammal, acute exposure scenario.                                    | WS-55 |
| <b>Worksheet F11a:</b> Consumption of contaminated vegetation by a large mammal, chronic exposure scenario on-site.                         | WS-57 |

## **Worksheet Table of Contents**

| <b>Section/Title</b>  | <b>Page No.</b> |
|---|-----------------|
| <b>Worksheet F11b:</b> Consumption of contaminated vegetation by a large mammal, chronic exposure scenario off-site.        | WS-59           |
| <b>Worksheet F12:</b> Consumption of contaminated vegetation by a large bird, acute exposure scenario.                      | WS-61           |
| <b>Worksheet F13a:</b> Consumption of contaminated vegetation by a large bird, chronic on-site exposure scenario.           | WS-62           |
| <b>Worksheet F13b:</b> Consumption of contaminated vegetation by a large bird, chronic exposure scenario off-site.          | WS-64           |
| <b>Worksheet F14a:</b> Consumption of contaminated insects by a small mammal, acute exposure scenario.                      | WS-66           |
| <b>Worksheet F14b:</b> Consumption of contaminated insects by a small bird, acute exposure scenario.                        | WS-67           |
| <b>Worksheet F15:</b> Potential exposures of non-target plants through the use of contaminated irrigation water.            | WS-68           |
| <b>Worksheet F16a:</b> Consumption of contaminated small mammal by a carnivorous mammal, acute exposure scenario. [SmMCCMA] | WS-70           |
| <b>Worksheet F16b:</b> Consumption of contaminated small mammal by a carnivorous bird, acute exposure scenario. [SmMCCBA]   | WS-71           |

### **SUMMARY TABLES FOR ECOLOGICAL RISK ASSESSMENT**

|  |  |
|--|--|
| <b>Worksheet G01:</b> Summary of Exposure Scenarios for terrestrial animals  |  |
| <b>Worksheet G02:</b> Summary of quantitative risk characterization for terrestrial animals.   |  |
| <b>Worksheet G03:</b> Quantitative Risk Characterization for Aquatic Species.  |  |
| <b>Worksheet G04:</b> Summary of Exposure Assessment and Risk Characterization for Terrestrial Plants from Runoff.   |  |
| <b>Worksheet G05a:</b> Summary of Exposure Assessment and Risk Characterization for Terrestrial Plants from Drift After Low-Boom Ground Applications and Wind Erosion. |  |
| <b>Worksheet G05b:</b> Summary of Exposure Assessment and Risk Characterization for Terrestrial Plants from Drift After Aerial Application.                            |  |

### **STANDARD REFERENCES FOR WORKSHEETS**

WS-72

## GENERAL ASSUMPTIONS, VALUES, and MODELS

**Worksheet A01 [CONST]:** Constants and conversion factors used in calculations

| Conversion                           | ID        | Value   |
|--------------------------------------|-----------|---------|
| mg/lb                                | mg_lb     | 453,600 |
| mL/gallon                            | ml_gal    | 3,785   |
| lb/gallon to mg/mL                   | lbg_mgml  | 119.8   |
| lb/acre to $\mu\text{g}/\text{cm}^2$ | lbac_ugcm | 11.21   |
| lb/acre to $\text{mg}/\text{cm}^2$   | lbac_mgcm | 0.01121 |
| gallons to liters                    | gal_lit   | 3.785   |

**Worksheet A02 [STD]:** General Assumptions Used in Worker Exposure Assessments

| Parameter  | ID    | Value | Units                   | Reference                  |
|--|-------|-------|-------------------------|----------------------------|
| Body Weight (General)                                      | BW    | 70    | kg                      | ICRP (1975), p. 13         |
| Surface area of both hands                                 | Hands | 840   | $\text{cm}^2$           | U.S. EPA/ORD 1992, p. 8-11 |
| Surface area of lower legs                                 | LLegs | 2070  | $\text{cm}^2$           | U.S. EPA/ORD 1992, p. 8-11 |
| Weight of liquid adhering to surface of skin after a spill | Liq   | 0.008 | $\text{mL}/\text{cm}^2$ | Mason and Johnson 1987     |

**Worksheet A03 [PUBL]: General Assumptions Used in Exposure Assessments for the General Public**

**Verbal Description:** This table contains various values used in the exposure assessments for the general public. Three general groups of individuals are considered: adult male, adult female, and a 2 year old child. Values are specified for body weight, surface areas for various parts of the body, water intake, fish consumption, and the consumption of fruits or vegetables. Not all types of value are specified for each group. The only values specified are those used in the risk assessment.

| Description  | ID   | Value | Units           | Reference  |
|--|------|-------|-----------------|--|
| <b>Body Weights</b>  |      |       |                 |  |
| Male, Adult  | BWM  | 70    | kg              | ICRP (1975), p. 13.  |
| Female, Adult  | BWF  | 64    | kg              | See Note 1 below.  |
| Child, 2-3 years old   | BWC  | 13.3  | kg              | U.S. EPA/ORD 1996, p. 7-1, Table 7-2   |
| <p><sup>1</sup>This is the average value (63.79 kg), rounded to the nearest kg for 3 different groups of women between 15-49 years old: control (62.07 kg), pregnant (65.90 kg), and lactating (63.48 kg). See Burnmaster 1998, Table III, p.218. This is identical to the body weight for females, 45-55 years old, 50<sup>th</sup> percentile from U.S. EPA, 1985, page 5, Table 2-2, rounded to nearest kilogram.</p> |      |       |                 |  |
| <b>Body Surface Areas</b>  |      |       |                 |  |
| Female, feet and lower legs  | SAF1 | 2915  | cm <sup>2</sup> | U.S. EPA/ORD 1992, p. 8-11, Table 8-3, total for feet and lower legs   |
| Female, exposed skin when wearing shorts and a T-shirt   | SAF2 | 5300  | cm <sup>2</sup> | U.S. EPA/ORD 1992, p. 8-11, Table 8-3, total for arms, hands, lower legs, and feet.  |
| Child, male, 2-3 years old, total body surface area  | SAC  | 6030  | cm <sup>2</sup> | U.S. EPA/ORD 1996, p. 6-15, Table 6-6, 50 <sup>th</sup> percentile.  |
| <b>Water Intake</b>  |      |       |                 |  |
| Adult  |      |       |                 |  |
| typical  | WCAT | 2     | L/day           | U.S. EPA/ORD 1996, p. 3-28, Table 3-30, midpoint of mean (1.4 L/day) and 90 <sup>th</sup> percentile (2.4 L/day) rounded to one significant place. |
| lower range for exposure assessment  | WCAL | 1.4   | L/day           | U.S. EPA/ORD 1996, p. 3-28, Table 3-30, mean   |
| upper range  | WCAH | 2.4   | L/day           | U.S. EPA/ORD 1996, p. 3-28, Table 3-30, 90 <sup>th</sup> percentile  |
| Child, < 3 years old   |      |       |                 |  |
| typical  | WCT  | 1     | L/day           | U.S. EPA/ORD 1996, p. 3-28, Table 3-30, midpoint of mean (0.61L/day) and 90 <sup>th</sup> percentile (1.5 L/day) rounded to one significant place. |
| lower range for exposure assessment  | WCL  | 0.61  | L/day           | U.S. EPA/ORD 1996, p. 3-28, Table 3-30, mean   |
| upper range  | WCH  | 1.50  | L/day           | U.S. EPA/ORD 1996, p. 3-28, Table 3-30, 90 <sup>th</sup> percentile  |

**Worksheet A03 [PUBL](continued):** General Assumptions Used in Exposure Assessments for the General Public

| Description   | ID     | Value     | Units              | Reference   |
|---|--------|-----------|--------------------|---|
| <b>Fish Consumption</b>   |        |           |                    |   |
| Freshwater anglers, typical intake per day over a prolonged period                              | FAT    | 0.010     | kg/day             | U.S. EPA/ORD 1996, p. 10-51, average of means from four studies rounded to one significant place.   |
| Freshwater anglers, maximum consumption for a single day  | FAU    | 0.158     | kg/day             | Ruffle et al. 1994  |
| Native American subsistence populations, typical intake per day                                 | FNT    | 0.081     | kg/day             | U.S. EPA/ORD 1996, p. 10-51, median value of 94 individuals   |
| Native American subsistence populations, maximum for a single day                               | FNU    | 0.770     | kg/day             | U.S. EPA/ORD 1996, p. 10-51, highest value of 94 individuals  |
| <b>Consumption of Fruits and Vegetables</b>   |        |           |                    |   |
| Consumption of fruit, total   |        |           |                    |   |
| Central   | FrTC   | 0.00168   | kg fruit/kg bw/day | U.S. EPA/ORD 1996, Table 9-3, p. 9-11, Central and upper estimates are mean and 95 <sup>th</sup> percentile, respectively. The 5 <sup>th</sup> percentile is given as zero. For these worksheets, the central estimate is used for the lower bound. |
| Lower   | FrTL   | 0.00168   |                    |   |
| Upper   | FrTU   | 0.01244   |                    |   |
| Consumption of vegetables, total  |        |           |                    |   |
| Central   | VgTC   | 0.0036    | kg veg/kg bw/day   | U.S. EPA/ORD 1996, Table 9-12, p. 9-12, mean, 5 <sup>th</sup> percentile and 95 <sup>th</sup> percentile.   |
| Lower   | VgTL   | 0.00075   |                    |   |
| Upper   | VgTU   | 0.01      |                    |   |
| Consumption of vegetables, homegrown  |        |           |                    |   |
| Central   | VgHC   | 0.000761  | kg veg/kg bw/day   | U.S. EPA/ORD 1996, Table 12-15, p. 9-14, mean, 5 <sup>th</sup> percentile and 95 <sup>th</sup> percentile for individuals between 20 and 39 years old..   |
| Lower   | VgHL   | 0.0000777 |                    |   |
| Upper   | VgHU   | 0.00492   |                    |   |
| Worst-case scenario for consumption in a single day, acute exposure scenario only.              | VAcute | 0.454     | kg food            | 1 lb. The approximate mid range of the above typical and upper limits based on the 64 kg body weight.   |
| <b>Miscellaneous</b>  |        |           |                    |   |
| Estimate of dislodgeable residue as a proportion of application rate shortly after application. | DisL   | 0.1       | none               | Harris and Solomon 1992, data on 2,4-D  |

**Worksheet A04 [HK]:** Estimated pesticide residues on various types of vegetation shortly after an application of 1 lb/acre.

| Type of Vegetation                                       | Concentration (mg chemical/kg vegetation) |       |             |       |
|--|---|-------|-------------|-------|
|  | Typical                                   |       | Upper Limit |       |
|  | ID  | Value | ID          | Value |
| The following values are from Hoerger and Kenaga (1972). |   |       |             |       |
| Range grass  | RGT                                       | 125   | RGU         | 240   |
| Grass  | GST                                       | 92    | GSU         | 110   |
| Leaves and leafy crops                                   | LVT                                       | 35    | LVU         | 125   |
| Forage crops   | FCT                                       | 33    | FCU         | 58    |
| Pods containing seeds                                    | PDT                                       | 3     | PDU         | 12    |
| Grain  | GNT                                       | 3     | GNU         | 10    |
| Fruit  | FRT                                       | 1.5   | FRU         | 7     |

The following values are from Fletcher et al. (1994)

|   |      |    |      |     |
|---|------|----|------|-----|
| Short grass                               | SGT  | 85 | SGU  | 240 |
| Tall grass                                | TGT  | 36 | TGU  | 110 |
| Broadleaf/forage plants and small insects | BLT  | 45 | BLU  | 135 |
| Fruits, pods, seeds, and large insects    | FRT2 | 7  | FRU2 | 15  |

**Worksheet A05 [FRUIT]:** Concentration of a chemical on spheres of various sizes at an application rate of 1 lb/acre.

| Diameter (cm)                       | Planar Surface Area (cm <sup>2</sup> ) <sup>a</sup> | Amount deposited (mg) <sup>b</sup> | Weight of sphere (kg) <sup>c</sup> | Concentration (mg/kg) <sup>d</sup> |
|-------------------------------------|---|------------------------------------|------------------------------------|------------------------------------|
| 1                                   | 0.78540   | 0.00880                            | 0.00052                            | 16.8                               |
| 5                                   | 19.63495  | 0.21991                            | 0.06545                            | 3.36                               |
| 10                                  | 78.53982  | 0.87965                            | 0.52360                            | 1.68                               |
| <b>Application rate</b> 1 lb/acre = |   |                                    | 0.0112                             | mg/cm <sup>2</sup>                 |

a Planar surface area of a sphere =  $\pi r^2$  where r is the radius in cm.

b Amount deposited is calculated as the application rate in mg/cm<sup>2</sup> multiplied by the planar surface area.

c Assumes a density of 1 g/cm<sup>3</sup> for the fruit. The volume of a sphere is  $(1 \div 6) \times \pi \times d^3$  where d is the diameter in cm. Assuming a density of 1 g/cm<sup>3</sup>, the weight of the sphere in kg is equal to:

$$\text{kg} = (1 \div 6) \times \pi \times d^3 \div 1000$$

d Amount of chemical in mg divided by the weight of the sphere in kg.

**Worksheet A06 [OFFSITE]:** Central estimates of off-site drift (expressed as fraction of application rate) associated with ground applications of pesticides <sup>1</sup> (from AgDRIFT Version 1.16, Teske et al. 2001)

| Distance Down Wind (feet) | Low Boom <sup>1</sup> | High Boom <sup>1</sup> | Orchard Airblast <sup>1</sup> (Normal) | Aerial <sup>2</sup> |
|---------------------------|-----------------------|------------------------|--|---------------------|
| 25                        | 0.0187                | 0.1034                 | 0.0057                                 | 0.1434              |
| 50                        | 0.0101                | 0.0515                 | 0.0029                                 | 0.0518              |
| 100                       | 0.0058                | 0.0262                 | 0.0007                                 | 0.0195              |
| 300                       | 0.0024                | 0.0078                 | 0.0001                                 | 0.0042              |
| 500                       | 0.0015                | 0.0038                 | 0.0000403                              | 0.0022              |
| 900                       | 0.0008                | 0.0015                 | 0.000013                               | 0.0009              |
| 990                       | 0.0007                | 0.0013                 | < 0.0000108                            | 0.0008              |

<sup>1</sup> Estimates based on very fine to fine spray. This will over-estimate drift for applications involving larger droplets.

<sup>2</sup> Estimated based on AgDrift defaults – Air Tractor AT-401, water, 8 ft. boom height, 4 mph wind speed. A large number of options are available in AgDrift for different weather conditions, pesticide mixtures, and aircraft.

**Worksheet A07a [KAMODEL]:** Estimate of first-order absorption rate ( $k_a$  in hour<sup>-1</sup>) and 95% confidence intervals (from SERA 1997).

| Model parameters  | ID          | Value         |                     |
|---|-------------|---------------|---------------------|
| Coefficient for $k_{o/w}$                               | C_KOW       | 0.233255      |                     |
| Coefficient for MW                                      | C_MW        | 0.005657      |                     |
| Model Constant  | C           | 1.49615       |                     |
| Number of data points                                   | DP          | 29            |                     |
| Degrees of Freedom (d.f.)                               | DF          | 26            |                     |
| Critical value of $t_{0.025}$ with 26 d.f. <sup>1</sup> | CRIT        | 2.056         |                     |
| Standard error of the estimate                          | SEE         | 16.1125       |                     |
| Mean square error or model variance                     | MDLV        | 0.619712      |                     |
| Standard deviation of model (s)                         | MSD         | 0.787218      | MDLV <sup>0.5</sup> |
| X'X, cross products matrix                              | 0.307537    | -0.00103089   | 0.00822769          |
|   | -0.00103089 | 0.000004377   | -0.0000944359       |
|   | 0.0082      | -0.0000944359 | 0.0085286           |

<sup>1</sup> Mendenhall and Scheaffer 1973, Appendix 3, 4, p. A31.

Central (maximum likelihood ) estimate:

$$\log_{10} k_a = 0.233255 \log_{10}(k_{o/w}) - 0.005657 MW - 1.49615$$

95% Confidence intervals for  $\log_{10} k_a$

$$\log_{10} k_a \pm t_{0.025} \times s \times (a'X'X a)^{0.5}$$

where  $a$  is a column vector of  $\{1, MW, \log_{10}(k_{o/w})\}$ .

**NB:** Although the equation for the central estimate is presented with  $k_{o/w}$  appearing before MW to be consistent with the way a similar equation is presented by EPA, MW must appear first in column vector  $a$  because of the way the statistical analysis was conducted to derive X'X .

See following page for details of calculating  $a'X'X a$  without using matrix arithmetic.

**Worksheet Worksheet A07a (continued)**

**Details of calculating  $a'X'Xa$**

The term  $a'(X'X)^{-1}a$  requires matrix multiplication. While this is most easily accomplished using a program that does matrix arithmetic, the calculation can be done with a standard calculator.

Letting

$$\mathbf{a} = \{a_1, a_2, a_3\}$$

and

$$(X'X)^{-1} = \begin{Bmatrix} \{b_1, b_2, b_3\}, \\ \{c_1, c_2, c_3\}, \\ \{d_1, d_2, d_3\} \\ \} \end{Bmatrix}$$

$a'(X'X)^{-1}a$  is equal to

$$\begin{aligned} \text{Term 1:} & \{a_1 \times ([a_1 \times b_1] + [a_2 \times c_1] + [a_3 \times d_1])\} + \\ \text{Term 2:} & \{a_2 \times ([a_1 \times b_2] + [a_2 \times c_2] + [a_3 \times d_2])\} + \\ \text{Term 3:} & \{a_3 \times ([a_1 \times b_3] + [a_2 \times c_3] + [a_3 \times d_3])\}. \end{aligned}$$

**Worksheet A07b [KPMODEL]:** Estimate of dermal permeability ( $K_p$  in cm/hr) and 95% confidence intervals (data from U.S. EPA/ORD 1992).

| Model parameters  | ID    | Value         |                     |
|---|-------|---------------|---------------------|
| Coefficient for $k_{o/w}$                               | C_KOW | 0.706648      |                     |
| Coefficient for MW                                      | C_MW  | 0.006151      |                     |
| Model Constant  | C     | 2.72576       |                     |
| Number of data points                                   | DP    | 90            |                     |
| Degrees of Freedom (d.f.)                               | DF    | 87            |                     |
| Critical value of $t_{0.025}$ with 87 d.f. <sup>1</sup> | CRIT  | 1.96          |                     |
| Standard error of the estimate                          | SEE   | 45.9983       |                     |
| Mean square error or model variance                     | MDLV  | 0.528716      |                     |
| Standard deviation of model (s)                         | MSD   | 0.727129      | MDLV <sup>0.5</sup> |
| X'X, cross products matrix                              |       | 0.0550931     | -0.0000941546       |
|   |       | -0.0000941546 | 0.0000005978        |
|   |       | -0.0103443    | -0.0000222508       |
|   |       | -0.0103443    | 0.00740677          |

<sup>1</sup> Mendenhall and Scheaffer, 1973, Appendix 3, Table 4, p. A31.

**NOTE:** The data for this analysis is taken from U.S. EPA/ORD (1992), Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, Table 5-4, pp. 5-15 through 5-19. The EPA report, however, does not provide sufficient information for the calculation of confidence intervals. The synopsis of the above analysis was conducted in STATGRAPHICS Plus for Windows, Version 3.1 (Manugistics, 1995) as well as Mathematica, Version 3.0.1.1 (Wolfram Research, 1997). Although not explicitly stated in the EPA report, 3 of the 93 data points are censored from the analysis because they are statistical outliers: [Hydrocortisone-21-yl]-hemipimelate, n-nonanol, and n-propanol. The model parameters reported above are consistent with those reported by U.S. EPA but are carried out to greater number of decimal places to reduce rounding errors when calculating the confidence intervals. See notes to Worksheet A07a for details of calculating maximum likelihood estimates and confidence intervals.

**CHEMICAL SPECIFIC VALUES**

**Worksheet B01 [APPL]: Anticipated Application and Dilution Rates**

| Item   |         | Code  | Value | Units     | Source      |
|--|---------|-------|-------|-----------|-------------|
| Application rate ( <i>R</i> )  |         |       |       |           |             |
|  | Central | Typ   | 0.1   | lbs/acre  | Section 2.4 |
|  | Lower   | Low   | 0.1   |           | Section 2.4 |
|  | Upper   | Hi    | 0.1   |           | Section 2.4 |
| Dilution ( <i>Dil</i> )  |         |       |       |           |             |
|  | Central | CDil  | 6     | gal./acre | Section 2.4 |
|  | Lower   | LDil  | 2     |           |             |
|  | Upper   | HDil  | 10    |           |             |
| Concentration in field solutions <sup>1</sup> : $R_{(lb/acre)} \div Dil_{(gal/acre)} \times 119.8 \text{ mg/mL} \div lb/gal$ |         |       |       |           |             |
|  | Central | TypDr | 2.0   | mg/mL     |             |
|  | Lower   | LowDr | 1.2   |           |             |
|  | Upper   | HI_Dr | 6.0   |           |             |

The typical concentration in applied solution is calculated as the typical application rate (lbs/acre) divided by the typical dilution (gal/acre), yielding units of lbs/gallon. This is converted to mg/mL using the relationship of lb/gal = 119.8 mg/mL from Worksheet A01. The lowest estimated concentration is calculated as the lowest application rate divided by the highest dilution. The highest estimated concentration is calculated as highest application rate divided by the lowest dilution.

**NOTE ON UNITS FOR APPLICATION RATE: In all cases, lb/acre refers to lb a.e./acre.**

**Worksheet B02 [CHEM]:** Summary of chemical specific values used in exposure assessment worksheets.

| Parameter   | ID      | Value  | Units        | Source/Reference  |   |
|---|---------|--------|--------------|---|---|
| Molecular weight, acid                                    | MW      | 275.31 | grams/mole   | Table 2-1   |   |
| Water Solubility, salt                                    | WS      | 36000  | mg/L         | Table 2-1   |   |
| $K_{o/w}$ (pH 7)  | Kow     | 288    | unitless     | Table 2-1,<br>$\text{Log}_{10} K_{o/w} = 2.46$  |   |
| Foliar half-time ( $t_{1/2}$ )                            |         |        |              |   |   |
|   | central | FrT12C | 4            | days  | Section 3.2.3.6   |
|   | lower   | FrT12L | 1.2          | days  |   |
|   | upper   | FrT12U | 12           | days  |   |
| Dissipation coefficients on vegetation                    |         |        |              |   |   |
|   | central | VgKC   | 0.1733       | day <sup>-1</sup>   | ln(2)/half-time.<br>The upper limit on half-time is used to calculate the lower limit on dissipation coefficient. |
|   | lower   | VgKL   | 0.0578       | day <sup>-1</sup>   |   |
|   | upper   | VgKU   | 0.5776       | day <sup>-1</sup>   |   |
| Bioconcentration factor, edible portion, acute exposure   | BCFT    | 0.11   | L/kg fish    | See Section 3.2.3.5. The actual BCF for Imazapic is probably less than unity. This has no impact on this risk assessment. |   |
| Bioconcentration factor, edible portion, chronic exposure | BCFCh   | 0.11   | L/kg fish    |   |   |
| Bioconcentration factor, whole fish, acute                | BCFWA   | 0.11   | L/kg fish    |   |   |
| Bioconcentration factor, whole fish, chronic              | BCFWC   | 0.11   | L/kg fish    |   |   |
| Chronic RfD <sup>a</sup>                                  | RfDP    | 0.5    | mg/kg bw/day | See Section 3.3   |   |
| Acute RfD   | RfDA    | 0.5    | mg/kg bw/day |   |   |

**Worksheet B03 [KA\_CHEM]:** Calculation of first-order dermal absorption rate ( $k_a$ )<sup>1</sup>.

| Parameters          | Value  | Units    | Reference |
|---------------------|--------|----------|-----------|
| Molecular weight    | 275.31 | g/mole   |           |
| $K_{o/w}$ at pH 7   | 288    | unitless |           |
| $\log_{10} K_{o/w}$ | 2.46   |          |           |

Column vector  $\mathbf{a}$  for calculating confidence intervals

|     |        |
|-----|--------|
| a_1 | 1      |
| a_2 | 275.31 |
| a_3 | 2.46   |

Calculation of  $\mathbf{a}' \cdot (\mathbf{X}'\mathbf{X})^{-1} \cdot \mathbf{a}$

|        |               |
|--------|---------------|
| Term 1 | 0.0438946741  |
| Term 2 | -0.0160149049 |
| Term 3 | 0.00789389    |

$$\mathbf{a}' \cdot (\mathbf{X}'\mathbf{X})^{-1} \cdot \mathbf{a} = 0.0358$$

$$\log_{10} k_a = 0.233255 \log_{10}(k_{o/w}) - 0.005657 MW - 1.49615$$

$\log_{10}$  of first order absorption rate ( $k_a$ )

|                  |                |                 |                   |  |
|------------------|----------------|-----------------|-------------------|--|
| Central estimate | -2.47991307527 | $\pm t_{0.025}$ | $\times s$        | $\times (\mathbf{a}' \cdot (\mathbf{X}'\mathbf{X})^{-1} \cdot \mathbf{a})^{0.5}$ |
| Lower limit      | -2.78615146992 | - 2.0560        | $\times 0.787218$ | $\times 0.18920887928$   |
| Upper limit      | -2.17367468061 | + 2.0560        | $\times 0.787218$ | $\times 0.18920887928$   |

First order absorption rates (i.e., antilog or  $10^x$  of above values).

|                  |          |                    |
|------------------|----------|--------------------|
| Central estimate | 3.31e-03 | hour <sup>-1</sup> |
| Lower limit      | 1.64e-03 | hour <sup>-1</sup> |
| Upper limit      | 6.70e-03 | hour <sup>-1</sup> |

<sup>1</sup> See Worksheet A07a for details of method.

**Worksheet B04 [KP\_CHEM]:** Calculation of dermal permeability rate ( $K_p$ ) in cm/hour<sup>1</sup>.

| Parameters          | Value         | Units    | Reference |
|---------------------|---------------|----------|-----------|
| Molecular weight    | 275.31        | g/mole   |           |
| $K_{o/w}$           | 288           | unitless |           |
| $\log_{10} K_{o/w}$ | 2.45939248776 |          |           |

Column vector  $\mathbf{a}$  for calculating confidence intervals

|     |               |
|-----|---------------|
| a_1 | 1             |
| a_2 | 275.31        |
| a_3 | 2.45939248776 |

Calculation of  $\mathbf{a}' \cdot (\mathbf{X}'\mathbf{X})^{-1} \cdot \mathbf{a}$

|        |             |
|--------|-------------|
| Term 1 | 0.003730703 |
| Term 2 | 0.004322991 |
| Term 3 | 0.004294067 |

$$\mathbf{a}' \cdot (\mathbf{X}'\mathbf{X})^{-1} \cdot \mathbf{a} = 0.0123$$

$$\log_{10} K_p = 0.706648 \log_{10}(k_{o/w}) - 0.006151 MW - 2.72576$$

$\log_{10}$  of dermal permeability

|                  |                |                 |                   |  |
|------------------|----------------|-----------------|-------------------|--|
| Central estimate | -2.68126702731 | $\pm t_{0.025}$ | $\times s$        | $\times \mathbf{a}' \cdot (\mathbf{X}'\mathbf{X})^{-1} \cdot \mathbf{a}^{0.5}$ |
| Lower limit      | -2.83932634141 | - 1.9600        | $\times 0.727129$ | $\times 0.11090536506$   |
| Upper limit      | -2.52320771321 | + 1.9600        | $\times 0.727129$ | $\times 0.11090536506$   |

Dermal permeability

|                  |          |         |
|------------------|----------|---------|
| Central estimate | 2.08e-03 | cm/hour |
| Lower limit      | 1.45e-03 | cm/hour |
| Upper limit      | 3.00e-03 | cm/hour |

<sup>1</sup> See Worksheet A07a for details of method.

**Worksheet B05 [DERM]:** Summary of chemical specific dermal absorption values.

| Description  | Code | Value  | Units              | Reference/Source  |
|--|------|--------|--------------------|---|
| <b>Zero-order absorption (<math>K_p</math>)</b>        |      |        |                    |   |
| Central estimate                                       | KpC  | 0.0021 | cm/hour            | Worksheet A07a, values rounded to two significant figures |
| Lower limit  | KpL  | 0.0014 | cm/hour            |   |
| Upper limit  | KpU  | 0.0030 | cm/hour            |   |
| <b>First-order absorption rates (<math>k_a</math>)</b> |      |        |                    |   |
| Central estimate                                       | AbsC | 0.0033 | hour <sup>-1</sup> | Worksheet A07b, values rounded to two significant figures |
| Lower limit  | AbsL | 0.0016 | hour <sup>-1</sup> |   |
| Upper limit  | AbsU | 0.0067 | hour <sup>-1</sup> |   |

**Worksheet B06 [AMBWAT]:** Estimates of the concentrations in ambient water per pound applied per acre are used in the chronic contaminated water exposure assessments.

| Scenario  | Description  | ID   | WCR<br>(mg/L) ÷<br>(lb/acre) |
|---|--|------|------------------------------|
| <b>Short-term Peak Concentrations in Streams</b><br>(See Section 3.2.3.4.1 for details) |  |      |                              |
| Central   | Based solely on GLEAMS modeling. No monitoring data are available. | AWPT | 0.0005                       |
| Lower   |  | AWPL | 0.00005                      |
| Upper   |  | AWPU | 0.01                         |
| <b>Longer-term Concentrations in Ponds</b><br>(See Section 3.2.3.4.2 for details)       |  |      |                              |
| Central   | Base solely on GLEAMS modeling. No monitoring data are available.  | AWT  | 0.00002                      |
| Lower   |  | AWL  | 0.00001                      |
| Upper   |  | AWU  | 0.00003                      |

## WORKER EXPOSURE ASSESSMENTS

**Worksheet C01a:** Worker exposure estimates for directed foliar (backpack) applications [WkBkExp01]

**Verbal Description:** The absorbed dose for the worker is calculated from the amount handled per day and the generic absorbed dose rate from several field studies on worker applications of a number of herbicides. The amount handled per day is calculated from the application rates as well as estimates of the hours worked per day and acres treated per hour.

| Parameter/Assumption   | Value    | Units         | Source/Designation |
|--|----------|---------------|--------------------|
| <b>Application rates (<i>R</i>)</b>                                      |          |               |                    |
| Central  | 0.1      | lb/acre       | APPL.TYP           |
| Lower  | 0.1      |               | APPL.LOW           |
| Upper  | 0.1      |               | APPL.HI            |
| <b>Hours of application per day (<i>Hrs</i>)</b>                         |          |               |                    |
| Central  | 7        | hours         | USDA 1989a,b,c     |
| Lower  | 6        |               | USDA 1989a,b,c     |
| Upper  | 8        |               | USDA 1989a,b,c     |
| <b>Acres treated per hour (<i>Acres</i>)</b>                             |          |               |                    |
| Central  | 0.625    | acres/hour    | USDA 1989a,b,c     |
| Lower  | 0.25     |               | USDA 1989a,b,c     |
| Upper  | 1        |               | USDA 1989a,b,c     |
| <b>Acres treated per day (<i>ATD</i>): <math>Hrs \times Acres</math></b> |          |               |                    |
| Central  | 4.375    | acres/day     |                    |
| Lower  | 1.5      |               |                    |
| Upper  | 8        |               |                    |
| <b>Amount handled per day (<i>AHD</i>): <math>R \times ATD</math></b>    |          |               |                    |
| Central  | 0.4375   | lb/day        |                    |
| Lower  | 0.15     |               |                    |
| Upper  | 0.8      |               |                    |
| <b>Absorbed dose rate (<i>ADR</i>):</b>                                  |          |               |                    |
| Central  | 0.003    | (mg agent/kg  | SERA 2001          |
| Lower  | 0.0003   | bw) ÷ (lbs    |                    |
| Upper  | 0.01     | agent handled |                    |
|  |          | per day)      |                    |
| <b>Absorbed dose [<math>D_{Abs}</math>]: <math>AHD \times ADR</math></b> |          |               |                    |
| Central  | 1.31e-03 | mg/kg bw/day  |                    |
| Lower  | 4.50e-05 |               |                    |
| Upper  | 8.00e-03 |               |                    |

**Worksheet C01b: Worker exposure estimates for boom spray (hydraulic ground spray) applications [WkHyExp01]**

**Verbal Description:** The absorbed dose for the worker is calculated from the amount handled per day and the generic absorbed dose rate from several field studies on worker applications of a number of herbicides. The amount handled per day is calculated from the application rates as well as estimates of the hours worked per day and acres treated per hour.

| Parameter/Assumption   | Value    | Units                  | Source/Designation   |
|--|----------|------------------------|--|
| <b>Application rates (<i>R</i>)</b>                                      |          |                        |  |
| Central  | 0.1      | lb/acre                | APPL.TYP   |
| Lower  | 0.1      |                        | APPL.LOW   |
| Upper  | 0.1      |                        | APPL.HI  |
| <b>Hours of application per day (<i>Hrs</i>)</b>                         |          |                        |  |
| Central  | 7        | hours                  | USDA 1989a,b,c   |
| Lower  | 6        |                        |  |
| Upper  | 8        |                        |  |
| <b>Acres treated per hour (<i>Acres</i>)</b>                             |          |                        |  |
| Central  | 4        | acres/hour             | <b>Note: This is substantially less than the 11 to 21 acres/hour values from USDA 1989a,b,c. See Section 2 for discussion.</b> |
| Lower  | 2        |                        |  |
| Upper  | 6        |                        |  |
| <b>Acres treated per day (<i>ATD</i>): <math>Hrs \times Acres</math></b> |          |                        |  |
| Central  | 28       | acres/day              |  |
| Lower  | 12       |                        |  |
| Upper  | 48       |                        |  |
| <b>Amount handled per day (<i>AHD</i>): <math>R \times ATD</math></b>    |          |                        |  |
| Central  | 2.8      | lb/day                 |  |
| Lower  | 1.2      |                        |  |
| Upper  | 4.8      |                        |  |
| <b>Absorbed dose rate (<i>ADR</i>)</b>                                   |          |                        |  |
| Central  | 0.0002   | (mg agent/kg           | SERA 2001  |
| Lower  | 0.00001  | bw) ÷ (lbs             |  |
| Upper  | 0.0009   | agent handled per day) |  |
| <b>Absorbed dose [<math>D_{Abs}</math>]: <math>AHD \times ADR</math></b> |          |                        |  |
| Central  | 5.60e-04 | mg/kg bw/day           |  |
| Lower  | 1.20e-05 |                        |  |
| Upper  | 4.32e-03 |                        |  |

**Worksheet C01c: Worker exposure estimates for aerial applications [WKAREXP01]**

**Verbal Description:** The absorbed dose for the worker is calculated from the amount handled per day and the generic absorbed dose rate from several field studies on worker applications of a number of herbicides (SERA 2001). The amount handled per day is calculated from the application rates as well as estimates of the hours worked per day and acres treated per hour.

| Parameter/Assumption   | Value    | Units         | Source/Designation |
|--|----------|---------------|--------------------|
| <b>Application rates (<i>R</i>)</b>                                      |          |               |                    |
| Central  | 0.1      | lb/acre       | Appl.Typ           |
| Lower  | 0.1      |               | Appl.Low           |
| Upper  | 0.1      |               | Appl.Hi            |
| <b>Hours of application per day (<i>Hrs</i>)</b>                         |          |               |                    |
| Central  | 7        | hours         | USDA 1989a,b,c     |
| Lower  | 6        |               |                    |
| Upper  | 8        |               |                    |
| <b>Acres treated per hour (<i>Acres</i>)</b>                             |          |               |                    |
| Central  | 70       | acres/hour    | USDA 1989a,b,c     |
| Lower  | 40       |               |                    |
| Upper  | 100      |               |                    |
| <b>Acres treated per day (<i>ATD</i>): <math>Hrs \times Acres</math></b> |          |               |                    |
| Central  | 490      | acres/day     |                    |
| Lower  | 240      |               |                    |
| Upper  | 800      |               |                    |
| <b>Amount handled per day (<i>AHD</i>): <math>R \times ATD</math></b>    |          |               |                    |
| Central  | 49       | lb/day        |                    |
| Lower  | 24       |               |                    |
| Upper  | 80       |               |                    |
| <b>Absorbed dose rate (<i>ADR</i>)</b>                                   |          |               |                    |
| Central  | 0.00003  | (mg agent/kg  | SERA 2001          |
| Lower  | 0.000001 | bw) ÷ (lbs    |                    |
| Upper  | 0.0001   | agent handled |                    |
|  |          | per day)      |                    |
| <b>Absorbed dose [<math>D_{Abs}</math>]: <math>AHD \times ADR</math></b> |          |               |                    |
| Central  | 1.47e-03 | mg/kg bw      |                    |
| Lower  | 2.40e-05 |               |                    |
| Upper  | 8.00e-03 |               |                    |

**Worksheet C02a: Workers: Accidental Dermal Exposure Assessments Using Zero-Order Absorption Wearing Contaminated Gloves for One Minute [WrkDrmZr01]**

**Verbal Description:** Dermal absorption is calculated using the zero-order model from U.S. EPA/ORD (1992):

$$\text{Dose (mg/kg)} = K_p \times C \times \text{Time} \times S \div W$$

Each of the above terms are described below.

| Parameter   | Value    | Units           | Source     |
|---|----------|-----------------|------------|
| Body weight ( <i>W</i> )  | 70       | kg              | STD.BW     |
| Surface Area of hands ( <i>S</i> )  | 840      | cm <sup>2</sup> | STD.Hands  |
| Dermal permeability ( <i>K<sub>p</sub></i> )  |          |                 |            |
| Central   | 2.10e-03 | cm/hour         | DERM.KpC   |
| Lower   | 1.40e-03 | cm/hour         | DERM.KpL   |
| Upper   | 3.00e-03 | cm/hour         | DERM.KpU   |
| Concentration in solution ( <i>C</i> ) <sup>1</sup>   |          |                 |            |
| Central   | 2        | mg/mL           | APPL.TypDr |
| Lower   | 1.2      | mg/mL           | APPL.LowDr |
| Upper   | 6        | mg/mL           | APPL.HI_Dr |
| Duration of Exposure ( <i>T</i> )   | 0.0167   | hours           | 1÷60       |
| Absorbed Dose ( <i>D<sub>Abs</sub></i> ): <b><math>K_p \times C \times T \times S \div W</math></b> |          |                 |            |
| Central   | 8.40e-04 | mg/kg           |            |
| Lower   | 3.36e-04 | mg/kg           |            |
| Upper   | 3.60e-03 | mg/kg           |            |

<sup>1</sup> Note that 1 mL is equal to 1 cm<sup>3</sup> and thus mg/mL = mg/cm<sup>3</sup>.

**Worksheet C02b: Workers: Accidental Dermal Exposure Assessments Using Zero-Order Absorption Wearing Contaminated Gloves for One Hour [WrkDrmZr60]**

**Verbal Description:** Dermal absorption is calculated using the zero-order model from U.S. EPA/ORD (1992):

$$\text{Dose (mg/kg)} = K_p \times C \times \text{Time} \times S \div W$$

Each of the above terms are described below.

| Parameter   | Value    | Units           | Source     |
|---|----------|-----------------|------------|
| Body weight ( <i>W</i> )  | 70       | kg              | STD.BW     |
| Surface Area of hands ( <i>S</i> )  | 840      | cm <sup>2</sup> | STD.Hands  |
| Dermal permeability ( <i>K<sub>p</sub></i> )  |          |                 |            |
| Central   | 2.10e-03 | cm/hour         | DERM.KpC   |
| Lower   | 1.40e-03 |                 | DERM.KpL   |
| Upper   | 3.00e-03 |                 | DERM.KpU   |
| Concentration in solution ( <i>C</i> ) <sup>1</sup>   |          |                 |            |
| Central   | 2        | mg/mL           | APPL.TypDr |
| Lower   | 1.2      |                 | APPL.LowDr |
| Upper   | 6        |                 | APPL.HI_Dr |
| Duration of Exposure ( <i>T</i> )   | 1        | hours           |            |
| Absorbed Dose ( <i>D<sub>Abs</sub></i> ): <b><math>K_p \times C \times T \times S \div W</math></b> |          |                 |            |
| Central   | 5.04e-02 | mg/kg bw        |            |
| Lower   | 2.02e-02 |                 |            |
| Upper   | 2.16e-01 |                 |            |

<sup>1</sup> Note that 1 mL is equal to 1 cm<sup>3</sup> and thus mg/mL = mg/cm<sup>3</sup>.

**Worksheet C03a: Accidental Spill onto the Hands for 1 Hour Based on the Assumption of First-Order Absorption [WrkDrmFrHnd]**

Verbal Description: A worker spills a solution of the compound at a specified concentration ( $C$ ) on a defined area of the skin ( $A$ ). Based on the amount of liquid adhering to the skin ( $L$ ), the amount of chemical absorbed (**Dose**) over a given period is calculated from the first order dermal absorption coefficient ( $k_a$ ), the amount of time that the chemical remains on the surface of the skin before it is effectively removed by washing ( $T$ ) and the body weight ( $W$ ) (Durkin et al. 1995).

| Parameter   | Value     | Units              | Source         |
|---|-----------|--------------------|----------------|
| Liquid adhering to skin after a spill ( $L$ )                                 | 0.008     | mL/cm <sup>2</sup> | STD.Liq        |
| Body weight ( $W$ )   | 70        | kg                 | STD.BW         |
| Surface Areas ( $A$ )   |           |                    |                |
| Hands   | 840       | cm <sup>2</sup>    | STD.Hands      |
| Duration of Exposure ( $T$ )  | 1         | hours              |                |
| First-order dermal absorption rates ( $k_a$ )                                 |           |                    |                |
| Central   | 0.00330   | hour <sup>-1</sup> | DERM.ABS<br>C  |
| Lower   | 0.001600  |                    | DERM.ABS<br>L  |
| Upper   | 0.00670   |                    | DERM.ABS<br>U  |
| Concentration in solution ( $C$ )   |           |                    |                |
| Central   | 2         | mg/mL              | APPL.TypDr     |
| Lower   | 1.2       |                    | APPL.LowD<br>r |
| Upper   | 6         |                    | APPL.HI_Dr     |
| Amount Deposited on Skin ( <b>Amnt</b> ): $L \times A \times C$               |           |                    |                |
| Central   | 13.44     | mg                 |                |
| Lower   | 8.064     |                    |                |
| Upper   | 40.32     |                    |                |
| Proportion absorbed over period $T$ ( <b>Prop</b> ): $1 - e^{-kT}$            |           |                    |                |
| Central   | 0.0032946 | unitless           |                |
| Lower   | 0.0015987 |                    |                |
| Upper   | 0.0066776 |                    |                |
| Absorbed Dose ( $D_{Abs}$ ): <b>Amnt</b> $\times$ <b>Prop</b> $\div$ <b>W</b> |           |                    |                |
| Central   | 6.33e-04  | mg/kg bw           |                |
| Lower   | 1.84e-04  |                    |                |

Upper

3.85e-03

**Worksheet C03b: Accidental Spill onto the Lower Legs for 1 Hour Based on the Assumption of First-Order Absorption [WrkDrmFrLeg]**

Verbal Description: A worker spills a solution of the compound at a specified concentration ( $C$ ) on a defined area of the skin ( $A$ ). Based on the amount of liquid adhering to the skin ( $L$ ), the amount of chemical absorbed (**Dose**) over a given period is calculated from the first order dermal absorption coefficient ( $k_a$ ), the amount of time that the chemical remains on the surface of the skin before it is effectively removed by washing ( $T$ ) and the body weight ( $W$ ) (Durkin et al. 1995).

| Parameter   | Value     | Units              | Source         |
|---|-----------|--------------------|----------------|
| Liquid adhering to skin after a spill ( $L$ )                 | 0.008     | mL/cm <sup>2</sup> | STD.Liq        |
| Body weight ( $W$ )   | 70        | kg                 | STD.BW         |
| Surface Areas ( $A$ )   |           |                    |                |
| Legs  | 2070      | cm <sup>2</sup>    | STD.LLegs      |
| Duration of Exposure ( $T$ )                                  | 1         | hours              |                |
| First-order dermal absorption rates ( $k_a$ )                 |           |                    |                |
| Central   | 0.00330   | hour <sup>-1</sup> | DERM.ABS<br>C  |
| Lower   | 0.001600  |                    | DERM.ABS<br>L  |
| Upper   | 0.00670   |                    | DERM.ABS<br>U  |
| Concentration in solution ( $C$ )                             |           |                    |                |
| Central   | 2         | mg/mL              | APPL.TypDr     |
| Lower   | 1.2       |                    | APPL.LowD<br>r |
| Upper   | 6         |                    | APPL.HI_Dr     |
| Amount Deposited on Skin ( $Amnt$ ): $L \times A \times C$    |           |                    |                |
| Central   | 33.12     | mg                 |                |
| Lower   | 19.872    |                    |                |
| Upper   | 99.36     |                    |                |
| Proportion absorbed over period $T$ ( $Prop$ ): $1 - e^{-kT}$ |           |                    |                |
| Central   | 0.0032946 | unitless           |                |
| Lower   | 0.0015987 |                    |                |
| Upper   | 0.0066776 |                    |                |
| Absorbed Dose ( $D_{Abs}$ ): $Amnt \times Prop \div W$        |           |                    |                |
| Central   | 1.56e-03  | mg/kg bw           |                |
| Lower   | 4.54e-04  |                    |                |

Upper

9.48e-03

## EXPOSURE ASSESSMENTS FOR THE GENERAL PUBLIC

### Worksheet D01a: Direct Spray of a Child, Assumption of First-Order Absorption [SpillFOACh01]

**Verbal Description:** A naked child is accidentally sprayed over the entire body surface ( $A$ ) with a field dilution of a specified concentration ( $C$ ). The child is effectively washed - i.e., all of the compound is removed - after a specified period of time ( $T$ ). The absorbed dose ( $D$ ) is calculated from the amount of liquid adhering to the skin ( $L$ ), the first-order dermal absorption rate ( $k_a$ ) and the body weight ( $W$ ).

| Parameter   | Value     | Units              | Source         |
|---|-----------|--------------------|----------------|
| Liquid adhering to skin after a spill ( $L$ )                 | 0.008     | mL/cm <sup>2</sup> | STD.Liq        |
| Body weight ( $W$ )   | 13.3      | kg                 | PUBL.BWC       |
| Exposed surface area ( $A$ )                                  |           |                    |                |
| Whole Body  | 6030      | cm <sup>2</sup>    | PUBL.SAC       |
| Duration of Exposure ( $T$ )                                  | 1         | hours              |                |
| First-order dermal absorption rates ( $k_a$ )                 |           |                    |                |
| Central   | 0.0033    | hour <sup>-1</sup> | DERM.ABS<br>C  |
| Lower   | 0.0016    |                    | DERM.ABS<br>L  |
| Upper   | 0.0067    |                    | DERM.ABS<br>U  |
| Concentration in solution ( $C$ )                             |           |                    |                |
| Central   | 2         | mg/mL              | APPL.TypDr     |
| Lower   | 1.2       |                    | APPL.LowD<br>r |
| Upper   | 6         |                    | APPL.HI_Dr     |
| Amount Deposited on Skin ( $Amnt$ ): $L \times A \times C$    |           |                    |                |
| Central   | 96.48     | mg                 |                |
| Lower   | 57.888    |                    |                |
| Upper   | 289.44    |                    |                |
| Proportion absorbed over period $T$ ( $Prop$ ): $1 - e^{-kT}$ |           |                    |                |
| Central   | 0.0032946 | unitless           |                |
| Lower   | 0.0015987 |                    |                |
| Upper   | 0.0066776 |                    |                |
| Absorbed Dose ( $D_{Abs}$ ): $Amnt \times Prop \div W$        |           |                    |                |
| Central   | 2.39e-02  | mg/kg bw           |                |

|       |          |
|-------|----------|
| Lower | 6.96e-03 |
| Upper | 1.45e-01 |

**Worksheet D01b: Direct Spray of a Woman, Assumption of First-Order Absorption  
[SpillFOAWm01]**

**Verbal Description:** A woman is sprayed over the feet and lower legs ( $A$ ) with a field dilution of a specified concentration ( $C$ ). The woman effectively washes - i.e., all of the compound is removed - after a specified period of time ( $T$ ). The absorbed dose ( $D$ ) is calculated from the amount of liquid adhering to the skin ( $L$ ), the first-order dermal absorption rate ( $k_a$ ) and the body weight ( $W$ ).

| Parameter   | Value     | Units              | Source         |
|---|-----------|--------------------|----------------|
| Liquid adhering to skin after a spill ( $L$ )                 | 0.008     | mL/cm <sup>2</sup> | STD.Liq        |
| Body weight ( $W$ )   | 64        | kg                 | PUBL.BWF       |
| Exposed surface area ( $A$ )                                  |           |                    |                |
| Feet and lower legs   | 2915      | cm <sup>2</sup>    | PUBL.SAF1      |
| Duration of Exposure ( $T$ )                                  | 1         | hours              |                |
| First-order dermal absorption rates ( $k_a$ )                 |           |                    |                |
| Central   | 0.00330   | hour <sup>-1</sup> | DERM.ABS<br>C  |
| Lower   | 0.001600  |                    | DERM.ABS<br>L  |
| Upper   | 0.00670   |                    | DERM.ABS<br>U  |
| Concentration in solution ( $C$ )                             |           |                    |                |
| Central   | 2         | mg/mL              | APPL.TypDr     |
| Lower   | 1.2       |                    | APPL.LowD<br>r |
| Upper   | 6         |                    | APPL.HI_Dr     |
| Amount Deposited on Skin ( $Amnt$ ): $L \times A \times C$    |           |                    |                |
| Central   | 46.64     | mg                 |                |
| Lower   | 27.984    |                    |                |
| Upper   | 139.92    |                    |                |
| Proportion absorbed over period $T$ ( $Prop$ ): $1 - e^{-kT}$ |           |                    |                |
| Central   | 0.0032946 | unitless           |                |
| Lower   | 0.0015987 |                    |                |
| Upper   | 0.0066776 |                    |                |
| Absorbed Dose ( $D_{Abs}$ ): $Amnt \times Prop \div W$        |           |                    |                |
| Central   | 2.40e-03  | mg/kg              |                |
| Lower   | 6.99e-04  |                    |                |

Upper

1.46e-02

**Worksheet D02:** Dermal contact with contaminated vegetation by a young woman [VegC\_FOA01].

**Verbal Description:** A woman wearing shorts and a short sleeved shirt is in contact with contaminated vegetation for 1 hour shortly after application of the compound - i.e. no dissipation or degradation is considered. The chemical is effectively removed from the surface of the skin - i.e., washing - after 24 hours.

| Parameter/Assumption  | Value    | Units                     | Source/Reference   |
|---|----------|---------------------------|--|
| Contact time ( $T_c$ )  | 1        | hour                      | N/A  |
| Exposure time ( $T_e$ )   | 24       | hours                     | N/A  |
| Body weight ( $W$ )   | 64       | kg                        | PUBL.BWF   |
| Exposed surface area ( $A$ )  | 5300     | cm <sup>2</sup>           | PUBL.SAF2  |
| Application Rates in lb/acre ( $R_{lb}$ )   |          |                           |  |
| Central   | 0.1      | lb/acre                   | APPL.TYP   |
| Lower   | 0.1      |                           | APPL.LOW   |
| Upper   | 0.1      |                           | APPL.HI  |
| First-order dermal absorption rate ( $k$ )  |          |                           |  |
| Central   | 0.00330  | hour <sup>-1</sup>        | DERM.AbsC  |
| Lower   | 0.001600 |                           | DERM.AbsL  |
| Upper   | 0.00670  |                           | DERM.AbsU  |
| Application Rates in $\mu\text{g}/\text{cm}^2$ ( $R_{\mu\text{g}}$ ): $R_{lb} \times \text{Const.lbac\_ugcm}$ |          |                           |  |
| Central   | 1.121    | $\mu\text{g}/\text{cm}^2$ |  |
| Lower   | 1.121    |                           |  |
| Upper   | 1.121    |                           |  |
| Proportion dislodgeable ( $PropDr$ )  | 0.1      | none                      | PUBL.DisL  |
| Dislodgeable residue ( $Dr$ ): $R_{\mu\text{g}} \times PropDr$  |          |                           |  |
| Central   | 0.1121   | $\mu\text{g}/\text{cm}^2$ |  |
| Lower   | 0.1121   |                           |  |
| Upper   | 0.1121   |                           |  |
| Transfer Rate ( $Tr$ ): $Tr = 10^{(1.09 \times \log_{10}(Dr) + 0.05)} \div 1000 \mu\text{g}/\text{mg}$        |          |                           |  |
| Central   | 1.03e-04 | mg/(cm <sup>2</sup> ·hr)  | The method of Durkin et al. (1995, p. 68, equation 4) is used to calculate the transfer rate ( $Tr$ ) in units of $\mu\text{g}/(\text{cm}^2 \cdot \text{hr})$ based on the dislodgeable residue ( $Dr$ ) in units of $\mu\text{g}/\text{cm}^2$ . This is converted to units of $\text{mg}/(\text{cm}^2 \cdot \text{hr})$ by dividing by 1000 $\mu\text{g}/\text{mg}$ . |
| Lower   | 1.03e-04 |                           |  |
| Upper   | 1.03e-04 |                           |  |
| Amount Transferred to Skin Surface ( $Amnt$ ): $Tr \times T_c \times A$                                       |          |                           |  |
| Central   | 0.54745  | mg                        |  |
| Lower   | 0.54745  |                           |  |
| Upper   | 0.54745  |                           |  |
| Proportion Absorbed ( $PropAbs$ ): $1 - e^{-ka \times T_e}$   |          |                           |  |
| Central   | 7.61e-02 | unitless                  |  |

|                              |   |          |          |
|------------------------------|---|----------|----------|
|                              | Lower                                   | 3.77e-02 |          |
|                              | Upper                                   | 1.49e-01 |          |
| Absorbed dose ( $D_{Abs}$ ): | <b>Amnt</b> × <b>PropAbs</b> ÷ <b>W</b> |          |          |
|                              | Central                                 | 6.51e-04 | mg/kg bw |
|                              | Lower                                   | 3.22e-04 |          |
|                              | Upper                                   | 1.27e-03 |          |

**Worksheet D03:** Consumption of contaminated fruit, acute exposure scenario  
[VegAcHHRA01].

**Verbal Description:** Edible fruit is contaminated by drift (*Dr*). A drift of 1 (unity) indicates direct spray. The individual consumes contaminated fruit shortly after application of the chemical - i.e. no dissipation or degradation is considered. The concentration of the chemical in fruit (*C*) is estimated from empirical relationships relating residues on plants to application rate.

| Parameters/Assumptions  | Value    | Units              | Source/Reference                         |
|---|----------|--------------------|--|
| Amount of fruit consumed per Unit Body Weight ( <i>A</i> ):                     |          |                    |  |
| Central   | 0.00168  | kg fruit/kg bw/day | PUBL.FrTC                                |
| Lower   | 0.00168  |                    | PUBL.FrTL                                |
| Upper   | 0.01244  |                    | PUBL.FrTU                                |
| Application rates ( <i>R</i> )  |          |                    |  |
| Central   | 0.1      | lb/acre            | APPL.Type                                |
| Lower   | 0.1      |                    | APPL.Low                                 |
| Upper   | 0.1      |                    | APPL.Hi                                  |
| Residue rates ( <i>rr</i> )   |          |                    |  |
| Central   | 7        | mg/kg per lb/acre  | HK.FRT2                                  |
| Lower   | 7        |                    | HK.FRT2                                  |
| Upper   | 15       |                    | HK.FRU2                                  |
| Drift ( <i>Drift</i> )  |          |                    |  |
| Central   | 1        | unitless           | Direct spray                             |
| Lower   | 1        |                    |  |
| Upper   | 1        |                    |  |
| Proportion Removed by Washing ( <i>Wash</i> )                                   |          |                    |  |
| Central   | 0        | unitless           | No washing is assumed for this scenario. |
| Lower   | 0        |                    |  |
| Upper   | 0        |                    |  |
| Concentration on fruit ( <i>C</i> ): $R \times rr \times Drift \times (1-Wash)$ |          |                    |  |
| Central   | 0.7      | mg/kg fruit        |  |
| Lower   | 0.7      |                    |  |
| Upper   | 1.5      |                    |  |
| Dose estimates ( <i>D</i> ): $C \times A$                                       |          |                    |  |
| Central   | 1.18e-03 | mg/kg bw           |  |
| Lower   | 1.18e-03 |                    |  |
| Upper   | 1.87e-02 |                    |  |

**Worksheet D04: Consumption of contaminated fruit, chronic exposure scenario [VegChHHRA01].**

**Verbal Description:** An individual consumes contaminated fruit for a period of time ( $t$ ) starting shortly after application of the chemical. The concentration of the chemical in fruit at time zero ( $C_0$ ) is estimated from the application rate ( $A$ ), the proportion of drift (**Drift**), and empirical residues rates ( $rr$ ) from Siltanen et al. (1981). The foliar half-time ( $t_{50}$ ) is used to estimate the foliar decay coefficient ( $k$ ):  $k = \ln(2)/t_{50}$ . The concentration on the vegetation after time  $t$  ( $C_t$ ) is calculated as  $C_t = C_0 e^{-kt}$ . The time-weighted average of the concentration on vegetation ( $C_{TWA}$ ) is calculated as the integral of the concentration after time  $t$  ( $C_t$ ) divided by the duration ( $T$ ).

| Parameters/Assumptions  |         | Value     | Units              | Source/Reference  |
|---|---------|-----------|--------------------|---|
| Half-time on vegetation ( $t_{50}$ )  | Central | 4         | days               | CHEM.FrT12C   |
|   | Lower   | 1.2       |                    | CHEM.FrT12L   |
|   | Upper   | 12        |                    | CHEM.FrT12U   |
| Duration of exposure ( $T$ )  |         | 90        | days               | N/A   |
| Amount of fruit consumed per unit body weight( $A$ ): Central is also used for lower. |         |           |                    |   |
|   | Central | 0.00168   | kg fruit/kg bw/day | PUBL.FrTC   |
|   | Lower   | 0.00168   |                    | PUBL.FrTL   |
|   | Upper   | 0.01244   |                    | PUBL.FrTU   |
| Application rates ( $R$ )   |         |           |                    |   |
|   | Central | 0.1       | lb/acre            | APPL.Typ  |
|   | Lower   | 0.1       |                    | APPL.Low  |
|   | Upper   | 0.1       |                    | APPL.Hi   |
| Residue rates ( $rr$ ):   |         |           |                    |   |
|   | Central | 7         | mg/kg per lb/acre  | HK.FRT2   |
|   | Lower   | 7         |                    | HK.FRT2   |
|   | Upper   | 15        |                    | HK.FRU2   |
| Drift ( <b>Drift</b> )  |         |           |                    |   |
|   | Central | 1         | unitless           | Assume direct spray   |
|   | Lower   | 1         |                    |   |
|   | Upper   | 1         |                    |   |
| Decay coefficient ( $k$ ): $\ln(2)/t_{50}$  |         |           |                    |   |
|   | Central | 0.1732868 | day <sup>-1</sup>  | Upper estimate of $t_{50}$ used to calculate lower limit of $k$ and lower estimate of $t_{50}$ used to calculate upper limit of $k$ . |
|   | Lower   | 0.057762  |                    |   |
|   | Upper   | 0.5776227 |                    |   |

**Worksheet D04 (continued):** Consumption of contaminated fruit, chronic exposure scenario [VegChHHRA01].

Initial Concentration on Vegetation ( $C_0$ ):  $C_0 = A \times \text{Drift} \times \text{rr}$

|         |     |            |
|---------|-----|------------|
| Central | 0.7 | mg/kg veg. |
| Lower   | 0.7 |            |
| Upper   | 1.5 |            |

Concentration on Vegetation at time  $T$  ( $C_T$ ):  $C_T = C_0 e^{-kT}$

|         |          |            |  |
|---------|----------|------------|--|
| Central | 1.18e-07 | mg/kg veg. | The upper bound on the decay coefficient is used to calculate lower bound of residue rate and the lower bound on the decay coefficient is used to calculate the upper bound on residue rate. |
| Lower   | 1.85e-23 |            |  |
| Upper   | 8.29e-03 |            |  |

Time-weighted Average Concentration on Raw Vegetation ( $C_{TWA}$ ):  $C_0 (1 - e^{-kT}) \div (k T)$

|         |          |            |  |
|---------|----------|------------|--|
| Central | 0.044884 | mg/kg veg. | The upper bound on the decay coefficient is used to calculate lower bound of residue rate and the lower bound on the decay coefficient is used to calculate the upper bound on residue rate. |
| Lower   | 0.013465 |            |  |
| Upper   | 0.286945 |            |  |

Proportion Removed by Washing ( $P_{wash}$ ):

|         |   |          |                                     |
|---------|---|----------|-------------------------------------|
| Central | 0 | unitless | Assume that washing is ineffective. |
| Lower   | 0 |          |                                     |
| Upper   | 0 |          |                                     |

TWA Concentration on Consumed Vegetation ( $C_{Con}$ ):  $C_{TWA} \times 1 - P_{Wash}$

|         |          |            |
|---------|----------|------------|
| Central | 4.49e-02 | mg/kg veg. |
| Lower   | 1.35e-02 |            |
| Upper   | 2.87e-01 |            |

Dose estimates ( $D$ ):  $C_{Con} \times A$

|         |          |              |
|---------|----------|--------------|
| Central | 7.54e-05 | mg/kg bw/day |
| Lower   | 2.26e-05 |              |
| Upper   | 3.57e-03 |              |

**Worksheet D05:** Consumption of contaminated water following an accidental spill, acute exposure scenario [DWAcHHRA01].

**Verbal Description:** A young child (2-3 years old) consumes contaminated water shortly after an accidental spill of 200 gallons of a field solution into a pond that has an average depth of 1 m and a surface area of 1000 m<sup>2</sup> or about one-quarter acre . No dissipation or degradation is considered.

| Parameters/Assumptions  | Value    | Units          | Source/Reference           |
|---|----------|----------------|----------------------------|
| Surface area of pond (SA)   | 1000     | m <sup>2</sup> | N/A                        |
| Average depth (DPTH)  | 1        | m              | N/A                        |
| Volume of pond in cubic meters (VM)   | 1000     | m <sup>3</sup> | N/A                        |
| Volume of pond in Liters (VL)   | 1000000  | L              | 1 m <sup>3</sup> = 1,000 L |
| Volume of spill (VS)  | 200      | gallons        | N/A                        |
|   | 757      | liters         | 1 gallon = 3.785 Liters    |
| Concentrations in field solution ( $C_{Fld}$ (mg/L))                                  |          |                |                            |
| Central   | 2000     | mg/L           | APPL.TypDR × 1000          |
| Lower   | 1200     |                | APPL.LowDR × 1000          |
| Upper   | 6000     |                | APPL.Hi_DR × 1000          |
| Concentrations in ambient water ( $C_{Wrt}$ ): $C_{Fld} \times VS_{(Liters)} \div VL$ |          |                |                            |
| Central   | 1.514    | mg/L           |                            |
| Lower   | 0.9084   |                |                            |
| Upper   | 4.542    |                |                            |
| Body weight ( $W$ )   | 13.3     | kg             | PUBL.BWC                   |
| Amount of water consumed ( $A$ )  |          |                |                            |
| Central   | 1        | L/day          | PUBL.WCT                   |
| Lower   | 0.61     |                | PUBL.WCL                   |
| Upper   | 1.5      |                | PUBL.WCH                   |
| Dose estimates ( $D$ ): $C_{wrt} \times A \div W$                                     |          |                |                            |
| Central   | 1.14e-01 | mg/kg bw       |                            |
| Lower   | 4.17e-02 |                |                            |
| Upper   | 5.12e-01 |                |                            |

**Worksheet D06:** Consumption of from a stream contaminated by runoff and/or percolation, acute exposure scenario [DWAcStrmHHRA01].

**Verbal Description:** A young child (2-3 years old) consumes contaminated ambient water from a stream that has been contaminated from run-off and/or percolation. The levels in water are estimated from modeling or monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. The calculations involve multiplying the application rate (**R**) by the water contamination rate to get the concentration in ambient water. This product is in turn multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

| Parameters/Assumptions  | Value    | Units                    | Source/Reference |
|---|----------|--------------------------|------------------|
| <b>Application Rates (<b>R</b>)</b>                                 |          |                          |                  |
| Central   | 0.1      | lb/acre                  | APPL.Typ         |
| Lower   | 0.1      |                          | APPL.Low         |
| Upper   | 0.1      |                          | APPL.Hi          |
| <b>Water Contamination Rate (<b>WCR</b>):</b>                       |          |                          |                  |
| Central   | 0.0005   | mg/L per lb/acre applied | AMBWAT.AWPT      |
| Lower   | 0.0001   |                          | AMBWAT.AWPL      |
| Upper   | 0.01     |                          | AMBWAT.AWPU      |
| Body weight ( <b>W</b> )  | 13.3     | kg                       | PUBL.BWC         |
| <b>Amount of water consumed (<b>A</b>)</b>                          |          |                          |                  |
| Central   | 1        | L/day                    | PUBL.WCT         |
| Lower   | 0.61     |                          | PUBL.WCL         |
| Upper   | 1.5      |                          | PUBL.WCH         |
| <b>Concentration in Water (<b>C</b>): <math>R \times WCR</math></b> |          |                          |                  |
| Central   | 0.0001   | mg/L                     |                  |
| Lower   | 0        |                          |                  |
| Upper   | 0.001    |                          |                  |
| <b>Dose estimates (<b>D</b>): <math>C \times A \div W</math></b>    |          |                          |                  |
| Central   | 3.76e-06 | mg/kg bw/day             |                  |
| Lower   | 2.29e-07 |                          |                  |
| Upper   | 1.13e-04 |                          |                  |

**Worksheet D07:** Consumption of contaminated water, chronic exposure scenario [DWChHHRA01].

**Verbal Description:** An adult (70 kg male) consumes contaminated ambient water for a lifetime. The levels in water are estimated from modeling or monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. The calculations involve multiplying the application rate by the water contamination rate to get the concentration in ambient water. This product is in turn multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

| Parameters/Assumptions  |         | Value    | Units        | Source/Reference |
|---|---------|----------|--------------|------------------|
| <b>Application Rates (<i>R</i>)</b>                                 |         |          |              |                  |
|   | Central | 0.1      | lb/acre      | APPL.Typ         |
|   | Lower   | 0.1      |              | APPL.Low         |
|   | Upper   | 0.1      |              | APPL.Hi          |
| <b>Water Contamination Rate (<i>WCR</i>):</b>                       |         |          |              |                  |
|   | Central | 0        | mg/L per     | AMBWAT.AWT       |
|   | Lower   | 0        | lb/acre      | AMBWAT.AWL       |
|   | Upper   | 0        | applied      | AMBWAT.AWU       |
| <b>Body weight (<i>W</i>)</b>                                       |         |          |              |                  |
|   |         | 70       | kg           | PUBL.BWM         |
| <b>Amount of water consumed (<i>A</i>)</b>                          |         |          |              |                  |
|   | Central | 2        | L/day        | PUBL.WCAT        |
|   | Lower   | 1.4      |              | PUBL.WCAL        |
|   | Upper   | 2.4      |              | PUBL.WCAH        |
| <b>Concentration in Water (<i>C</i>): <math>R \times WCR</math></b> |         |          |              |                  |
|   | Central | 0        | mg/L         |                  |
|   | Lower   | 0.0000   |              |                  |
|   | Upper   | 0        |              |                  |
| <b>Dose estimates (<i>D</i>): <math>C \times A \div W</math></b>    |         |          |              |                  |
|   | Central | 5.71e-08 | mg/kg bw/day |                  |
|   | Lower   | 2.00e-08 |              |                  |
|   | Upper   | 1.03e-07 |              |                  |

**Worksheet D08a:** Consumption of contaminated fish, acute exposure scenarios for recreational fisherman following an accidental spill [FishAcHHRA01].

**Verbal Description:** An adult angler consumes fish taken from contaminated water shortly after an accidental spill of a fixed amount of a field solution into a pond of a specified depth and surface area. No dissipation or degradation is considered. As in the acute drinking water scenario, the concentration in the pond estimated from the concentration in the spilled solution, the volume spilled and the volume of the pond, assuming instantaneous mixing. The concentration in fish is estimated as the product of the concentration in water and the chronic BCF. The dose is calculated as the product of the concentration in the fish and the amount of fish consumed divided by the body weight.

| Parameters/Assumptions  | Value    | Units          | Source/Reference           |
|---|----------|----------------|----------------------------|
| Surface area of pond [SA]   | 1000     | m <sup>2</sup> | N/A                        |
| Average depth [DPTH]  | 1        | m              | N/A                        |
| Volume of pond in cubic meters [VM]   | 1000     | m <sup>3</sup> | N/A                        |
| Volume of pond in Liters [VL]   | 1000000  | L              | 1 m <sup>3</sup> = 1,000 L |
| Volume of spill [VS]  | 200      | gallons        | N/A                        |
|   | 757      | liters         | 1 gallon = 3.785 Liters    |
| Concentrations in spilled solution ( $C_{Fld}$ (mg/L))                                |          |                |                            |
| Central   | 2000     | mg/L           | APPL.TYPDR×1000            |
| Lower   | 1200     |                | APPL.LOWDR×1000            |
| Upper   | 6000     |                | APPL.HI_DR×1000            |
| Concentrations in ambient water ( $C_{Wat}$ ): $C_{Fld} \times VS_{(Liters)} \div VL$ |          |                |                            |
| Central   | 1.514    | mg/L           |                            |
| Lower   | 0.9084   |                |                            |
| Upper   | 4.542    |                |                            |
| Bioconcentration factor ( $BCF_{(L/kg\ fish)}$ )                                      | 0.11     | L/kg fish      | CHEM.BCFT                  |
| Concentration in fish ( $C_{Fish}$ ): $C_{Wat} \times BCF$                            |          |                |                            |
| Central   | 0.16654  | mg/kg fish     |                            |
| Lower   | 0.099924 |                |                            |
| Upper   | 0.49962  |                |                            |
| Body weight ( $W$ )   | 70       | kg             | PUBL.BWM                   |
| Amount of fish consumed ( $A$ )   |          |                |                            |
| Central   | 0.158    | kg/day         | PUBL.FAU                   |
| Lower   | 0.158    |                | PUBL.FAU                   |
| Upper   | 0.158    |                | PUBL.FAU                   |
| Dose estimates ( $D$ ): $C_{Fish} \times A \div W$                                    |          |                |                            |
| Central   | 3.76e-04 | mg/kg bw       |                            |
| Lower   | 2.26e-04 |                |                            |
| Upper   | 1.13e-03 |                |                            |

**Worksheet D08b:** Consumption of contaminated fish, acute exposure scenarios for subsistence populations following an accidental spill [FishAcHHRA02].

**Verbal Description:** An individual who relies on caught fish as a major source of protein consumes fish taken from contaminated water shortly after an accidental spill of a fixed amount of a field solution into a pond of a specified depth and surface area. As in the acute drinking water scenario, the concentration in the pond estimated from the concentration in the spilled solution, the volume spilled and the volume of the pond, assuming instantaneous mixing. The concentration in fish is estimated as the product of the concentration in water and the chronic BCF. The dose is calculated as the product of the concentration in the fish and the amount of fish consumed divided by the body weight.

| Parameters/Assumptions  | Value    | Units          | Source/Reference           |
|---|----------|----------------|----------------------------|
| Surface area of pond [SA]   | 1000     | m <sup>2</sup> | N/A                        |
| Average depth [DPTH]  | 1        | m              | N/A                        |
| Volume of pond in cubic meters [VM]   | 1000     | m <sup>3</sup> | N/A                        |
| Volume of pond in Liters [VL]   | 1000000  | L              | 1 m <sup>3</sup> = 1,000 L |
| Volume of spill [VS]  | 200      | gallons        | N/A                        |
|   | 757      | liters         | 1 gallon = 3.785 Liters    |
| Concentrations in spilled solution ( $C_{Fld}$ (mg/L))                                |          |                |                            |
| Central   | 2000     | mg/L           | APPL.TYPDR×1000            |
| Lower   | 1200     |                | APPL.LOWDR×1000            |
| Upper   | 6000     |                | APPL.HI_DR×1000            |
| Concentrations in ambient water ( $C_{Wat}$ ): $C_{Fld} \times VS_{(Liters)} \div VL$ |          |                |                            |
| Central   | 1.514    | mg/L           |                            |
| Lower   | 0.9084   |                |                            |
| Upper   | 4.542    |                |                            |
| Bioconcentration factor ( $BCF_{(L/kg\ fish)}$ )                                      | 0.11     | L/kg fish      | CHEM.BCFT                  |
| Concentration in fish ( $C_{Fish}$ ): $C_{Wat} \times BCF$                            |          |                |                            |
| Central   | 0.16654  | mg/kg fish     |                            |
| Lower   | 0.099924 |                |                            |
| Upper   | 0.49962  |                |                            |
| Body weight ( $W$ )   | 70       | kg             | PUBL.BWM                   |
| Amount of fish consumed ( $A$ )   |          |                |                            |
| Central   | 0.77     | kg/day         | PUBL.FNU                   |
| Lower   | 0.77     |                | PUBL.FNU                   |
| Upper   | 0.77     |                | PUBL.FNU                   |
| Dose estimates ( $D$ ): $C_{Fish} \times A \div W$                                    |          |                |                            |
| Central   | 1.83e-03 | mg/kg bw       |                            |
| Lower   | 1.10e-03 |                |                            |
| Upper   | 5.50e-03 |                |                            |

**Worksheet D09a:** Consumption of contaminated fish, chronic exposure scenario for recreational fisherman [FishChHHRA01].

**Verbal Description:** An adult (70 kg male) consumes fish taken from contaminated ambient water for a lifetime. The levels in water are estimated from monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. As in the chronic drinking water scenario, the concentration in water is calculated as the application rate multiplied by the water contamination rate. The concentration in fish is estimated as the product of the concentration in water and the chronic BCF. The dose is calculated as the product of the concentration in the fish and the amount of fish consumed divided by the body weight.

| Parameters/Assumptions  | Value    | Units                    | Source/Reference |
|---|----------|--------------------------|------------------|
| <b>Application Rates (<i>R</i>)</b>   |          |                          |                  |
| Central   | 0.1      | lb/acre                  | APPL.Typ         |
| Lower   | 0.1      |                          | APPL.Low         |
| Upper   | 0.1      |                          | APPL.Hi          |
| <b>Water Contamination Rate (<i>WCR</i>)</b>  |          |                          |                  |
| Central   | 0.00002  | mg/L per lb/acre applied | AMBWAT.AWT       |
| Lower   | 0.00001  |                          | AMBWAT.AWL       |
| Upper   | 0.00003  |                          | AMBWAT.AWU       |
| <b>Concentration in Water (<math>C_{Wat}</math>): <math>R \times WCR</math></b>       |          |                          |                  |
| Central   | 0        | mg/L                     |                  |
| Lower   | 0        |                          |                  |
| Upper   | 0        |                          |                  |
| Bioconcentration factor ( <i>BCF</i> )  | 0.11     | L/kg fish                | CHEM.BCFCh       |
| <b>Concentration in fish (<math>C_{Fish}</math>): <math>C_{Wat} \times BCF</math></b> |          |                          |                  |
| Central   | 0        | mg/kg fish               |                  |
| Lower   | 0        |                          |                  |
| Upper   | 0        |                          |                  |
| Body weight ( <i>W</i> )  | 70       | kg                       | PUBL.BWM         |
| <b>Amount of fish consumed (<i>A</i>)</b>   |          |                          |                  |
| Central   | 0.01     | kg/day                   | PUBL.FAT         |
| Lower   | 0.01     |                          | PUBL.FAT         |
| Upper   | 0.01     |                          | PUBL.FAT         |
| <b>Dose estimates (<i>D</i>): <math>C_{Fish} \times A \div W</math></b>               |          |                          |                  |
| Central   | 3.14e-11 | mg/kg bw/day             |                  |
| Lower   | 1.57e-11 |                          |                  |
| Upper   | 4.71e-11 |                          |                  |

**Worksheet D09b:** Consumption of contaminated fish, chronic exposure scenario for subsistence populations [FishChHHRA02].

**Verbal Description:** An individual who relies on caught fish as a major source of protein consumes fish taken from contaminated ambient water for a lifetime. The levels in water are estimated from monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. As in the chronic drinking water scenario, the concentration in water is calculated as the application rate multiplied by the water contamination rate. The concentration in fish is estimated as the product of the concentration in water and the chronic BCF. The dose is calculated as the product of the concentration in the fish and the amount of fish consumed divided by the body weight.

| Parameters/Assumptions  | Value    | Units                    | Source/Reference |
|---|----------|--------------------------|------------------|
| <b>Application Rates (<math>R</math>)</b>   |          |                          |                  |
| Central   | 0.1      | lb/acre                  | APPL.Typ         |
| Lower   | 0.1      |                          | APPL.Low         |
| Upper   | 0.1      |                          | APPL.Hi          |
| <b>Water Contamination Rate (<math>WCR</math>): <math>C \div R</math></b>             |          |                          |                  |
| Central   | 0.00002  | mg/L per lb/acre applied | AMBWAT.AWT       |
| Lower   | 0.00001  |                          | AMBWAT.AWL       |
| Upper   | 0.00003  |                          | AMBWAT.AWU       |
| <b>Concentration in Water (<math>C</math>): <math>R \times WCR</math></b>             |          |                          |                  |
| Central   | 0        | mg/L                     |                  |
| Lower   | 0        |                          |                  |
| Upper   | 0        |                          |                  |
| Bioconcentration factor ( $BCF$ )   | 0.11     | L/kg fish                | CHEM.BCFCh       |
| <b>Concentration in fish (<math>C_{Fish}</math>): <math>C_{Wat} \times BCF</math></b> |          |                          |                  |
| Central   | 0        | mg/kg fish               |                  |
| Lower   | 0        |                          |                  |
| Upper   | 0        |                          |                  |
| Body weight ( $W$ )   | 70       | kg                       | PUBL.BWM         |
| <b>Amount of fish consumed (<math>A</math>)</b>                                       |          |                          |                  |
| Central   | 0.081    | kg/day                   | PUBL.FNT         |
| Lower   | 0.081    |                          | PUBL.FNT         |
| Upper   | 0.081    |                          | PUBL.FNT         |
| <b>Dose estimates (<math>D</math>): <math>C_{Fish} \times A \div W</math></b>         |          |                          |                  |
| Central   | 2.55e-10 | mg/kg bw/day             |                  |
| Lower   | 1.27e-10 |                          |                  |
| Upper   | 3.82e-10 |                          |                  |

**SUMMARY TABLES FOR HUMAN HEALTH RISK ASSESSMENT**

**Worksheet E01: Summary of Worker Exposure Scenarios**

| Scenario  | Dose (mg/kg/day or event) |          |          | Exposure Assessment Worksheet |
|---|---------------------------|----------|----------|-------------------------------|
|   | Central                   | Lower    | Upper    |                               |
| General Exposures (dose in mg/kg/day)                 |                           |          |          |                               |
| Directed ground spray (Backpack)                      | 1.31e-03                  | 4.50e-05 | 8.00e-03 | C01a                          |
| Broadcast ground spray (Boom spray)                   | 5.60e-04                  | 1.20e-05 | 4.32e-03 | C01b                          |
| Aerial applications                                   | 1.47e-03                  | 2.40e-05 | 8.00e-03 | C01c                          |
| Accidental/Incidental Exposures (dose in mg/kg/event) |                           |          |          |                               |
| Immersion of Hands, 1 minute                          | 8.40e-04                  | 3.36e-04 | 3.60e-03 | C02a                          |
| Contaminated Gloves, 1 hour                           | 5.04e-02                  | 2.02e-02 | 2.16e-01 | C02b                          |
| Spill on hands, 1 hour                                | 6.33e-04                  | 1.84e-04 | 3.85e-03 | C03a                          |
| Spill on lower legs, 1 hour                           | 1.56e-03                  | 4.54e-04 | 9.48e-03 | C03b                          |

**Worksheet E02:** Summary of risk characterization (HQ's<sup>1</sup>) for workers.

|   |         |           |              |
|---|---------|-----------|--------------|
| Acute RfD   | 0.5     | mg/kg/day | Sect. 3.3.3. |
| Chronic RfD                                       | 0.5     | mg/kg/day | Sect. 3.3.3. |
| Hazard Quotient Based on Chronic RfD              |         |           |              |
| Scenario  | Central | Lower     | Upper        |
| Exposure Assessment Worksheet                     |         |           |              |
| General Exposures [using Chronic RfD]             |         |           |              |
| Directed ground spray (Backpack)                  | 3e-03   | 9e-05     | 2e-02        |
| Broadcast ground spray (Boom spray)               | 1e-03   | 2e-05     | 9e-03        |
| Aerial applications                               | 3e-03   | 5e-05     | 2e-02        |
| Accidental/Incidental Exposures [using Acute RfD] |         |           |              |
| Hazard Quotient Based on Acute RfD                |         |           |              |
| Scenario  | Central | Lower     | Upper        |
| Exposure Assessment Worksheet                     |         |           |              |
| Immersion of Hands, 1 minute                      | 2e-03   | 7e-04     | 7e-03        |
| Contaminated Gloves, 1 hour                       | 1e-01   | 4e-02     | 4e-01        |
| Spill on hands, 1 hour                            | 1e-03   | 4e-04     | 8e-03        |
| Spill on lower legs, 1 hour                       | 3e-03   | 9e-04     | 2e-02        |

<sup>1</sup> Hazard quotient is the level of exposure divided by the RfD then rounded to one significant decimal place or digit. See Worksheet E01 for summary of exposure assessment.

**Worksheet E03: Summary of Exposure Scenarios for the General Public**

| Scenario                                     | Target | Dose (mg/kg/day) |          |          | Worksheet |
|--|--------|------------------|----------|----------|-----------|
|  |        | Central          | Lower    | Upper    |           |
| <b>Acute/Accidental Exposures</b>            |        |                  |          |          |           |
| Direct spray, entire body                    | Child  | 2.39e-02         | 6.96e-03 | 1.45e-01 | D01a      |
| Direct spray, lower legs                     | Woman  | 2.40e-03         | 6.99e-04 | 1.46e-02 | D01b      |
| Dermal, contaminated vegetation              | Woman  | 6.51e-04         | 3.22e-04 | 1.27e-03 | D02       |
| Contaminated fruit                           | Woman  | 1.18e-03         | 1.18e-03 | 1.87e-02 | D03       |
| Contaminated water, spill                    | Child  | 1.14e-01         | 4.17e-02 | 5.12e-01 | D05       |
| Contaminated water, stream                   | Child  | 3.76e-06         | 2.29e-07 | 1.13e-04 | D06       |
| Consumption of fish, general public          | Man    | 3.76e-04         | 2.26e-04 | 1.13e-03 | D08a      |
| Consumption of fish, subsistence populations | Man    | 1.83e-03         | 1.10e-03 | 5.50e-03 | D08b      |
| <b>Chronic/Longer Term Exposures</b>         |        |                  |          |          |           |
| Contaminated fruit                           | Woman  | 7.54e-05         | 2.26e-05 | 3.57e-03 | D04       |
| Consumption of water                         | Man    | 5.71e-08         | 2.00e-08 | 1.03e-07 | D07       |
| Consumption of fish, general public          | Man    | 3.14e-11         | 1.57e-11 | 4.71e-11 | D09a      |
| Consumption of fish, subsistence populations | Man    | 2.55e-10         | 1.27e-10 | 3.82e-10 | D09b      |

**Worksheet E04: Summary of risk characterization (HQ's<sup>1</sup>) for the general public <sup>1</sup>.**

| Chronic RfD                                     |        | 0.5             | mg/kg/day | Sect. 3.3.3. |           |
|---|--------|-----------------|-----------|--------------|-----------|
| Acute RfD                                       |        | 0.5             | mg/kg/day | Sect. 3.3.3. |           |
| Scenario  | Target | Hazard Quotient |           |              | Worksheet |
|   |        | Central         | Lower     | Upper        |           |
| <b>Acute/Accidental Exposures</b>               |        |                 |           |              |           |
| Direct spray, entire body                       | Child  | 5e-02           | 1e-02     | 3e-01        | D01a      |
| Direct spray, lower legs <sup>2</sup>           | Woman  | 5e-03           | 1e-03     | 3e-02        | D01b      |
| Dermal, contaminated <sup>2</sup><br>vegetation | Woman  | 1e-03           | 6e-04     | 3e-03        | D02       |
| Contaminated fruit <sup>2</sup>                 | Woman  | 2e-03           | 2e-03     | 4e-02        | D03       |
| Contaminated water, spill                       | Child  | 2e-01           | 8e-02     | 1.0          | D05       |
| Contaminated water, stream                      | Child  | 8e-06           | 5e-07     | 2e-04        | D06       |
| Consumption of fish,<br>general public          | Man    | 8e-04           | 5e-04     | 2e-03        | D08a      |
| Consumption of fish,<br>subsistence populations | Man    | 4e-03           | 2e-03     | 1e-02        | D08b      |
| <b>Chronic/Longer Term Exposures</b>            |        |                 |           |              |           |
| Contaminated fruit                              | Woman  | 2e-04           | 5e-05     | 7e-03        | D04       |
| Consumption of water                            | Man    | 1e-07           | 4e-08     | 2e-07        | D07       |
| Consumption of fish, general<br>public          | Man    | 6e-11           | 3e-11     | 9e-11        | D09a      |
| Consumption of fish,<br>subsistence populations | Man    | 5e-10           | 3e-10     | 8e-10        | D09b      |

<sup>1</sup> The hazard quotients are the level of exposure divided by the RfD then rounded to one or two significant decimal places or digits. Hazard quotients >1 and ≤2 are shown to two significant digits. All others are rounded to one significant decimal place or integer. All hazard quotients that are below the level of concern – i.e., a hazard quotient below unity – are expressed in scientific notation. All hazard quotients greater than unity are expressed in fixed point decimal notation and highlighted with a shaded background.

## EXPOSURE ASSESSMENTS FOR TERRESTRIAL SPECIES

**Worksheet F01:** Direct spray of small mammal assuming first order absorption kinetics [DDFOAEco01].

**Verbal Description:** A mammal of a specified body weight is directly sprayed over one half of the body surface as the chemical is being applied. An empirical relationship between body weight and surface area is used to estimate the surface area of the animal. The absorbed dose over the first day – i.e., a 24 hour period – is estimated using the assumption of first-order dermal absorption.

| Parameter/Assumption  | Value                           | Units           | Source/Reference                       |
|---|---------------------------------|-----------------|--|
| Period of exposure ( <i>T</i> )   | 24                              | hour            | N/A                                    |
| Body weight ( <i>W</i> )  | 0.020                           | kg              | Section 4.2.1.                         |
| Exposed surface area ( <i>A</i> )   | $m^2=0.11 \times BW(kg)^{0.65}$ |                 | U.S. EPA/ORD 1993, eq. 3-22, p. 3-14   |
|   | 0.0086509                       | m <sup>2</sup>  |  |
|   | 86.51                           | cm <sup>2</sup> | 10,000 cm <sup>2</sup> /m <sup>2</sup> |
| Application rate in lbs/acre ( <i>R<sub>lbs</sub></i> )                               | Central                         | 0.1             | lb/acre                                |
|   | Lower                           | 0.1             | APPL.LOW                               |
|   | Upper                           | 0.1             | APPL.HI                                |
|   |                                 |                 | APPL.TYP                               |
| Conversion Factor ( <i>CF</i> ) for lb/acre to mg/cm <sup>2</sup>                     | 0.01121                         |                 | Const.LBAC_MGCM                        |
| Application rate in mg/cm <sup>2</sup> ( <i>R<sub>mg</sub></i> ): $R_{lbs} \times CF$ | Central                         | 0.001121        | lb/acre                                |
|   | Lower                           | 0.001121        |  |
|   | Upper                           | 0.001121        |  |
|   |                                 |                 |  |
| First-order dermal absorption rate ( <i>k</i> )                                       | Central                         | 0.00330         | hour <sup>-1</sup>                     |
|   | Lower                           | 0.001600        | DERM.AbsL                              |
|   | Upper                           | 0.00670         | DERM.AbsU                              |
|   |                                 |                 | DERM.AbsC                              |
| Amount deposited on animal ( <i>Amnt</i> ): $0.5 \times A \times R_{mg}$              | Central                         | 0.04849         | mg                                     |
|   | Lower                           | 0.048488        |  |
|   | Upper                           | 0.04849         |  |
|   |                                 |                 |  |
| Proportion absorbed over period <i>T</i> ( <i>Prop</i> ): $1-e^{-kT}$                 | Central                         | 0.07614         | unitless                               |
|   | Lower                           | 0.037672        |  |
|   | Upper                           | 0.14854         |  |
|   |                                 |                 |  |
| Estimated Absorbed Doses ( <i>D</i> ): $Amnt \times Prop \div W$                      | Central                         | 1.85e-01        | mg/kg                                  |
|   | Lower                           | 9.13e-02        |  |
|   | Upper                           | 3.60e-01        |  |
|   |                                 |                 |  |

**Worksheet F02a:** Direct spray of small mammal assuming 100% absorption over the first 24 hour period [DDEco01].

**Verbal Description:** *A 20 g mammal is directly sprayed over one half of the body surface as the chemical is being applied. The deposited dose is assumed to be completely absorbed during the first day. An empirical relationship between body weight and surface area is used to estimate the surface area of the animal.*

| Parameter/Assumption  | Value                           | Units              | Source/Reference                        |
|---|---------------------------------|--------------------|---|
| Period of exposure ( <i>T</i> )   | 24                              | hour               | N/A                                     |
| Body weight ( <i>W</i> )  | 0.020                           | kg                 | Section 4.2.1.                          |
| Exposed surface area  | $m^2=0.011 \times BW(g)^{0.65}$ |                    | U.S. EPA/ORD 1993, eq. 3-22, p. 3-14    |
|   | 0.0086509                       | m <sup>2</sup>     |   |
|   | ( <i>SA</i> ) 86.51             | cm <sup>2</sup>    | m <sup>2</sup> = 10,000 cm <sup>2</sup> |
| Application rate in lbs/acre ( <i>R<sub>lbs</sub></i> )                               |                                 |                    |   |
|   | Central 0.1                     | lb/acre            | APPL.TYP                                |
|   | Lower 0.1                       |                    | APPL.LOW                                |
|   | Upper 0.1                       |                    | APPL.HI                                 |
| Conversion Factor ( <i>CF</i> ) for lb/acre to mg/cm <sup>2</sup>                     | 0.01121                         |                    | Const.LBAC_MGCM                         |
| Application rate in mg/cm <sup>2</sup> ( <i>R<sub>mg</sub></i> ): $R_{lbs} \times CF$ |                                 |                    |   |
|   | Central 0.001121                | mg/cm <sup>2</sup> |   |
|   | Lower 0.001121                  |                    |   |
|   | Upper 0.001121                  |                    |   |
| Amount deposited on animal ( <i>Amnt</i> ): $0.5 \times SA \times R_{mg}$             |                                 |                    |   |
|   | Central 0.04849                 | mg                 |   |
|   | Lower 0.048488                  |                    |   |
|   | Upper 0.04849                   |                    |   |
| Estimated Absorbed Doses ( <i>D<sub>Abs</sub></i> ): $Amnt \div W$                    |                                 |                    |   |
|   | Central 2.42e+00                | mg/kg              |   |
|   | Lower 2.42e+00                  |                    |   |
|   | Upper 2.42e+00                  |                    |   |

**Worksheet F02b:** Direct spray of bee assuming 100% absorption over the first 24 hour period [DDEco02].

**Verbal Description:** A honeybee is directly sprayed over one half of the body surface as the chemical is being applied. The deposited dose is assumed to be completely absorbed during the first day. An empirical relationship between body weight and surface area is used to estimate the surface area of the animal.

| Parameter/Assumption   | Value                            | Units     | Source/Reference           |
|--|----------------------------------|-----------|----------------------------|
| Period of exposure ( $T$ )   | 24                               | hour      | N/A                        |
| Body weight ( $W$ )  | 0.000093                         | kg        | Section 4.2.1.             |
| Exposed surface area ( $SA$ )  | $cm^2=1110 \times BW(kg)^{0.65}$ |           | Boxenbaum and D'Souza 1990 |
|  | 2.6597260                        | $cm^2$    |                            |
| Application rate ( $R_{lbs}$ )                                       |                                  |           |                            |
|  | Central 0.1                      | lb/acre   | APPL.TYP                   |
|  | Lower 0.1                        |           | APPL.LOW                   |
|  | Upper 0.1                        |           | APPL.HI                    |
| Conversion Factor ( $CF$ ) for lb/acre to $mg/cm^2$                  | 0.01121                          |           | Const.LBAC_MGCM            |
| Application rate in $mg/cm^2$ ( $R_{mg}$ ): $R_{lbs} \times CF$      |                                  |           |                            |
|  | Central 0.001121                 | $mg/cm^2$ |                            |
|  | Lower 0.001121                   |           |                            |
|  | Upper 0.001121                   |           |                            |
| Amount deposited on animal ( $Amnt$ ): $0.5 \times SA \times R_{mg}$ |                                  |           |                            |
|  | Central 0.00149                  | mg        |                            |
|  | Lower 0.001491                   |           |                            |
|  | Upper 0.00149                    |           |                            |
| Estimated Absorbed Doses ( $D_{Abs}$ ): $Amnt \div W$                |                                  |           |                            |
|  | Central 1.60e+01                 | mg/kg     |                            |
|  | Lower 1.60e+01                   |           |                            |
|  | Upper 1.60e+01                   |           |                            |

**Worksheet F03:** Consumption of contaminated fruit by a small mammal, acute exposure scenario [VegAcERA01].

**Verbal Description:** A 20 g mammal consumes fruit shortly after application of the chemical - i.e. no dissipation or degradation is considered. The contaminated vegetation accounts for 100% of the diet. Residue estimates based on relationships for fruit from Siltanen et al. (1981).

| Parameters/Assumptions  | Value            | Units             | Source/Reference                  |
|---|------------------|-------------------|-----------------------------------|
| Body weight ( <i>W</i> )  | 0.020            | kg                | Section 4.2.1                     |
| Allometric coefficients for food consumption in g based on body weight in g |                  |                   |                                   |
|   | a 0.621          |                   | Rodents U.S. EPA/ORD 1993, p. 3-6 |
|   | b 0.584          |                   |                                   |
| Food consumed per day ( <i>A</i> ): $a \times (W \times 1000)^b \div 1000$  | 0.003572         | kg                |                                   |
| Application rates ( <i>R</i> )  |                  |                   |                                   |
|   | Central 0.1      | lb/acre           | APPL.Typ                          |
|   | Lower 0.1        |                   | APPL.Low                          |
|   | Upper 0.1        |                   | APPL.Hi                           |
| Residue rates ( <i>rr</i> )   |                  |                   |                                   |
|   | Central 7        | mg/kg per lb/acre | HK.FRT2                           |
|   | Lower 7          |                   | HK.FRT2                           |
|   | Upper 15         |                   | HK.FRU2                           |
| Concentration in food ( <i>C</i> ): $R \times rr$                           |                  |                   |                                   |
|   | Central 0.7      | mg/kg food        |                                   |
|   | Lower 0.7        |                   |                                   |
|   | Upper 1.5        |                   |                                   |
| Dose estimates ( <i>D</i> ): $A \times C \div W$                            |                  |                   |                                   |
|   | Central 1.25e-01 | mg/kg bw          |                                   |
|   | Lower 1.25e-01   |                   |                                   |
|   | Upper 2.68e-01   |                   |                                   |

**Worksheet F04a:** Consumption of contaminated fruit by a small mammal, chronic exposure scenario at application site [VegChSmMam01].

**Verbal Description:** A 20 g mammal consumes contaminated fruit for a 90 day period starting shortly after application of the chemical. Food consumption is estimated from allometric relationships. The concentration of the chemical in fruit at time zero ( $C_0$ ) is estimated from the application rate ( $A$ ), the proportion of drift (**Drift**), and empirical residues rates ( $rr$ ) from Siltanen et al. (1981). Because the animal is assumed to inhabit the application site, drift is taken as unity - i.e., direct spray. The foliar half-time ( $t_{50}$ ) is used to estimate the foliar decay coefficient ( $k$ ):  $k = \ln(2) \div t_{50}$ . The concentration on the vegetation after time  $t$  ( $C_t$ ) is calculated as  $C_t = C_0 e^{-kt}$ . The time-weighted average of the concentration on vegetation ( $C_{TWA}$ ) is calculated as the integral of the concentration after time  $t$  ( $C_t$ ) divided by the duration ( $t$ ). The daily dose is calculated as the product of food consumption and the proportion of the diet that is contaminated divided by the body weight.

| Parameters/Assumptions  |         | Value     | Units             | Source/Reference  |
|---|---------|-----------|-------------------|---|
| Duration of exposure ( $T$ )  |         | 90        | days              | N/A   |
| Body weight ( $W$ )   |         | 0.02      | kg                | N/A   |
| Allometric coefficients for food consumption in g based on body weight in g |         |           |                   |   |
|   | a       | 0.621     |                   | U.S. EPA/ORD 1993, p. 3-6   |
|   | b       | 0.584     |                   |   |
| Food consumed per day ( $A$ ): $a \times (W \times 1000)^b \div 1000$       |         | 0.0035718 | kg                |   |
| Foliar half-times ( $t_{1/2}$ )   | Central | 4         | days              | CHEM.FrT12C   |
|   | Lower   | 1.2       |                   | CHEM.FrT12L   |
|   | Upper   | 12        |                   | CHEM.FrT12U   |
| Application rates ( $R$ )   |         |           |                   |   |
|   | Central | 0.1       | lb/acre           | APPL.Typ  |
|   | Lower   | 0.1       |                   | APPL.Low  |
|   | Upper   | 0.1       |                   | APPL.Hi   |
| Residue rates ( $rr$ ):   |         |           |                   |   |
|   | Central | 7         | mg/kg per lb/acre | HK.FRT2   |
|   | Lower   | 7         |                   | HK.FRT2   |
|   | Upper   | 15        |                   | HK.FRU2   |
| Drift ( <b>Drift</b> ):   |         |           |                   |   |
|   | Central | 1         | unitless          | Assume direct spray   |
|   | Lower   | 1         |                   |   |
|   | Upper   | 1         |                   |   |
| Decay coefficient ( $k$ ): $\ln(2)/t_{50}$                                  |         |           |                   |   |
|   | Central | 0.1732868 | day <sup>-1</sup> | Upper estimate of $t_{50}$ used to calculate lower limit of $k$ and lower estimate of $t_{50}$ used to calculate upper limit of $k$ . |
|   | Lower   | 0.0577623 |                   |   |
|   | Upper   | 0.5776227 |                   |   |

**Worksheet F04a (continued):** Consumption of contaminated vegetation by a small mammal, chronic exposure scenario .

Initial Concentration on Vegetation ( $C_0$ ):  $C_0 = R \times rr \times \text{Drift}$

|         |     |            |
|---------|-----|------------|
| Central | 0.7 | mg/kg veg. |
| Lower   | 0.7 |            |
| Upper   | 1.5 |            |

Concentration on Vegetation at time  $T$  ( $C_T$ ):  $C_T = C_0 e^{-kT}$

|         |          |            |   |
|---------|----------|------------|---|
| Central | 1.18e-07 | mg/kg veg. | These values are not used directly in calculating the dose. |
| Lower   | 1.85e-23 |            |   |
| Upper   | 8.29e-03 |            |   |

Time-weighted Average Concentration on Vegetation ( $C_{TWA}$ ):  $C_0 (1 - e^{-kT}) \div (k T)$

|         |          |            |
|---------|----------|------------|
| Central | 4.49e-02 | mg/kg veg. |
| Lower   | 1.35e-02 |            |
| Upper   | 2.87e-01 |            |

Proportion of Diet Contaminated ( $Prop$ )<sup>1</sup>:

|         |      |          |               |
|---------|------|----------|---------------|
| Central | 0.1  | unitless | See footnote. |
| Lower   | 0.05 |          |               |
| Upper   | 0.2  |          |               |

Dose estimates ( $D_{Abs}$ ):  $C_{TWA} \times A \times Prop \div W$

|         |          |           |
|---------|----------|-----------|
| Central | 8.02e-04 | mg/kg/day |
| Lower   | 1.20e-04 |           |
| Upper   | 1.02e-02 |           |

<sup>1</sup> Based on data on the shrew (U.S. EPA/ORD 1996, p. 2-214.), the vegetation accounts for about 5% of the diet. This is used as the lower limit. The typical and upper values are judgmentally set to account for incidental contamination of other food items such as insects as well as different feeding preferences among other small mammals.

**Worksheet F04b:** Consumption of contaminated fruit by a small mammal, chronic exposure scenario off-site [VegChSmMam02].

**Verbal Description:** A 20 g mammal consumes contaminated fruit for a 90 day period starting shortly after application of the chemical. Food consumption is estimated from allometric relationships. The concentration of the chemical in fruit at time zero ( $C_0$ ) is estimated from the application rate ( $A$ ), the proportion of drift (**Drift**), and empirical residues rates ( $rr$ ) from Siltanen et al. (1981). Drift is estimated for distances of 25 to 100 feet from the application site. The foliar half-life ( $t_{50}$ ) is used to estimate the foliar decay coefficient ( $k$ ):  $k = \ln(2) \div t_{50}$ . The concentration on the vegetation after time  $t$  ( $C_t$ ) is calculated as  $C_t = C_0 e^{-kt}$ . The time-weighted average of the concentration on vegetation ( $C_{TWA}$ ) is calculated as the integral of the concentration after time  $t$  ( $C_t$ ) divided by the duration ( $t$ ). The daily dose is calculated as the product of food consumption and the proportion of the diet that is contaminated divided by the body weight.

| Parameters/Assumptions  |          | Value     | Units             | Source/Reference  |
|---|----------|-----------|-------------------|---|
| Duration of exposure ( $T$ )  |          | 90        | days              | N/A   |
| Body weight ( $W$ )   |          | 0.02      | kg                | Section 4.2.1   |
| Allometric coefficients for food consumption in g based on body weight in g |          |           |                   |   |
|   | a        | 0.621     |                   | U.S. EPA/ORD 1993, p. 3-6   |
|   | b        | 0.584     |                   |   |
| Food consumed per day ( $A$ ): $a \times (W \times 1000)^b \div 1000$       |          |           |                   |   |
|   |          | 0.0035718 | kg                |   |
| Foliar half-lives ( $t_{1/2}$ )   | Central  | 4         | days              | CHEM.FrT12C   |
|   | Lower    | 1.2       |                   | CHEM.FrT12L   |
|   | Upper    | 12        |                   | CHEM.FrT12U   |
| Application rates ( $R$ )   |          |           |                   |   |
|   | Central  | 0.1       | lb/acre           | APPL.Typ  |
|   | Lower    | 0.1       |                   | APPL.Low  |
|   | Upper    | 0.1       |                   | APPL.Hi   |
| Residue rates ( $rr$ ):   |          |           |                   |   |
|   | Central  | 7         | mg/kg per lb/acre | HK.FRT2   |
|   | Lower    | 7         |                   | HK.FRT2   |
|   | Upper    | 15        |                   | HK.FRU2   |
| Drift ( <b>Drift</b> ):   |          |           |                   |   |
|   | 50 feet  | 0.0101    | unitless          | Estimated from AgDRIFT for low-boom applications. See Worksheet A06.  |
|   | 100 feet | 0.0058    |                   |   |
|   | 25 feet  | 0.0187    |                   |   |
| Decay coefficient ( $k$ ): $\ln(2) \div t_{50}$                             |          |           |                   |   |
|   | Central  | 0.1732868 | day <sup>-1</sup> | Upper estimate of $t_{50}$ used to calculate lower limit of $k$ and lower estimate of $t_{50}$ used to calculate upper limit of $k$ . |
|   | Lower    | 0.0577623 |                   |   |
|   | Upper    | 0.5776227 |                   |   |

**Worksheet F04b (continued):** Consumption of contaminated vegetation by a small mammal, chronic off-site exposure scenario .

Initial Concentration on Vegetation ( $C_0$ ):  $C_0 = R \times rr \times \text{Drift}$

|         |         |            |
|---------|---------|------------|
| Central | 0.00707 | mg/kg veg. |
| Lower   | 0.00406 |            |
| Upper   | 0.02805 |            |

Concentration on Vegetation at time  $T$  ( $C_T$ ):  $C_T = C_0 e^{-kT}$

|         |          |            |
|---------|----------|------------|
| Central | 1.19e-09 | mg/kg veg. |
| Lower   | 1.07e-25 |            |
| Upper   | 1.55e-04 |            |

Time-weighted Average Concentration on Vegetation ( $C_{TWA}$ ):  $C_0 (1 - e^{-kT}) \div (k T)$

|         |          |            |
|---------|----------|------------|
| Central | 4.53e-04 | mg/kg veg. |
| Lower   | 7.81e-05 |            |
| Upper   | 5.37e-03 |            |

Proportion of Diet Contaminated ( $Prop$ )<sup>1</sup>:

|         |      |          |               |
|---------|------|----------|---------------|
| Central | 0.1  | unitless | See footnote. |
| Lower   | 0.05 |          |               |
| Upper   | 0.2  |          |               |

Dose estimates ( $D$ ):  $C_{TWA} \times A \times Prop \div W$

|         |          |              |
|---------|----------|--------------|
| Central | 8.10e-06 | mg/kg bw/day |
| Lower   | 6.97e-07 |              |
| Upper   | 1.92e-04 |              |

<sup>1</sup> Based on data on the shrew (U.S. EPA/ORD 1996, p. 2-214.), the vegetation accounts for about 5% of the diet. This is used as the lower limit. The typical and upper values are judgementally set to account for incidental contamination of other food items such as insects as well as different feeding preferences among other small mammals.

**Worksheet F05:** Consumption of contaminated water by a small mammal, acute exposure scenario for an accidental spill. [DWAcERA01].

**Verbal Description:** An animal of a specified weight consumes contaminated water shortly after an accidental spill into a small pond. No dissipation or degradation is considered. The amount of water consumed is estimated from allometric relationships. The calculations involve multiplying the concentration in the field solution by the amount of solution spilled to get the amount of chemical released. This is divided by the volume of water in the pond to get the concentration in ambient water. The resulting concentration is multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

| Parameters/Assumptions  | Value            | Units          | Source/Reference                                   |
|---|------------------|----------------|--|
| Surface area of pond [SA]   | 1000             | m <sup>2</sup> | N/A  |
| Average depth [DPTH]  | 1                | m              | N/A  |
| Volume of pond in cubic meters [VM]   | 1000             | m <sup>3</sup> | N/A  |
| Volume of pond in Liters [VL]   | 1000000          | L              | 1 m <sup>3</sup> = 1,000 L                         |
| Volume of spill [VS]  | 200              | gallons        | N/A  |
|   | 757              | liters         | 1 gallon = 3.785 Liters                            |
| Concentrations in field solution ( $C_{Fld}$ (mg/L))                                  |                  |                |  |
|   | Central 2000     | mg/L           | APPL.TypDR × 1000                                  |
|   | Lower 1200       |                | APPL.LowDR × 1000                                  |
|   | Upper 6000       |                | APPL.Hi_DR × 1000                                  |
| Concentrations in ambient water ( $C_{Wrt}$ ): $C_{Fld} \times VS_{(Liters)} \div VL$ |                  |                |  |
|   | Central 1.514    | mg/L           |  |
|   | Lower 0.9084     |                |  |
|   | Upper 4.542      |                |  |
| Body weight ( $W$ )   | 0.02             | kg             | Section 4.2.1                                      |
| Allometric coefficients for water consumption in L based on body weight in kg         |                  |                |  |
|   | a 0.099          |                | All mammals. U.S. EPA/ORD 1993, Eq. 3-17, p. 3-10. |
|   | b 0.9            |                |  |
| Water consumed per day ( $A$ ): $a \times W^b$  |                  |                |  |
|   | 0.002928         | L              |  |
| Dose estimates ( $D$ ): $C_{wrt} \times A \div W$                                     |                  |                |  |
|   | Central 2.22e-01 | mg/kg bw       |  |
|   | Lower 1.33e-01   |                |  |
|   | Upper 6.65e-01   |                |  |

**Worksheet F06:** Consumption of contaminated water by a small mammal, acute exposure scenario for runoff or percolation into a stream. [DWAcStrmERA01].

**Verbal Description:** An small mammal consumes stream water contaminated by runoff and/or percolation. The peak levels in water are estimated from modeling or monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. The calculations involve multiplying the application rate by the water contamination rate to get the concentration in ambient water. This product is in turn multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

| Parameters/Assumptions   |         | Value    | Units        | Source/Reference  |
|--|---------|----------|--------------|---|
| <b>Application Rates (<i>R</i>)</b>  |         |          |              |   |
|  | Central | 0.1      | lb/acre      | APPL.Typ  |
|  | Lower   | 0.1      |              | APPL.Low  |
|  | Upper   | 0.1      |              | APPL.Hi   |
| <b>Peak Water Contamination Rate (<i>rr</i>):</b>                                    |         |          |              |   |
|  | Central | 0.0005   | mg/L per     | AMBWAT.AWPT   |
|  | Lower   | 0.0001   | lb/acre      | AMBWAT.AWPL   |
|  | Upper   | 0.01     | applied      | AMBWAT.AWPU   |
| <b>Body weight (<i>W</i>)</b>  |         |          |              |   |
|  |         | 0.02     | kg           |   |
| <b>Allometric coefficients for water consumption in L based on body weight in kg</b> |         |          |              |   |
|  | a       | 0.099    |              | All mammals. U.S.   |
|  | b       | 0.9      |              | EPA/ORD 1993, Eq. 3-17, p. 3-10.  |
| <b>Water consumed per day (<i>A</i>): <math>a \times W^b</math></b>                  |         |          |              |   |
|  |         | 0.002928 | L            |   |
| <b>Concentration in Water (<i>C</i>): <math>R \times rr</math></b>                   |         |          |              |   |
|  | Central | 0.0001   | mg/L         | These values are used in Worksheet G03 for characterizing acute risks to aquatic species. |
|  | Lower   | 0        |              |   |
|  | Upper   | 0.001    |              |   |
| <b>Dose estimates (<i>D</i>): <math>C \times A \div W</math></b>                     |         |          |              |   |
|  | Central | 7.32e-06 | mg/kg bw/day |   |
|  | Lower   | 7.32e-07 |              |   |
|  | Upper   | 1.46e-04 |              |   |

**Worksheet F07:** Consumption of contaminated water by a small mammal, chronic exposure scenario [DWChERA01].

**Verbal Description:** A small mammal consumes contaminated ambient water for an extended period of time. The levels in water are estimated from modeling or monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. The calculations involve multiplying the application rate by the water contamination rate to get the concentration in ambient water. This product is in turn multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

| Parameters/Assumptions   |         | Value    | Units     | Source/Reference                                   |
|--|---------|----------|-----------|--|
| <b>Application Rates (<i>R</i>)</b>  |         |          |           |  |
|  | Central | 0.1      | lb/acre   | APPL.Typ   |
|  | Lower   | 0.1      |           | APPL.Low   |
|  | Upper   | 0.1      |           | APPL.Hi  |
| <b>Water Contamination Rate (<i>rr</i>):</b>   |         |          |           |  |
|  | Central | 0        | mg/L per  | AMBWAT.AWT   |
|  | Lower   | 0        | lb/acre   | AMBWAT.AWL   |
|  | Upper   | 0        | applied   | AMBWAT.AWU   |
| <b>Body weight (<i>W</i>)</b>  |         |          |           |  |
|  |         | 0.02     | kg        |  |
| <b>Allometric coefficients for water consumption in L based on body weight in kg</b> |         |          |           |  |
|  | a       | 0.099    |           | All mammals. U.S. EPA/ORD 1993, Eq. 3-17, p. 3-10. |
|  | b       | 0.9      |           |  |
| <b>Water consumed per day (<i>A</i>): <math>a \times W^b</math></b>                  |         |          |           |  |
|  |         | 0.002928 | L         |  |
| <b>Concentration in Water (<i>C</i>): <math>R \times rr</math></b>                   |         |          |           |  |
|  | Central | 0        | mg/L      |  |
|  | Lower   | 1.00e-06 |           |  |
|  | Upper   | 0        |           |  |
| <b>Dose estimates (<i>D</i>): <math>C \times A \div W</math></b>                     |         |          |           |  |
|  | Central | 2.93e-07 | mg/kg/day |  |
|  | Lower   | 1.46e-07 |           |  |
|  | Upper   | 4.39e-07 |           |  |

**Worksheet F08: Consumption of contaminated fish by predatory bird, acute exposure scenario after accidental spill. [FishBirdAcute]**

**Verbal Description:** A predatory bird consumes fish taken from contaminated water after an accidental spill of 200 gallons of a field solution into a pond that has an average depth of 1 m and a surface area of 1000 m<sup>2</sup> or about one-quarter acre. No dissipation or degradation is considered. The assumption is made that bioconcentration will reach equilibrium. This probably will overestimate exposure and subsequent risk.

| Parameters/Assumptions   | Value                     | Units          | Source/Reference  |
|--|---------------------------|----------------|---|
| Surface area of pond (SA)  | 1000                      | m <sup>2</sup> | N/A   |
| Average depth (DPTH)   | 1                         | m              | N/A   |
| Volume of pond in cubic meters (VM)                                  | 1000                      | m <sup>3</sup> | N/A   |
| Volume of pond in Liters (VL)  | 1000000                   | L              | 1 m <sup>3</sup> = 1,000 L                                |
| Volume of spill (VS)   | 200                       | gallons        | N/A   |
|  | <b>VS<sub>L</sub></b> 757 | liters         | 1 gallon = 3.785 liters                                   |
| <b>Concentrations in field solution (FC)</b>                         |                           |                |   |
|  | Central 2000              | mg/L           | APPL.TypDR×1000   |
|  | Lower 1200                |                | APPL.LowDR×1000   |
|  | Upper 6000                |                | APPL.Hi_DR×1000   |
| <b>Concentrations in ambient water (WC): FC × VS<sub>L</sub> /VL</b> |                           |                |   |
|  | Central 1.514             | mg/L           |   |
|  | Lower 0.9084              |                |   |
|  | Upper 4.542               |                |   |
| Bioconcentration factor (BCF)  | 0.11                      | L/kg fish      | CHEM.BCFWA  |
| <b>Concentrations in whole fish (C<sub>Fish</sub>): WC × BCF</b>     |                           |                |   |
|  | Central 0.16654           | mg/kg fish     |   |
|  | Lower 0.099924            |                |   |
|  | Upper 0.49962             |                |   |
| <b>Fish consumed as a proportion of body weight (P<sub>F</sub>)</b>  |                           |                |   |
|  | Central 0.1               | g fish/g bw    | Various species based on values from U.S. EPA/ORD (1993). |
|  | Lower 0.05                |                |   |
|  | Upper 0.15                |                |   |
| <b>Dose estimates (D) (C<sub>Fish</sub> × P<sub>F</sub>)</b>         |                           |                |   |
|  | Central 1.67e-02          | mg/kg bw/day   |   |
|  | Lower 5.00e-03            |                |   |
|  | Upper 7.49e-02            |                |   |

**Worksheet F09:** Consumption of contaminated fish by predatory bird, chronic exposure scenario.

[FishBirdChronic]

*Verbal Description:* An predatory bird consumes fish taken from contaminated ambient water for a lifetime. The levels in water are estimated from monitoring and modeling data and dissipation, degradation and other environmental processes are considered.

| Parameters/Assumptions   |         | Value    | Units                    | Source/Reference  |
|--|---------|----------|--------------------------|---|
| <b>Application Rates (<i>R</i>)</b>  |         |          |                          |   |
|  | Central | 0.1      | lb/acre                  | APPL.Typ  |
|  | Lower   | 0.1      |                          | APPL.Low  |
|  | Upper   | 0.1      |                          | APPL.Hi   |
| <b>Water Contamination Rate (<i>WCR</i>)</b>                               |         |          |                          |   |
|  | Central | 0.00002  | mg/L per lb/acre applied | AMBWAT.AWT  |
|  | Lower   | 0.00001  |                          | AMBWAT.AWL  |
|  | Upper   | 0.00003  |                          | AMBWAT.AWU  |
| <b>Concentration in Water (<i>C</i>): <math>WCR \times R</math></b>        |         |          |                          |   |
|  | Central | 0        | mg/L                     | These values are used in G03 for chronic assessment of aquatic species. |
|  | Lower   | 0        |                          |   |
|  | Upper   | 0        |                          |   |
| <b>Bioconcentration factor (<i>BCF</i>)</b>                                |         |          |                          |   |
|  |         | 0.11     | L/kg fish                | CHEM.BCFWhl   |
| <b>Concentrations in whole fish (<i>FC</i>): <math>C \times BCF</math></b> |         |          |                          |   |
|  | Central | 0        | mg/kg fish               |   |
|  | Lower   | 0        |                          |   |
|  | Upper   | 0        |                          |   |
| <b>Fish consumed as a proportion of body weight (<i>P<sub>F</sub></i>)</b> |         |          |                          |   |
|  | Central | 0.1      | g fish/g bw              | Various species based on values from U.S. EPA/ORD (1993).               |
|  | Lower   | 0.05     |                          |   |
|  | Upper   | 0.15     |                          |   |
| <b>Dose estimates (<i>D</i>): <math>FC \times P_F</math></b>               |         |          |                          |   |
|  | Central | 2.20e-08 | mg/kg bw/day             |   |
|  | Lower   | 5.50e-09 |                          |   |
|  | Upper   | 4.95e-08 |                          |   |

**Worksheet F10:** Consumption of contaminated vegetation by a large mammal, acute exposure scenario on-site.  
 [VGCLMA]

**Verbal Description:** A 70 kg herbivore, such as a deer, consumes short grass shortly after application of the chemical - i.e. no dissipation or degradation is considered. Caloric requirements are used to estimate food consumption.

| Parameters/Assumptions  | Value    | Units    | Source/Reference               |   |
|---|----------|----------|--------------------------------|---|
| Body weight ( <i>W</i> )  | 70       | kg       | N/A                            |   |
| Caloric requirement ( <i>KR</i> )   | 5226.288 | kcal/day | U.S. EPA/ORD (1993, p. 3-6)    |   |
| above based on following equation: $kcal/day = 1.518 \times W(g)^{0.73}$  |          |          |                                |   |
| Caloric content of vegetation (dry weight, <i>KCD</i> )                   | 2.46     | kcal/g   | U.S. EPA (1993, p. 3-5)        |   |
| Water content of vegetation (proportion, <i>PW</i> )                      | 0.85     | unitless | U.S. EPA/ORD (1993, p. 4-14)   |   |
| Caloric content of vegetation (wet weight, <i>KCW</i> )                   | 0.37     | kcal/g   | $KCD \times (1-PW)$            |   |
| Food consumed per day (wet weight, <i>A</i> )                             | 14.16338 | kg       | $(KR \div KCW)/1000$ g/kg      |   |
| Duration of exposure ( <i>T</i> )   | 1        | day      | N/A                            |   |
| Application rates ( <i>R</i> )  |          |          |                                |   |
|   | Central  | 0.1      | lb/acre                        | APPL.Typ  |
|   | Lower    | 0.1      |                                | APPL.Low  |
|   | Upper    | 0.1      |                                | APPL.Hi   |
| Residue rates ( <i>rr</i> )   |          |          |                                |   |
|   | Central  | 85       | mg/kg veg. per lb/acre applied | HK.SGT  |
|   | Lower    | 85       |                                | HK.SGT  |
|   | Upper    | 240      |                                | HK.SGU  |
| Conc. in Vegetation ( <i>C</i> ): $R \times rr$                           |          |          |                                |   |
|   | Central  | 8.5      | mg/kg                          | Note: lower value based on typical <i>rr</i> and lower <i>R</i> . |
|   | Lower    | 8.5      |                                |   |
|   | Upper    | 24       |                                |   |
| Drift ( <i>Drift</i> )  |          |          |                                |   |
|   | Central  | 1        | unitless                       | Direct spray on-site  |
|   | Lower    | 1        |                                |   |
|   | Upper    | 1        |                                |   |
| Proportion of Diet Contaminated ( <i>Prop</i> )                           |          |          |                                |   |
|   | Central  | 1        | unitless                       | Assume grazing exclusively on-site.                               |
|   | Lower    | 1        |                                |   |
|   | Upper    | 1        |                                |   |
| Dose estimates ( <i>D</i> ): $Drift \times Prop \times C \times A \div W$ |          |          |                                |   |
|   | Central  | 1.72e+00 | mg/kg bw                       |   |
|   | Lower    | 1.72e+00 |                                |   |
|   | Upper    | 4.86e+00 |                                |   |

**Worksheet F11a:** Consumption of contaminated vegetation by a large mammal, chronic exposure scenario on-site [VegChLrgMam01].

**Verbal Description:** A 70 kg herbivore, such as a deer, consumes short grass for a 90 day period after application of the chemical. The contaminated vegetation accounts for 10 to 100% of the diet assuming that the animal would spend 10 to 100% of the grazing time at the application site. Because the animal is assumed to be on-site, drift is set to unity - i.e., direct spray. Residue estimates based on relationships for range grass. Caloric requirements are used to estimate food consumption. Dissipation is considered using the foliar half-life and taking time-weighted average concentration over the exposure period.

| Parameters/Assumptions   | Value      | Units     | Source/Reference             |   |
|--|------------|-----------|------------------------------|---|
| Duration of exposure ( <i>T</i> )  | 90         | days      | N/A                          |   |
| Body Weight ( <i>W</i> )   | 70         | kg        |                              |   |
| Caloric requirement ( <i>KR</i> )  | 5226.28803 | kcal/day  | U.S. EPA/ORD (1993, p. 3-6)  |   |
| above based on following equation: $kcal/day = 1.518 \times W(g)^{0.73}$ |            |           |                              |   |
| Caloric content of vegetation (dry weight, <i>KCD</i> )                  | 2.46       | kcal/g    | U.S. EPA/ORD (1993, p. 3-5)  |   |
| Water content of vegetation (proportion, <i>PW</i> )                     | 0.85       | unitless  | U.S. EPA/ORD (1993, p. 4-14) |   |
| Caloric content of vegetation (wet weight, <i>KCW</i> )                  | 0.369      | kcal/g    | $KCD \times (1-PW)$          |   |
| Food consumed per day (wet weight, <i>A</i> )                            | 14.1633822 | kg        | $(KR \div KCW)/1000$ g/kg    |   |
| Foliar half-times ( <i>t</i> <sub>½</sub> )                              | Central    | 4         | days                         | Worksheet B03   |
|  | Lower      | 1.2       |                              |   |
|  | Upper      | 12        |                              |   |
| Application rates ( <i>R</i> )   | Central    | 0.1       | lb/acre                      | APPL.Typ  |
|  | Lower      | 0.1       |                              |   |
|  | Upper      | 0.1       |                              |   |
| Residue rates ( <i>rr</i> ):   | Central    | 85        | mg/kg veg per lb/acre        | HK.SGT  |
|  | Lower      | 85        |                              |   |
|  | Upper      | 240       |                              |   |
| Drift ( <i>Drift</i> )   | Central    | 1         | unitless                     | On-site scenario assumes a function drift of 1 - i.e., direct spray   |
|  | Lower      | 1         |                              |   |
|  | Upper      | 1         |                              |   |
| Decay coefficient ( <i>k</i> ): $\ln(2)/t_{50}$                          | Central    | 0.1732868 | day <sup>-1</sup>            | Upper estimate of <i>t</i> <sub>50</sub> used to calculate lower limit of <i>k</i> and lower estimate of <i>t</i> <sub>50</sub> used to calculate upper limit of <i>k</i> . |
|  | Lower      | 0.0577623 |                              |   |
|  | Upper      | 0.5776227 |                              |   |

**Worksheet F11a (continued):** Consumption of contaminated vegetation by a large mammal, chronic exposure scenario on-site.

Initial Concentration on Vegetation ( $C_0$ ):  $R \times rr \times \text{Drift}$

|         |     |            |
|---------|-----|------------|
| Central | 8.5 | mg/kg veg. |
| Lower   | 8.5 |            |
| Upper   | 24  |            |

Concentration on Vegetation at time  $T$  ( $C_T$ ):  $C_0 e^{-kT}$

|         |          |            |
|---------|----------|------------|
| Central | 1.43e-06 | mg/kg veg. |
| Lower   | 2.25e-22 |            |
| Upper   | 1.33e-01 |            |

Time-weighted Average Concentration on Vegetation ( $C_{TWA}$ ):  $C_0 (1 - e^{-kT}) \div (k T)$

|         |            |            |
|---------|------------|------------|
| Central | 0.54501803 | mg/kg veg. |
| Lower   | 0.16350544 |            |
| Upper   | 4.59112064 |            |

Proportion of Diet Contaminated ( $Prop$ )

|         |     |          |
|---------|-----|----------|
| Central | 0.3 | unitless |
| Lower   | 0.1 |          |
| Upper   | 1.0 |          |

Dose estimates ( $D$ ):  $C_{TWA} \times A \times Prop \div W$

|         |          |              |
|---------|----------|--------------|
| Central | 3.31e-02 | mg/kg bw/day |
| Lower   | 3.31e-03 |              |
| Upper   | 9.29e-01 |              |

**Worksheet F11b:** Consumption of contaminated vegetation by a large mammal, chronic exposure scenario off-site [VegChLrgMam02].

**Verbal Description:** A 70 kg herbivore, such as a deer, consumes range grass for a 90 day period after application of the chemical. The contaminated vegetation accounts for 100% of the diet assuming that the animal would spend all of the grazing time near the application site. Drift is estimated at distances of 25 to 100 feet from the application site. Residue estimates based on relationships for range grass. Caloric requirements are used to estimate food consumption. Dissipation is considered using the foliar half-time and taking time-weighted average concentration over the exposure period.

| Parameters/Assumptions                                  |          | Value  | Units                 | Source/Reference  |
|---|----------|--|-----------------------|---|
| Duration of exposure ( <b>D</b> )                       |          | 90   | days                  | N/A   |
| Body Weight ( <b>W</b> )                                |          | 70   | kg                    |   |
| Caloric requirement ( <b>KR</b> )                       |          | 5226.28803   | kcal/day              | U.S. EPA/ORD (1993, p. 3-6)   |
|   |          | above based on following equation: $kcal/day = 1.518 \times W(g)^{0.73}$ |                       |   |
| Caloric content of vegetation (dry weight, <b>KCD</b> ) |          | 2.46   | kcal/g                | U.S. EPA/ORD (1993, p. 3-5)   |
| Water content of vegetation (proportion, <b>PW</b> )    |          | 0.85   | unitless              | U.S. EPA/ORD (1993, p. 4-14)  |
| Caloric content of vegetation (wet weight, <b>KCW</b> ) |          | 0.37   | kcal/g                | $KCD \times (1-PW)$   |
| Food consumed per day (wet weight, <b>A</b> )           |          | 14.16  | kg                    | $(KR \div KCW)/1000$ g/kg   |
| Foliar half-times ( $t_{1/2}$ )                         | Central  | 4  | days                  | Worksheet B03   |
|   | Lower    | 1.2  |                       |   |
|   | Upper    | 12   |                       |   |
| Application rates ( <b>R</b> )                          | Central  | 0.1  | lb/acre               | APPL.Typ  |
|   | Lower    | 0.1  |                       | APPL.Low  |
|   | Upper    | 0.1  |                       | APPL.Hi   |
| Residue rates ( <b>rr</b> ):                            | Central  | 85   | mg/kg veg per lb/acre | HK.SGT  |
|   | Lower    | 85   |                       | HK.SGU  |
|   | Upper    | 240  |                       | HK.SGU  |
| Drift ( <b>Drift</b> )                                  | 50 feet  | 0.0101   | unitless              | Estimated from AgDRIFT for low-boom applications. See Worksheet A06.  |
|   | 100 feet | 0.0058   |                       |   |
|   | 25 feet  | 0.0187   |                       |   |
| Decay coefficient ( <b>k</b> ): $\ln(2)/t_{50}$         | Central  | 0.1732868  | day <sup>-1</sup>     | Upper estimate of $t_{50}$ used to calculate lower limit of <b>k</b> and lower estimate of $t_{50}$ used to calculate upper limit of <b>k</b> . |
|   | Lower    | 0.0577623  |                       |   |
|   | Upper    | 0.5776227  |                       |   |

**Worksheet F11b (continued):** Consumption of contaminated vegetation by a large mammal, chronic exposure scenario off-site.

Initial Concentration on Vegetation ( $C_0$ ):  $R \times rr \times \text{Drift}$

|         |         |            |
|---------|---------|------------|
| Central | 0.08585 | mg/kg veg. |
| Lower   | 0.0493  |            |
| Upper   | 0.4488  |            |

Concentration on Vegetation at time  $T$  ( $C_T$ ):  $C_0 e^{-kT}$

|         |          |            |
|---------|----------|------------|
| Central | 1.45e-08 | mg/kg veg. |
| Lower   | 1.31e-24 |            |
| Upper   | 2.48e-03 |            |

Time-weighted Average Concentration on Vegetation ( $C_{TWA}$ ):  $C_0 (1 - e^{-kT}) \div (k T)$

|         |          |            |
|---------|----------|------------|
| Central | 0.005505 | mg/kg veg. |
| Lower   | 0.00095  |            |
| Upper   | 0.085854 |            |

Proportion of Diet Contaminated ( $Prop$ )

|         |   |          |
|---------|---|----------|
| Central | 1 | unitless |
| Lower   | 1 |          |
| Upper   | 1 |          |

Dose estimates ( $D$ ):  $C_{TWA} \times A \times Prop \div W$

|         |          |              |
|---------|----------|--------------|
| Central | 1.11e-03 | mg/kg bw/day |
| Lower   | 1.92e-04 |              |
| Upper   | 1.74e-02 |              |

**Worksheet F12:** Consumption of contaminated vegetation by a large bird, acute exposure scenario. [VGCLBA]

**Verbal Description:** A 4 kg herbivorous bird, such as a Canada Goose, consumes grass shortly after application of the chemical - i.e. no dissipation or degradation is considered. The contaminated vegetation accounts for 100% of the diet. Residue estimates based on relationships for short grass summarized in Worksheet A05.

| Parameters/Assumptions  | Value    | Units    | Source/Reference                       |   |
|---|----------|----------|--|---|
| Body weight ( <i>W</i> )  | 4        | kg       | N/A                                    |   |
| Caloric requirement ( <i>KR</i> )   | 467.5185 | kcal/day | U.S. EPA/ORD (1993, Eq. 3-35, p. 3-22) |   |
| above based on following equation: $kcal/day = 3.12 \times W(g)^{0.604}$  |          |          |  |   |
| Caloric content of vegetation (dry weight, <i>KCD</i> )                   | 2.46     | kcal/g   | U.S. EPA/ORD (1993, p. 3-5)            |   |
| Water content of vegetation (proportion, <i>PW</i> )                      | 0.85     | unitless | U.S. EPA/ORD (1993, p. 4-14)           |   |
| Caloric content of vegetation (wet weight, <i>KCW</i> )                   | 0.369    | kcal/g   | $KCD \times (1-PW)$                    |   |
| Food consumed per day (wet weight, <i>A</i> )                             | 1.266988 | kg       | $(KR \div KCW)/1000$ g/kg              |   |
| Duration of exposure ( <i>T</i> )   | 1        | day      | N/A                                    |   |
| Application rates ( <i>R</i> )  |          |          |  |   |
|   | Central  | 0.1      | lb/acre                                | APPL.Typ  |
|   | Lower    | 0.1      |  | APPL.Low  |
|   | Upper    | 0.1      |  | APPL.Hi   |
| Residue rates ( <i>rr</i> )   |          |          |  |   |
|   | Central  | 85       | mg/kg                                  | HK.SGT  |
|   | Lower    | 85       | vegetation per lb/acre applied         | HK.SGT  |
|   | Upper    | 240      |  | HK.SGU  |
| Conc. in Vegetation ( <i>C</i> ): [ <i>R</i> × <i>rr</i> ]                |          |          |  |   |
|   | Central  | 8.5      | mg/kg                                  | Note: lower value based on typical <i>rr</i> and lower <i>R</i> . |
|   | Lower    | 8.5      |  |   |
|   | Upper    | 24       |  |   |
| Drift ( <i>Drift</i> )  |          |          |  |   |
|   | Central  | 1        | unitless                               | Direct spray on-site  |
|   | Lower    | 1        |  |   |
|   | Upper    | 1        |  |   |
| Proportion of Diet Contaminated ( <i>Prop</i> )                           |          |          |  |   |
|   | Central  | 1        | unitless                               | Assume feeding exclusively on-site.                               |
|   | Lower    | 1        |  |   |
|   | Upper    | 1        |  |   |
| Dose estimates ( <i>D</i> ): $Drift \times Prop \times C \times A \div W$ |          |          |  |   |
|   | Central  | 2.69e+00 | mg/kg bw                               |   |
|   | Lower    | 2.69e+00 |  |   |
|   | Upper    | 7.60e+00 |  |   |

**Worksheet F13a:** Consumption of contaminated vegetation by a large bird, chronic on-site exposure scenario.  
 [VegChLBrd01]

**Verbal Description:** A 4 kg herbivorous bird, such as a Canada Goose, consumes grass for a 90 day period after application of the chemical. The contaminated vegetation accounts for 10 to 100% of the diet assuming that the animal spends 10% to 100% of the time feeding at the site. Because the location is the application site, drift is set to unity - i.e., direct spray. Residue estimates based on short grass. Caloric requirements are used to estimate food consumption from U.S. EPA/ORD (1993). Dissipation is considered using the foliar half-time and taking the geometric mean of the initial and day-90 residues as the measure of dose.

| Parameters/Assumptions  | Value    | Units    | Source/Reference             |                                      |
|---|----------|----------|------------------------------|--------------------------------------|
| Body weight ( <i>W</i> )  | 4        | kg       | N/A                          |                                      |
| Caloric requirement ( <i>KR</i> )   | 467.5185 | kcal/day | U.S. EPA/ORD (1993, p. 3-6)  |                                      |
| above based on following equation: $kcal/day = 3.12 \times W(g)^{0.666}$                |          |          |                              |                                      |
| Caloric content of vegetation (dry weight, <i>KCD</i> )                                 | 2.46     | kcal/g   | U.S. EPA/ORD (1993, p. 3-5)  |                                      |
| Water content of vegetation (proportion, <i>PW</i> )                                    | 0.85     | unitless | U.S. EPA/ORD (1993, p. 4-14) |                                      |
| Caloric content of vegetation (wet weight, <i>KCW</i> )                                 | 0.369    | kcal/g   | $KCD \times (1-PW)$          |                                      |
| Food consumed per day (wet weight, <i>A</i> )   | 1.266988 | kg       | $(KR \div KCW)/1000$ g/kg    |                                      |
| Duration of exposure ( <i>T</i> )   | 90       | days     | N/A                          |                                      |
| Application rates ( <i>R</i> )  |          |          |                              |                                      |
|   | Central  | 0.1      | lb/acre                      | APPL.Typ                             |
|   | Lower    | 0.1      |                              | APPL.Low                             |
|   | Upper    | 0.1      |                              | APPL.Hi                              |
| Residue rates ( <i>rr</i> )   |          |          |                              |                                      |
|   | Central  | 85       | mg/kg veg per lb/acre        | HG.SGT                               |
|   | Lower    | 85       |                              | HG.SGT                               |
|   | Upper    | 240      |                              | HG.SGU                               |
| Drift ( <i>Drift</i> ):   |          |          |                              |                                      |
|   | Central  | 1        | unitless                     | Set to unity for on-site assessment. |
|   | Lower    | 1        |                              |                                      |
|   | Upper    | 1        |                              |                                      |
| Day 0 Conc. in Vegetation ( <i>C<sub>0</sub></i> ): $R \times rr \times Drift$          |          |          |                              |                                      |
|   | Central  | 8.5      | mg/kg                        |                                      |
|   | Lower    | 8.5      |                              |                                      |
|   | Upper    | 24       |                              |                                      |
| Foliar dissipation coefficient ( <i>k</i> )   |          |          |                              |                                      |
|   | Central  | 0.173287 | day <sup>-1</sup>            | Worksheet B02                        |
|   | Lower    | 0.05776  |                              |                                      |
|   | Upper    | 0.577623 |                              |                                      |
| Conc. in Vegetation at time T ( <i>C<sub>T</sub></i> ) [ $C_0 \times e^{-k \times T}$ ] |          |          |                              |                                      |
|   | Central  | 1.43e-06 | mg/kg                        |                                      |
|   | Lower    | 2.25e-22 |                              |                                      |
|   | Upper    | 1.33e-01 |                              |                                      |

**Worksheet F13a (continued):** Consumption of contaminated vegetation by a large bird, chronic on-site exposure scenario.

Time-weighted Average Concentration on Vegetation ( $C_{TWA}$ ):  $C_0 (1 - e^{-kT}) \div (k T)$

|         |          |       |
|---------|----------|-------|
| Central | 0.545018 | mg/kg |
| Lower   | 0.163505 |       |
| Upper   | 4.591121 |       |

Proportion of diet contaminated ( $P_D$ )

|         |     |          |                      |
|---------|-----|----------|----------------------|
| Central | 0.3 | unitless | See section 4.2.2.3. |
| Lower   | 0.1 |          |                      |
| Upper   | 1.0 |          |                      |

Dose estimates ( $D$ ):  $P_D \times C_{TWA} \times A \div W$

|         |          |          |
|---------|----------|----------|
| Central | 5.18e-02 | mg/kg bw |
| Lower   | 5.18e-03 |          |
| Upper   | 1.45e+00 |          |

**Worksheet F13b:** Consumption of contaminated vegetation by a large bird, chronic off-site exposure scenario.  
 [VegChLBrd02]

**Verbal Description:** A 4 kg herbivorous bird, such as a Canada Goose, consumes grass for a 90 day period after application of the chemical. The contaminated vegetation accounts for 100% of the diet assuming that the animal spends all of the feeding time near the site. Drift is estimated at 25 to 100 feet from the application site. Residue estimates are based on short grass. Caloric requirements are used to estimate food consumption. Dissipation is considered using the foliar half-time and taking the geometric mean of the initial and day-90 residues as the measure of dose.

| Parameters/Assumptions   | Value    | Units    | Source/Reference             |  |
|--|----------|----------|------------------------------|--|
| Body weight ( <i>W</i> )   | 4        | kg       | N/A                          |  |
| Caloric requirement ( <i>KR</i> )  | 467.5185 | kcal/day | U.S. EPA/ORD (1993, p. 3-6)  |  |
| above based on following equation: $kcal/day = 3.12 \times W(g)^{0.666}$             |          |          |                              |  |
| Caloric content of vegetation (dry weight, <i>KCD</i> )                              | 2.46     | kcal/g   | U.S. EPA/ORD (1993, p. 3-5)  |  |
| Water content of vegetation (proportion, <i>PW</i> )                                 | 0.85     | unitless | U.S. EPA/ORD (1993, p. 4-14) |  |
| Caloric content of vegetation (wet weight, <i>KCW</i> )                              | 0.369    | kcal/g   | $KCD \times (1-PW)$          |  |
| Food consumed per day (wet weight, <i>A</i> )  | 1.266988 | kg       | $(KR \div KCW)/1000$ g/kg    |  |
| Duration of exposure ( <i>T</i> )  | 90       | days     | N/A                          |  |
| Application rates ( <i>R</i> )   |          |          |                              |  |
|  | Central  | 0.1      | lb/acre                      | APPL.Typ   |
|  | Lower    | 0.1      |                              | APPL.Low   |
|  | Upper    | 0.1      |                              | APPL.Hi  |
| Residue rates ( <i>rr</i> )  |          |          |                              |  |
|  | Central  | 85       | mg/kg veg per lb/acre        | HG.SGT   |
|  | Lower    | 85       |                              | HG.SGT   |
|  | Upper    | 240      |                              | HG.SGU   |
| Drift ( <i>Drift</i> ):  |          |          |                              |  |
|  | 50 feet  | 0.0101   | unitless                     | Estimated from AgDRIFT for low-boom applications. See Worksheet A06. |
|  | 100 feet | 0.0058   |                              |  |
|  | 25 feet  | 0.0187   |                              |  |
| Day 0 Conc. in Vegetation ( <i>C<sub>0</sub></i> ): $R \times rr \times Drift$       |          |          |                              |  |
|  | Central  | 0.08585  | mg/kg                        | Note: lower value based on typical <i>rr</i> and lower <i>R</i> .    |
|  | Lower    | 0.0493   |                              |  |
|  | Upper    | 0.4488   |                              |  |
| Foliar dissipation coefficient ( <i>k</i> )  |          |          |                              |  |
|  | Central  | 0.173287 | day <sup>-1</sup>            | Worksheet B02  |
|  | Lower    | 0.05776  |                              |  |
|  | Upper    | 0.577623 |                              |  |
| Conc. in Vegetation at time T ( <i>C<sub>T</sub></i> ): $C_0 \times e^{-k \times T}$ |          |          |                              |  |
|  | Central  | 1.45e-08 | mg/kg                        |  |
|  | Lower    | 1.31e-24 |                              |  |
|  | Upper    | 2.48e-03 |                              |  |

**Worksheet F13b (continued):** Consumption of contaminated vegetation by a large bird, chronic off-site exposure scenario.

Time-weighted Average Concentration on Vegetation ( $C_{TWA}$ ):  $C_0 (1 - e^{-kT}) \div (k T)$

|         |         |       |
|---------|---------|-------|
| Central | 0.0055  | mg/kg |
| Lower   | 0.001   |       |
| Upper   | 0.08585 |       |

Proportion of diet contaminated ( $P_D$ )

|         |     |          |                                      |
|---------|-----|----------|--------------------------------------|
| Central | 1.0 | unitless | 100% of time spent feeding near site |
| Lower   | 1.0 |          |                                      |
| Upper   | 1.0 |          |                                      |

Dose estimates ( $D$ ):  $P_D \times C_{TWA} \times A \div W$

|         |          |          |
|---------|----------|----------|
| Central | 1.74e-03 | mg/kg bw |
| Lower   | 3.00e-04 |          |
| Upper   | 2.72e-02 |          |

**Worksheet F14a:** Consumption of contaminated insects by a small mammal, acute exposure scenario.

[InsCSMA]

**Verbal Description:** A small insectivorous mammal (20g) consumes insects shortly after application of the chemical - i.e. no dissipation or degradation is considered. The contaminated food accounts for 100% of the diet. Residue estimates in insects are based on relationships from Fletcher et al. (1994) summarized in Worksheet A04.

| Parameters/Assumptions  | Value    | Units                     | Source/Reference  |
|---|----------|---------------------------|---|
| Body weight ( <i>W</i> )  | 0.02     | kg                        | N/A   |
| Caloric requirement ( <i>KR</i> ): = $a \times W^b$                       |          |                           |   |
| <b>a</b> coefficient  | 1.894    |                           | U.S. EPA (1993, p. 3-6), equation 3-11                  |
| <b>b</b> coefficient  | 0.7      |                           |   |
| Calculated caloric requirement ( <i>KR</i> )                              | 15.42059 | kcal/day                  |   |
| Caloric content of prey (wet weight, <i>KCW</i> )                         | 1.5      | kcal/g                    | U.S. EPA (1993), Table 4-1, p. 4-13. Value for beetles. |
| Food consumed per day (wet weight, <i>A</i> )                             | 0.01028  | kg                        | $(KR \div KCW)/1000$ g/kg                               |
| Duration of exposure ( <i>T</i> )   | 1        | day                       | N/A   |
| Application rates ( <i>R</i> )  |          |                           |   |
| Central   | 0.1      | lb/acre                   | APPL.Typ  |
| Lower   | 0.1      |                           | APPL.Low  |
| Upper   | 0.1      |                           | APPL.Hi   |
| Residue rates ( <i>rr</i> )   |          |                           |   |
| Central   | 45       | mg/kg per lb/acre applied | @@HK.BLT  |
| Lower   | 45       |                           | HK.BLT  |
| Upper   | 135      |                           | HK.BLU  |
| Conc. in Vegetation ( <i>C</i> ): $R \times rr$                           |          |                           |   |
| Central   | 4.5      | mg/kg                     |   |
| Lower   | 4.5      |                           |   |
| Upper   | 13.5     |                           |   |
| Drift ( <i>Drift</i> )  |          |                           |   |
| Central   | 1        | unitless                  | Direct spray on-site                                    |
| Lower   | 1        |                           |   |
| Upper   | 1        |                           |   |
| Proportion of Diet Contaminated ( <i>Prop</i> )                           |          |                           |   |
| Central   | 1        | unitless                  | Assume feeding exclusively on-site.                     |
| Lower   | 1        |                           |   |
| Upper   | 1        |                           |   |
| Dose estimates ( <i>D</i> ): $Drift \times Prop \times C \times A \div W$ |          |                           |   |
| Central   | 2.31e+00 | mg/kg bw                  |   |
| Lower   | 2.31e+00 |                           |   |
| Upper   | 6.94e+00 |                           |   |

**Worksheet F14b:** Consumption of contaminated insects by a small bird, acute exposure scenario. [InsCSBA]

**Verbal Description:** A small insectivorous bird (10g) consumes insects shortly after application of the chemical - i.e. no dissipation or degradation is considered. The contaminated food accounts for 100% of the diet. Residue estimates in insects are based on relationships for seed containing pods and forage crops from Fletcher et al. (1994) summarized in Worksheet A04.

| Parameters/Assumptions  | Value    | Units                     | Source/Reference  |
|---|----------|---------------------------|---|
| Body weight ( <i>W</i> )  | 0.01     | kg                        | N/A   |
| Caloric requirement (KR): = $a \times W^b$                                |          |                           |   |
| <b>a</b> coefficient  | 3.12     |                           | U.S. EPA (1993, Eq.3-35, p.3-6)                         |
| <b>b</b> coefficient  | 0.604    |                           |   |
| Calculated caloric requirement ( <b>KR</b> )                              | 12.53587 | kcal/day                  |   |
| Caloric content of prey (wet weight, <b>KCW</b> )                         | 1.5      | kcal/g                    | U.S. EPA (1993), Table 4-1, p. 4-13. Value for beetles. |
| Food consumed per day (wet weight, <b>A</b> )                             | 0.0084   | kg                        | $(KR \div KCW)/1000$ g/kg                               |
| Duration of exposure ( <b>T</b> )   | 1        | day                       | N/A   |
| Application rates ( <b>R</b> )  |          |                           |   |
| Central   | 0.1      | lb/acre                   | APPL.Typ  |
| Lower   | 0.1      |                           | APPL.Low  |
| Upper   | 0.1      |                           | APPL.Hi   |
| Residue rates ( <b>rr</b> )   |          |                           |   |
| Central   | 45       | mg/kg per lb/acre applied | @@HK.BLT  |
| Lower   | 45       |                           | HK.BLT  |
| Upper   | 135      |                           | HK.BLU  |
| Conc. in Vegetation ( <b>C</b> ): $R \times rr$                           |          |                           |   |
| Central   | 4.5      | mg/kg                     |   |
| Lower   | 4.5      |                           |   |
| Upper   | 13.5     |                           |   |
| Drift ( <b>Drift</b> )  |          |                           |   |
| Central   | 1        | unitless                  | Direct spray on-site                                    |
| Lower   | 1        |                           |   |
| Upper   | 1        |                           |   |
| Proportion of Diet Contaminated ( <b>Prop</b> )                           |          |                           |   |
| Central   | 1        | unitless                  | Assume feeding exclusively on-site.                     |
| Lower   | 1        |                           |   |
| Upper   | 1        |                           |   |
| Dose estimates ( <b>D</b> ): $Drift \times Prop \times C \times A \div W$ |          |                           |   |
| Central   | 3.76e+00 | mg/kg bw                  |   |
| Lower   | 3.76e+00 |                           |   |
| Upper   | 1.13e+01 |                           |   |

**Worksheet F15:** Potential exposures of non-target plants through the use of contaminated irrigation water.

**Verbal Description:** *Non-target plants/crops are irrigated with 1 inch of contaminated ambient water. The levels in water are estimated from modeling and/or monitoring data thus dissipation, degradation and other environmental processes are considered.*

| Parameters/Assumptions  | Value    | Units        | Source/Reference |
|---|----------|--------------|------------------|
| <b>Application Rates (<math>R</math>) (lb a.e./acre)</b>  |          |              |                  |
| Central   | 0.1      | lb a.e./acre | WSB01.Typ        |
| Low   | 0.1      |              | WSB01.Low        |
| High  | 0.1      |              | WSB01.Hi         |
| <b>Water Contamination Rate (WCR)(<math>C</math>) (<math>C</math> (mg/L) ÷ <math>R</math> (lb a.e./acre)</b>  |          |              |                  |
| Central   | 0.0005   | mg/L/lb      | WSB07.AWT        |
| Low   | 0.0001   | a.e./acre    | WSB07.AWL        |
| High  | 0.01     |              | WSB07.AWU        |
| <b>Concentrations in irrigation water (<math>C</math>) (<math>C</math> (mg/L) (<math>A \times WRC</math>)</b> |          |              |                  |
| Central   | 5.00e-05 | mg/L         |                  |
| Low   | 5.00e-06 | mg/L         |                  |
| High  | 1.00e-03 | mg/L         |                  |
| Irrigation rate   | 1        | inch         | U.S. EPA 1989a   |
| Liters of water applied per acre ( $L$ )  | 10,279   | L            | see below        |
| <b>Functional Application Rate(<math>A</math>) (<math>C \times L \times 0.0000022</math> lbs/mg ÷ 1 acre)</b> |          |              |                  |
| Central   | 1.13e-06 | lb/acre      |                  |
| Low   | 1.13e-07 | lb/acre      |                  |
| High  | 2.26e-05 | lb/acre      |                  |

**Calculations of constants:**

Liters of water applied per acre per inch irrigation water:

$$1 \text{ m}^2 = 100 \text{ cm} \times 100 \text{ cm} = 10,000 \text{ cm}^2$$

$$1 \text{ acre} = 4047 \text{ m}^2 = 4047 \text{ m}^2 \times 10,000 \text{ cm}^2/\text{m}^2 = 4,047,000 \text{ cm}^2$$

$$1 \text{ inch} = 2.54 \text{ cm}$$

$$2.54 \text{ cm} \times 4,047,000 \text{ cm}^2 = 10,279,380 \text{ cm}^3 = 10,279,380 \text{ mL} = 10,279 \text{ L}$$

Number of lbs/mg:

$$1 \text{ kg} = 2.2 \text{ lbs}$$

$$1 \text{ g} = 0.0022 \text{ lbs}$$

$$1 \text{ mg} = 0.0000022 \text{ lbs}$$

**Worksheet F16a:** Consumption of contaminated small mammal by a carnivorous mammal, acute exposure scenario. [*SmMCCMA*]

**Verbal Description:** *A carnivorous mammal consumes small mammals shortly after the direct spray of the small mammal at the specified application rate - i.e. no dissipation or degradation is considered. The amount consumed is sufficient to satisfy the caloric requirements for one day. Residue estimates for the small mammal are taken from Worksheet F02a, Direct Spray of a Small Mammal assuming 100% absorption.*

| Parameters/Assumptions  | Value    | Units    | Source/Reference   |
|---|----------|----------|--|
| Body weight ( <i>W</i> )  | 5        | kg       | Red Fox, U.S. EPA (1993, p. 2-221).<br>Range of 3 to 7 kg. |
| Caloric requirement (KR): = $a \times W^b$                      |          |          |  |
| <b>a</b> coefficient  | 1.894    |          | U.S. EPA (1993, p. 3-6), equation 3-11                     |
| <b>b</b> coefficient  | 0.7      |          |  |
| Calculated caloric requirement ( <b>KR</b> )                    | 735.629  | kcal/day |  |
| Caloric content of prey (wet weight, <b>KCW</b> )               | 1.7      | kcal/g   | U.S. EPA (1993),<br>Table 4-1, p. 4-13                     |
| Food consumed per day (wet weight, <i>A</i> )                   | 0.43272  | kg       | $(KR \div KCW)/1000$<br>g/kg                               |
| Concentration on Small Mammal After Direct Spray ( <b>CSM</b> ) |          |          |  |
| Central   | 2.42e+00 | mg/kg    | Worksheet F02a   |
| Lower   | 2.42e+00 |          |  |
| Upper   | 2.42e+00 |          |  |
| Total Amount to Predator (TA): $A \times CSM$                   |          |          |  |
| Central   | 1.05e+00 | mg/kg bw |  |
| Lower   | 1.05e+00 |          |  |
| Upper   | 1.05e+00 |          |  |
| Dose to Predator: TA/BW   |          |          |  |
| Central   | 2.10e-01 | mg/kg bw |  |
| Lower   | 2.10e-01 |          |  |
| Upper   | 2.10e-01 |          |  |

**Worksheet F16b:** Consumption of contaminated small mammal by a carnivorous bird, acute exposure scenario. [SmMCCBA]

**Verbal Description:** A carnivorous bird consumes small mammals shortly after the direct spray of the small mammal at the specified application rate - i.e. no dissipation or degradation is considered. The amount consumed is sufficient to satisfy the caloric requirements for one day. Residue estimates for the small mammal are taken from Worksheet F02a, Direct Spray of a Small Mammal assuming 100% absorption.

| Parameters/Assumptions  | Value    | Units    | Source/Reference  |
|---|----------|----------|---|
| Body weight ( <i>W</i> )  | 0.637    | kg       | Female Spotted Owl ( <i>Strix occidentalis</i> ), Dunning 1993, p. 97. Range of 548 to 760 g. |
| Caloric requirement (KR): = $a \times W^b$                      |          |          |   |
| <b>a</b> coefficient  | 1.146    |          | U.S. EPA (1993, p. 3-23), equation 3-37   |
| <b>b</b> coefficient  | 0.749    |          |   |
| Calculated caloric requirement ( <b>KR</b> )                    | 144.3727 | kcal/day |   |
| Caloric content of prey (wet weight, <b>KCW</b> )               | 1.7      | kcal/g   | U.S. EPA (1993), Table 4-1, p. 4-13   |
| Food consumed per day (wet weight, <i>A</i> )                   | 0.08493  | kg       | $(KR \div KCW)/1000$ g/kg   |
| Concentration on Small Mammal After Direct Spray ( <b>CSM</b> ) |          |          |   |
| Central   | 2.42e+00 | mg/kg    | Worksheet F02a  |
| Lower   | 2.42e+00 |          |   |
| Upper   | 2.42e+00 |          |   |
| Total Amount to Predator (TA): $A \times CSM$                   |          |          |   |
| Central   | 2.06e-01 | mg/kg bw |   |
| Lower   | 2.06e-01 |          |   |
| Upper   | 2.06e-01 |          |   |
| Dose to Predator: TA/BW   |          |          |   |
| Central   | 3.23e-01 | mg/kg bw |   |
| Lower   | 3.23e-01 |          |   |
| Upper   | 3.23e-01 |          |   |

**Worksheet G01: Summary of Exposure Scenarios for Terrestrial Animals.**

| Scenario                             | Dose (mg/kg/day) |          |          | Worksheet |
|--------------------------------------|------------------|----------|----------|-----------|
|                                      | Central          | Lower    | Upper    |           |
| <b>Acute/Accidental Exposures</b>    |                  |          |          |           |
| <b>Direct spray</b>                  |                  |          |          |           |
| small mammal, first-order absorption | 1.85e-01         | 9.13e-02 | 3.60e-01 | F01       |
| small animal, 100% absorption        | 2.42e+00         | 2.42e+00 | 2.42e+00 | F02a      |
| bee, 100% absorption                 | 1.60e+01         | 1.60e+01 | 1.60e+01 | F02b      |
| <b>Contaminated vegetation</b>       |                  |          |          |           |
| small mammal                         | 1.25e-01         | 1.25e-01 | 2.68e-01 | F03       |
| large mammal                         | 1.72e+00         | 1.72e+00 | 4.86e+00 | F10       |
| large bird                           | 2.69e+00         | 2.69e+00 | 7.60e+00 | F12       |
| <b>Contaminated water</b>            |                  |          |          |           |
| small mammal, spill                  | 2.22e-01         | 1.33e-01 | 6.65e-01 | F05       |
| stream                               | 7.32e-06         | 7.32e-07 | 1.46e-04 | F06       |
| <b>Contaminated insects</b>          |                  |          |          |           |
| small mammal                         | 2.31e+00         | 2.31e+00 | 6.94e+00 | F14a      |
| small bird                           | 3.76e+00         | 3.76e+00 | 1.13e+01 | F14b      |
| <b>Contaminated fish</b>             |                  |          |          |           |
| predatory bird, spill                | 1.67e-02         | 5.00e-03 | 7.49e-02 | F08       |
| <b>Contaminated small mammal</b>     |                  |          |          |           |
| carnivorous mammal                   | 2.10e-01         | 2.10e-01 | 2.10e-01 | F16a      |
| carnivorous bird                     | 3.23e-01         | 3.23e-01 | 3.23e-01 | F16b      |
| <b>Longer-term Exposures</b>         |                  |          |          |           |
| <b>Contaminated vegetation</b>       |                  |          |          |           |
| small mammal, on site                | 8.02e-04         | 1.20e-04 | 1.02e-02 | F04a      |
| off-site                             | 8.10e-06         | 6.97e-07 | 1.92e-04 | F04b      |
| large mammal, on site                | 3.31e-02         | 3.31e-03 | 9.29e-01 | F11a      |
| off-site                             | 1.11e-03         | 1.92e-04 | 1.74e-02 | F11b      |
| large bird, on site                  | 5.18e-02         | 5.18e-03 | 1.45e+00 | F13a      |
| off-site                             | 1.74e-03         | 3.00e-04 | 2.72e-02 | F13b      |
| <b>Contaminated water</b>            |                  |          |          |           |
| small mammal                         | 2.93e-07         | 1.46e-07 | 4.39e-07 | F07       |
| <b>Contaminated fish</b>             |                  |          |          |           |
| predatory bird                       | 2.20e-08         | 5.50e-09 | 4.95e-08 | F09       |

**Worksheet G02: Summary of quantitative risk characterization for terrestrial animals<sup>1</sup>**

| Scenario                                  | Hazard Quotient <sup>2</sup> |       |           |
|---|------------------------------|-------|-----------|
|   | Central                      | Lower | Upper     |
| <b>Acute/Accidental Exposures</b>         |                              |       |           |
| <b>Direct spray</b>                       |                              |       |           |
| small mammal, first-order absorption      | 5e-04                        | 3e-04 | 1e-03     |
| small animal, 100% absorption             | 7e-03                        | 7e-03 | 7e-03     |
| bee, 100% absorption                      | 4e-02                        | 4e-02 | 4e-02     |
| <b>Contaminated vegetation</b>            |                              |       |           |
| small mammal                              | 4e-04                        | 4e-04 | 8e-04     |
| large mammal                              | 5e-03                        | 5e-03 | 1e-02     |
| large bird                                | 2e-03                        | 2e-03 | 7e-03     |
| <b>Contaminated water</b>                 |                              |       |           |
| small mammal, spill                       | 6e-04                        | 4e-04 | 2e-03     |
| small mammal, stream                      | 2e-08                        | 2e-09 | 4e-07     |
| <b>Contaminated insects</b>               |                              |       |           |
| small mammal                              | 7e-03                        | 7e-03 | 2e-02     |
| small bird                                | 3e-03                        | 3e-03 | 1e-02     |
| <b>Contaminated fish</b>                  |                              |       |           |
| predatory bird, spill                     | 2e-05                        | 5e-06 | 7e-05     |
| <b>Contaminated small mammal</b>          |                              |       |           |
| carnivorous mammal                        | 6e-04                        | 6e-04 | 6e-04     |
| carnivorous bird                          | 3e-04                        | 3e-04 | 3e-04     |
| <b>Longer-term Exposures</b>              |                              |       |           |
| <b>Contaminated vegetation</b>            |                              |       |           |
| small mammal, on site                     | 2e-05                        | 2e-06 | 2e-04     |
| off-site                                  | 2e-07                        | 1e-08 | 4e-06     |
| large mammal, on site                     | 7e-04                        | 7e-05 | 2e-02     |
| off-site                                  | 2e-05                        | 4e-06 | 3e-04     |
| large bird, on site                       | 5e-04                        | 5e-05 | 1e-02     |
| off-site                                  | 2e-05                        | 3e-06 | 2e-04     |
| <b>Contaminated water</b>                 |                              |       |           |
| small mammal                              | 6e-09                        | 3e-09 | 9e-09     |
| <b>Contaminated fish</b>                  |                              |       |           |
| predatory bird                            | 2e-10                        | 5e-11 | 4e-10     |
| <b>Toxicity Indices<sup>3</sup></b>       |                              |       |           |
| Acute toxicity value for mammal - NOAEL   | 350                          |       | mg/kg     |
| Chronic toxicity value for mammal - NOAEL | 50                           |       | mg/kg/day |
| Acute toxicity value for bird - NOAEL     | 1100                         |       | mg/kg     |
| Chronic toxicity value for birds- NOAEL   | 113                          |       | mg/kg/day |
| Toxicity value for bee - no mortality     | 387                          |       | mg/kg     |

<sup>1</sup> See Worksheet G01 for summary of exposure assessment.<sup>2</sup> Estimated dose ÷ toxicity index<sup>3</sup> See Section 4.3 of the risk assessment for a discussion of the dose-response assessments for each group: Section 4.3.2.1 for mammals, Section 4.3.2.2 for birds, and Section 4.3.2.3 for insects.

**Worksheet G03: Quantitative Risk Characterization for Aquatic Species.**

| <b>Hazard Quotients</b>                               | <b>Central</b> | <b>Lower</b> | <b>Upper</b> | <b>Toxicity Value (mg/L)</b> | <b>End-point</b> |
|---|----------------|--------------|--------------|------------------------------|------------------|
| Fish, Acute Exposures <sup>1</sup>                    |                |              |              |                              |                  |
| Tolerant species                                      | 5e-07          | 5e-08        | 1e-05        | 100                          | NOEC             |
| Sensitive species                                     | 5e-07          | 5e-08        | 1e-05        | 100                          | NOEC             |
| Fish, Chronic Exposures <sup>1</sup>                  |                |              |              |                              |                  |
| Tolerant species                                      | 2e-08          | 1e-08        | 3e-08        | 100                          | NOEC             |
| Sensitive species<br>(estimated from daphnid data)    | 2e-08          | 1e-08        | 3e-08        | 100                          | NOEC             |
| Aquatic Invertebrates, Acute Exposures <sup>1</sup>   | 5e-07          | 5e-08        | 1e-05        | 100                          | NOEC             |
| Aquatic Invertebrates, Chronic Exposures <sup>1</sup> | 2e-08          | 1e-08        | 3e-08        | 100                          | NOEC             |
| Aquatic Plants, Acute exposures                       |                |              |              |                              |                  |
| Algae   | 1e-03          | 1e-04        | 2e-02        | 0.05                         | LOEC             |
| Macrophytes   | 4e-02          | 4e-03        | 8e-01        | 0.00127                      | NOEC             |
| Aquatic Plants, Chronic exposures                     |                |              |              |                              |                  |
| Algae   | 4e-05          | 2e-05        | 6e-05        | 0.05                         | LOEC             |
| Macrophytes   | 2e-03          | 8e-04        | 2e-03        | 0.00127                      | NOEC             |
| Exposures (mg/L)                                      | Central        | Lower        | Upper        | Worksheets                   |                  |
| Acute   | 5.0e-05        | 5.0e-06      | 1.0e-03      | F06                          | Stream           |
| Longer-term   | 2.0e-06        | 1.0e-06      | 3.0e-06      | F09                          | Stream           |

*See Sections 4.3.3.2 and 4.3.3.3 for a discussion and derivation of the toxicity values for fish, invertebrates, and aquatic plants. See Worksheets F06 and F09 for the derivation of the concentrations in streams and ponds, respectively.*

<sup>1</sup> As indicated in Sections 4.3.3.2 and 4.3.3.3, there is no basis for differentiating tolerant and sensitive species of fish or aquatic invertebrates or for differentiating short-term and longer-term NOEC values. The same toxicity value is used for all species in acute and longer-term exposures.

**Worksheet G04:** Summary of Exposure Assessment and Risk Characterization for Terrestrial Plants from Runoff [TerrPlntRU].

|   | lb a.e./acre | Note                          |             |
|---|--------------|-------------------------------|-------------|
| <b>Application rate</b>                                 | 0.1          | Typical FS rate, Section 2.4. |             |
| <b>Sensitive Species</b>                                | 0.032        | Section 4.3.2.4.              |             |
| <b>Tolerant Species</b>                                 | 0.064        | Section 4.3.2.4.              |             |
| <b>Annual Rainfall</b>                                  | <b>Clay</b>  | <b>Loam</b>                   | <b>Sand</b> |
| <b>Proportion lost</b>                                  |              |                               |             |
| 5   | 0.00e+00     | 0.00e+00                      | 0.00e+00    |
| 10  | 0.00e+00     | 0.00e+00                      | 0.00e+00    |
| 15  | 2.53e-02     | 0.00e+00                      | 0.00e+00    |
| 20  | 4.83e-02     | 0.00e+00                      | 0.00e+00    |
| 25  | 7.13e-02     | 0.00e+00                      | 0.00e+00    |
| 50  | 1.70e-01     | 2.79e-04                      | 0.00e+00    |
| 100   | 3.09e-01     | 1.57e-02                      | 0.00e+00    |
| 150   | 3.99e-01     | 2.39e-02                      | 0.00e+00    |
| 200   | 4.62e-01     | 2.72e-02                      | 0.00e+00    |
| 250   | 5.07e-01     | 2.86e-02                      | 0.00e+00    |
| <b>Functional Off-site Application Rate<sup>1</sup></b> |              |                               |             |
| 5   | 0.00e+00     | 0.00e+00                      | 0.00e+00    |
| 10  | 0.00e+00     | 0.00e+00                      | 0.00e+00    |
| 15  | 2.53e-03     | 0.00e+00                      | 0.00e+00    |
| 20  | 4.83e-03     | 0.00e+00                      | 0.00e+00    |
| 25  | 7.13e-03     | 0.00e+00                      | 0.00e+00    |
| 50  | 1.70e-02     | 2.79e-05                      | 0.00e+00    |
| 100   | 3.09e-02     | 1.57e-03                      | 0.00e+00    |
| 150   | 3.99e-02     | 2.39e-03                      | 0.00e+00    |
| 200   | 4.62e-02     | 2.72e-03                      | 0.00e+00    |
| 250   | 5.07e-02     | 2.86e-03                      | 0.00e+00    |
| <b>Sensitive Species -Hazard Quotient<sup>2</sup></b>   |              |                               |             |
| 5   | 0            | 0                             | 0           |
| 10  | 0            | 0                             | 0           |
| 15  | 8e-02        | 0                             | 0           |
| 20  | 2e-01        | 0                             | 0           |
| 25  | 2e-01        | 0                             | 0           |
| 50  | 5e-01        | 9e-04                         | 0           |
| 100   | 1.0          | 5e-02                         | 0           |
| 150   | 1.2          | 7e-02                         | 0           |
| 200   | 1.4          | 8e-02                         | 0           |
| 250   | 1.6          | 9e-02                         | 0           |
| <b>Tolerant Species - Hazard Quotient<sup>2</sup></b>   |              |                               |             |
| 5   | 0            | 0                             | 0           |
| 10  | 0            | 0                             | 0           |
| 15  | 4e-02        | 0                             | 0           |
| 20  | 8e-02        | 0                             | 0           |
| 25  | 1e-01        | 0                             | 0           |
| 50  | 3e-01        | 4e-04                         | 0           |
| 100   | 5e-01        | 2e-02                         | 0           |
| 150   | 6e-01        | 4e-02                         | 0           |
| 200   | 7e-01        | 4e-02                         | 0           |
| 250   | 8e-01        | 4e-02                         | 0           |

<sup>1</sup> The functional off-site application rate is calculated as the nominal application rate (specified above after the worksheet title) multiplied by the proportion lost in runoff.

<sup>2</sup> The hazard quotient is calculated as the functional off-site application rate divided by the NOEC value. The NOEC's are specified above on the lines following the application rate.

**Worksheet G05a:** Summary of Exposure Assessment and Risk Characterization for Terrestrial Plants from Drift After Low-Boom Ground Applications and Wind Erosion [TerrPlntWind].

|                                   | Most Sensitive Plant<br>(lb a.e./acre) | Note  |
|-----------------------------------|--|---|
| Most sensitive species            | 0.001                                  | NOEC for most sensitive species in vegetative vigor assay. Section 4.3.2.4. |
| Most tolerant species             | 0.032                                  | NOEC for most tolerant species in vegetative vigor assay. Section 4.3.2.4.  |
| Application Rate, lb<br>a.e./acre | 0.1                                    | See chemical specific notes   |

**Estimates of the proportion of offsite drift**

| Distance (feet) | Drift  | Terrestrial Drift based on<br>AGDRIFT using a low<br>boom ground sprayer.<br>See Worksheet A06 for<br>details and drift estimates<br>based on other methods<br>of application. |
|-----------------|--------|--|
| 25              | 0.0187 |  |
| 50              | 0.0101 |  |
| 100             | 0.0058 |  |
| 300             | 0.0024 |  |
| 500             | 0.0015 |  |
| 900             | 0.0008 |  |

**Estimates of functional offsite application rate**

| Distance (feet) | Rate (lb/acre) | Calculated as the product<br>of the application rate and<br>the estimated proportion<br>of offsite drift. |
|-----------------|----------------|---|
| 25              | 0.00187        |   |
| 50              | 0.00101        |   |
| 100             | 0.00058        |   |
| 300             | 0.00024        |   |
| 500             | 0.00015        |   |
| 900             | 0.00008        |   |

**Hazard Quotient - Sensitive Species**

|     |       |   |
|-----|-------|---|
| 25  | 1.9   | Calculated as the offsite<br>application rate divided<br>by the NOEC for the most<br>sensitive species. |
| 50  | 1.0   |   |
| 100 | 6e-01 |   |
| 300 | 2e-01 |   |
| 500 | 2e-01 |   |
| 900 | 8e-02 |   |

**Hazard Quotient - Tolerant Species**

| Distance (feet) |       | Calculated as the offsite<br>application rate divided<br>by the NOEC for the most<br>tolerant species. |
|-----------------|-------|--|
| 25              | 6e-02 |  |
| 50              | 3e-02 |  |
| 100             | 2e-02 |  |
| 300             | 7e-03 |  |
| 500             | 5e-03 |  |
| 900             | 3e-03 |  |

**Worksheet G05b:** Summary of Exposure Assessment and Risk Characterization for Terrestrial Plants from Drift After Aerial Applications [TerrPlntAirDrift].

| Most Sensitive Plant      |       |   |
|---------------------------|-------|---|
| Most sensitive species    | 0.001 | NOEC for most sensitive species in vegetative vigor assay. Section 4.3.2.4. |
| Most tolerant species     | 0.032 | NOEC for most tolerant species in vegetative vigor assay. Section 4.3.2.4.  |
| Application Rate, lb/acre | 0.1   | See chemical specific notes   |

**Estimates of the proportion of offsite drift**

| Distance (feet) | Drift  | Estimated based on  |
|-----------------|--------|---|
| 25              | 0.1434 | AgDrift defaults – Air Tractor AT-401, water, 8 ft. boom height, 4 mph wind speed. A large number of options are available in AgDrift for different weather conditions, pesticide mixtures, and aircraft. |
| 50              | 0.0518 |   |
| 100             | 0.0195 |   |
| 300             | 0.0042 |   |
| 500             | 0.0022 |   |
| 900             | 0.0009 |   |

**Estimates of functional offsite application rate**

| Distance (feet) | Rate (lb/acre) |  |
|-----------------|----------------|--|
| 25              | 0.01434        | Calculated as the product of the application rate and the estimated proportion of offsite drift. |
| 50              | 0.00518        |  |
| 100             | 0.00195        |  |
| 300             | 0.00042        |  |
| 500             | 0.00022        |  |
| 900             | 0.0000900      |  |

**Hazard Quotient - Sensitive Species**

|     |       |  |
|-----|-------|--|
| 25  | 14    | Calculated as the offsite application rate divided by the NOEC for the most sensitive species. |
| 50  | 5     |  |
| 100 | 2     |  |
| 300 | 4e-01 |  |
| 500 | 2e-01 |  |
| 900 | 9e-02 |  |

**Hazard Quotient - Tolerant Species**

| Distance (feet) |       | Calculated as the offsite application rate divided by the NOEC for the most tolerant species. |
|-----------------|-------|---|
| 25              | 4e-01 |   |
| 50              | 2e-01 |   |
| 100             | 6e-02 |   |
| 300             | 1e-02 |   |
| 500             | 7e-03 |   |
| 900             | 3e-03 |   |

## STANDARD REFERENCES FOR WORKSHEETS

- {Boxenbaum and D'Souza. 1990} Boxenbaum J; D'Souza R. 1990. Interspecies pharmacokinetic scaling, biological design and neoteny. *Adv. Drug Res.* 19: 139-195.
- {Burnmaster. 1998} Burnmaster DE. 1998. Lognormal distribution for total water intake and tap water intake by pregnant and lactating women in the United States. *Risk Analysis.* 18(5): 215-219
- {Dunning. 1993} Dunning JB. 1993. *CRC Handbook of Avian Body Masses.* CRC Press, Boca Raton FL, 371 pp.
- {Durkin et al. 1995} Durkin PR; Rubin L; Withey J; Meylan W. 1995. Methods of assessing dermal absorption with emphasis on uptake from contaminated vegetation. *Toxicol. Indust. Health.* 11(1): 63-79.
- {Fletcher et al. 1994} Fletcher JS; Nellessen JE; Pfleeger TG. 1994. Literature review and evaluation of the EPA food-chain (Kenega) nomogram, an instrument for estimating pesticide residues on plants. *Environ. Toxicol. Chem.* 13(9):1383-1391.
- {Harris and Solomon. 1992} Harris SA; Solomon KR. 1992. Human exposure to 2,4-D following controlled activities on recently sprayed turf. *J. Environ. Sci. Health.* B27(1): 9-22.
- {Hoerger and Kenaga. 1972} Hoerger F; Kenaga EE. 1972. Pesticide residues on plants: Correlation of representative data as a basis for estimation of their magnitude in the environment. In: *Environmental Quality and Safety, Volume I: Global Aspects of Toxicology and Technology as Applied to the Environment.* F. Coulston and F. Kerte (eds.). Academic Press, New York, NY. pp. 9-28.
- {ICRP. 1975} ICRP (International Commission on Radiologic Protection). 1975. Report of the Task Group on Reference Man. Recommendations of the International Commission on Radiological Protection (ICRP) Publ. No. 23. Pergamon Press, New York, NY.
- {Knisel et al. 1992} Knisel WG; Davis FM; Leonard RA. 1992. GLEAMS Version 2.0 User Manual. U.S. Department of Agriculture, Agricultural Research Service, Southeast Watershed Research Laboratory, Tifton, GA. 202pp. {}
- {Manugistics. 1995} Manugistics. 1995. Statgraphics Plus for Windows. Version 3. Available from Manugistics, Inc. Rockville, Maryland.
- {Mason and Johnson. 1987} Mason RW; Johnson BL. 1987. Ergonomic factors in chemical hazard control. In: *Handbook of Human Factors.* Salvény, G; ed. John Wiley and Sons, New York, NY. pp. 772-741.
- {Mendenhall and Scheaffer. 1973} Mendenhall W; Scheaffer RF. 1973. *Mathematical Statistics with Applications.* Duxbury Press, North Scituate, Massachusetts. 461 pp. plus appendices.
- {Ruffle et al. 1994} Ruffle B; Burnmaster DE; Anderson PD; Gordon HD. 1994. Lognormal distributions for fish consumption by the general U.S. population. *Risk Analy.* 14(4): 395-404.
- {SERA. 1997} SERA (Syracuse Environmental Research Associates, Inc.). 1997. Reevaluation of Methods for Assessing Worker Exposure to Pesticides, SERA TR 96-21-08-01, draft dated December 31, 1997. Prepared under USDA/FS Contract 53-3187-5-12. Syracuse Environmental Research Associates, Inc., Fayetteville, NY.
- {SERA. 2001} SERA (Syracuse Environmental Research Associates, Inc.). 2001. Preparation of Environmental Documentation and Risk Assessments, SERA MD 2001-01a, draft dated July 2001. Syracuse Environmental Research Associates, Inc., Fayetteville, NY. Available at [www.sera-inc.com](http://www.sera-inc.com) {}

{Teske et al. 2001} Teske ME; Bird SL; Esterly DM; Ray SL; Perry SG. 2001. A User's Guide for AgDRIFT 2.0: A Tiered Approach for the Assessment of Spray Drift. Continuum Dynamics, Inc. Public Use Version. C.D.I. Report No. 01-01. Available, with executable model at: <http://www.agdrift.com/> {}

{USDA. 1989a} USDA (U.S. Department of Agriculture/Forest Service). 1989a. Final Environmental Impact Statement: Vegetation Management in the Coastal Plain/Piedmont, Management Bulletin R8-MB-23, dated January, 1989. 1213 pp.

{USDA. 1989b} USDA (U.S. Department of Agriculture/Forest Service). 1989b. Draft Environmental Impact Statement: Vegetation Management in the Ozark/Ouachita Mountains, Management Bulletin R8-MB-23, dated June, 1989. 499 pp.

{USDA. 1989c} USDA (U.S. Department of Agriculture/Forest Service). 1989c. Final Environmental Impact Statement: Vegetation Management in the Appalachian Mountains, Management Bulletin R8-MB-38, dated July, 1989. 1104 pp.

{U.S. EPA/OPP. 1999} U.S. EPA/OPP ((U.S. Environmental Protection Agency/Office of Pesticide Programs). 1999. ECOFRAM: Terrestrial ECOFRAM Terrestrial Draft Report. Ecological Committee on FIFRA Risk Assessment Methods(ECOFRAM). Report dated May 10, 1999. Available at: <http://www.epa.gov/oppefed1/ecorisk/terreport.pdf>.

{U.S. EPA/ORD. 1992} U.S. EPA/ORD (U.S. Environmental Protection Agency/Office of Research and Development). 1992. Dermal Exposure Assessment: Principles and Applications. EPA/600/8-91/011B. Interim Report. Exposure Assessment Group, Office of Health and Environmental Assessment, Washington, DC.

{U.S. EPA/ORD. 1993} U.S. EPA/ORD (U.S. Environmental Protection Agency/Office of Research and Development). 1993. Wildlife Exposure Factors Handbook. Volumes 1 and 2. EPA/600/R-93/187a,b. Pagination not continuous. Available NTIS: PB94-174778 and PB94-174779.

{U.S. EPA/ORD. 1996} U.S. EPA (U.S. Environmental Protection Agency/Office of Research and Development). 1996. Exposure Factors Handbook. National Center for Environmental Assessment, U.S. EPA, Washington, DC. EPA/600/P-95/002Ba-c. Avail. NTIS: PB97-117683, 97-117691, PB97-117709.

{Wolfram Research. 1997} Wolfram Research. 1997. Mathematica Version 3.0.1. Available from Wolfram Research, Inc. Champaign, IL.