DRAFT DISCLAIMER

This contractor document was prepared for the U.S. Department of Energy (DOE), but has not undergone programmatic, policy, or publication review, and is provided for information only. The document provides preliminary information that may change based on new information or analysis, and is not intended for publication or wide distribution; it is a lower level contractor document that may or may not directly contribute to a published DOE report. Although this document has undergone technical reviews at the contractor organization, it has not undergone a DOE policy review. Therefore, the views and opinions of authors expressed do not necessarily state or reflect those of the DOE. However, in the interest of the rapid transfer of information, we are providing this document for your information, per your request.

DF03
0/1

B0010

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
ANALYSIS/MODEL COVER SHEET
Complete Only Applicable Items

1. QA: QA
Page: 1 of: 34

2. ☒ Analysis ☐ Engineering ☒ Performance Assessment ☐ Scientific	3. ☐ Model ☐ Conceptual Model Documentation ☐ Model Documentation ☐ Model Validation Documentation

4. Title:
Identification of the Critical Group (Consumption of Locally Produced Food and Tap Water)

5. Document Identifier (including Rev. No. and Change No., if applicable):
ANL-MGR-MD-000005, REV 00

6. Total Attachments:	7. Attachment Numbers - No. of Pages in Each:
2	I-4, II-3

	Printed Name	Signature	Date
8. Originator	John B. Bland	John B. Bland	1/14/2000
9. Checker	Carl B. Ellis	Carl B. Ellis	1/14/00
10. Lead/Supervisor	Robert L. Kimble	R. Kimble	1/14/00
11. Responsible Manager	Robert L. Kimble	R. Kimble	1/14/00

12. Remarks:

CONTENTS

FIGURES

Page

TABLES

1. PURPOSE

The purpose of this Analysis and Model Report (AMR) is designed to support the Biosphere component of Total System Performance Assessment/Site Recommendation (TSPA/SR) for the proposed geological repository after permanent closure (Dyer 1999, p. 18 of enclosure). This AMR does this by: (1) developing screening groups using attributes of the potential behaviors and characteristics of the population surrounding Yucca Mountain from which a critical group can be identified; (2) identifying a critical group consistent with DOE guidance (Dyer, 1999, p. 19 of enclosure) using the screening groups; and (3) providing food and water consumption parameters and other characteristics of the critical group to be used in calculations of Biosphere Dose Conversion Factors (BDCFs). Section 4.2 provides criteria for identifying the critical group (Dyer 1999, p. 19 of enclosure). The parameters provide inputs to the GENII-S code used to generate the BDCFs that are to be generated for TSPA/SR.

The analysis was conducted according to AP-3.10Q, *Analysis and Models*, and an approved development plan (CRWMS M&O 1999a). The only constraints, caveats, or limitations common to the entire analysis are those described above.

All references cited in this AMR and listed in Section 8 were included to support or corroborate the assumptions, methods, and conclusions of the analysis.

2. QUALITY ASSURANCE

The analyses in this AMR have been determined to be Quality Affecting in accordance with CRWMS M&O procedure QAP-2-0, *Conduct of Activities*, because the information will be used to support Performance Assessment and other quality-affecting activities. Therefore, this AMR is subject to the requirements of the *Quality Assurance Requirements and Description* document (DOE 1998a). This AMR is covered by the Activity Evaluation for *Scientific Investigation of Radiological Doses in the Biosphere* (CRWMS M&O 1999b)

Personnel performing work on this analysis were trained and qualified according to Office of Civilian Radioactive Waste Management (OCRWM) procedures AP-2.1Q, *Indoctrination and Training of Personnel*, and AP-2.2Q, *Establishment and Verification of Required Education and Experience of Personnel*. Preparation of this analysis did not require the classification of items in accordance with CRWMS M&O procedure QAP-2-3, *Classification of Permanent Items*. This analysis is not a field activity. Therefore, an evaluation in accordance with CRWMS M&O procedure NLP-2-0, *Determination of Importance Evaluation* was not required. The governing procedure for preparation of this AMR is OCRWM procedure AP-3.10Q, *Analyses and Models*, which invokes procedures that affect this analysis, document the control of inputs and outputs, and provide for the control of "non-Q" data.

3. COMPUTER SOFTWARE AND MODEL USAGE

Version 6.0 of the NCSS statistical package (Hintze 1995) was used for calculations and analysis involving parameters associated with an ingestion exposure pathway, the consumption of locally produced food and tap water by a critical group. In accordance with provisions in sections 2.0 and 5.1 of AP-SI.1Q, *Software Management*, NCSS is determined to be exempt from AP-SI.1Q requirements because it is a statistical software package and no special routines or macros were written for it in order to conduct this analysis. In calculating parameters associated with the consumption of locally produced food and tap water, no model is being used in addition to the NCSS software.

NCSS 6.0 was acquired by the Regional Studies Division in 1997 through regular Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) channels from NCSS, Inc., 329 North 1000 East, Kaysville, UT 84037. NCSS is a statistical analysis software package with worldwide use and a 15-year history. The original disks containing NCSS are maintained by the CRWMS M&O software library, Information Technical Operations/End User Support. It was installed onto CPU 111044, located at SUM1/224B by a staff technician from Information Technical Operations/End User Support. CPU 111044 is assigned to David A. Swanson (SUM1/224B), the primary authorized user of NCSS 6.0. The secondary authorized user is Robert L. Kimble. The CPU on which NCSS 6.0 resides is password-protected in accordance with CRWMS M&O procedures.

4. INPUTS

4.1 PARAMETERS

Behavioral and life-style data are limited for the population in the vicinity of Yucca Mountain. The only known sources of data that can be used for defining the site-specific parameters for the population at risk are the 1997 food consumption survey of communities located within an 84-km radius of Yucca Mountain (DOE 1997) and data from the 1990 Census (Bureau of the Census 1999) on employment and housing. These Census data are approved as "Accepted Data" (Mellington 1999). The survey data are used to determine the consumption levels of locally produced food and tap water needed for the ingestion exposure analysis. Census data are used to develop a profile of the population for use in assessing potential exposure pathways other than food and water consumption.

The 1997 survey was primarily designed to gather information for biosphere modeling purposes that could be used to determine the attributes of a critical group in the Yucca Mountain region. In the survey, dietary and selected characteristics and behavioral data were collected on adults residing within the 84-km grid centered on Yucca Mountain (DOE 1997, p. vi). Included within this grid are the communities of Amargosa Valley, Beatty, Indian Springs, and Pahrump (DOE 1997, p. 7).

In accordance with AP-SIII.3Q, the survey data were placed in the Technical Data Management System (DOE 1997, MOL.19990409.0144). Theses data are "to be verified" in accordance with AP-SIII.2Q. The survey was a stratified random sample consisting of 1,079 respondents, of which 195 were in the Amargosa Valley. Complete documentation on the survey is provided in the report, "The 1997 'Biosphere' Food Consumption Survey: Summary Findings and Technical Documentation" (DOE 1997).

4.2 CRITERIA

There are no applicable standards and criteria available at this time. The Yucca Mountain Project (YMP) *Monitored Geologic Repository Requirements Document* (MGR-RD) (DOE 1999) will be revised to include any final regulatory standards. The standards in the MGR-RD then will be followed.

Two proposed regulations have been issued. The Environmental Protection Agency (EPA) has issued a draft of 40 CFR 197, Environmental Radiation Protection Standards for Yucca Mountain, Nevada (see the Federal Register (FR) for August 27, 1999, 64 FR 46976). Also, a new Nuclear Regulatory Commission (NRC) regulation, 10 CFR 63, has been proposed for a potential repository at Yucca Mountain. This proposed regulation identifies the required characteristics of the reference biosphere and critical group (64 FR 8640, p. 8677). Until the final rulemaking for 10 CFR 63 is completed, interim guidance issued by the DOE will be followed (Dyer, 1999, with enclosure). The DOE interim guidance and the NRC proposed 10 CFR 63 both state, in part: "The critical group is selected to represent those persons in the vicinity of Yucca Mountain who are reasonably expected to receive the greatest exposure to radioactive material released from a geologic repository at Yucca Mountain. Characteristics of

the reference biosphere and the critical group are to be based on current human behavior and biospheric conditions in the region." (Dyer 1999, p. 16 of enclosure; and 64 FR 8640, p. 8675). The DOE provides the following criteria for identification of the reference biosphere and the critical group in Section 115 of the interim guidance (Dyer 1999, p. 19 of enclosure):

(a) *Reference biosphere.*

(1) Features, events, and processes that describe the reference biosphere shall be consistent with present knowledge of the conditions in the region surrounding the Yucca Mountain site.

(2) Biosphere pathways shall be consistent with arid or semi-arid conditions.

(b) *Critical group.*

(1) The critical group shall reside within a farming community located approximately 20 km south from the underground facility (in the general location of the junction of U.S. Route 95 and Nevada Route 373).

(2) The behaviors and characteristics of the farming community shall be consistent with current conditions of the region surrounding the Yucca Mountain site. Changes over time in the behaviors and characteristics of the critical group including, but not necessarily limited to, land use, lifestyle, diet, human physiology, or metabolics; shall not be considered.

(3) The critical group resides within a farming community consisting of approximately 100 individuals, and exhibits behaviors or characteristics that will result in the highest expected annual doses.

(4) The behaviors and characteristics of the average member of the critical group shall be based on the mean value of the critical group's variability range. The mean value shall not be unduly biased based on the extreme habits of a few individuals.

(5) The average member of the critical group shall be an adult. Metabolic and physiological considerations shall be consistent with present knowledge of adults.

4.3 CODES AND STANDARDS

This is not applicable to this report, because there are no applicable codes and standards as defined in AP-3.10Q, *Analysis and Models*, that apply to this analysis.

5. ASSUMPTIONS

The communities around Yucca Mountain can be assessed to identify a representative farming community. This farming community is assumed to contain the following hypothetical screening groups: subsistence farmers, residential farmers, residents, and inhabitants. Individuals within these screening groups are assumed to represent the conditions and expected variability in a farming community. This assumption is discussed in Section 6.1. The characteristics and behaviors of one of these screening groups is assumed to represent those individuals who will receive the highest annual expected exposures. Potential exposure scenarios include the following characteristics: diet from locally produced food and drinking water, which is discussed in Section 6.1, and lifestyle, and land use which are discussed in Section 6.2. The assessment of each characteristic in Section 6 assumes that in the post-closure period, under no disruptive events, the only source of contamination is groundwater.

For the dietary characteristic, the following attributes are evaluated:

(1) A group of adults who raise all of their own food, eat nothing but locally produced food, and obtain all their drinking water and irrigation water from a contaminated groundwater supply. This would be the dietary attributes of subsistence farmers.

(2) A group of adults who raise some of their own food, eat a substantial amount of locally produced food, and obtain most of their drinking water and irrigation water from a contaminated groundwater supply. This would be the dietary attributes of residential farmers.

(3) A group of adults who raise none of their own food, eat some locally produced food, and obtain some of their drinking water from a contaminated groundwater supply. This would be the dietary attributes of residents.

(4) A group of adults who raise none of their own food, eat no locally produced foods, and obtain none of their drinking water from a contaminated groundwater supply. This would be the dietary attributes of inhabitants.

For the lifestyle characteristic, the analysis looks at the attributes of employment, recreational activities, and type of residence.

The employment attribute is considered in terms of the following Standard Industrial Classifications (US Bureau of the Census 1999):

- Agriculture, forestry, and fisheries (and farming)
- Mining
- Construction
- Manufacturing (non-durable and durable goods)
- Transportation
- Communications and other public utilities
- Trade (wholesale and retail)

- Finance, Insurance, and Real Estate
- Services (personal, entertainment and recreation, and professional)
- Public Administration

The recreational attribute is considered in terms of the following:

- Hiking
- Golfing
- Gardening
- Indoor activities
- Horseback riding
- Bicycle or motorcycle riding

The residence type attribute is considered in terms of the following US Bureau of the Census identified housing types:

- Apartment
- Detached, single ("stick-built") house
- Mobile/ Manufactured home or trailer
- Other

The land use characteristic contains the following attributes (DOE 1998b, Figure 2-3, page 2-8):

- Rangeland
- Forest land
- Barren land
- Built up or Urban Land
- Wetland
- Agricultural
- Private landholdings – light industrial or business (offices, retail, services)
- Private landholdings – residential

6. ANALYSIS

This AMR identifies a critical group using attributes of the potential behaviors and characteristics of the population surrounding Yucca Mountain in order to provide support for the development of BDCFs. The behavior and characteristics of the hypothetical screening groups are based upon the best available data and are consistent with the current conditions in the region surrounding Yucca Mountain. Final identification of a critical group, based on a quantitative assessment of potential dose, is an iterative process that is linked to the results of other AMRs, calculations, and TSPA/SR. As information and data are developed in these documents, additional data and analyses will be incorporated, as necessary.

This AMR considers diet from locally produced food and water and other potential radiation exposure pathways to the members of the population at risk. The AMR qualitatively assesses the potential for exposure associated with pathways in order to identify characteristics of a critical group.

Characteristics to be examined are diet from locally produced food and tap water, lifestyle, and land use. For each characteristic, attributes are identified and their exposure potential assessed. The attributes of the screening groups with the highest potential exposure are identified and if the attributes' parameters are considered "reasonably conservative" and not unrealistic, these attributes are used to identify a critical group. The results of the AMR will be used to support the TSPA/SR and to provide inputs to generate the BDCFs.

The potential exposures are a result of contamination from the potential repository at Yucca Mountain through three pathways. These are: (1) external exposure; (2) inhalation exposure; and (3) ingestion (Brenk et al. 1983, p. 2-1).

As discussed in Section 4.2, NRC's proposed 10 CFR 63 at section 115 (b) identifies characteristics of the critical group. Further, Section VI of the proposed rule (64 FR 8640, p. 8645) states, "The identification of those individuals expected to receive the highest dose will be most sensitive to attributes such as location, percentage of diet from locally-produced food, lifestyle, and land use." These provide the regulatory framework for this AMR.

6.1 IDENTIFICATION OF DIETARY CHARACTERISTICS AND ATTRIBUTES IN TERMS OF CONSUMPTION OF LOCALLY PRODUCED FOOD AND TAP WATER

This section uses the assumptions given in Section 5 and the best available data regarding consumption of locally produced food and tap water to identify the dietary characteristics and attributes of the screening groups. This information is used to identify a community, which, in comparison to other communities in the vicinity of Yucca Mountain exhibits behaviors or characteristics that will result in the highest expected annual exposures from consuming locally produced food and tap water. Further, using these data, the dietary attributes described in Section 5 are assessed to identify a critical group within this community, which will consist of approximately 100 adults who will receive the highest expected annual exposure. Finally, following the identification of a critical group based on the dietary characteristic, the analysis

determines the dietary parameters of the average member of this critical group such that the mean value of the critical group's variability range yields exposure parameters that result in the highest expected annual exposure.

The only source of data on the consumption of locally produced food and tap water specific to the Amargosa Valley is a 1997 survey (DOE 1997, p.1). The approximate statistical precision for the 1997 food consumption survey is 5 percent at a 99 percent level of confidence for the sample as whole (DOE 1997, p. 40). For subsets (e.g., the Amargosa Valley), the precision is less (DOE 1997, p. 40).

Table 1 shows the percent of survey respondents consuming tap water and locally produced food, by type, for the Amargosa Valley and in the total study area. The data in this table are taken from Table 2.3.1 in "The 1997 'Biosphere' Food Consumption Survey: Summary Findings and Technical Documentation" (DOE 1997, p. 10). Table 1 shows: (1) 88 out of every 100 adults in the Amargosa Valley reported consuming tap water compared to 81 out of 100 in the total study area; and (2) with the exception of grains, a higher percent of the adults in the Amargosa Valley consume locally produced food across all types than found in the total study area. For purposes of this study, the operational definition of an adult is that of a person 18 years of age and over.

Table 1. Percent of Resident Adults Consuming Locally Produced Food and Tap Water, by Food Type and Area[1]

Food Type	Amargosa Valley	Total Study Area
Leafy Vegetables	64.7	46.5
Root Vegetables	58.2	35.4
Grains	2.7	3.4
Fruit	62.2	44.1
Poultry	15.8	8.3
Meat[2]	34.2	12.5
Fish[3]	15.3	5.0
Eggs	55.1	33.9
Milk	10.9	8.0
Tap Water[4]	87.5	80.8

NOTES: [1]The data are taken from Table 2.3.1 (DOE 1997, p. 10). Although the total sample was 195 in the Amargosa Valley and 884 in the remainder of the study area, some respondents either could not or would not provide specific information (i.e., they responded "don't know" or otherwise declined). The percentages shown do not reflect weighting.
[2]"Meat" is comprised of beef and pork.
[3]The most common sources of "locally produced" fish in the entire study area are a catfish farm in the Amargosa Valley and one in Pahrump.
[4]This refers to water from a local ground source. It excludes any bottled water purchased from a commercial vendor.

Table 2 shows that the average consumption of tap water is higher in the Amargosa Valley (684 liters annually per adult) than in the total study area (646 liters annually per adult). With the exception of grains and milk, adults in the Amargosa Valley, on average, consume more locally produced food across all food types than do adults in the total study area. This indicates that Amargosa Valley is the community with highest potential exposure through consumption of locally produced food and tap water. The analysis focuses on Amargosa Valley data to determine the attributes of the dietary characteristic. Of the 195 cases representing Amargosa Valley respondents, one had so many missing values that it was deemed unsuitable for analysis. This resulted in 194 cases available for further analysis.

Table 2. Annual Mean Consumption Levels of Locally Produced Food by Type and Tap Water for Resident Adults, by Area[1]

Food Type[2]	Amargosa Valley	Total Study Area
Leafy Vegetables	8.01	4.39
Root Vegetables	4.20	2.13
Grains	0.17	0.40
Fruit	8.53	4.47
Poultry	0.49	0.45
Meat[3]	2.75	0.92
Fish[4]	0.19	0.04
Eggs	4.03	2.32
Milk	4.42	4.84
Tap Water[5]	683.84	646.20

NOTES: [1] The data for the Amargosa Valley are taken from Table 2.3.5 (DOE 1997, p. 15); the data for the total study area are taken from Table 2.3.2 (DOE 1997, p. 12).
[2] The values shown for food are in kilograms; for milk and tap water they are in liters. The arithmetic mean is calculated by summing the annual consumption amount of locally produced food reported by those who responded and dividing this sum by the number responding. Keep in mind that many of the respondents reported that they consumed no locally produced food of the type in question. The conceptual denominator of this mean is the total resident adult population of the area in question, not just those who reported consuming locally produced food (or tap water) of the type in question. The values shown reflect weighting by gender.
[3] "Meat" is comprised of beef and pork.
[4] The most common sources of "locally produced" fish in the entire study area are a catfish farm in the Amargosa Valley and one in Pahrump.
[5] This refers to water from a local ground source. It excludes any bottled water purchased from a commercial vendor.

The four dietary attributes identified in Section 5 were:

(1) A group of adults who raise all of their own food, eat nothing but locally produced food, and obtain all their drinking water and irrigation water from a contaminated groundwater supply. This would be the dietary attributes of subsistence farmers.

(2) A group of adults who raise some of their own food, eat a substantial amount of locally produced food, and obtain most of their drinking water and irrigation water from a

contaminated groundwater supply. This would be the dietary attributes of residential farmers.

(3) A group of adults who raise none of their own food, eat some locally produced food, and obtain some of their drinking water from a contaminated groundwater supply. This would be the dietary attributes of residents.

(4) A group of adults who raise none of their own food, eat no locally produced foods, and obtain none of their drinking water from a contaminated groundwater supply. This would be the dietary attributes of inhabitants.

The analysis first examines the dietary attributes of "subsistence farmers." This group has the potential for highest exposure through consumption of locally produced food and tap water. However, available evidence shows that there is nobody in the Amargosa Valley that exhibits this attribute because no respondents in the 1997 survey indicated that all of the meat or grains they consumed were locally produced (DOE 1997. p. 17). Thus, this attribute is eliminated from further consideration.

Second, the analysis looks at the dietary attributes of "inhabitants." While this group does exist, it exhibits dietary patterns that would result in the lowest potential exposure from consumption of locally produced food and tap water because "inhabitants" do not eat locally produced food or drink from a contaminated groundwater supply. Thus, this attribute is also eliminated from further consideration.

Third, the analysis compares the dietary attributes of the "residential farmer" with those of "residents." The "residential farmer" is operationally defined as having a food garden, while the "residents" do not have a food garden. Data from the 1997 survey (DOE 1997, MOL.19990409.0144) indicate that 77 survey respondents exhibit "residential farmer" attributes and 52 demonstrate attributes of "residents". Table 3 shows that, on average the "residential farmer" consumes more tap water and locally produced food across all food types than does the "resident".

This comparison (Tables 1 through 3) suggests that the critical group is likely to be comprised of Amargosa Valley adults who exhibit the following dietary characteristics and behaviors: (1) they consume some locally produced food and tap water; and (2) they have a garden. Thus, the subsequent analysis will focus on this set.

Table 3. Annual Mean Consumption Levels of Locally Produced Food by Type and Tap Water for "Residential Farmers" and "Residents" in Amargosa Valley

Food Type[2]	Residential farmers	Residents
Leafy Vegetables	15.14	5.10
Root Vegetables	7.81	2.92
Grains	0.48	0.06
Fruit	15.57	6.51
Poultry	0.80	0.40
Meat[3]	2.93	4.10
Fish[4]	0.47	0.08
Eggs	6.68	3.76
Milk	4.14	9.46
Tap Water[5]	752.85	627.87

NOTES: [1] The data are taken from the "Nye1" data set (DOE 1997, MOL.19990409.0144) by using the filter function to screen out all but Amargosa Valley Residents (AREA2=1) and selecting those who reported that they eat at least some locally produced food (FOOD1 > 0). Then, the descriptive statistics routine was run with "Group = Q6" (if Q6=1, then a garden was reported; if Q6=2, no garden was reported).
[2] The values shown for food are in kilograms; for milk and tap water they are in liters. The values shown are not weighted.
[3] "Meat" is comprised of beef and pork.
[4] The most common source of "locally produced" fish in the Amargosa Valley is the catfish farm.
[5] This refers to water from a local ground source. It excludes any bottled water purchased from a commercial vendor.

In order to extract data for "residential farmers" group and the "residents" group from the full set of survey respondents (DOE 1997, MOL.19990409.0144), the analysis used the "filter" procedure in NCSS (Hintze 1995, pp. 24-25). The respondents who meet the criteria of either the "residential farmer" group (77) or the "residents" group (52) were selected from the survey respondent file ("NYE1.s1"), separately. The "residential farmer" group consisted of respondents that met the following three conditions: (1) were located in the Amargosa Valley ("AREA2" =1); (2) did have a food garden last year ("Q6"=1); and (3) consumed locally produced food ("Food1" > 0.00) (see DOE 1997, Appendix B). Similarly, the "residents" group consisted of respondents that: (1) were located in the Amargosa Valley ("AREA2" =1); (2) did not have a food garden last year ("Q6"=2); and (3) consumed locally produced food ("Food1" > 0.00) (see DOE 1997, Appendix B). Separately, these filters and the NCSS procedure, "Descriptive Tables" (Hintze 1995, pp. 181-200), were used to produce summary statistics for each group, including a count of the number of respondents satisfying the three conditions in each set of filters. The results indicated that 77 respondents met the desired criteria of the "residential farmers" group (see Attachment II, DTN: MO9908COLPRFTW.000) and 52 respondents met the desired criteria of the "residents" group (DTN: MO0001SPACON05.015).

Each of these 77 adults represents an Amargosa Valley household, which on average has 2.80 persons (DOE 1997, p. 22). Thus, the implicit total number of persons in the farming community is 216 (77 residential farmers + 77*1.8 other household members).

Table 4 provides a set of dietary pattern parameters for the residential farmers. These parameters are computed directly from the values shown in Attachment II using the "Descriptive Tables" routine in NCSS 6.0 (Hintze 1995, pp. 181-200). Calculation of these same parameters by other means may result in minor differences from what is shown in Table 2. These differences may be due to rounding, definitional and precision differences between NCSS 6.0 and other software used to calculate these parameters.

The survey data underlying the data presented in Table 3 are subject to error from a number of sources. However, tests done in regard to non-response bias as well as validity and reliability tests suggested that the survey data are valid and reliable and sufficient for biosphere modeling purposes (DOE 1997, p. 43). The data in Table 3 as well as other data from the survey are sufficient for the task of developing food and water consumption parameters.

Table 4. Consumption Parameters of the Residential Farmer for Locally Produced Food by Type and Tap Water

Food Type[1]	Mean	95th Percentile[2]	Maximum
Leafy Vegetables	15.14	45.68	59.68
Root Vegetables	7.81	25.01	29.86
Grains	0.48	0.00	12.33
Fruit	15.57	45.44	97.69
Poultry	0.80	7.00	10.50
Meat[3]	2.93	11.87	53.11
Fish[4]	0.47	1.51	8.79
Eggs	6.68	19.65	33.34
Milk	4.14	24.73	100.36
Tap Water[5]	752.85	1487.45	1487.45

NOTES: [1] The values shown for food are in kilograms; for milk and tap water they are in liters. The values do not reflect weighting.
[2] The percentile formula used is "closest to np" (Hintze 1995, p. 121), in which the $100p^{th}$ percentile is computed as $Z_p = X_{[k1]}$, where k1 the equals the integer that is closet to np and $X_{[k]}$ is the kth observation when the data are sorted from lowest to highest, X is a given observation, and n equals the number of valid observations. There are five methods for calculating percentiles available in NCSS (Hintze 1995, p. 120-121) and each may result in different values of the 95^{th} percentile. Some may even be counter-intuitive in the presence of many zero-valued observations.
[3] "Meat" is comprised of beef and pork.
[4] The most common source of "locally produced" fish in the Amargosa Valley area is the catfish farm. Thus, the values provided are specific to the consumption of fish from this location.
[5] This refers to water from a local ground source. It excludes any bottled water purchased from a commercial vendor.

This set of 77 adults forms a group that exhibits dietary patterns that will result in the highest expected annual exposures. Therefore it is identified as constituting the dietary characteristic.

An alternative approach to developing parameters such as the mean is by specifying a distribution rather than a fixed value. Graphs are useful in this regard. Histograms produced by

NCSS 6.0 (Hintze 1995, pp. 689-698) for each food type and water are shown as Figure 1 through Figure 10. The number on the vertical axis of each histogram shows a count of the number of critical group members (identified through dietary attributes), while the number on the horizontal axis shows the level of consumption in either kilograms or liters, as appropriate.

The graphs suggest that the consumption of locally produced food of all types is skewed to the right, with near-monotonically descending counts, and an abrupt termination on the left at zero. Of the distributions found in GENII-S (SNL 1993, p. 5-33), the log uniform appears to be the most suitable candidate to use with food consumption. As a consequence, the log uniform distribution is recommended for use with all food types in terms of using a set of estimated parameters developed using a distributional approach. Tap water appears more like a uniform distribution (see Figure 10). GENII-S does accommodate a uniform distribution (SNL 1993, p.5-33), so this is recommended for tap water.

Two parameters are required for the log uniform distribution: the minimum and the maximum (SNL 1993, p. 5-33). However, the minimum value in the empirical data from which the log uniform distribution is generated cannot be zero (SNL 1993, p. 5-33). Thus, the actual minimum of zero must be replaced. In order to avoid unduly biasing the mean by this action, a very small value is required. Ragan (1998) developed an analytical function for estimating the lowest possible, non-zero value for a log-uniform distribution directly from the mean and maximum values of food consumption: $\text{minimum} = e^{[\ln(\text{maximum}) - (\text{maximum}/\text{mean})]}$. This function relies on the approximation of the mean of the log-uniform distribution as being equal to {maximum/[ln(maximum) - ln(minimum)]}, which with some simple rearranging of terms yields Ragan's formula.

Using the preceding approximation, the estimated minimum values of food consumption associated with a log-uniform distribution are shown in Table 5, along with the maximum values and a recommended distribution. Except for tap water consumption, the minimum values were found using calculations performed on a Hewlett Packard 33C electronic desk calculator, with input and display set to two significant digits. Calculation of these minimum values by other means may result in minor differences from what is shown in Table 5. These differences may be due to rounding, as well as definitional and precision differences between the Hewlett Packard 33C and other means used to calculate these parameters.

Table 5. Distributions and Distributional-Based Consumption Parameters of a Critical Group for Locally Produced Food by Type and Tap Water

Food Type[1]	Distribution	Minimum[2]	Maximum
Leafy Vegetable	Log uniform	1.16	59.68
Root Vegetable	Log uniform	0.65	29.86
Grains	Log uniform	8.61E-11	12.33
Fruit	Log uniform	0.18	97.69
Poultry	Log uniform	2.09E-05	10.50
Meat[3]	Log uniform	7.13E-07	53.11
Fish[4]	Log uniform	6.63E-08	8.79
Eggs	Log uniform	0.23	33.34
Milk	Log uniform	2.98E-09	100.36
Tap Water[5]	Uniform	0.00	1487.45

NOTES: [1] The values shown for food are in kilograms; for milk and tap water they are in liters. All values are shown in the original units of measurement, not logarithmic form. The values shown do not reflecting any type of weighting.

[2] For each food type where the recommended distribution is log-uniform, the actual minimum is zero. However, to accommodate the GENII-S input parameters for a log uniform distribution, the minimum was estimated using the function developed by Ragan (1998): minimum = $e^{[\ln(\text{maximum}) - (\text{maximum/mean})]}$.

[3] "Meat" is comprised of beef and pork.

[4] The most common source of "locally produced" fish in the Amargosa Valley is the catfish farm. Thus, the values provided are specific to the consumption of fish from this location.

[5] This refers to water from a local ground source. It excludes any bottled water purchased from a commercial vendor.

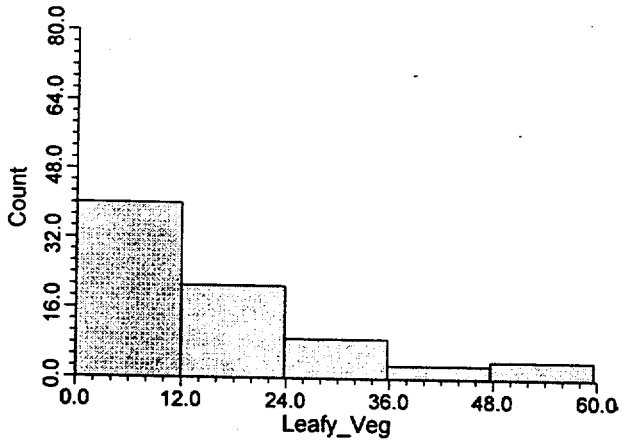

Figure 1. Histogram: Leafy Vegetable Consumption

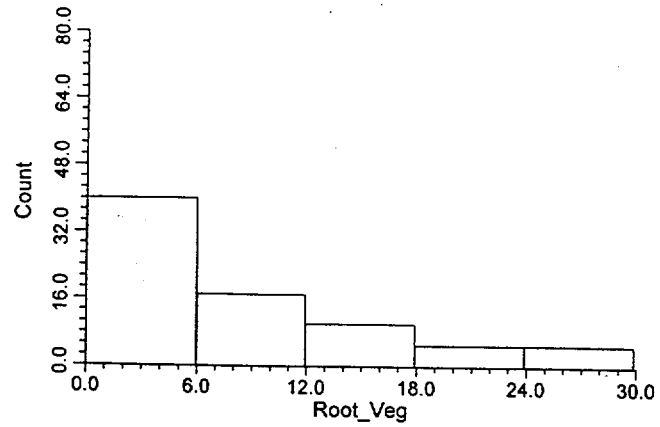

Figure 2. Histogram: Root Vegetable Consumption

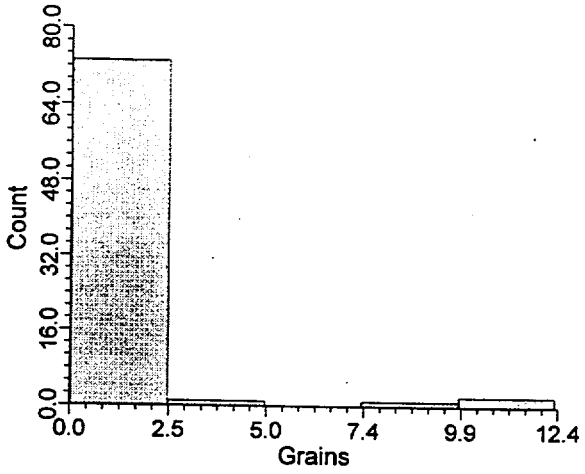

Figure 3. Histogram: Grain Consumption

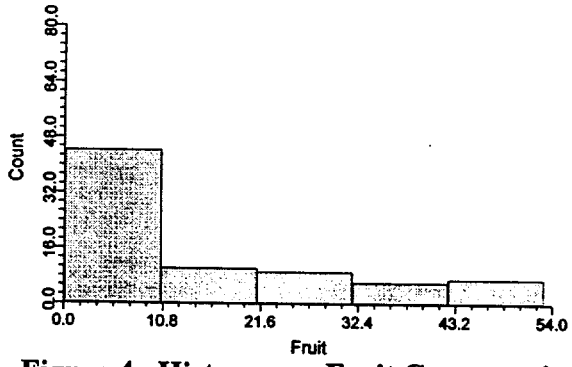

Figure 4. Histogram: Fruit Consumption

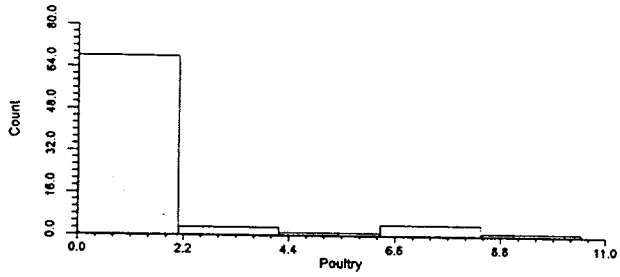

Figure 5. Histogram: Poultry Consumption

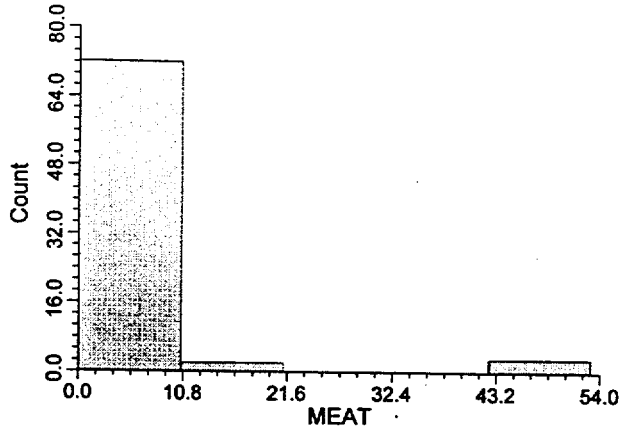

Figure 6. Histogram: Meat Consumption

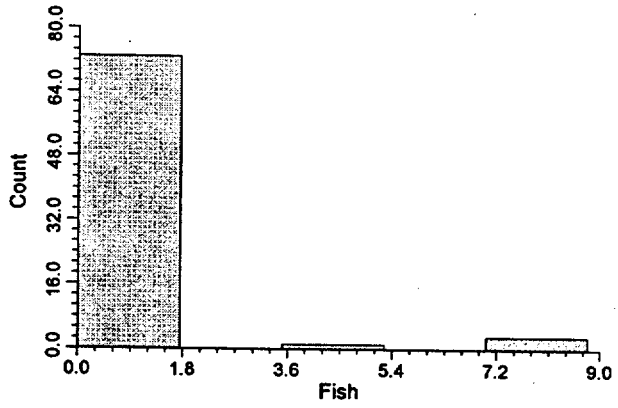

Figure 7. Histogram: Fish Consumption

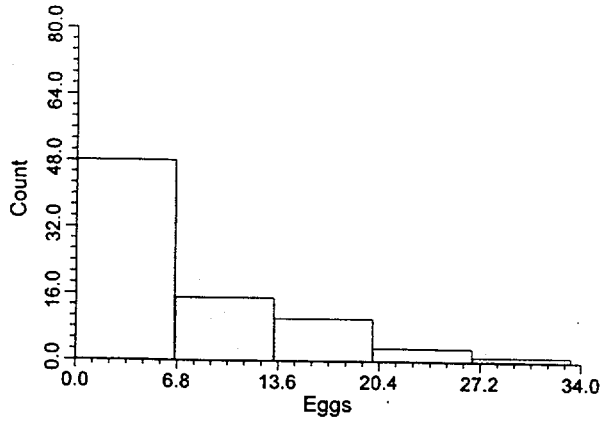

Figure 8. Histogram: Egg Consumption

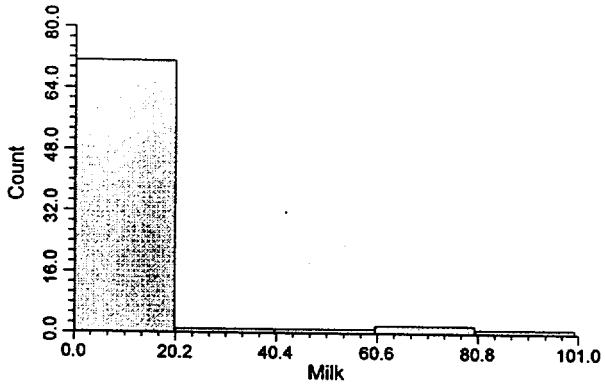

Figure 9. Histogram: Milk Consumption

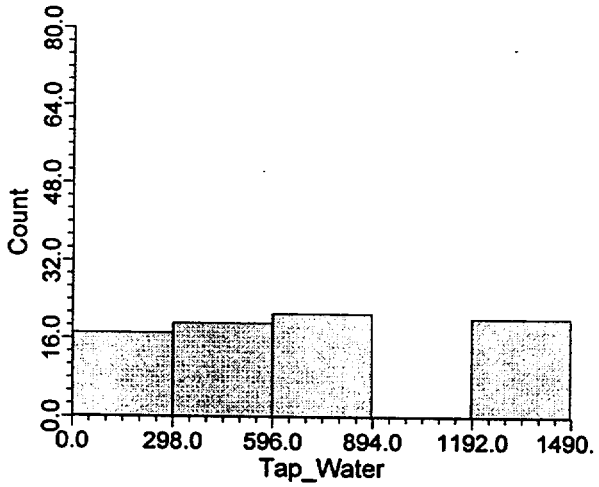

Figure 10. Histogram: Tap Water Consumption

6.2 IDENTIFICATION OF LIFESTYLE AND LAND USE CHARACTERISTICS AND ATTRIBUTES

This section identifies lifestyle and land use characteristics and attributes that relate to the three pathway components of interest: (1) external exposure; (2) inhalation exposure; and (3) ingestion exposure through means other than the consumption of contaminated food and water (which was discussed in Section 6.1).

The potential exposure subpathways associated with the lifestyle characteristic (employment, recreation, and residence type attributes) and the land use characteristic are:

- external exposure to penetrating radiation from soil sources while outdoors
- inhalation exposure to resuspended soil while outdoors
- inadvertent ingestion of soil, including consumption of unwashed food and inadvertent transfer of soil from hands or other objects
- external exposure to penetrating radiation from soil sources while indoors
- inhalation exposure to resuspended soil while indoors

Examining these subpathways, it is known that external exposure per unit measure of time to penetrating radiation from soil surfaces while outdoors is greater than the exposure while indoors due to the protection of the building. Similarly, inhalation exposure to resuspended soil per unit measure of time is greater while outdoors because the potential recipient is closer to the contaminated soil which is being resuspended. Inadvertent consumption of soil from unwashed food is not dependent on whether the potential recipient is spending time indoors or outdoors, however, inadvertent consumption of soil from other contaminated sources may be assumed to be at least as great outdoors where hands and other potential transfer objects are more likely to become contaminated. Based on this examination, it can be concluded that potential exposure per unit of time is greater if the potential recipient is outdoors.

This analysis uses data for the Amargosa Valley to be consistent with the population analyzed in Section 6.1. Because there is no source of site-specific data that pinpoint time spent outdoors, this analysis, while relying on available data, will be largely qualitative in nature. As appropriate, the reader will be referred to *Input Parameter Values For External And Inhalation Radiation Exposure Analysis* (CRWMS M&O 1999c) which analyzes lifestyle and provides time-specific exposure estimates for the least, average, and most exposed members of a critical group.

The first attribute of lifestyle to be examined is type of employment. The key element, as discussed above is time spent outdoors where potential exposure to contaminated soil and resuspended soil is the greatest. The 1990 Census data (Bureau of the Census 1999) show that 7 percent of the total population of the Amargosa Valley Census County division resided on a farm in 1990 (53 of 724 persons). U.S. Census data (Bureau of the Census 1999) also show that all of the 343 workers reported in the 1990 census worked within Nevada. That is, of the 489 persons aged 16 years or over counted in the 1990 census, 70 percent (343) were employed during the 1990 census reference week. Of the 343 employed persons, 327 (95 percent) worked in Nye County, while the remaining 5 percent worked in a Metropolitan Statistical Area (the nearest

MSA within Nevada is Clark County). Only 5 percent of the employed persons (18 of 343) reported that they worked at home. Of the 325 who commuted to work, 94 percent did so by car, truck, or van. Of the 325 who commuted to work (i.e., those who did not work at home), 151 (46 percent of those who commuted) took less than 30 minutes to reach their place of work. Based on this, the average commute time is assumed to be 30 minutes.

U.S. Census data (Bureau of the Census 1999) show that of the 375 persons aged 16 years and over who reported that they worked during the year prior to the 1990 census, only 190 (51 percent) reported that they did so more than 35 hours a week for 50 or more weeks throughout the year. That is, just over half of those working during 1989 could be considered as having a full-time, year-round job.

The 1990 Census provides valid information on employment of Amargosa Valley residents. Table 6 provides this information by Standard Industrial Classification (SIC) (some SICs have been grouped together). It is noted that there is information available that indicates the numbers have changed both in absolute and relative terms. For example, since the 1990 Census, the Ponderosa Dairy opened in the Southern part of Amargosa Valley. This has increased the demand for feed crops such as alfalfa. Employment at the dairy and on farms growing feed grains has consequently grown since the census. It is reasonable to assume that some of that increased employment is filled by Amargosa Valley residents. Conversely, employment in the mining sector in Nye County (and potentially by Amargosa Valley residents) has fallen in recent years with the closing of the Bullfrog Mine near Beatty (Thurlow 1998). In addition, total population in Amargosa has risen from 761 in 1990 to 990 in 1997 (Nevada State Demographer 1998). However, the changes since 1990 do not impact the discussion and conclusions regarding lifestyle characteristics of a critical group in this analysis.

Table 6. 1990 Amargosa Valley Employment by Standard Industrial Classification

Employment Category	1990 Employment	1990 Percentage	Assumed Primary Location of Employment
Agriculture, forestry, and fisheries (and farming)	9	2.6%	Outdoor
Mining	130	37.9%	Outdoor
Construction	25	7.3%	Outdoor
Manufacturing (non-durable and durable goods)	33	9.6%	Indoor
Communications and other public utilities	9	2.6%	Outdoor and Indoor
Trade (wholesale and retail)	41	12.0%	Indoor
Finance, Insurance, and Real Estate	9	2.6%	Indoor
Services (personal, entertainment and recreation, and professional)	70	20.4%	Primarily Indoor with some Outdoor
Public Administration	17	5.0%	Indoor
TOTAL	343	100.0%	

DTN: MO9911ANLMGRMD.003

Source: Bureau of the Census 1999

Only nine of the 343 employed persons (3 percent) reported that they were engaged in the industry of "farming, forestry, and fishing." Virtually all of these workers can be expected to be farmers, as there is no forest industry in Amargosa Valley and only one small commercial catfish pond facility. Only 25 (7 percent) of the 343 employed persons reported that they were employed in the construction industry. Mining, the third outdoor-based employment category, employed 130 (38 percent). The balance of the employment categories are primarily indoor or mixed, as follows and as shown in Table 6: 33 (10 percent) in manufacturing; nine (3 percent) in communications and other public utilities; 41 (12 percent) in retail trade; nine (3 percent) in finance, insurance, and real estate; 70 (20 percent) in services; and 17 (5 percent) in public administration.

The census data show that 70 percent of the adults in the Amargosa Valley are employed and, further, that 95 percent of them work in Nye County. Only half of the employed adults are employed fulltime, year round. About 164 (48 percent) of the employed adults in the Amargosa Valley work in a primarily outdoor industry. However, because mining is not above the surface of the ground and external exposure to contaminated soil is assumed to be less, it can be concluded that potential exposure in the other two outdoor employment categories of agriculture and construction is potentially greater. Subtracting out the mining employment, about 34 (10 percent) of the employed adults in the Amargosa valley work in an industry in which much time is spent outdoors, above the surface of the ground in the open. These are "farming, forestry, and fishing" (3 percent) and construction (7 percent).

Extrapolating this to the 77 members of the critical group (based on dietary patterns) identified in Section 6.1, 54 of the 77 are expected to be employed (70 percent of 77). Of the 54 employed persons, it is expected that 49 (90 percent of 54) would not spend the majority of their working time outdoors, above ground; while 5 (10 percent of 54) would spend the majority of their working time outdoors, above ground. Further, of the 54 employed persons, 28 work full-time year round (51 percent of 54 employed persons). Of these, three spend the majority of their time working outdoors, above ground (10 percent of 28). It can be assumed that the most exposed member of a critical group is a person who works outdoors, above ground, full-time year-round, while the average member of a critical group does not work outdoors, above ground. This average member commutes approximately 30 minutes to work, outside the "farming community."

The second attribute of lifestyle to be examined is recreation. In the Amargosa Valley area there are several activities that are generally available. While not all-inclusive, these are representative of a western rural lifestyle. These include golf, gardening, hiking, bicycle (or motorcycle/ dirt bike) riding, and horseback riding. There is no available data on how much time is spent on these activities, therefore, the following discussion focuses on potential exposure to a contamination source for each activity. Indoor recreational activities by definition have less exposure outside and therefore have less potential for exposure. Indoor activities are not further discussed.

Those recreational activities which take place close to areas of contamination (i.e., contaminated soil) will have the highest potential for external exposure. Horseback and bike riding would primarily occur on non-irrigated land, as would hiking. Gardening (on irrigated soil) and golfing

(on irrigated grass) are the activities most associated with irrigated areas, and would have the highest potential.

However, each of the 77 members of the critical group (based on dietary patterns) came from a household with a garden. Thus, a reasonable estimate is that all of them (100 percent) spend time outdoors working in a garden. Thus, the average member of that critical group could be expected to spend several hours each day outside over the course of a year, some of which involves gardening. Time estimates are provided in *Input Parameter Values For External And Inhalation Radiation Exposure Analysis* (CRWMS M&O 1999c).

The final attribute of lifestyle to be examined is residence type. Table 7 provides information on the types and percentages of housing structures in the Amargosa Valley, as counted in the 1990 Census. As a result of population growth since that time, the number of units will have increased. However, there is no information to indicate that manufactured/ mobile homes are no longer the dominant housing type, although there are now a small number of one and two story apartment units in Amargosa Valley.

Table 7. 1990 Amargosa Valley Housing by Type of Structure

Housing Type	Number of Units	Percent of Units
Single, detached	21	6.6%
Manufactured/ Mobile or Trailer	281	88.6%
Multiunit (apartments)	0	0.0%
Other - Not described	15	4.7%
Total	317	

DTN: MO0001SPACEN05.014

Source: Bureau of the Census 1999

Potential exposure could vary based on the type of house in which a person lives.

Inhalation exposure to resuspended soil while indoors is a product of several items including the tightness of the house, the effectiveness of the housing unit's filtration systems, and personal preferences of the resident, such as leaving doors and windows open as opposed to using air conditioning. Personnel preferences cannot be accounted for to distinguish between housing types and will not be considered in this discussion. A modern mobile home/ manufactured house may be equally tight as a single, detached home, and may have an equivalent air conditioning system. There does not appear to be a clear differentiation between these two types of housing units for potential exposure due to inhalation of resuspended particles.

The protection factor from external exposure to penetrating radiation from soil sources while indoors is dependent upon the thickness and type of materials of the walls, roof, and floor. Because residences are assumed not built from contaminated materials in Amargosa Valley and all materials provide some level of shielding, external exposure from penetrating radiation from soil sources while indoors is not expected to be a factor. This subpathway is not further discussed.

Due to the lack of apartments in the Amargosa Valley, apartments would not be considered to be typical of Amargosa Valley residents. As the Amargosa Valley area has a high percentage of mobile/ manufactured homes, it is reasonable to infer that the average member of a critical group lives in a mobile/ manufactured home or trailer.

The final characteristic to be examined is land use. Land uses in the area of Yucca Mountain were identified in Section 5, however, some of those uses are not present at a location 20 km south of the potential repository. There are no wetlands or forest land at this location, nor is there built-up or urban land in Amargosa Valley. There are wetlands at Ash Meadows, but these are approximately another 25 km south southeast of the potential location of the farming community at the junction of US Route 95 and Nevada Route 373 (Dyer 1999, p. 19 of enclosure). These potential land uses can be dropped from this discussion. The remaining uses will be discussed relative to potential exposure.

Agricultural land is irrigated, therefore the soil is assumed contaminated. Rangeland and barren land are not irrigated and the soil is potentially contaminated only indirectly through transfer of soils from contaminated lands. In addition to reduced direct external exposure to penetrating radiation from soil, potential inadvertent ingestion of soil and inhalation exposure would be decreased due to increased distance from the source of contaminated soil. Similarly, private landholdings used for light industrial or business would also have a lesser potential for exposure than agricultural land. Because many of the activities that take place at such a location would be indoors, direct external exposure would be decreased due to the shielding effect of buildings. Further, potential inadvertent ingestion of soil and inhalation exposure would be decreased due to increased distance from the source of contaminated soil. Residential use would also have a lesser potential than agricultural use due to the shielding effect of the house, although exposure through outdoor use at the residence could be similar to exposure on agricultural land. In short, agricultural use provides the greatest potential for exposure among the land uses considered.

Estimates of annual exposure times for inhalation of resuspended soil and external exposure to soil while outdoors are provided in *Input Parameter Values For External And Inhalation Radiation Exposure Analysis* (CRWMS M&O 1999c) for the least exposed, average, and most exposed members of a critical group.

7. CONCLUSIONS

This AMR identifies a critical group using attributes of the potential behaviors and characteristics of the population surrounding Yucca Mountain. The behavior and characteristics of the hypothetical screening groups are based upon the best available data and are consistent with the current conditions in the region surrounding Yucca Mountain. Characteristics to be examined are diet from locally produced food and tap water, lifestyle, and land use. For each characteristic, attributes are identified and their exposure potential assessed. The characteristics of the screening groups with the highest potential exposure are identified and if the parameters are considered reasonably conservative and not unrealistic, are used to identify a critical group.

This report examined data from the 1997 food consumption survey (DOE 1997) and evaluated the attributes of four possible groups of adults categorized by the amount of locally produced food and tap water each group might raise and/or consume. The data showed that Residential Farmers have the highest potential for annual exposure of the groups likely to exist in Amargosa Valley. The analysis established consumption values for locally produced food and tap water for Residential Farmers, a critical group based on dietary patterns and behaviors. These values, minimum, mean, maximum, and 95th percentile, will be used, as appropriate, as inputs to the GENII-S code used to generate the BDCFs that are to be generated for TSPA/SR. These values are provided in Tables 4 and 5.

This report qualitatively examined the characteristics and attributes of lifestyle and land use. The analysis of potential exposure pathways (inhalation, external, and ingestion other than through consumption of contaminated food and water) showed that for each pathway, the total potential exposure is directly related to the amount of time spent outdoors in proximity to contaminated land. For the lifestyle characteristic, the attributes of importance are employment and recreation. The employment classifications with the highest potential exposure include outdoor, above ground occupations, which in Amargosa Valley, based on Census data, are agriculture and construction. All outdoor, recreational activities examined in Section 6.2 have potential for exposure, but gardening, due to its proximity to irrigated, contaminated land, has the greatest potential. Estimated values for the exposure times for inhalation and external exposure for the least exposed, average, and most exposed members of a critical group are provided in *Input Parameter Values For External And Inhalation Radiation Exposure Analysis* (CRWMS M&O 1999c).

The land use characteristic also was examined and the most important attributes for potential exposure were whether or not the land was potentially contaminated, and if so, the extent of that potential contamination. The discriminator for directly contaminated land and land only indirectly contaminated was determined to be irrigation. As a result, agricultural use has the greatest potential for exposure of the land uses considered.

Figure 11 depicts the relative ranking by exposure potential of key characteristics and attributes of diet of locally produced food and tap water, lifestyle, and land use in Amargosa Valley.

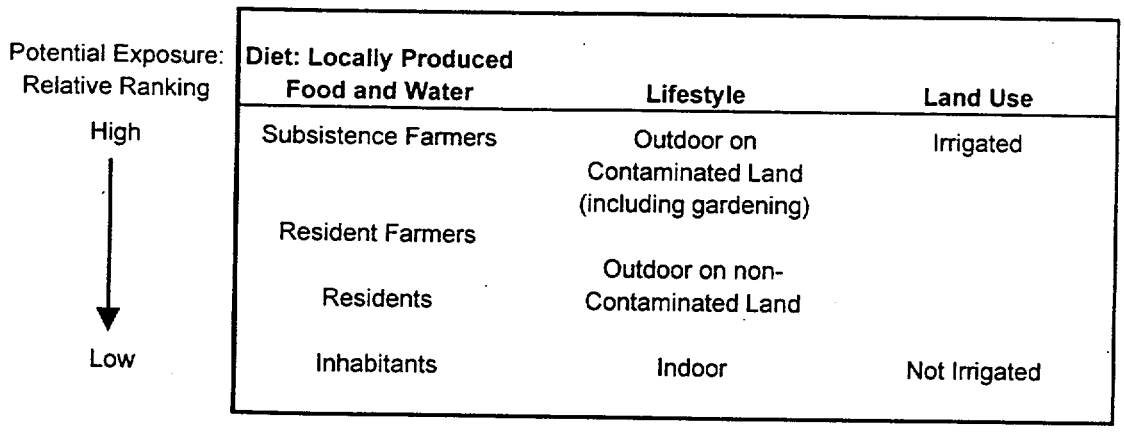

Figure 11. Relative Ranking of Potential Exposure for Key Characteristics and Attributes in Amargosa Valley

This analysis has evaluated possible characteristics for those most likely to have the highest potential annual exposure. As discussed, available evidence shows that there is nobody that exhibits the dietary behaviors of the "subsistence farmer" group, and "inhabitants" exhibit behaviors that would result in the lowest potential exposure from eating locally produced food and tap water. Data from the 1990 survey (DOE 1997, MOL.19990409.0144) show that on average, "residential farmers" consume more locally produced food and tap water than do "residents." Figure 11 shows that a critical group would be expected to exhibit the following attributes:

- Residential farmer group, who have a garden and raise some of their own food, eat a substantial amount of locally produced food, and obtain most of their drinking water and irrigation water from a contaminated groundwater supply.

- Lifestyle with considerable time spent outdoors on contaminated land, which includes outdoor employment, particularly in agriculture or construction, and outdoor recreational activities including gardening and other activities on contaminated land. Although not addressed in Figure 11, members of this group are expected to live in a mobile/manufactured home as it is the predominant type of housing in Amargosa Valley.

- Land use associated with irrigated land.

As has been previously stated, the results of this AMR will be used to support the TSPA/SR and to provide inputs to generate the BDCFs. Final identification of a critical group, based on a quantitative assessment of potential dose, is an iterative process that is linked to the results of other AMRs, calculations, and TSPA/SR. The need for additional data will be examined and, as needed, additional data will be developed. These subsequent analyses may serve as the basis for revisions of this AMR.

This document and its conclusions may be affected by technical product input information that requires confirmation. Any changes to the document or its conclusions that may occur as a result

of completing the confirmation activities will be reflected in subsequent revisions. The status of the input information quality may be confirmed by review of the Document Input Reference System database.

8. REFERENCES

8.1 DOCUMENTS CITED

64 FR (Federal Register) 8640. Disposal of High-Level Radioactive Waste in a Proposed Geologic Repository at Yucca Mountain. Proposed Rule 10 CFR 63. Readily available.

64 FR 46976. Environmental Radiation Protection Standards for Yucca Mountain, Nevada. Proposed Rule 40 CFR 197. Readily available.

Brenk, H.D.; Fairobent, J.; and Markee, E. 1983. "Transport of Radionuclides in the Atmosphere" pp. 2-1 to 2-86 in *Radiological Assessment: A Textbook on Environmental Dose Analysis (NUREG/CR-3332)*, Till, J. and Meyer, H.R., eds. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 223809.

Bureau of the Census 1999. "1990 Census Data for the Amargosa Valley CCD." 1990 Census Database: C90STF3A. State-county-county subdivision. FIPS.State=32, FIPS.County=023, FIPS.cousub=94028. http://venus.census.gov/cdrom/lookup. Washington D.C.: U.S. Department of Commerce, Bureau of the Census. TIC: 245829.

CRWMS M&O 1999a. *Technical Product Development Plan for Identification of the Critical Group (Consumption of Locally Produced Food and Tap Water).* DI: TDP-MGR-MD-000003 REV00. ACC: MOL.19990806.0059.

CRWMS M&O 1999b. *Scientific Investigation of Radiological Doses in the Biosphere.* B00000000-01717-2200-00169 Rev 2. ACC: MOL.19990222.0091.

CRWMS M&O 1999c. *Input Parameter Values For External And Inhalation Radiation Exposure Analysis.* DI: ANL-MGR-MD-000001 REV 00. ACC: MOL.19990923.0235.

DOE (U.S. Department of Energy) 1997. *The 1997 "Biosphere" Food Consumption Survey: Summary Findings and Technical Documentation.* (Two diskettes each with one NCSS data file, in which the two files are linked in that NYE1.TIC.S1 contains the data and NYE1.TIC.S0 contains the variable information dictionary for the data). Las Vegas, Nevada: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19981021.0301; MOL.19990409.0144.

DOE 1998a. *Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program.* DOE/RW-0333P Rev. 8, Washington, D.C. U.S. Department of Energy. ACC: MOL.19980601.0022.

DOE 1998b. *Viability Assessment of a Repository at Yucca Mountain.* Volume 1. DOE/RW-0508. Las Vegas, Nevada. U.S. Department of Energy, Yucca Mountain Site Characterization Office. ACC: MOL.19981007.0028.

DOE 1999. *Monitored Geologic Repository Requirements Document.* YMP/CM-0025. Rev. 3, DCN 01. Las Vegas, Nevada: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19990429.0228

Dyer, J.R. 1999. "Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations for Yucca Mountain." Letter from J.R. Dyer (DOE/YMSCO) to D.R. Wilkins (CRWMS M&O), June 18, 1999, OL&RC:AVG:1435, with enclosure. ACC: MOL.19990623.0026; MOL.19990623.0027.

Hintze, J. 1995. *NCSS 6.0 User's Guide.* Kaysville, Utah: NCSS, Inc. TIC: 237955.

Mellington, S. 1999. "Office of Project Execution (OPE) Approval of LV.ESR.RLK.03/99-042 as Accepted Data." Letter from S. P. Mellington (DOE/YMSCO) to M.W. Harris (CRWMS M&O), October 1, 1999, OPE:ERC-2084, with enclosure. ACC: MOL.19991104.0063.

Nevada State Demographer 1998. "Population of Nevada's Unincorporated Towns." *Population Estimates – State, Counties, Incorporated Cities, and Unincorporated Towns.* February 24. Reno, Nevada: Nevada Department of Taxation. TIC: 237863.

Ragan, G.E. 1998. "Supplement to the Biosphere Input Data Files on Using Log-uniform Distributions in GENII-S to Model Uncertainty in Food Consumption Rates." Memorandum from G.E. Ragan (CRWMS M&O) to D.A. Swanson (CRWMS M&O), March 25, 1998. ACC: MOL.19990406.0479.

SNL (Sandia National Laboratories) 1993. *User's Guide for GENII-S: A Code for Statistical and Deterministic Simulations of Radiation Doses to Humans from Radionuclides in the Environment.* SAND91-0561 UC-721. Albuquerque, NM: Sandia National Laboratories. TIC: 231133.

Thurlow, Rich 1998. "Amargosa, Beatty clinic contracts approved." *Pahrump Valley Times.* April 10. [Newspaper article provides information on declining employment at Barrick Bullfrog Mine in Beatty, Nevada] Pahrump, Nevada. TIC: 242702.

8.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

AP-2.1Q, *Indoctrination and Training of Personnel,* Washington, D.C.: Office of Civilian Radioactive Waste Management. ACC: MOL.19990702.0318.

AP-2.2Q, *Establishment and Verification of Required Education and Experience of Personnel,* Washington, D.C.: Office of Civilian Radioactive Waste Management. ACC: MOL.19990701.0618.

AP-3.10Q, Rev. 1. *Analyses and Models.* Washington, D.C.: Office of Civilian Radioactive Waste Management. ACC: MOL.19991019.0467.

AP-SI.1Q, Rev. 1. *Software Management* Washington, D.C.: Office of Civilian Radioactive Waste Management. ACC: MOL.19990630.0395.

AP-SIII.2Q, Rev.0 ICN 2. Qualification Of Unqualified Data And The Documentation Of Rationale For Accepted Data. ACC: MOL.19991214.0625

AP-SIII.3Q, Rev.0 ICN 2. Submittal And Incorporation Of Data To The Technical Data Management System. ACC: MOL.19991214.0632

NLP-2-0, *Determination of Importance Evaluation.* Washington, D.C.: Office of Civilian Radioactive Waste Management. ACC: MOL.19981116.0120.

QAP-2-0, Rev. 5. *Conduct of Activities*. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980826.0209.

QAP-2-3, *Classification of Permanent Items*, Washington, D.C.: Office of Civilian Radioactive Waste Management. ACC: MOL.19990316.0006.

8.3 SOURCE DATA, LISTED BY DATA TRACKING NUMBER

MO9908COLPRFTW.000. Consumption of Locally Produced Food and Tap Water. Submittal date: 08/05/1999.

MO9911ANLMGRMD.003. Employment And Occupational Characteristics Of People Living In Amargosa Valley, Nye County, Nevada. Submittal date: 11/29/1999.

MO0001SPACON05.015. Consumption values for the Amargosa Valley Resident Group. Submittal date: 01/12/2000.

MO0001SPACEN05.014. Amargosa Valley Census Division Housing Data. Submittal date: 01/11/2000.

ATTACHMENT I. DOCUMENT INPUT REFERENCE SHEET

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
DOCUMENT INPUT REFERENCE SHEET

1. Document Identifier No./Rev.:	Change:	Title:
ANL-MGR-MD-000005 REV 00	0	Identification of the Critical Group (Consumption of Locally Produced Food and Tap Water)

Input Document							8. TBV Due To		
	2. Technical Product Input Source Title and Identifier(s) with Version	3. Section	4. Input Status	5. Section Used in	6. Input Description	7. TBV/TBD Priority	Unqual.	From Uncontrolled Source	Un-confirmed
2a									
1	Bureau of the Census 1999. "1990 Census Data for the Amargosa Valley CCD." 1990 Census Database: C90STF3A. State-county-county subdivision. FIPS.State=32, FIPS.County=023,FIPS.cousub=94028. Washington D.C.: U.S. Department of Commerce, Bureau of the Census. TIC: 245829. http://venus.census.gov/cdrom/lookup	no pages	Accepted data – AMOPE accepted	pp. 9, 11, 24, and 25	Farm population, place of work, travel time to work, employment status, industry, work status, and housing	N/A	N/A	N/A	N/A
2	DOE (U.S. Department of Energy) 1997. *The 1997 "Biosphere" Food Consumption Survey: Summary Findings and Technical Documentation.* Las Vegas, Nevada: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19981021.0301; MOL.19990409.0144	pp. vi, 1, 7, 10, 12, 15, 27-30, 34, 40, and 43	N/A; reference only	pp. 9, 14, 15, 16, 17, 18, 29 and 30	Summary findings and technical documentation of food consumption survey of communities in region of Yucca Mountain Site	N/A	N/A	N/A	N/A
3	64 FR (Federal Register) 8640. Disposal of High-Level Radioactive Waste in a Proposed Geologic Repository at Yucca Mountain. Proposed rule 10 CFR 63. Readily available.	Part 115	N/A; reference only	p. 9, 10, and 13	Proposed definition of the critical group	N/A	N/A	N/A	N/A
4	Dyer, J.R. 1999. "Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations for Yucca Mountain." Letter from J.R. Dyer (DOE/YMSCO) to D.R. Wilkins (CRWMS M&O), June 18, 1999, OL&RC:AVG:1435, with enclosure. ACC: MOL.19990623.0026; MOL.19990623.0027.	Letter and enclosures	N/A; manage-ment edict	pp. 6, 9, 10, and 28	Letter from J.R. Dyer to D.R. Wilkins on using Proposed 10 CFR 63.	N/A	N/A	N/A	N/A

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
DOCUMENT INPUT REFERENCE SHEET

1. Document Identifier No./Rev.:	Change:	Title:
ANL-MGR-MD-000005 REV 00	0	Identification of the Critical Group (Consumption of Locally Produced Food and Tap Water)

Input Document							8. TBV Due To		
	2. Technical Product Input Source Title and Identifier(s) with Version	3. Section	4. Input Status	5. Section Used in	6. Input Description	7. TBV/TBD Priority	Unqual.	From Uncontrolled Source	Un-confirmed
5	Hintze, J. 1995. *NCSS 6.0 User's Guide.* Kaysville, Utah: NCSS, Inc. TIC: 237955.	pp. 23, 24, 25, 181 to 200, 670, 675, and 689 to 698	N/A; reference only	pp. 8, 17, 18, and 19	User's guide for the NCSS statistical program	N/A	N/A	N/A	N/A
6	SNL (Sandia National Laboratories) 1993. *User's Guide for GENII-S: A Code for Statistical and Deterministic Simulations of Radiation Doses to Humans from Radionuclides in the Environment.* SAND91-0561 UC-721. Albuquerque, NM: Sandia National Laboratories. TIC: 231133.	pp. 5 to 33	N/A; reference only	p. 19	User's Guide for the GENII-S simulation program	N/A	N/A	N/A	N/A
7	MO9908COLPRFTW.000. Consumption of Locally Produced Food and Tap Water.	---	TBV: 3926	pp. 17 and II-3	Data on consumption of locally produced food and tap water by the critical group. Survey data to be qualified	1	X	X	
8	Ragan, G.E. 1998. "Supplement to the Biosphere Input Data Files on Using Log-uniform Distributions in GENII-S to Model Uncertainty in Food Consumption Rates." Memorandum from G.E. Ragan (CRWMS M&O) to D.A. Swanson (CRWMS M&O), March 25, 1998. ACC: MOL.19990406.0479.	pp. 1 to 4	N/A; reference only	p. 19 and 20	Log-uniform distribution minimum	N/A	N/A	N/A	N/A
9	CRWMS M&O 1999a. *Technical Product Development Plan for Identification of the Critical Group (Consumption of Locally Produced Food and Tap Water).* DI: TDP-MGR-MD-000003 REV00. ACC: MOL.19990806.0059.	all	N/A; reference only	p. 6	Technical Guidance	N/A	N/A	N/A	N/A

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
DOCUMENT INPUT REFERENCE SHEET

1. Document Identifier No./Rev.:	Change:	Title:
ANL-MGR-MD-000005 REV 00	0	Identification of the Critical Group (Consumption of Locally Produced Food and Tap Water)

Input Document							8. TBV Due To		
	2. Technical Product Input Source Title and Identifier(s) with Version	3. Section	4. Input Status	5. Section Used in	6. Input Description	7. TBV/TBD Priority	Unqual.	From Uncontrolled Source	Un-confirmed
10	DOE 1998a. *Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program.* DOE/RW-0333P Rev. 8, Washington, D.C. U.S. Department of Energy. ACC: MOL.19980601.0022.	all	N/A; reference only	p. 7	QA requirement	N/A	N/A	N/A	N/A
11	Brenk, H.D., Fairobent, J., and Markee, E. 1983. "Transfer of Radionuclides in The Atmosphere." Pp. 2-1 to 2-86 in J. Till and H.R. Meyer (editors), *Radiological Assessment: A Textbook on Environmental Dose Analysis (NUREG/CR-3332).* Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 223809	p. 2-1	N/A; reference only	p. 13	Radiation Exposure Pathways	N/A	N/A	N/A	N/A
12	Mellington, S. 1999. "Office of Project Execution (OPE) Approval of LV.ESR.RLK.03/99-042 as Accepted Data." Letter from S. P. Mellington(DOE/YMSCO) to M.W. Harris (CRWMS M&O), October 1, 1999, OPE:ERC-2084, with enclosure. ACC: MOL.19991104.0063	all	N/A; reference only	p. 9	Letter stating that census data and other data are "accepted	N/A	N/A	N/A	N/A
13	CRWMS M&O 1999b. *Scientific Investigation of Radiological Doses in the Biosphere.* B00000000-01717-2200-00169 Rev 2. ACC: MOL.19990222.0091.	all	N/A; reference only	p. 7	QA requirement	N/A	N/A	N/A	N/A
14	CRWMS M&O 1999c. Input Parameter Values for External and Inhalation Radiation Exposure Analysis. DI: ANL-MGR-MD-000001 Rev. 01. ACC: MOL.19990923.0235	all	N/A; reference only	pp. 24, 27, 28, and 29	Link to other AMR where data is located	N/A	N/A	N/A	N/A
15	DOE 1998b. Viability Assessment of a Repository at Yucca Mountain Volume 1. DOE/RW-0508. Las Vegas, Nevada. U.S. Department of Energy, Yucca Mountain Site Characterization Office. ACC: MOL.19991007.0028	p. 2-8	N/A; reference only	p. 12	Identification of land use types	N/A	N/A	N/A	N/A

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
DOCUMENT INPUT REFERENCE SHEET

1. Document Identifier No./Rev.:	Change:	Title:
ANL-MGR-MD-000005 REV 00	0	Identification of the Critical Group (Consumption of Locally Produced Food and Tap Water)

Input Document			4. Input Status	5. Section Used in	6. Input Description	7. TBV/TBD Priority	8. TBV Due To		
	2. Technical Product Input Source Title and Identifier(s) with Version	3. Section					Unqual.	From Uncontrolled Source	Un-confirmed
16	Nevada State Demographer 1998. "Population of Nevada's Unincorporated Towns." *Population Estimates – State, Counties, Incorporated Cities, and Unincorporated Towns.* February 24. Reno, Nevada: Nevada Department of Taxation. TIC: 237863.	all	N/A; reference only	p. 25	1997 population of Amargosa Valley	N/A	N/A	N/A	N/A
17	Thurlow, Rich 1998. "Amargosa, Beatty clinic contracts approved." *Pahrump Valley Times.* April 10. [Newspaper article provides information on declining employment at Barrick Bullfrog Mine in Beatty, Nevada] Pahrump, Nevada. TIC: 242702.	all	N/A; reference only	p. 25	Decline in employment in mining	N/A	N/A	N/A	N/A
18	64 FR (Federal Register) 46976. Environmental Radiation Protection Standards for Yucca Mountain, Nevada. Proposed Rule 40 CFR 197. Readily available.	all	N/A; reference only	p. 9	Proposed regulation.	N/A	N/A	N/A	N/A
19	MO0001SPACON05.015. Consumption Values for the Amargosa Valley Resident Group. Submittal date: 01/12/2000.		TBV	p. 17	Data on consumption of locally produced food and tap water by the resident group. Survey data to be qualified.	1	X	X	
20	MO0001SPACEN05.014. Amargosa Valley Census Division Housing Data. Submittal date: 01/11/2000		Accepted data-AMOPE accepted	p. 27	Housing type data for Amargosa Valley	N/A	N/A	N/A	N/A
21	MO9911ANLMGRMD.003. Employment and Occupational Characteristics of People Living in Amargosa Valley, Nye County, Nevada. Submittal date: 11/29/1999		Accepted data-AMOPE accepted	p. 25	Employment classification data for Amargosa Valley	N/A	N/A	N/A	N/A
22	DOE 1999. Monitored Geologic Repository Requirements Document. YMP/CM-0025. Rev. 3, DCN 01. Las Vegas, Nevada: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19990429.0228	All	N/A; reference only	p. 9	Requirements document	N/A	N/A	N/A	N/A

ATTACHMENT II. SCIENTIFIC DATA FOR THE IDENTIFICATION OF THE RESIDENTIAL FARMER GROUP (CONSUMPTION OF LOCALLY PRODUCED FOOD AND TAP WATER)

II. SCIENTIFIC DATA FOR THE IDENTIFICATION OF THE RESIDENTIAL FARMER GROUP (CONSUMPTION OF LOCALLY PRODUCED FOOD AND TAP WATER)

The reported consumption values and gender for all 77 cases used in calculating consumption values for locally produced food and tap water by the Residential Farmer Group are shown below.

Gender and Consumption Values for the Residential Farmer Group [1]

Case	Gender[2]	Leafy Veg	Root Veg	Grains	Fruit	Poultry	Fish	Eggs	Milk	Tap Water	Meat
1	2	30.07	22.40	4.11	97.69	2.51	0	1.69	0	867.68	0
2	1	13.26	5.68	0	48.19	0	0	19.65	0	1198.22	53.11
3	2	12.89	14.25	0	44.40	0.11	0.13	18.60	0.33	537.13	49.18
4	2	49.47	13.57	12.33	34.89	1.34	1.51	18.60	0	537.13	5.49
5	1	30.53	17.05	0	12.05	0	7.50	12.50	0	867.68	48.53
6	2	58.51	6.48	0	48.84	0	0	3.23	0	867.68	2.07
7	2	20.04	29.86	0	41.87	7.36	0	18.60	0	867.68	0
8	1	14.25	25.01	0	26.51	7.88	0	33.34	68.02	867.68	7.18
9	1	35.28	25.01	0	53.01	0	0	0	0	537.13	0
10	1	35.17	29.47	0	45.44	0	0	0	0	867.68	0
11	2	31.13	16.29	0	36.63	0	0	18.60	0	867.68	0
12	2	0	19.00	0	36.63	7.80	7.03	23.67	100.36	537.13	0
13	1	59.68	22.73	0	9.64	0	0.11	0	0	867.68	0
14	2	59.26	14.93	0	4.44	0.67	1.51	0.92	0	867.68	0.94
15	1	21.40	5.36	0	18.93	0	0	25.01	0	537.13	11.87
16	2	42.72	13.57	0	1.90	0.67	0	11.84	0	1198.22	9.67
17	2	10.61	19.00	0	26.17	0	0	18.60	0	1487.45	0
18	2	14.70	6.91	0	38.38	0.11	0.75	11.84	0	537.13	0.68
19	2	45.68	19.00	0	3.81	0	0	3.69	0	0	0
20	1	43.40	8.53	0	18.07	0	0	0.32	0	1487.45	0.44
21	2	12.23	10.18	0	44.40	0	0.50	0	0	537.13	2.36
22	2	32.75	9.50	0	10.47	0.56	0.38	11.84	0	1198.22	0.06
23	2	9.36	14.25	0	26.17	3.68	0	11.84	0	0	0
24	1	21.43	11.37	0	9.64	2.39	1.36	12.12	0	247.91	5.95
25	1	30.71	27.28	0	0	0	0	5.68	0	1198.22	0.22
26	1	8.88	11.37	0	24.10	7.00	0	7.58		537.13	0.93

27	2	22.49	6.48	0	13.32	0.67	1.51	13.53	45.62	867.68	1.58
28	2	2.21	1.85	0	41.87	0	0	11.84	0	867.68	0
29	1	22.70	1.46	0	7.23	0	0	24.25	0	867.68	0.94
30	1	24.04	12.50	0	1.89	0	0	16.67	0	0	0.15
31	2	7.88	4.07	0	22.20	0	0	18.60	0	537.13	1.88
32	2	14.29	10.18	0	24.42	0	0	5.38	0	867.68	0
33	1	9.52	1.95	0	24.10	10.50	0	7.14	0	867.68	0
34	2	18.37	9.50	0	5.23	0	8.79	5.07	0	0	0.19
35	2	14.06	6.91	0	26.17	0	0	0	0	867.68	0
36	2	0.89	0.74	0	44.40	0	0	0.23	0	537.13	0
37	2	34.26	0	0	4.44	0	0	5.07	0	537.13	2.07
38	2	12.46	2.96	0	26.64	0	0	1.69	0	1487.45	0
39	1	21.83	0.97	0	19.28	0	0.34	0	0	1487.45	0
40	2	7.85	6.79	0	6.66	0	0	18.60	0	867.68	1.88
41	1	20.84	12.50	0	3.79	0	0	0.65	0	1198.22	0
42	2	7.12	16.29	8.22	0	0.67	0	0.54	0	247.91	0.81
43	2	3.55	9.50	0	1.90	0	0.13	3.80	0	537.13	13.62
44	1	9.82	5.68	0	7.23	1.19	0.23	8.34	24.73	82.64	0
45	2	4.41	8.14	0	15.70	0	0	1.15	0	1487.45	0.38
46	2	7.96	8.64	0	0.95	0	0	11.84	0	1487.45	0
47	2	15.70	3.45	0	8.88	0	0	0	0	1487.45	0
48	1	8.51	5.68	0	12.05	0	0	1.79	0	247.91	0
49	2	15.59	0.74	0	11.10	0	0	0.46	0	1487.45	0
50	2	13.22	4.07	0	8.88	0	0	0.92	75.27	1487.45	0.38
51	2	7.15	5.18	12.33	1.90	0	0.25	0	0	247.91	0
52	2	2.80	2.59	0	17.76	0	0	2.31	0	247.91	0
53	2	6.66	1.85	0	8.88	0	0	5.07	0	537.13	0
54	2	12.54	8.64	0	0	0	0	0.92	0	1198.22	0
55	2	6.40	0.37	0	4.44	0	0	8.88	0	537.13	0
56	1	10.96	9.09	0	0	0	0	0	0	867.68	0
57	2	2.08	2.59	0	6.66	0	3.77	4.23	0	537.13	0.38
58	2	7.66	0.37	0	2.22	0	0	8.88	0	0	0
59	2	0.44	0.86	0	17.76	0	0	0	0	1487.45	0
60	1	17.28	0	0	0	0.48	0	0.32	0	537.13	0.23
61	1	3.81	1.95	0	9.64	0	0	0	0	867.68	0
62	2	1.47	0	z0	4.44	0	0	8.88	0	537.13	0
63	1	0.74	0	0	4.13	6.13	0	3.25	0	0	0
64	1	6.98	2.44	0	0	0.16	0	3.79	0	1487.45	0.47

65	2	0	0.37	0	4.44	0	0	8.61	0	247.91	0
66	2	5.88	0	0	0	0	0.25	5.07	0	867.68	0
67	2	6.79	0.74	0	0.95	0	0	2.69	0	867.68	0
68	2	0.44	0	0	8.88	0	0	0	0	82.64	0
69	1	0.74	0	0	0.34	0	0	3.57	0	247.91	0
70	1	0	0	0	2.07	0	0	0	0	1198.22	2.34
71	2	0.15	2.0	0	1.27	0	0	0	0	867.68	0
72	2	0	2.59	0	0	0	0	0.46	0	1198.22	0
73	1	0.58	0	0	2.06	0	0	0	0	1198.22	0
74	2	0.79	0	0	0	0	0	0.15	0	247.91	0
75	1	0.19	0.16	0	0.34	0	0	0	0	247.91	0
76	2	0.30	0.25	0	0	0	0	0	0	537.13	0
77	1	0	0	0	0	0	0	0.32	0	537.13	0

DTN: MO9908COLPRFTW.000

NOTES: [1]The values shown for food are in kilograms; for milk and tap water they are in liters. A blank cell indicates that the respondent did not provide an answer.
[2]Females are coded as a 2 and males are coded as a 1.