I. Revised OP Cumulative Risk Assessment

H. Risk Characterization

1. Introduction

Risk characterization is the interpretation phase of the assessment process. Appropriate interpretation of results is particularly important for an assessment as complex as the OP cumulative risk assessment. Many types of data, derived from a variety of sources, have been combined to produce highly detailed estimates of risk from multiple OPs in food, drinking water or from residential use. The outputs of the assessment should be evaluated in a variety of ways. Potential biases in input parameters, the direction of the bias, and the uncertainty surrounding the inputs and the exposure model must be considered with regard to their potential impact on the results of the assessment.

OPP has attempted to reflect the completed risk mitigation measures from the single-chemical assessments. OPP will continue to make risk decisions about individual pesticides over the next months. Changes resulting from risk mitigation measures completed through March 2002 have been included in this assessment. Modifications in OP use patterns made after that date can be incorporated after they occur. The current document presents the estimates of risk associated with exposures to OPs in food, drinking water and from residential uses of OPs. The current assessment has used two modes of analysis (single-day and 7-day)to provide bounding estimates of potential exposures, and also reflects the risk estimates at a variety of percentiles of exposure. In addition, analyses were performed for periods of 14 days and 21 days to demonstrate that extending the averaging time for the risk assessment has little impact on the results obtained. The detailed results of this assessment are presented as a plot of MOEs over a period of 365 days. Contributions from various pathways and routes of exposure are arrayed separately. The results are presented graphically for the seven Regions, for the 1-2 year old and 3-5 year old age groups (Appendix III.J.2 to III.P.2). Data output tables for the 20 to 49 year old and 50+ groups are presented as spreadsheets (Appendix III.J.3) The results presented are based on a one day and seven day rolling average. For Region A the assessment also presents the 14 and 21 day rolling average results for the 1-2 and 3-5 year old groups. **No single value in the assessment should be used to independently arrive at the interpretation of the results.** As discussed below, interpretation of the assessment depends upon the synthesis of a vast body of information about the input data and the processing of that data to determine whether an acceptable risk has been achieved. A number of crop/chemical combinations in the food assessment and one chemical/use combination in the residential risk assessment warrant additional scrutiny in determining any future activities arising from this assessment.

2. Hazard and Dose-Response Assessment

The hazard and dose-response assessment is presented in detail in section I.B. That section outlines the steps in developing the dose-response relationships for each pesticide and its capacity to inhibit acetylcholinesterase in the brain of female rats. It includes a description of all of the data used in the dose-response analyses. Reasons for the selection of methamidophos as the index chemical for the OP cumulative risk assessment are also discussed. Finally, section I.B. describes the exponential dose-response model used to develop the dose response curves that provided the basis for developing the relative potency factors (RPF) for each chemical and the points of departure (POD) for the index chemical for each route of exposure (i.e., oral, dermal, and inhalation).

a. Acetylcholinesterase Inhibition: Data Quality & Common Effect

The first step in deciding that a cumulative risk assessment was needed was the determination that the OPs were toxic by a common mechanism, i.e., cholinesterase inhibition. This determination was made and subjected to peer review by the Scientific Advisory Panel in 1998 (http://www.epa.gov/scipoly/sap/1998/march/comec.htm). Once a common mechanism was identified, the next step in the process was to select an appropriate method for combining the risks from exposures to several pesticides from more than one source/route. A large body of data describing the inhibition of acetylcholinesterase in plasma, red blood cells and brain has been generated for each registered OP. OPP has elected to use the brain acetylcholinesterase data from female rats as the basis for developing RPFs and PODs for use in the assessment. The choice addressed a number of the concerns raised by the SAP and the public. Brain acetylcholinesterase inhibition is the endpoint used because it reflects a response in a target tissue of concern that is relevant to humans. Although RBC and plasma cholinesterase inhibition do reflect exposure to OPs and, therefore, the potential for adverse effects, brain acetylcholinesterase inhibition is an indication of direct effects upon the brain itself. Error due to the extrapolation between the response in a surrogate tissue (i.e., red blood cell and plasma) and a target tissue itself (brain) is eliminated. In addition, the data for the brain compartment have very narrow confidence limits when compared to those from the plasma and RBC compartments, suggesting that there is much less variability in this compartment across the data base.

This assessment uses the Relative Potency Factor (RPF) approach which applies dose addition. Briefly, the RPF approach uses an index chemical as the point of reference for standardizing the common toxicity of the chemical members of the cumulative assessment group (CAG). Relative potency factors (i.e., the ratio of the toxic potency of a given chemical to that of the index chemical) are then used to convert exposures of all chemicals in the CAG into exposure equivalents of the index chemical. The RPF approach

utilizes dose-response information to provide an estimate of each OP's potency for the common toxicity, and thus allows for the quantification of exposure as it relates to the joint risk of the CAG. OPP selected the relative potency factor approach based upon the relatively rich oral toxicity data base on cholinesterase inhibition available for the OPs which permitted consideration of the entire dose-response curve for each pesticide rather than only focusing on NOAELs that are a function of study design. Although a biological or pharmacokinetic modeling approach would have advantages in determining the cumulative risk for these OPs, the input parameters for such an approach are not available. Thus, the pharmacokinetic (PK) characteristics of the OPs could not be incorporated in the dose-response assessment which would allow for a more refined estimate of the combined risk to humans. Therefore, OPP has applied simple dose addition and used an empirical curve fitting model (i.e., the exponential model described below) to determine RPFs and PODs.

b. Exponential Dose-Response Model

OPP, in collaboration with ORD, developed an exponential model to describe the oral dose response curves for each OP that permitted fitting of a combination of cholinesterase (ChE) activity data from different studies. This model has been subjected to public comment and peer review by the SAP (http://www.epa.gov/scipoly/sap/2001/september/finalreport.htm). Although a PK model is the ideal approach, the SAP regarded the exponential model (with their recommended improvements) to be appropriate for the data being analyzed for derivation of relative potency factors and points of departure. OPP has responded to the SAP recommendations on the exponential model by making modifications to address the issues raised. One issue was that the original model did not appropriately reflect cholinesterase inhibition at very low doses. The revised statistical model now incorporates, to the extent supported by the data, a flat region at the low dose portion of the dose response curve. Another issue raised by the SAP concerned the derivation of the factor "B". The B value is the limiting value for the maximum cholinesterase inhibition (called the horizontal asymptote). The SAP raised the issue that the weighting strategy used for calculating the "B" which assumed 100% cholinesterase inhibition (i.e., 0% ChE activity) did not adequately reflect the actual B value for each OP (the B value was often less than 100% inhibition at the asymptote). The revised approach has been modified in order to generate B values for each OP reflective of its dose-response data.

OPP assumed dose additivity by application of a single model to all of the OP's dose-response curves. There is some uncertainty surrounding the assumption of dose additivity given that the B values (horizontal asymptotes) are heterogeneous among the OPs analyzed. This heterogeneity is indicative that the dose-response curves are not parallel and, therefore the application of simple dose addition is only an approximation of joint risk and may not be

precise. Dose additivity assumes that the common mechanism chemicals behave in a similar fashion (i.e., same pharmacokinetics and pharmacodynamics) and that their dose response curves will be parallel (i.e., the ratio of their relative toxic potencies remain the same throughout their dose range). The underlying biological processes that determine the toxic potency of each OP are extremely complex and involve several metabolic systems in different organs as well as re-synthesis rates of the different cholinesterases. The activation and/or deactivation rates differ for some of these OPs. However, because of insufficient data, these pesticides can not be separated into subgroups based on pharmacokinetic and pharmacodynamic characteristics. Thus, current information on OP pharmacokinetics and pharmacodynamics cannot provide a sufficient basis to depart from the assumption of dose additivity. Also, available studies on OP mixture interactions do not provide a sufficient basis for departure from dose additivity.

In summary, OPP believes that the model fitting procedure used in this assessment provides reliable estimates of relative potency and points of departure. The cholinesterase data used for the oral route of exposure was quite extensive and, in general, of good quality for dose-response modeling. The data for the inhalation and dermal routes tended to be less extensive and not as robust for dose response modeling. OPP has refined the dose response modeling for the oral dose by incorporating the SAP recommendations in its dose response assessment of these OPs. OPP has attempted to address uncertainty in extrapolating to lower human exposures by the revised model and by using a low model estimate (BMD10) to develop OP relative potency factors. OPP acknowledges that there is uncertainty that dose addition applies to all of these OPs at human exposure levels. In the absence of data to the contrary, however, dose additivity is assumed. OPP realizes that the assumptions of additivity and the dose response modeling used in this assessment may slightly overestimate response due to the assumption that response will be uniform regardless of the underlying background exposure level.

A BMD10 was selected as the basis for comparison of the dose-response curves for the OPs. OPP's goals in selecting a point of comparison were to choose a point in the observed response range, but low enough on the curve to reduce the impact of any lack of proportionality between response that might result from deviation from the assumption of proportionate dose response between OPs. In addition, OPP was concerned that the magnitude of the response (cholinesterase inhibition) be sufficient to ensure that it was reliably distinguishable from background. A power analysis of the data used in deriving the 21-day steady state determination indicated that there was insufficient power to distinguish the change in cholinesterase inhibition reliably below 10% inhibition. In addition, OPP has used the central estimate of the BMD10 instead of the BMDL generally used for single chemical assessment. This decision reflects the complexity brought to the analysis by the joint

consideration of multiple studies for multiple chemicals. The use of the BMDL has been suggested for those instances in which single studies are modeled to provide an indication of a reasonable lower limit on response. In the OP cumulative risk assessment, the results of several studies were combined, introducing the potential for inappropriately broadening the confidence limits about the BMD10 and making the BMDL a likely underestimate of the POD for each chemical. These considerations strengthened the case for selection of methamidaphos as the index chemical because the BMD10 and the BMDL were very similar suggesting a very good fit of the data to the model.

c. Selecting the Index Chemical

OPP selected methamidophos as the index chemical for the current assessment. Methamidophos has sufficient data for cholinesterase inhibition to support modeling of a BMD10 by all three routes of exposure. The high quality dose response data for methamidophos permits reliable estimates of PODs for all routes without resorting to the use of the less precise NOAELs. Certainty in the PODs was considered to be of great importance in as much as they will impact the outcome of the assessment to a greater extent than any other aspect of the toxicity data base.

d. Use of Steady State

During the data evaluation phase, OPP elected to use only those data points that resulted from exposure of rats for 21 days or longer. This choice was made for a number of reasons. First, because of the many agricultural uses of OPs and the resulting residues that occur in food and water, and also the application of OPs in homes across the US (as reflected in the assessment), the likelihood of encountering an exposure to OPs with no prior recent exposure was considered to be small. Therefore, the use of single-day toxicity data was considered inappropriate. Further, following exposure to an OP, regeneration of cholinesterases to pre-exposure levels occurs in the time scale of days to weeks, not a single day, making the exposed individual potentially more vulnerable to subsequent exposures during that period. Examination of the rat data suggested that for most pesticides, cholinesterase inhibition reached steady state approximately by 21 to 30 days after the start of dosing. After that point, little change occurred in the degree of inhibition resulting from continued administration of the dose for a longer period. OPP selected 21 days as a reasonable time point to assume that steady state had been achieved. For the purposes of this discussion, steady state is defined as the point at which further inhibition of the enzyme is offset by regeneration of the enzyme and equilibrium has been achieved. All of the pesticides considered have very stable, reproducible levels of cholinesterase inhibition in all compartments measured.

The selection of the data set to support the steady state decision hinged upon two determinations about the data available. The first was the

evaluation of rate of change in cholinesterase inhibition as discussed above. The second was the decision that a 10% inhibition of brain cholinesterase was a tolerable level of inhibition that was unlikely to result in an unacceptable adverse outcome for the exposed individual. This decision is the more critical in determining the application of the hazard data to the running time frame approach than the actual selection of the time point of determining the extent of inhibition. The application of a steady state approach is predicated on the assumption that the extent of cholinesterase inhibition on any given day reflects the balance between prior exposures and the extent of recovery experienced. The processes of inhibition and recovery are balanced in the rat data as they are in exposed human populations. The major distinction between the steady state data from the rat studies and the likely inhibition in the exposed population is that the actual dose to the rat on any day and on preceding days is known. In the human population, the prior exposures can not be known with certainty. However, as demonstrated by the current exposure assessment, the prior exposures may be either higher or lower than for the current day. OPP believes that the use of steady state data is consistent with the results of biomonitoring data available in the literature. There is a body of evidence that indicates a sizeable proportion of the US population has a fairly constant background exposure to OPs. This is evident from the results of the NHANES III in which 82% of people who provided urine samples for analysis were found to be positive for trichloropyridinol, a metabolite of the OPs chlorpyrifos and chlorpyrifos-methyl (Hill et al., 1995). Further examination of the NHANES III data indicate that a sizeable proportion of the population have metabolites in their urine that are not compound specific, but are associated with other OPs. Preliminary analyses of data collected under the auspices of NHEXAS also indicate that metabolites from a variety of OPs are found in urine from populations of adults and children sampled around the US.

The use of 21-day steady state data in rats may over- or understate the potential for cholinesterase inhibition based upon exposure in the current day combined with residual effects from the preceding day(s). The extent and direction of the error can not be known, however, data pertaining to prior exposure to OPs such as those cited above reflect a pattern of exposure to humans that is qualitatively different from the repeated daily dosing used in rat feeding studies and therefore there is a possibility that risk is overstated. The use of the 21-day steady state data fixes the estimate of dose relating to a 10% cholinesterase decrement and permits a reasonable estimate of risk from exposure to OPs.

This finding was important in determining the appropriate manner in which to incorporate the available acetylcholinesterase inhibition data into the hazard assessment. In conjunction with the understanding that the period of reversibility for OP-induced cholinesterase inhibition is on the order of several days to weeks, it provides a reasonable basis for the decision to use steady state measures of cholinesterase inhibition as the basis for OPs RPFs and

the PODs for methamidophos. It also supports the need to consider multiple modes of exposure, focusing on both more extreme episodic exposures as well as longer term average exposures. These two modes of analysis when used together acknowledge the potential for continuous exposure over an extended period of time while allowing an evaluation of the potential impact of periods of elevated OP exposure.

In summary, OPP has taken steps to address the most significant methodological issues raised concerning the dose response assessment developed in support of the OP cumulative risk assessment. OPP is confident that the assessment as performed is scientifically and statistically sound and based upon a reliable data set.

3. Use of Calendex and the Mode of Analysis

The use of Calendex in conducting the current assessment is described in section I.F of this document. Calendex permits the simultaneous evaluation of more than one pathway of exposure. It also permits the evaluation of exposure on a calendar basis, considering changes in exposure patterns with season as pest pressures change. In the December 3 Preliminary OP Cumulative Risk Assessment, OPP demonstrated the use of Calendex to develop a distribution of linked single-day exposures. This approach to estimating an annualized distribution of exposures for use in risk assessment received numerous public comments and reviews from the FIFRA Scientific Advisory Panel.

The single day analysis approximates an analysis similar to that performed for acute dietary evaluations in single-chemical assessments. As in the acute dietary analyses, a full range of inputs for dietary residues is paired with the individual consumption records from the CSFII. In addition, a water concentration value is paired with the water consumption value developed as described in section I.E. Finally, an estimate of exposure from residential sources is calculated and combined to develop an estimate of the total MOE. A distribution of total MOEs is generated for each day of the year. A series of percentiles are then selected for each day to evaluate potential risk concern for the combined uses of the OPs. This analysis assumes that the potential exists to experience a high-end exposure on every day of the year. In the current assessment, values are presented for the 99.9^{th}, 99.5^{th}, 99^{th}, and 95^{th} percentiles of exposure.

OPP developed a second assessment considering the potential risk from a series of 7-day rolling averages across the year. This process is described in section I.F. This analysis is an attempt to better match the time frames for the toxicity data with the consumption data which are not directly comparable. The toxicity data used in the assessment are based upon 21 days of exposure to rats in feed. This data reflects steady state measures of cholinesterase inhibition and is readily available for all OPs. Food consumption data are available only on a single-day basis. The 7-day average allows for consideration of the variable

nature of likely exposures to an individual across time. It permits consideration of the impact of varying exposure in the diet and from residential uses of OPs from day to day. OPP also investigated the potential impact of longer averaging times (14 and 21 days) on the results of the risk assessment. The longer averaging times resulted in incrementally small decreases in the estimated risk, with the effect of duration decreasing with increasing time. This behavior is not unexpected in that with longer averaging time, the exposure will approach the mean exposure for the output distribution. However, the longer time frames will further obscure any time-related variability in exposure. The use of the 7-day rolling average provides a more realistic profile of exposure across a series of multi-day exposures while maintaining some sense of anticipated variability.

OPP believes that the results of the single day and 7-day analyses successfully bound the anticipated exposures resulting from residues of multiple OPs in food. The one-day analysis assumes that an individual is exposed to OP exposures from the tail of the distribution every day. This assumption overestimates risk. The seven-day analysis incorporates day-to-day variability in exposure and is more representative of anticipated exposures. The major sources of difference in the results of the two analyses arise from differences in how the data is incorporated into the analyses and the ability to reflect day to day variability. The differences are: the selection process for the two days of CSFII data, the assumption of independence of residue data inherent in the use of the PDP data in the assessment, and the inability of the approaches to allow for carryover cholinesterase inhibition from prior exposures.

a. Use of CSFII Data

In the single day analysis, one diary for each individual in the CSFII is selected to be paired with a randomly selected set of residue values for each food consumed. A set of exposures from OPs in foods is developed and arrayed as a distribution from high to low exposures. This type of assessment assumes that the consumption of foods from one day to another is independent, with no consideration of the potential for eating leftovers or consuming foods purchased in bulk such as juices or potatoes. As a result, the assessment over emphasizes variability in the diet. This factor may bias the exposure assessment up or down depending the food/pesticide combination that is not repeated appropriately. The magnitude of the effect also will vary depending upon the specific food/pesticide combination.

The use of the CSFII data in the 7-day rolling average consists of a random redraw of the two available days of consumption data for each person in the data base. This process is intended to maintain the integrity of the data for individuals, including to the extent possible, any information defining patterns of diet peculiar to them. However, the redraw process results in the implicit assumption that every individual in the CSFII consumes a diet that is limited to the records in the diaries repeated randomly across the year. As a result, the variability likely to occur in the diet is not fully expressed in the

current risk assessment. This factor is expected to reduce the range of exposures to which any particular individual can be exposed by limiting the number of commodities and pesticides possible to those reported in the two daily diaries. This factor is anticipated to introduce a downward bias into the exposure assessment. However, the impact on the assessment is anticipated to be small because all possible combinations of exposures are still available. The shape of the final distribution may be modestly affected by the difference in averaging that occurs due to the reduction in combinations available, but the exposure estimates at the upper percentiles of exposure should not be significantly affected.

b. Use of PDP Data

PDP data are used for most of the pesticide residues in food assessment. These data are introduced into the assessment in a manner that imposes the assumption that all eating days are independent with regard to the source of food consumed. In fact, consumption on any given day may not be independent of preceding days to the extent that individuals consume bulk items such as juice, bunches of grapes, or bags of produce or left-overs that have the same level of residues on multiple days. As a result, exposure from items of these types may be under represented in the single day and 7-day rolling analyses to the extent that a high end residue may be selected on one day, but not resampled on the subsequent days. As result, these assessments may be biased downward with respect to the exposure estimates developed, although the magnitude of the error is not known.

c. Impact of Residual Cholinesterase Inhibition

Cholinesterase inhibition resulting from OP exposure is not immediately reversible. OPs bind covalently to the active site of the enzyme. Recovery is largely due to regeneration of the enzyme rather than dissociation. As a result, the recovery time (time required for cholinesterase levels to return to pre-exposure levels) is extended, requiring on average 1 to 2 weeks in humans. As a result, the cholinesterase inhibition experienced on any given day is the sum of inhibition from that day's exposure combined with residual inhibition due to exposure on the preceding several days. As each day passes, the importance of inhibition from any given preceding day declines until it is fully reversed. The single day analysis does not incorporate an estimate of the phenomenon. This results in a downward bias of unknown magnitude. The magnitude of the bias will be dependent on the likelihood of exposures on previous days. The Calendex model attempts to incorporate some aspect of the prior exposure in the 7-day rolling average approach by allowing for the combined exposure over a 7-day period of time. To this extent, Calendex captures the carryover aspect of **exposure** to pesticides. However, this approach can not account for the biological aspect of declining importance of an exposure with the passage of time. It also de-emphasizes the impact of intermittent high exposures as they are averaged into the

background. To the extent that Calendex can not reflect this aspect of the impact of exposure to OPs, the 7-day rolling average will tend to be biased downward with regard to the estimate of risk from exposure to OPs.

4. Food Assessment

The food component of the OP cumulative risk assessment is based primarily upon two extensive, reliable data sets: 1) USDA's Pesticide Data Program, and 2) USDA's Continuing Survey of Food Intakes by Individuals, 1994 -1996 + 1998 (CSFII). The PDP data provide a very reliable estimate of pesticide residues in the major children's foods. They also provide an indication of the co-occurrence of OPs in the same sample, alleviating much of the uncertainty about co-occurrence in foods that are monitored in the program. The CSFII provides a detailed representation of the food consumption patterns of the US public across all age groups, during all times of the year and across the 48 contiguous states. These two data components provide a firm foundation upon which to assemble other data to develop the OP cumulative risk assessment.

a. Consumption Data

Up until this time, OPP has performed its risk assessments using the 1989-91Continuing Survey of Food Intakes by Individuals (CSFII). This survey was conducted by USDA and was based on responses over three consecutive days. A more recent CSFII was performed (the 1994-96 CSFII) which was supplemented in 1998 by the Supplemental Children's Survey. This 1998 survey focused on children from birth to 9 years old and greatly expanded the number of birth to 4 year old children in the survey data base. Importantly, the Supplemental survey was designed in a manner such that the results from the 1998 CSFII survey could be combined with the 1994-96 survey. OPP believes that the newer survey information provides a more realistic estimate of potential risk concerns because it reflects the current eating habits of the US public. Based in part on past recommendations of the FIFRA Scientific Advisory Panel and other advisory bodies, based in part on OPP analyses of dietary and behavioral patterns, and based in part on a minimum number of individuals needed to provide a good representation of eating patterns, OPP has determined that the following age groupings are appropriate for the cumulative assessment: birth to 1 year of age (i.e., 0 - 11 months); 1 to 2 year of age (i.e., 12 - 36 months); 3 through 5 years of age; 6 through 12 years of age; 13 through19 years of age; 20 through 49 years of age; and 50 years of age and greater.

For this assessment, the following age groups were analyzed for all regions: 1 to 2 years of age; 3 through 5 years of age; 20 through 49 years of age; and 50 years of age and greater. These age groups were selected because the other age groups are rarely the most highly exposed in the single-chemical assessments. For Region A, all subpopulations were evaluated to confirm this assertion. Region A was selected as an appropriate

analysis to demonstrate the impact of a variety of parameters within the assessment because it consistently demonstrates the highest exposures and risks estimated for regions across the US. The change to the more refined age groupings should improve our ability to identify age-related differences in food consumption (especially among young children). The use of the newer CSFII and the finer age breakouts should increase the accuracy and utility of the risk assessment overall by making it more descriptive of the anticipated exposures and risks for each age group.

OPP is confident that the consumption data available from the CSFII permit a reasonable basis for estimating exposure to OPs in foods. The data are used empirically in combination with residue values to estimate exposure. As a result, no issues relating to the appropriateness of curve fitting procedures have been introduced into the assessment. OPP also believes that an adequate number of samples are available to support estimation of exposure. Approximately 4000 consumption days for 2000 individuals are available for each subpopulation. This body of data is sufficient to support simulation well out into the tails of the exposure distribution with little concern for overestimation of consumption. However, as is the case with all sampling protocols, the proportion of samples available declines toward the extremes of the output distribution. As a result, extreme output distribution values are less well represented than those reflecting the central tendency for the output distribution. OPP acknowledges that the use of CSFII in this assessment may not fully reflect the eating habits of high end eaters, introducing some uncertainty with respect to the tails of the distribution of estimated exposures in the assessment.

b. PDP Monitoring Data in the Assessment

The use of PDP as a source of residue data has a number of inherent benefits that preclude the need for the use of conservative assumptions in the assessment. PDP provides a direct measure of the occurrence of more than one OP in any sample analyzed. OPP can use these data as an indication of pesticide co-occurrence likely to be encountered in foods. OPP assumes that co-occurrence mirrors the PDP values; in fact PDP composites contain multiple individual units which may have different profiles of co-occurrence. Therefore, use of PDP data in this manner may overstate potential risk. PDP implicitly reflects the percent of a crop that has been treated with any given OP by measurement of the residues.

Samples with non-detectable residues are assumed to be "zero" values in this assessment. The impact of this assumption was tested in the OP Cumulative Risk Case Study (USEPA, 2000c) that was presented to the SAP in December 2000. In the Case Study, a similar use of PDP data as the residue data source in this assessment was demonstrated for 24 OPs. The resulting data set had characteristics very similar to the one used in the current assessment. The analysis performed demonstrated that the use of

the "zero" values had only negligible impact on the MOEs developed at the upper percentiles of exposure.

Although the result of replacing all non-detectable residues with "zero" values would intuitively suggest an under-estimation bias, OPP has demonstrated through its case study that this change has little impact at all on the portion of the exposure curve likely to be used for regulatory purposes. This result is not surprising for a multiple chemical assessment addressing the number of chemicals under evaluation here. This assessment combines many data elements, with no single chemical or commodity dominating the exposure. The residue data used in this assessment include highly consumed foods, and several of these have large numbers of detects as well as a few high detects of OPs. There are detectable residues of at least one OP on 25% of the samples used in this assessment with a high of 66% on one commodity. Generally, the LODs for PDP data are very low (the average LOD for the entire data base is about 0.01 ppm). Therefore, it seems reasonable that the effect of assumptions related to estimation of values below the LOD would not significantly influence exposures at the highest percentiles of exposure. This result may not be the case for other assessments containing fewer foods or lower levels of detectable residues and should be evaluated for each subsequent case.

c. Data Translation from PDP

Not all foods to which OPs are applied are monitored in PDP. OPP has developed a scheme by which commodities that are measured by PDP serve as surrogate data sources for commodities that are not. This approach is outlined in OPP/HED SOP 99.3 (USEPA, 1999b). It is based upon the concept that families of commodities with similar cultural practices and insect pests are likely to have similar pesticide use patterns. Although this approach is generally sound, it introduces uncertainty with regard to how similar the use patterns for a given pesticide are to those for even closely related commodities.

For example, the same OP may be applied on a similar time schedule. However, the rates of application may differ between the crops treated. The number of treatments may also differ for application to the two crops. This issue is of importance to consider when conducting sensitivity analyses of the results of the risk assessment. When the data are adapted for the use of several chemicals simultaneously, and estimates of co-occurrence are derived from that data, the likelihood of an inappropriately assigned residue becomes greater. Although the commodities may have similar cultural practices, they may differ in the number of OPs registered for these uses. In addition, the translation from one commodity to another implicitly assigns the inherent percent crop treated information from one commodity to another. The direction and magnitude of this error will differ from one commodity to another.

OPP believes that this potential source of error in its assessment will most likely result in over-estimation bias. However, the magnitude of the error is probably not great in that the commodities for which PDP data was translated represent only ~1% of a child's diet.

d. Other Sources of Residue Data

PDP data and surrogate PDP data do not cover all commodities of interest. For meats, seafood and eggs, FDA's Total Diet Study and FDA Monitoring data provided residue estimates. These data suggest that eggs and seafood contain negligible residues. For most meats (beef, pork, sheep and goat), the maximum residue from the Total Diet Study was used. Although the use of the maximum residue as a single data point for meats is an overestimate, OPP has conducted a sensitivity analysis making all residues for meats zero and found that there was no change in the outcome of the risk assessment at the upper percentiles of exposure. This is not surprising in that the highest residue observed is itself very low. Therefore, OPP considers these factors neutral with regard to their impact on the results of the assessment.

Approximately 3% of the foods consumed by children 1 - 2 years of age still remained unaccounted for after using FDA Total Diet Study and FDA Monitoring data. Sugar, molasses and syrups were assigned a residue value of zero. These products are highly processed commodities that are unlikely to retain any significant residues following the processing steps. The limited data from the Total Diet Study found no residues in pancake syrup or sugar. No data are available for field corn or dried beans. However, these commodities are also blended and highly processed before consumption. OPP believes that omission of these foods from the assessment will not result in any change in the results of the assessment.

e. Impact of Regulatory Actions

Inherent in the use of monitoring data to estimate future residues is the concern that any changes in use patterns will not be reflected in the data. The OPs are currently undergoing use changes as a result of the individual chemical decisions. In most cases for which legal agreements have been signed, the uses have been removed from the assessment. For other pesticides, pre-harvest intervals have been extended or rates have already been reduced. These changes are not reflected in the assessment as they are not yet apparent in the monitoring data available. A specific example of this issue is the rate reductions agreed upon for azinphos-methyl on apples in 1999. Although the rate reductions have been implemented, they will not be reflected in monitoring data until the 2002 PDP data become available. This delay reflects the year lag in affecting a new growing season following implementation as well as the long period during which treated apples can remain in the chain of commerce following harvest.

Decisions have not been completed for all OPs included in this assessment. Completion of the regulatory process for these pesticides could result in additional exposure and risk reduction measures. These changes could result in further reductions in exposure in the food portion of the assessment. The magnitude of that change is uncertain.

f. Model Outputs

The single-day food component of the OP cumulative risk assessment was conducted using the DEEM software. This program evaluates the full range of dietary exposures across a single day. It permits a detailed evaluation of the source of exposures with regard to which foods and pesticides are the likely sources of the exposure. This analysis served as the basis for determining which commodity/pesticide combinations warrant further scrutiny in the event that further regulatory action is determined to be needed. The use of the single day assessment was considered to be appropriate because exposure to OPs in foods is uniform nationally, and it has no significant seasonal variations. OPP has extensive experience with the two data bases that confirm this assumption as reasonable. OPP has conducted a large number of seasonal assessments of exposure to individual pesticides in foods. These assessments show virtually no differences in exposures across seasons. This finding is not surprising in light of the widespread distribution of foods across the United States, and the proportion of foods that are imported. Lack of seasonal consumption patterns is also not unexpected given the ability to preserve and store foods for delayed consumption, and the import of seasonal foods to bridge gaps in domestic production periods. Similarly, PDP does not suggest any significant alteration in the types of pesticides encountered or the magnitude of residues across the year. The assumption of nationally uniform distribution of foods does not reflect highly localized consumption events that may be encountered by individuals who obtain foods at road side stands and consume it closer to the time of harvest than the foods available in larger grocery stores. OPP does not have reliable data on either consumption or anticipated pesticide residues to permit evaluation of this type of exposure, however we anticipate that only a small percentage of food consumed would be affected.

The results of the food portion of the revised OP cumulative risk assessment are summarized in Table I.H-1. The results are presented in the form of MOE for children 1 - 2 years of age, 3 - 5, adults 20 - 49, and adults 50+, at the 95th, 99th, 99.5th and 99.9th percentiles of exposure. The percentile of exposure as used in this document indicates the percent of the output distribution that is predicted to experience exposure less than or equal to the exposure at that point on the exposure distribution curve. In other words, at the 95th percentile of exposure, 95% of the output distribution is likely to have the exposure indicated or less. Five percent are likely to be exposed to higher amounts of OPs. The 1 - 2 year age group is consistently the most highly exposed subgroup in the analysis. This is due to a higher consumption

to body weight ratio for this age group. Results are presented for both single-day and 7-day analyses for all regions, with 14-day and 21-day analyses included for Region A. The FQPA Safety Factor was incorporated into the RPFs to permit modification of the assessment on a chemical-specific basis as appropriate based upon our current understanding of age-related sensitivity. The toxicity endpoints for this assessment were developed in consideration of a 10X uncertainty factor to account for interspecies variability and a 10X uncertainty factor to account for intraspecies variability. As discussed fully in section I. G., because some OP pesticides show age-dependent sensitivity and there are missing comparative ChE inhibition data in young animals for many of the OP's, the magnitude of the FQPA Safety Factor was set at 3X for most of the OP pesticides. Age-dependent susceptibility data are available for seven of the OP's. The data for dimethoate, omethoate (a metabolite of dimethoate), chlorpyrifos, and methamidophos support reducing the FQPA Safety Factor to 1X.

MOEs from the 7-day analysis exceeded 100 with all remaining uses (Table I.H-1). The MOE for children 1 - 2 years was 119 at the 99.9th percentile of exposure. As discussed above, OPP believes that this estimate is a reasonable approximation of the risk anticipated from consumption of OPs in foods.

MOEs for the single-day assessment do not reach the target value of 100 at the 99.9th percentile (Table I.H-1). The MOE for children 1 - 2 years was 45 at the 99.9th percentile of exposure. An MOE of 100 was reached at the 99.4th percentile of exposure. OPP believes that the 99.9th percentile of exposure in the single-day assessment is an overestimate of anticipated exposure, especially when considered as occurring over more than one day at a time. In addition, there is an overestimation of exposure resulting from the inability to reflect changes in residues due to recently implemented mitigation activities such as application rate changes and extended pre-harvest intervals increases. This value may be biased toward overstating the risk from OPs in food. However, bias reflected in this particular point estimate is anticipated to diminish at lower percentiles of exposure. OPP can not determine at what point in the exposure distribution the exposure estimate begins to be biased toward understating the exposure anticipated.

The decision as to whether additional mitigation activities are needed can not be made by looking at any single value in the results. Many factors must be weighed in determining the extent to which any particular value over- or understates the need for additional action. OPP believes that the actual exposures to the US public fall somewhere between the results of the two analyses presented. In addition, the application of hazard values results in offsetting issues with regard to the direction of change in the MOEs calculated.

OPP has identified commodity/pesticide combinations that appear at the upper end of the distribution and may warrant further study. These include: acephate on green peppers and succulent beans; azinphos methyl on apples and pears; dimethoate on apples, grapes, green peppers, pears, spinach, succulent beans, and tomatoes,; methamidaphos on potatoes and tomatoes; mevinphos on grapes and spinach; phorate on potatoes; and phosmet on apples, grapes, and pears. Until the individual assessments for DDVP and dimethoate are complete, it is premature to attach significance to these commodity/pesticide combinations. The significance of these commodity/pesticide combinations cannot be fully understood without taking into account all other relevant information, such as the results of the sensitivity analyses.

OPP has evaluated the consumption records occurring in the tail of the distribution to ensure that they reflect reasonable consumption patterns. Analysis of the tail of the distribution (>99th percentile) indicates that no small subset of consumption records dominates the outcome. This observation increases OPP's confidence that the food and water components of the assessment are not unduly influenced by unusual consumption patterns and reflect the consumption habits of the public at large.

Table I.H-1. Summary of the OP Cumulative Food Assessment

Children 1-2 Route: Food*	Percentile	Exposure Period Single Day Analysis MOE**	Exposure Period 7-day Analysis Mean MOE	Exposure Period 14-day Analysis Mean MOE	Exposure Period 21-day Analysis Mean MOE
	95	353	475	517	539
	99	128	249	295	320
	99.5	91	197	239	262
	99.9	45	119	151	166

*The additional FQPA Safety Factor is included as an adjustment to the chemical-specific Relative Potency Factors
**For the single day analysis for food, MOEs were calculated using DEEM software rather than Calendex software and thus no mean is applicable

Children 3-5 Route: Food*	Percentile	Exposure Period Single Day Analysis MOE**	Exposure Period 7-day Analysis Mean MOE	Exposure Period 14-day Analysis Mean MOE	Exposure Period 21-day Analysis Mean MOE
	95	437	570	616	634
	99	158	290	340	364
	99.5	111	225	271	295
	99.9	53	131	165	184

*The additional FQPA Safety Factor is included as an adjustment to the chemical-specific Relative Potency Factors
**For the single day analysis for food, MOEs were calculated using DEEM software rather than Calendex software and thus no mean is applicable

Adults 20-49 Route: Food*	Percentile	Exposure Period Single Day Analysis MOE**	Exposure Period 7-day Analysis Mean MOE
	95	1286	826
	99	439	784
	99.5	304	622
	99.9	146	364

*The additional FQPA Safety Factor is included as an adjustment to the chemical-specific Relative Potency Factors
**For the single day analysis for food, MOEs were calculated using DEEM software rather than Calendex software and thus no mean is applicable

Adults 50+ Route: Food*	Percentile	Exposure Period Single Day Analysis MOE**	Exposure Period 7-day Analysis Mean MOE
	95	1136	824
	99	403	735
	99.5	282	537
	99.9	139	340

*The additional FQPA Safety Factor is included as an adjustment to the chemical-specific Relative Potency Factors
**For the single day analysis for food, MOEs were calculated using DEEM software rather than Calendex software and thus no mean is applicable

5. Residential Assessment

The residential component of the preliminary OP cumulative risk assessment is the most sophisticated analysis of its type that OPP has ever conducted. It is the first application of distributional analysis to residential exposure assessments. It also factors in the seasonal and regional aspects of pesticide use. Three types of data are used in the residential assessment: pesticide use; pesticide residue dissipation; and exposure contact and exposure factors. Pesticide use data are utilized to determine the percent of households using a pesticide, the timing of the pesticide treatments, frequency and duration of exposure. Use data are also important in identifying geographic regions where the pesticide will be applied. In the current assessment, use data are specific to the region under evaluation and vary according to the specific aspects of that region. Pesticide residue dissipation data address the fate of the pesticides once applied to an environment (e.g., lawns). Exposure contact data are exposure-specific metrics that relate human exposure to pesticide residues. Humans come in contact with the residues by contacting the product directly or by contacting the residues left after the pesticide applications are made. Distributions of human exposure factors, such as breathing rates, body weight and surface areas used in this assessment come from the Agency Exposure Factors Handbook. These will not be discussed in the risk characterization of the document because the values are established and used throughout the Agency.

OPP has used all of the known available data to assess the significant residential uses of the OP pesticides. The residential uses not covered by this assessment are pet collars (DDVP and tetrachlorvinphos), crack and crevice uses (DDVP) and pest strips (DDVP) used in attics, basements and other areas with limited human access. Use of DDVP pest strips in closets and cupboards were included. It should be noted that the DDVP pet collars are currently not being marketed. While the tetrachlorvinphos pet collars have not been assessed, the CRA does address the use of tetrachlorvinphos pet shampoos , sponge-on treatments and powders. Exposure from the shampoo, sponge-on and powder treatments is likely to be higher than from pet collar use. This is because greater amounts of active ingredient are applied and larger areas of the pet are being treated. Although tetrachlorvinphos treated pet collars represent the largest usage of the product, the number of people treating pets with the liquid and powder products were adjusted upwards to reflect the collar use in addition to the use of the other products. The usage data was taken from NHGPUS.

Each data set used in the assessment introduces some potential bias in the outcome of the exposure assessment. A summary of these biases, their direction and magnitude, is presented in Table I.H-2.

EPA recently funded a study assessing adult and children's exposure to insecticides in flea collars. Preliminary results show that the use of pet collars does not result in significant exposure to pesticides (Boone et al., 2001). Spot urine analysis of 110 pre-school children in the Seattle Metropolitan area monitored for dialkylphosphate (DAP) metabolites suggested that DAP concentrations were not significantly higher in children whose parents reportedly used pet care products (Lu et al., 2002).

a. Exposure Contact and Pesticide Residue Dissipation Data

Exposure contact data used to assess exposures experienced by the applicator of consumer oriented pesticides are by far the most robust information used in the residential portion of this assessment. In addition, the application of pesticides is one of the more straight-forward activity patterns to measure since it represents easily defined activities. Recent data generated by the Outdoor Residential Exposure Task Force (ORETF) have been used to assess the use of hose-end sprayers (lawn care products), rotary granular spreaders (lawn care products), hand-pump sprayers (home gardens and orchards) and hand held dusters (home vegetable gardens). Another study, submitted by a registrant, was also used to assess residential applicator exposure using granular shaker cans to apply disulfoton. All studies meet or exceed current Agency guideline requirements (in particular regarding the number of replicates) and can be extrapolated to include clothing scenarios ranging from short-sleeved shirts and short pants to long-sleeved shirts and long pants. OPP has high confidence in the use of these data. Exposure contact data used to address the pet scenarios include chemical specific handler exposure

There are two post-application dermal exposure scenarios addressed in this assessment. These are: post application dermal exposure to lawn care products, and post-application exposure to vegetable and home orchard pesticide applications. Like the applicator scenarios, the post application garden and home orchard exposure scenarios are easily defined activities. For harvesting vegetables or weeding, there is a substantial amount of data based on farm worker exposure performing similar activities in crops requiring substantial hand labor. These contact values have the potential to overestimate exposure since they are based on individuals working for profit based largely on their productivity. Such workers are likely to be more efficient and therefore exposed to a larger amount of treated surface than most home gardeners. A uniform distribution of values representing hoeing and harvesting may overestimate early season activities that consist of potential exposure to small plants.

Dermal exposure from post-application contact with the lawn chemicals is equally varied. Contact data, representative of the range of human activities has been difficult to model. Dermal contact exposure values were identified in data described in Vaccaro et al., 1996, for adults who performed scripted

activities and contact values for children performing non scripted activities on lawns treated with a non-toxic substance were described by Black in 1993. Rates of pesticide transfer in the studies with surrogate compounds were similar to those observed in the chemical specific dissipation data available to OPP.

Turf transferable residue data are available for all turf chemicals. For malathion, these studies were conducted at multiple locations. Studies conducted in Missouri, North Carolina and Pennsylvania were used for the eastern regions and the study conducted in California was used for the western regions. Similar regional residue data were available for the use of malathion on home gardens and orchards and were used accordingly in this assessment. These data are of good quality and provide accurate estimates for this parameter.

There are no chemical specific data that measure the influence of wet hands and the mouthing behavior of young children on the efficiency of residue transfer. OPP considered a study performed by Clothier et al. (2000) in which he observed an increase in transfer efficiency (1.5- to 3-fold) when comparing a turf residue collection method to volunteers pressing dry hands or hands wetted with saliva. He observed a higher transfer rate for the compound with the lowest application rate. This may suggest that the hand surface becomes saturated and thus results in a lower transfer rate at higher application rates. The factor of from 1.5- to 3-fold was used in the assessment. The factor may overestimate the transfer of residues at higher application rates.

Estimates of exposure to pet care products were developed using an approach similar to the one taken with the turf care products. For applicator exposure, the Agency used dermal and inhalation unit exposures coupled with important statistics that influence exposure such as animal weights and number of animals treated. The latter two variables were gleaned from proprietary sources and an EPA funded study (Boone et al., 2001). For post application exposure, surrogate dermal exposure data of individuals exposed to treated animals were used to generate transfer coefficients, based on the transfer efficiency of the available dislodgeable residue data for tetrachlorvinphos on fur.

Tetrachlorvinphos specific data addressing exposure of individuals while treating pets and post application pet fur measurements were recently submitted to the Agency. The unit exposures from pet care product applicator data (n-15) were expressed as an empirical distribution. Dog weights (n-176) were expressed as a cumulative distribution. To assess post application dermal exposure, an exposure study of 16 pet groomers, each exposed to 8 dogs treated with carbaryl, was used. Dermal transfer coefficients were generated based on the transfer efficiencies of the tetrachlorvinphos pet fur data and the measured exposure of the groomers. These data were also

treated as an empirical distribution. Duration of exposure was based on video analysis of children (n-3) playing with pets (Freeman et al., 2001). At this time the method OPP is using in this assessment is the best available as it uses chemical specific data (applicator and fur residue), real world contact data (groomers and video analysis of children).

b. Pesticide Use Data

Accurate pesticide use data are key to the residential risk assessment. Useful information include regional site/pest markets, timing of application and the percent of households using their products. In the absence of specific pesticide use information, OPP developed exposure scenarios based on timing aspects found in regional Cooperative Extension Service publications and surveys such as the National Home and Garden Pesticide Use Survey (NHGPUS), the National Garden Survey, and Doane's GolfTrak. The Cooperative Extension Service publications were useful for establishing the timing of various turf chemicals. The survey data were used to establish the number of households that may use a given pesticide. For some regions, these application windows were expanded to account for the differences in length of growing season. This is particularly important when regions consist of several USDA Plant Hardiness Zones (e.g., Region 8). The NHGPUS delineates percent of households using pesticides based on a large national survey. These values consider users and non-users as well as homes having lawns and those that do not. The use of this survey introduces uncertainty into the analysis because of the age of the survey (1989-90). The data may not reflect reductions in current OP use patterns and therefore overestimate exposure. Doane's GolfTrak was used to identify the percent of golf courses treated with pesticides and is more timely (1998-99). OPP believes this is a robust data source. The National Garden Survey has been tracking percent of households employing lawn care applicators and is considered very robust. In addition, variables such as vegetable garden size are well characterized since these gardens are easy for survey respondents to define.

c. Use of Calendex

OPP believes using a calendar-based model is justified in order to manage the timing of pesticide applications and delineating subsequent exposures in the general population. Models that can employ distributions of the available residue and contact exposure data are needed to capture the inherent variability in the exposed population and can be used to provide justification regarding co-occurrence of pesticide exposure events. This method is preferable to relying solely on point estimates and combining "what if" scenarios which only adds uncertainty, while providing little information to risk managers regarding the potential numbers of exposed individuals and their ranges of exposure. Calendex provides the ability to evaluate route specific pathways which are defined by the model user so that appropriate residue and residue contact data can be used.

d. Non-dietary ingestion

Non-dietary ingestion is an important exposure pathway in the residential assessment in the southern regions. Frequencies of hand to mouth events used in the assessment are based on real world observations of children in homes and day care centers enumerated on video tape. However, a number of issues surround the estimation of the impact of this activity. The number of hand-to-mouth events occurring in a given time frame was developed by observing children's behavior during quiet play. Video tape data are based on children situated indoors and not outdoors. Hand to mouth frequency may be higher when children are engaged in "quiet play" (e.g., listening to stories) than when engaged in active play (running, tag, etc.). Children playing on lawns are likely to be engaged in active play. Therefore, the frequency of hand-to-mouth events used in the current assessment may be an overestimate.

The variety of hand-to-mouth events (such as the hand being near the mouth rather than in it) makes the enumeration of events difficult. Further, video tape values provide no information on rate of transfer from treated surfaces to hands. Transfer estimates in the assessment were based on studies measuring wet hand transfer efficiency with wet hands using surrogate compounds. No chemical specific data are available. For each hand-to-mouth event, the hand is assumed to have residue when data indicates a child may touch other things (e.g., clothing, non-treated surfaces or nothing).

e. Results

The results of the residential portion of the cumulative risk assessment are relatively straight-forward to interpret. The results of the individual regional assessments can be found in section II of this document. Inhalation exposures to DDVP from No-Pest strips are the major contributor to residential exposures. This determination is relatively obvious because this is the only remaining indoor use for OPs. Removal of DDVP from the assessment resulted in MOEs that were essentially the same as those deriving from food alone. Some of the regional assessments from the southern regions also indicate hand-to-mouth activities by children in conjunction with lawn scenarios as an important contributor to exposure. Some uncertainty surrounds the estimate of exposure from hand-to-mouth behaviors in the assessment. Any bias from this uncertainty is anticipated to overestimate exposure. The magnitude of overestimation is uncertain. OPP believes that the current OP cumulative risk assessment represents a reasonable, health protective estimate of likely exposure to OPs from residential uses.

Table I.H-2. Input Parameters Used in the Exposure Models: Bias, Assumptions, Uncertainties, and Strengths

Model	Input Parameter	Bias*	Assumptions, Uncertainties, or Strengths and Other Comments
Exposure Model for Residential Pathway (Rex)	Human Activity Pattern	+ = upward ~ = neutral - = downward	
Lawn Exposure	**Unit Exposure:push-type rotary spreader** (mg exposure per amount of active ingredient applied)	**~**	**Assumptions/Uncertainties** 1. This unit exposure is based on 30 replicates consisting of individuals using a push-type rotary spreader. A number of clothing scenarios are possible to be generated from these data. In this assessment short-sleeved shirt and short pants were assumed. This may overestimate exposure as large portion of exposure is to the lower legs. Although a surrogate compound was used, exposure is believed to be more influenced by the type of equipment used rather being chemical specific. OPP has high confidence in these data. 2. A lognormal distribution was selected. 3. Assumed gloves are not worn. Survey data do indicate that some residential handlers use gloves. Because consumers are unlikely to use, remove and care for PPE in the manner of professionals, it is unclear what impact this may have on actual use. 4. The surrogate compound (dacthal) used in the exposure study may be dustier than the granular formulations of the OP compounds assessed. This factor increases confidence that this variable will not underestimate exposure.
	Area treated (square feet)	**- to ~**	**Assumptions/Uncertainties** 5. A difficult variable to estimate. However, the assumption is reasonable given the application equipment used. Although, may underestimate areas that have larger lawns (midwest), margins of exposure are large.

Model	Input Parameter	Bias*	Assumptions, Uncertainties, or Strengths and Other Comments
Exposure Model for Residential Pathway (Rex)	Human Activity Pattern	+ = upward ~ = neutral - = downward	
	Dermal Contact Transfer	**~ to +**	6. Adults: activities performed with tank tops and short pants, lognormal distributions may be reflective of study design rather than actual activities (choreographed) 7. Children: Includes above scripted activities and a range of non scripted activities. Non-scripted activities lognormal distribution may be influenced by use of a non-toxic substance (not a pesticide) 8. Assumes all adults and children living in households being treated with lawn care products are exposed (enter treated area).
	Turf Residues: dermal	**~**	9. Chemical specific data reflect a range of high values (e.g., immediately after application) and influenced by watering-in and rainfall.
	Turf Residues: hand-to-mouth	**~ to +**	10. Based on surrogate data. Lone OP in surrogate data had the lowest transfer.
	Frequency of hand-to-mouth events	**~ to +**	11. Based on video-observations of children situated indoors. Active play outdoors may result in lower hand-to-mouth frequencies.
	Duration on lawn	**~ to +**	12. For children, the value is time spent outdoors in addition to time spent on lawns. Does not account for survey responses of individuals that did not play on lawns or go outside.
Public Health	**Drift**	**~**	13. Distribution of aerial and ground equipment values
	Population Exposed	**~ to +**	14. Assumes a large percentage of the population being exposed (based on those having lawns).

Model	Input Parameter	Bias*	Assumptions, Uncertainties, or Strengths and Other Comments
Exposure Model for Residential Pathway (Rex)	Human Activity Pattern	+ = upward ~ = neutral - = downward	
Home Garden	**Applicator: Small Tank Sprayer**	**~ to +**	15. This unit exposure is based on 20 replicates. individuals using a push-type rotary spreader. A number of clothing scenarios are possible to be generated from these data. In this assessment short-sleeved shirt and short pants were assumed. This may overestimate exposure as large portion of exposure is to the lower legs and upper arms. Although a surrogate compound was used, exposure is believed to be more influenced by the type of equipment used rather being chemical specific. OPP has high confidence in these data. 16. A lognormal distribution was selected. 17. Assumed gloves are not worn. Survey data do indicate that some residential handlers use gloves. Because consumers are unlikely to use, remove and care for PPE in the manner of professionals, it is unclear what impact this may have on actual use. confidence in these data
	Applicator: Granular	**~ to +**	18. This unit exposure is based on 15 replicates. Chemical specific data. Used study assessing exposure while treating shrubs which had higher unit exposures than for flowers. 19. A lognormal distribution was selected.
	Area treated: ornamentals	**~ to +**	20. Assumes all plants are treated.
	Area treated: vegetables/fruits	**~**	21. A lognormal distribution of a well studied variable.
	Postapplication: vegetables/fruits	**~ to +**	22. Contact values represent a wide range of activities. All plants are assumed to be treated.
	Frequency of applications	**- to +**	23. Based on survey responses to use of insecticides. Not chemical specific.

Model	Input Parameter	Bias*	Assumptions, Uncertainties, or Strengths and Other Comments
Exposure Model for Residential Pathway (Rex)	Human Activity Pattern	+ = upward ~ = neutral - = downward	
	Plant residues	**~**	24. Regional and chemical specific
Indoor Air	**Residues**	**~**	25. Chemical specific
	Reduction in air concentration based on presumed use of smaller strips than in above residue study	**- to ~**	26. Proportional reduction is an assumption
	Duration	**~**	27. Use of CHAD consisting of several time activity surveys.
	Population Exposed	**~ to +**	28. Values based on use of all pest strips, not just those containing specific active ingredient.
Pet Treatments	**Applicator**	**~**	29. Chemical/formulation specific data. Number of pets and pet weights reasonable based on an "n" of 148 pets.
	Postapplication	**~**	30. dermal contact value, from studies in which there was substantial contact 31. Chemical specific fur residue data 32. video-analysis of children in contact with pets. However small n (3). 33. Best available at this time
Calendex	**Input parameter are describe above**		34. confidence in these data

6. Regional Water Exposure Assessments

The regional water exposure assessments are designed to represent exposures from typical OP usage conditions at one of the more vulnerable surface watersheds in the region. Regions were selected to reflect the climate and soil conditions causing increased pest pressure and resulting OP use. Each regional assessment focuses on areas where combined OP residues in drinking water is likely to be among the highest within the region as a result of total OP usage and vulnerability of the drinking water sources. In this manner, OPP is confident that if the regional cumulative risk assessment finds that exposure in water is not a significant contributor to the overall OP exposure from a vulnerable area, it will not be a significant contributor in other areas in the region. However, because the assessment is based on typical usage, it is not a high-end estimate of pesticide exposure via drinking water at that vulnerable site. A comparison of the estimated concentrations from individual OPs with available monitoring indicates that this assessment is by no means worst case or unrealistic. In each region, levels of one or more OP pesticides detected in monitoring studies exist that are greater than that estimated by the cumulative water assessment; in some cases, the estimates are off by an order of magnitude or more. However, in that same region, estimates of other OP pesticides are similar to or greater than detections found in monitoring studies (see Appendices III.E.1 and III.E.3, as well as the regional assessments in II.A through II.G, for detailed comparisons). Although the potential exists that peak water concentrations for one or more OP pesticides may not be captured in this approach, the impact on the contribution from water to the overall risk assessment is anticipated to be small.

The discussion that follows characterizes the results of the regional water exposure distributions, and identifies assumptions and approaches to the assessment that might impact the level of certainty in the results.

a. What Each Regional Assessment Represents

Each region in the assessment is represented by a geographic area with the highest apparent potential for cumulative exposure to OPs in drinking water. The vulnerable drinking water source in each geographic area represents an area with relatively high usage of multiple OP pesticides in relation to other parts of the region and coincides with surface water sources of drinking water that are vulnerable to potential contamination by these OPs. The focus on surface water sources of drinking water is a likely source of overestimation bias inasmuch as ground water sources generally have lower OP residues than are found in surface water.

Because OP usage varies within the region, the initial evaluation focused on the areas of highest use, based upon the crops grown, which OP(s) are used on these crops, how much OP pesticides are applied and when they are used. Because the relative potency factors (RPF) have a large impact on the

overall OP cumulative distribution, site selection tended to favor high-RPF OPs such as disulfoton, dicrotophos, and terbufos. Since the purpose of the assessment is to identify the impact from multiple OPs occurring in water in the same area, the area(s) selected for the assessment do not necessarily represent the highest exposure of a single chemical, but rather the highest multiple OP exposure within the region. Since OP use may vary from year to year and cropping and usage patterns may change, some areas in other parts of the region may have greater water exposure in a given year.

Because OPP considers both total OP usage and vulnerability of the drinking water sources, the site selected may not necessarily coincide with the highest OP use area in the region or the area where runoff alone is greatest. For instance, the highest OP use areas in the Northwest region (Region B) are in Yakima County and eastern Washington and in southeast Idaho. However, because of low rainfall, few surface-water intakes, and irrigation-dominated agriculture, OP use in this area did not necessarily pose the greatest risk to drinking water sources. Instead, the surface-water sources of drinking water in the Willamette Valley were potentially more vulnerable, despite lower OP usage.

Comparisons of the estimated pesticide concentrations with available monitoring in each region indicate that, in almost every region, a few known detections of one or more OP pesticides occur at higher levels than are being predicted for the cumulative assessment. As noted, because the estimate focuses on the cumulative impact from multiple OP pesticides, it doesn't necessarily focus on the conditions that lead to the highest concentration of one particular OP. In addition, some of the monitoring data may come from water bodies that are not representative of drinking water sources. In some instances, the higher monitoring levels may reflect uses that are being cancelled, such as the residential uses of chlorpyrifos and diazinon. In the case of azinphos methyl, in which upper percentile regional distributions were consistently one to three orders of magnitude less than monitoring detections, the underestimates may be due to inadequate or missing data on pesticide fate and transport properties or usage.

b. What PRZM-EXAMS and the Index Reservoir Represent

OPP adapted available tools to provide daily distributions of OP levels in water for incorporation into the probabilistic cumulative exposure assessment. While these tools have provided OP distributions that are, in many cases, comparable with available monitoring data in the same or nearby locations, assumptions regarding the nature of the drinking water source and watershed influence the estimated distributions.

i. Nature of the Drinking Water Source

The Index Reservoir is based on the specific geometry (watershed and reservoir size) of an actual reservoir (Shipman City) in the midwest. As such, it may best represent potential transport to similar drinking-water sources in high rainfall areas such as the eastern US. It may not so well represent reservoirs in drier parts of the west, where inflow and outflow are artificially managed. In addition, while the Index Reservoir scenario will not necessarily reflect short pulses of higher concentrations found in flowing rivers and streams, long-term average concentrations in a reservoir may be greater than in streams because of differences in the residence time for water in these water bodies.

The Index Reservoir is adapted to the runoff and stream inflow calculated from local soil and weather data. OPP used the PRZM runoff data for the cropping scenario that generated the lowest total runoff volume in the region to derive the inflow and outflow of the Index Reservoir. This introduces a small additional error into the concentrations calculated for the other chemical-crop simulations in each region.

ii. Nature of the Watershed

PRZM is not a basin-scale model, but a field-scale model which provides an edge-of-field estimate of pesticide loads in runoff to the 5.3-hectare reservoir simulated by EXAMS from a 172.8-hectare watershed. PRZM does not explicitly account for the relative contributions of each field to the Index Reservoir. OPP used a cumulative adjustment factor (a combination of the regional percentage of the total watershed area in crops with OP uses and the percentage of acres treated by each OP on each crop) to adjust the resulting reservoir concentrations calculated by EXAMS. Further information on the assumptions involved in applying Percent Crop Area (PCA) factors for drinking water assessments of individual pesticides can be found in the science policy paper, "Applying a Percent Crop Area Adjustment to Tier 2 Surface Water Model Estimates for Pesticide Drinking Water Exposure Estimates" (USEPA, 2000e).

PRZM does not account for location in the watershed: all fields are assumed to be uniformly distributed within the watershed, with runoff going directly into the reservoir. The simulation of multiple chemicals to multiple crops grown in different soils represents a significant adaptation of PRZM-EXAMS. Ideally, the cumulative drinking-water exposure assessment for a region would allow separating the different crop-soil regions within a watershed, and could simulate the different path lengths through runoff and stream-flow to the Index Reservoir. However, since PRZM is an edge-of-field model, runoff from fields representing the application of each OP to a different crop follows the same path length in the treated field and empties directly to the reservoir. In other words, this

simulation assumes that the treated fields with their individual soils are uniformly distributed throughout the watershed and essentially ring the index reservoir for direct deposition of the edge-of-field load.

Each crop use simulated in PRZM assumes that the entire area of the watershed planted in the crop consists of a single soil. In each of the regions, OPP used actual soil data from local soils on which the crops are grown. When possible, the soil selected for each scenario was a benchmark soil that was prone to runoff (classified as hydrologic group "C" or "D" soils). While OPP attempted to simulate soils that might be prone to runoff, the emphasis in developing the scenarios was to choose important local soils for which sufficient data are available, and which are known to be used to grow the crops of interest. These soils may not represent those most prone to runoff, but afford reasonable certainty that the simulation represents local soil conditions. While an assessment using a single soil assumes that each part of the watershed will be equally vulnerable to runoff, areas of higher and lower runoff vulnerability will exist in an actual watershed.

iii. Multiple Years of Local Weather Data

Because the application rates, frequencies, and timing are held constant, the PRZM/ EXAMS Index Reservoir simulations over multiple years evaluate the impact of the variability in precipitation on the amount of pesticide that reaches surface water. Because weather data spanning 24 to 36 years is available for many locations across the country, PRZM and EXAMS can account for OP runoff from a wide range of weather patterns not otherwise possible with monitoring studies that span relatively few years. The age of the data (collected through 1983) limits OPP's ability to compare of the modeling output to more recent monitoring data.

Weather data files for PRZM are available for weather stations across the country. The weather station nearest to the county or counties used for the simulations was chosen for the cumulative assessment. To the extent that precipitation in these counties over the period of record might have been greater or less than that recorded at the nearest weather station, runoff for that area may have been over- or underestimated by PRZM.

Additional uncertainty in the modeling results is associated with application of OPs to irrigated crops. PRZM has a relatively simple irrigation subroutine, applying a user-specified amount of irrigation to the simulated field when the moisture content of the top soil layer drops to some fraction of field capacity. Actual irrigation in the field follows a more complicated formula, with irrigation timing dependent on the grower's professional judgement of crop needs. In addition, PRZM has a limited ability to distinguish between various irrigation methods.

c. What the Usage, Cropping Areas, and Acre Treatments Represent

Typical application rates and frequencies for each OP pesticide on each crop were generated by taking the average reported in the USDA NASS (National Agricultural Statistics Service) Agricultural Chemical Usage summaries. This assumes that all applications were made at this typical or average rate and that frequencies of applications were constant year to year. The assessment considered only yearly variations in weather, and not variations in application rates. Thus, using these typical application rates and frequencies may underestimate water concentrations in years when pest pressure is higher than in our reported years and may overestimate in years when lower amounts of pesticide is used. The usage data was generally not sufficient to conduct a probabilistic assessment over a distribution of actual application rates.

In some instances, the typical and maximum label application rates were identical. For instance, the typical rate for phorate application on sugarcane in Florida was at the maximum label rate. In many cases the maximum label rates were one to eight times greater than the typical rates (see Appendix III.E.11). The extent to which the differences in rates would be reflected in the OP cumulative distribution depends on a number of factors, including timing of application relative to runoff events and relative potency of the pesticide. As a result, the net difference in estimated cumulative distributions between all typical and all maximum rates ranges from no difference in all but the lowest percentiles in Region A to a factor of 2 to 4 times greater at the higher percentiles (95^{th} and above) in Regions E and G (Appendix III.E.11).

Those comparisons reflect the maximum potential difference between typical and maximum application rates by assuming that all OP pesticides would be applied at the maximum rates to all crops. In reality, given the range in crops and pests treated by OP pesticides, it is more likely that only some of the OP pesticides might be applied at maximum rates in a given year and, thus, the difference would be less than that found in the comparison.

The regional percent crop area (PCA) factors are based on a large area: the size of the hydrologic units (average > 1000 square miles) used generally span multiple counties and may contain several watersheds that supply drinking water intakes. These regional PCAs represent the aggregation of crop areas from county-level NASS data and assume that the cropping area is uniformly distributed. However, cropping intensity is variable and smaller watersheds, including those capable of supporting drinking water supplies, may have a much different (higher or lower) percentage of crop land than the rest of the large basin. An example is Zollner Creek in the Willamette River Valley. This watershed had the highest concentrations and frequencies of detection of OPs among all of the NAWQA monitoring sites in the Willamette Valley. This stream drained a watershed that was 99% agriculture, much greater than the regional PCA of 60%.

The regional assessment areas coincided with the area with the highest PCA in all of the regions except the Northwest. In the Northwest, the regional assessment focused in the Willamette River Valley, a generally lower-intensity agricultural area which was otherwise more vulnerable because of OP usage and/or the nature of the drinking water source. However, as already noted, portions of the Willamette Valley had higher percentages in agriculture than reflected by the PCAs generated using the larger hydrologic units.

The typical application rates and percent acres treated are derived from state-level data (or NASS reporting districts) and assume uniform use practices across the state. Indeed, an uneven distribution of application rates and percent acres treated is expected in response to differing pest pressures. This assumption will underestimate areas where pest pressures may dictate a higher percentage of acres treated in a given year; similarly, it will overestimate areas where low pest pressures will require fewer acre treatments. In the Red River Valley (Northeast/North Central region), differences in percent acres treated and application rates between the Minnesota counties and the North Dakota counties located within the Red River Valley are more likely due to differences in the state-level data than in actual differences between the adjacent counties.

d. Timing of Application

OPP used crop profiles and other relative crop production publications to establish a time frame for making the applications of the pesticide on a particular crop (application window). The length of the window doesn't necessarily reflect the range over which a pesticide will be applied in a particular year, but the year-to-year variation in the application dates over time. Thus, in any given year, the timing of application may be clustered within a shorter time-frame than suggested by the application window. However, because of weather and other environmental factors, the timing of intensive pest pressure and/or OP application may vary across the window.

The date of application can have an effect on the predicted concentrations generated by PRZM/EXAMS, depending on how close the pesticide application coincides with rainfall events in any given year. To evaluate how this may impact on the OP cumulative distribution, where multiple pesticides are applied at different dates, OPP varied dates of application across the active window for each OP-crop combination in Regions A and D (see Appendix III.E.11 for details). The impact of varying dates of application was most evident at the extremes in the distributions. The ratio in maximum concentrations between the lowest and highest estimates was a factor of 5 to 6. For 99th and lower percentiles of exposure to OPs, the differences were not as dramatic, with the ratio between lowest and highest values generally two or less. This analysis only looked at the cumulative OP distribution and did not evaluate variations in individual chemical distributions. In both regions, the cumulative distribution generated at the beginning of the

application window and used for the regional assessment was less than the maximum estimated distribution. The ratio between the highest estimated concentration distributions and that used for the regional assessment was between 2 to 4 for the maximum estimated concentrations, but less than 2 for 99th and lower distributions.

In the absence of data to show otherwise, OPP assumed that all of the pesticide applied on a particular crop is done on the same date. While this may be an unreasonable assumption for a large watershed, it is not unrealistic for the size of the watershed used in this assessment. This assumption may result in higher peaks, but similar overall average concentrations than if applications are spread out over time. The resulting estimate of exposure may result in a small overestimation bias in the results that will be greater in large than in small watersheds.

In California (Region C - Arid/Semiarid West), OPP used California Department of Pesticide Regulations (CDPR) census data for its regional assessment. This information provided a distribution of applications by actual date of application. For that regional assessment, OPP split the total application into 5 applications, with each application representing 20% of the total amount applied on that particular chemical. The absence of information on application dates in NASS precludes OPP from taking a similar approach in other regions. OPP also generated an estimated cumulative OP distribution by using a single application at the beginning of the application window, as was done in other regions. The cumulative OP concentration distribution estimated using a single application was greater than that estimated using 5 split applications by a factor of two or less (see Appendix III.E.11 for details). While splitting the application over multiple days is expected to result in lower peaks than a single application, the degree to which a difference is seen depends on a number of factors, including the mobility and persistence of the pesticide and the timing of applications in relation to runoff-producing rainfalls.

e. Water Treatment Effects

Although not extensive, scientific evidence suggests that many of the parent OP pesticide residues in water are likely to be transformation by oxidation during water treatment, through chlorination or similar disinfection treatments. These oxidative transformation products, such as sulfones, sulfoxides, and oxons, are still of toxicological concern, have been detected in treated water from water treatment plants. Limited data suggest that these treatment by-products may be stable for sufficient periods of time (for least 24 to 96 hours) to move through the distribution system.

The information is not sufficient to make quantitative adjustments to the cumulative exposure estimates. To estimate potential impacts and to determine whether additional information is needed, OPP assumed that any transformation due to chlorination results in the conversion to a product of toxicological concern. Thus, all OP parents that form oxons, sulfoxides, or sulfones (see Table I.E-1) were assumed to be transformed into those products as a result of oxidation. Where the transformation is less than complete, and where non-toxic products are also formed, the such an assumption will overestimate the ultimate drinking water exposure. While limited information suggests that the other OP parent would be transformed and removed from treated drinking water, sufficient information is not available to quantify this for all OP pesticides. Thus, OPP did not assume that any of the other OP parent pesticides would be removed. OPP assumed that the sulfoxide and sulfone products are equal in toxicity to the parent and that the oxon products are ten times more toxic than the parent. A comparison of the RPFs for dimethoate (0.32) and omethoate (0.96), the oxon of dimethoate, suggests that this assumption would be protective.

Table I.H-3 compares the cumulative OP distribution used in the risk assessment (labeled “No treatment effects”) with an estimated distribution using the assumptions of treatment impacts described above (labeled “oxon conversion w/ 10X increase in RPF”). In each region, the main cumulative OP “pulse” in any given year is dominated by an OP which transforms into sulfoxide and sulfone products (terbufos, phorate, or disulfoton). Since the estimated distributions for those OP pesticides reflect the combined parent plus sulfoxide/sulfone residues, any potential treatment effects from oxidation of these chemicals is covered in the assessment. Conversion of OP parents to oxons would not add significantly to the cumulative OP load in these regions because (a) those OP pesticides which form oxons are not contributing significantly to the cumulative “pulse” for the region, and/or (b) those oxon-forming OP pesticides that are frequently detected in water (chlorpyrifos, diazinon, malathion) have very low RPFs in comparison to other OP pesticides (such as dicrotophos, terbufos, and phorate).

Table I.H-3. Comparison of OP cumulative distribution (ppm, methamidophos equivalents) assuming no drinking water treatment effects to distribution assuming oxon conversion with increase in toxicity

	Cumulative OP Distribution, ppm		Ratio no treat: 10X oxon	Cumulative OP Distribution, ppm		Ratio no treat: 10X oxon	Cumulative OP Distribution, ppm		Ratio no treat: 10X oxon
	No treatment effects	Convert to oxon w/ 10X increase in RPF		No treatment effects	Convert to oxon w/ 10X increase in RPF		No treatment effects	Convert to oxon w/ 10X increase in RPF	
Region	**A (Florida)**			**B (Northwest)**			**C (Arid/Semiarid West)**		
Max	1.4E-02	1.4E-02	1.0	1.4E-04	2.6E-04	1.8	7.6E-04	9.9E-04	1.3
99th	9.0E-04	9.0E-04	1.0	1.2E-04	1.4E-04	1.1	2.2E-04	2.7E-04	1.2
95th	7.8E-05	1.0E-04	1.3	9.2E-05	1.0E-04	1.1	1.6E-04	2.0E-04	1.2
90th	3.6E-05	5.8E-05	1.6	7.5E-05	8.1E-05	1.1	1.4E-04	1.7E-04	1.2
80th	2.0E-05	3.5E-05	1.7	5.1E-05	5.7E-05	1.1	1.2E-04	1.4E-04	1.2
75th	1.7E-05	2.9E-05	1.7	4.6E-05	5.3E-05	1.1	1.1E-04	1.3E-04	1.2
50th	8.1E-06	1.6E-05	2.0	3.0E-05	3.6E-05	1.2	7.6E-05	1.1E-04	1.4
25th	3.4E-06	8.3E-06	2.4	2.0E-05	2.6E-05	1.3	4.6E-05	7.8E-05	1.7
10th	1.5E-06	4.5E-06	3.1	1.5E-05	2.0E-05	1.3	3.0E-05	5.4E-05	1.8
Min	4.1E-07	1.1E-06	2.6	8.3E-06	9.5E-06	1.1	1.7E-05	2.4E-05	1.4
Mean	4.6E-05	5.5E-05	1.2	3.7E-05	4.4E-05	1.2	8.3E-05	1.1E-04	1.4
Contributors to cumul. OP pulses	Phorate + sulfoxide/ sulfone; ethoprop			Ethoprop; azinphos methyl; chlorpyrifos			Disulfoton + sulfoxide/ sulfone, Phorate + sulfoxide/ sulfone		
Oxon-formers	Chlorpyrifos, diazinon			AzM, bensulide, chlorpyrifos, diazinon, dimethoate, malathion, MePara, Phosmet			AzM, chlorpyrifos, diazinon, dimethoate, malathion, MePara, Phosmet		
Region	**D (Northeast/ North Central)**			**E (Humid Southeast)**			**F (Lower Midwest)**		
Max	4.9E-03	4.9E-03	1.0	3.7E-03	3.8E-03	1.0	3.7E-03	3.9E-03	1.1
99th	1.5E-03	1.5E-03	1.0	1.1E-03	1.1E-03	1.0	1.3E-03	1.4E-03	1.1
95th	4.8E-04	4.9E-04	1.0	3.6E-04	3.9E-04	1.1	4.7E-04	5.7E-04	1.2
90th	2.0E-04	2.2E-04	1.1	1.6E-04	1.9E-04	1.2	2.3E-04	3.1E-04	1.4
80th	5.5E-05	8.5E-05	1.5	6.5E-05	8.3E-05	1.3	5.7E-05	1.2E-04	2.1
75th	3.1E-05	6.0E-05	2.0	4.9E-05	6.4E-05	1.3	3.0E-05	8.2E-05	2.7
50th	5.5E-06	1.2E-05	2.3	1.8E-05	2.2E-05	1.2	4.6E-06	2.3E-05	5.0
25th	1.5E-06	3.8E-06	2.5	9.6E-06	1.1E-05	1.2	1.8E-06	8.4E-06	4.7
10th	5.8E-07	1.8E-06	3.2	6.2E-06	7.2E-06	1.2	9.7E-07	3.4E-06	3.5
Min	2.0E-08	2.0E-07	10.0	3.9E-07	7.3E-07	1.9	1.5E-07	4.7E-07	3.2
Mean	9.2E-05	1.0E-04	1.1	7.9E-05	8.9E-05	1.1	8.2E-05	1.2E-04	1.4
Contributors to cumul. OP pulses	Terbufos, phorate with sulfoxide/ sulfone transformation products			Terbufos, phorate, & disulfoton with sulfoxide/ sulfone; acephate			Terbufos + sulfoxide/ sulfone; phostebupirim		
Oxon-formers	AzM, chlorpyrifos, dimethoate			Chlorpyrifos, dimethoate			Chlorpyrifos, dimethoate, malathion, MePara, phostebupirim		

	Cumulative OP Distribution, ppm		Ratio no treat: 10X oxon	Cumulative OP Distribution, ppm		Ratio no treat: 10X oxon	Cumulative OP Distribution, ppm		Ratio no treat: 10X oxon
	No treatment effects	Convert to oxon w/ 10X increase in RPF		No treatment effects	Convert to oxon w/ 10X increase in RPF		No treatment effects	Convert to oxon w/ 10X increase in RPF	
Region	**G (Mid-south)**								
Max	8.7E-03	9.0E-03	1.0						
99th	4.3E-03	4.4E-03	1.0						
95th	1.9E-03	2.0E-03	1.0						
90th	1.0E-03	1.1E-03	1.1						
80th	4.4E-04	5.2E-04	1.2						
75th	3.1E-04	3.8E-04	1.2						
50th	4.1E-05	7.4E-05	1.8						
25th	8.4E-06	1.5E-05	1.8						
10th	4.2E-06	6.8E-06	1.6						
Min	1.4E-06	1.8E-06	1.3						
Mean	3.6E-04	4.1E-04	1.1						
Contributors to cumul. OP pulses	Dicrotofos; acephate; terbufos + sulfoxide/ sulfone								
Oxon-formers	Chlorpyrifos, dimethoate, malathion, MePara, phostebupirim								

The assumption of oxon conversion with a 10X increase in toxicity had no impact on the upper percentile of the concentration distributions for OPs in water in the two regions with the highest estimated cumulative OP load in drinking water – Region A or Region G . In Region B, the assumptions regarding oxon transformation increased the maximum estimated cumulative OP concentration by a factor of 2, but had little effect on the 99th or lower percentiles of the water concentration distribution. This resulted in two spikes off the peak OP pulses in two years of simulations, but a lower impact during other times.

7. Conclusions

A multi-route, calendar-based risk assessment for a single chemical requires the assessor to consider a variety of new issues in designing and interpreting a risk assessment. The issues are more complex when the analyses address the simultaneous exposures to more than one pesticide. OPP advanced its risk assessment methods, across the board, as it developed this specific OP cumulative risk assessment.

Many questions arise when interpreting results generated in a complex, highly refined assessment. The detailed outputs allow in-depth analysis of interactions of data sets to estimate the possible risk concerns and identify the sources of exposures. In this assessment, assumptions are replaced with data from surveys and monitoring studies and, as a result, the assessment provides a more refined picture of what is likely to be encountered in the real world. In most cases the assessment uses distributions of data. This practice permits expression of the full range of values for each parameter.

This revised assessment presents results as a range of estimated Margins of Exposure (MOEs) using one-day and seven-day rolling averages at different percentiles of exposure distribution. After careful analysis, the Agency believes that the real world exposure is somewhere between the one-day and seven-day rolling average, and generally these MOEs do not represent a concern. OPP is analyzing the sources of exposure that are significant at the lower end of the MOE range at the high percentiles of exposure distribution.

One of the major factors influencing the results at the highest portion of the range (99.9th percentile) of exposure is the fact that for a few individual OPs, risk assessments and mitigation actions have not been finalized. This is particularly true for DDVP and dimethoate. This conclusion is supported by the results of the analysis that removed pest strips containing DDVP from the assessment. The resulting total (food, water and residential) MOE is essentially identical to that for a food-only MOE analysis.

OPP has identified that a few uses of OP pesticides on food crops generally play a larger role in the results of the food risk assessment. Overall evaluation of the risk from exposure to OPs in foods suggests that, with the exception of completion of outstanding single chemical assessments, the cumulative MOEs from exposure to OPs in foods do not raise a concern.

The results of the residential risk assessment indicate that remaining uses of OPs in a residential setting are anticipated to provide only minimal contributions to the cumulative risks from OPs with the exception of pest strips containing DDVP. The single chemical risk mitigation activities for DDVP have not been completed. The impact of these activities may significantly reduce the contribution of DDVP to the cumulative risk assessment.

OP cumulative risk from drinking water is generally at least one order of magnitude lower than the contribution from OPs in food at percentiles of exposure above 95th for all subpopulations evaluated. As the percentile of exposure increases, the difference between the food and water contributions increase. Below the 95th percentile of exposure, the water risk comes within one order of magnitude of the food contribution. This pattern is consistent for all regions in the current risk assessment. OP exposure from drinking water does not play a significant role in the cumulative risk from OP use in the US