Assessment:
Balmertown, Ontario
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Appendix B
Revised Preliminary Calculations Using
New Bioavailability Estimates

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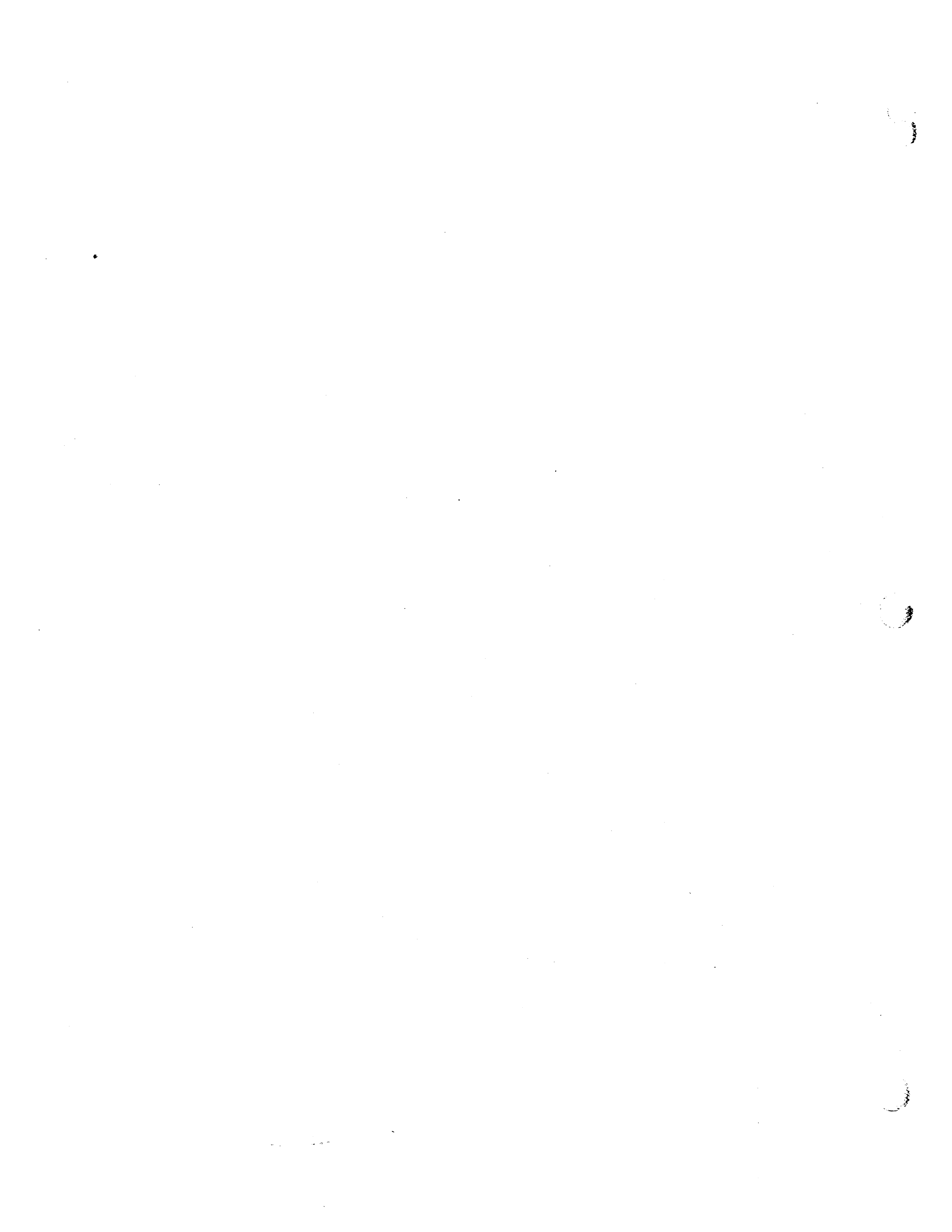

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Revised Preliminary Calculations Using New Bioavailability Estimates

Gradient conducted preliminary exposure calculations in order to establish which exposure pathways and populations of concern would be evaluated in the final exposure assessment. The preliminary exposure calculations estimated arsenic uptake from incidental ingestion of and dermal contact with soil, dust, and drinking water; and, inhalation of indoor and outdoor particulates. The potentially exposed populations evaluated included: a child ages 0 to 6, a child ages 3 to 9, and an adult. The results of the preliminary calculations are presented in a letter report by Gradient (1994) and are summarized in Section 3 of this report. The preliminary calculations, which form the basis of the list of pathways included in the final exposure assessment, utilized default assumptions regarding the bioavailability of arsenic. Since December 1994, when Gradient issued the preliminary exposure calculations, PTI has reported the results of a study conducted to determine the site-specific bioavailability of arsenic in soil and house dust (PTI, 1995). The remainder of this section discusses the revised preliminary exposure calculations, incorporating site-specific arsenic bioavailability information.

B.1 New Bioavailability Estimates

As described in Section 3, the preliminary calculations involved two calculations for each receptor/pathway combination: one assuming the bioavailability of arsenic to be 33 percent and one assuming the bioavailability of arsenic to be 100 percent. From this, we calculated the range of estimated arsenic uptake for all receptors. The results of the preliminary exposure assessment, using assumed bioavailability values, indicated that ingestion of drinking water, ingestion of soil, and ingestion of dust, along with exposure to inorganic arsenic from food contributed up to 95 percent of exposure for all exposure groups (Gradient, 1994). As a result, we focused on these four pathways in the final exposure assessment.

However, the PTI report indicates that site-specific average arsenic bioavailability is as follows: 15 percent for garden, perimeter, and play/bare area soil samples combined; and 14 percent for interior dust samples (PTI, 1995). These values are significantly lower than the bioavailability values assumed in the initial calculations. Based on this information, we revised the preliminary exposure calculations to determine how the site-specific bioavailability information influenced the relative importance of the

different exposure pathways evaluated in the final exposure assessment. The revisions included an arsenic relative bioavailability adjustment of 15 percent for soil and 14 percent for house dust. In addition, the revised calculations include a factor of 0.1 percent to reflect the dermal absorption of arsenic from soil/dust, as compared to the 1 percent used in the preliminary exposure calculations. We obtained the 0.1 percent value from the dermal absorption fraction for metals in soil, reported in Ryan *et al.* (1987) to range from 0.1 to 1 percent. We used the low end of this range to be consistent with the reduced bioavailability of arsenic in the gastrointestinal tract as determined in the PTI study (PTI, 1995). Use of the low end of the reported range of percent dermal absorption of arsenic is further supported by the results of *in vitro* studies of dermal absorption of arsenic from soil. For example, a study by Rahman *et al.* (1993) reports *in vitro* percutaneous absorption of sodium arsenate (in soil) in mice ranging from approximately 0.06 to < 0.15 percent of the applied dose. Another study reports *in vitro* percutaneous absorption of arsenic on human skin to be 0.33 ± 0.25 percent from soil (Wester *et al.*, 1993). Therefore, 0.1 percent dermal absorption of arsenic from soil is justified.

B.2 Results

The following tables show the revised percent contribution of total inorganic arsenic uptake by exposure pathway, presented as a range for all runs evaluated in the original preliminary calculations. Table B-1 shows percent contribution including food ingestion and Table B-2 shows percent contribution excluding food ingestion.

Table B-1
Contribution to Total Daily Arsenic Uptake Based on Revised Preliminary Calculations Including Food Ingestion

Exposure Pathway	Adult	Child
Ingestion of food	67.9 - 72.3%	61.3 - 77.2%
Ingestion of drinking water	27.2 - 28.6%	18.0 - 20.4%
Incidental ingestion of soil	0.0 - 1.2%	0.2 - 7.3%
Incidental ingestion of dust	0.2 - 2.7%	1.8 - 17.0%
Dermal contact with soil	0.0 - 0.2%	0.0 - 1.1%
Dermal contact with dust	0.0 - 0.4%	0.3 - 2.7%
Dermal contact with drinking water	0.2 - 0.2%	0.0 - 0.0%
Inhalation of particulates	0.0 - 0.2%	0.0 - 0.1%

Table B-2
Contribution to Total Daily Arsenic Uptake Based on Revised Preliminary Calculations Excluding Food Ingestion

Exposure Pathway	Adult	Child
Ingestion of drinking water	88.2 - 98.2%	46.5 - 89.6%
Incidental ingestion of soil	0.1 - 3.9%	0.9 - 20.4%
Incidental ingestion of dust	0.9 - 8.3%	7.9 - 44.0%
Dermal contact with soil	0.0 - 0.5%	0.1 - 3.0%
Dermal contact with dust	0.1 - 1.2%	1.3 - 7.0%
Dermal contact with drinking water	0.5 - 0.6%	0.1 - 0.2%
Inhalation of particulates	0.2 - 0.7%	0.1 - 0.2%

These tables were constructed by identifying, for each pathway, the lowest and highest percentage contribution to exposure, thereby creating the range of percent contribution, including food and excluding food. The results of the revised preliminary exposure calculations are consistent with the original calculations, indicating that ingestion of drinking water, incidental ingestion of soil, and incidental ingestion of dust are the most significant contributors to inorganic arsenic uptake. Together with

ingestion of food, these three ingestion pathways contribute nearly 100 percent of the total uptake of inorganic arsenic. Excluding ingestion of food, uptake of inorganic arsenic from the soil, dust, and drinking water ingestion pathways contributes more than 93 percent of total inorganic arsenic uptake. Inhalation of particulates, dermal contact with soil, dust, and drinking water accounted for less than 3 percent of the total uptake (including food ingestion).

In summary, based on the revised preliminary exposure calculations, uptake of inorganic arsenic from food is the most significant contributor to total uptake for all receptors. Other than food, the revised calculations demonstrate that the three additional pathways that contribute most significantly to arsenic uptake are ingestion of drinking water, incidental ingestion of soil, and incidental ingestion of dust. This conclusion is the same as that drawn from the initial preliminary calculations and indicates that these are the most important populations and exposure pathways to address in the final exposure assessment.