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Revision 0

Data Quality Objectives Supporting the Environmental Direct Radiation Monitoring Program for the Idaho National Laboratory

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June 2015

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Approved by:

[signature]	June 25, 2015
Scott Lee Manager, Regulatory and Environmental Services	Date

ABSTRACT

This document presents the development of the data quality objectives (DQOs) for the Idaho National Laboratory (INL) Environmental Direct Radiation Monitoring Program and follows the Environmental Protection Agency (EPA) DQO process (*EPA 2006*). This document also develops and presents the logic to determine the specific number of direct radiation monitoring locations around INL facilities on the desert west of Idaho Falls and in Idaho Falls, at locations bordering the INL Site, and in the surrounding regional area. The selection logic follows the guidance from the Department of Energy (DOE) (2015) for environmental surveillance of DOE facilities.

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ACRONYMS

AP	activation products
ARA	Auxiliary Reactor Area
ATR	Advanced Test Reactor
BCTC	Bonneville County Technology Center
CFA	Central Facilities Area
DQO	data quality objectives
DS	decision statement
EPA	Environmental Protection Agency
FP	fission products
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IRC	INL Research Center
LCL	lower control limit
MEI	maximally exposed individual
MFC	Materials and Fuels Complex
NESHAP	National Emission Standards for Hazardous Air Pollutants
NRF	Naval Reactors Facility
OSLD	Optically Stimulated Luminescence dosimeter
PINS	Portable Isotopic Neutron Spectroscopy
PSQ	principal study question
REC	Research and Education Campus
RRL	residential receptor location
RWMC	Radioactive Waste Management Complex
SMC	Specific Manufacturing Capability
TIC	time-integrated concentration
TLD	thermoluminescent dosimeter
TREAT	Transient Reactor Test Facility
UCL	upper control limit
UTL	upper tolerance limit

1. INTRODUCTION

This document presents the development of the data quality objectives (DQOs) for the Idaho National Laboratory (INL) Environmental Direct Radiation Monitoring Program. This DQO follows the Environmental Protection Agency (EPA) DQO process (EPA 2006). The DQO process is used to clarify objectives, define the type of data, and specify the limits on the likelihood of making potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decision-making. In this document, the term INL comprises the INL Site 50 miles west of Idaho Falls and DOE facilities in Idaho Falls. For simplicity, the INL Site will be referred to as the Site.

The INL Environmental Direct Radiation Monitoring Program monitors radiation exposure of the public and non-involved workers within Site boundaries and surrounding areas. The program involves placing dosimeters around INL facilities, along the Site perimeter, and in areas within a 50-mile radius of the Site boundary.

Direct radiation monitoring is performed on and around the Site to meet the regulatory requirements set forth in DOE Order 458.1, "Radiation Protection of the Public and the Environment." Direct radiation monitoring is conducted following the guidance for environmental surveillance of DOE facilities (DOE 2015). This guidance document will be referred to in this DQO document as the "Handbook."

Dosimeters provide a cost-effective method to monitor direct radiation near INL facilities with radioactive materials or radiation-generating work processes or near INL facilities with radioactive waste. While less likely, dosimeters are able to monitor for exposure to noble gas plumes, such as Ar-41. Lastly, dosimeters determine exposure from terrestrial and cosmic sources.

The INL Environmental Direct Radiation Monitoring Program has two components. The on-Site program emphasizes monitoring within the Site boundaries and includes INL facilities in Idaho Falls. The off-Site program focuses on regional monitoring distant from the Site and near the Site boundary. There is some intentional overlap in on-Site and off-Site program monitoring locations to provide comparison and verification for the monitoring results.

1.1 Historical Summary of the Direct Radiation Program Dosimeter Use

This section gives a summary of the types of dosimetry used over time. Background 24-hour readings of direct radiation were first made in 1951 across the Site using small, detachable ionization chambers installed at the Experimental Breeder Reactor, Central Facilities Area (CFA), and the Meteorological Station at Midway (Singlevich et al. 1951).

Intermittent testing of film badges was started in 1959, and a continuous program started in 1960 (AEC 1960). The badges were placed at locations along highways traversing the Site and at various agricultural areas in the surrounding perimeter. The badges were collected and read monthly. The average total dose for the year was less than 160 mrem for gamma radiation from all sources of radiation, including terrestrial and cosmic.

Film badges were replaced by thermoluminescent dosimeters (TLDs) during the fourth quarter of 1966 (AEC 1966). At each monitoring location, a dosimeter containing five individual Harshaw TLD-700 chips was placed 1 m above the ground. TLDs measure penetrating radiation (gamma plus beta radiation >200 keV). TLDs were chosen as a better measurement method of long-term low-dose accumulation.

In 2010, testing began and continues of the use of the Optically Stimulated Luminescence dosimeter (OSLD) manufactured by Landauer, Inc. The OSLD also measures ambient ionizing radiation. OSLDs and TLDs are similar in that both dosimeters respond to the absorption of energy from ionizing radiation by trapping electrons that are excited to a higher energy band. However, unlike TLDs, in which exposure to heat releases these electrons, the trapped electrons in the OSLD are released by exposure to a green light from a laser.

Monitoring results from the Direct Radiation Program have consistently shown since inception that the measured radiation near the Site boundary and at distant regional locations is indistinguishable from background radiation calculated from terrestrial and cosmic sources (see Section 7.3 in the 2013 ASER as an example, DOE-ID 2014). This means that INL operations do not make any measurable contribution to measured radiation dose at those boundary or distant locations. Monitoring at locations within the Site boundary primarily show the same thing, that measured radiation is indistinguishable from background. At some monitoring locations immediately adjacent to large facilities on the desert, there are some locations such as the northeast corner of INTEC (ICPP O-15 and ICPP O-9), east of the RWMC (RWMC O-41), and west of ATR Complex (TRA O-13) that consistently show either elevated or slightly elevated radiation measurements. These elevated measurements have been attributed to previous wind-blown depositions or to temporary activities inside the facilities (see the DOE ASER reports). Appendix C presents the direct radiation monitoring results for all monitored locations beginning with calendar year 2007. Results from earlier years are available in Annual Site Environmental Reports.

1.2 Data Quality Objectives Process

The overall objective of the Environmental Direct Radiation Monitoring Program is to determine the radiation exposure to the public and non-involved workers from INL activities. The DQOs are discussed in the context of the DQO process as defined by *Guidance for the Data Quality Objectives Process* (EPA 2006). The EPA developed this process to ensure that the type, quantity, and quality of data used in decision-making are appropriate for the intended application. The DQO process includes seven steps, each of which has specific outputs. The following sections correspond to a step in the DQO process, and the output for each step is provided as appropriate. The DQOs do the following:

1. Clarify the study objective
2. Define the most appropriate type of data to collect
3. Determine the most appropriate conditions from which to collect the data
4. Specify tolerable limits on decision errors that will be used as a basis for establishing the quantity and quality of data needed to support the decision(s) to be made using the data.

The DQOs for the Environmental Direct Radiation Monitoring Program are discussed in the rest of this document.

2. STEP 1: STATE THE PROBLEM

Radioactive materials and emission sources can contribute to direct external radiation exposure. INL facilities contain radioactive material and conduct work processes that generate radioactivity; therefore, there is a small potential to emit radioactivity via environmental exposure pathways. Direct radiation monitoring is performed within the Site boundaries, along the Site perimeter, and within a 50-mile radius of the Site to ensure public safety.

The problem statement addressed by this DQO is to determine the radiation dose in areas where the public and non-affected workers may be present and potentially affected by radiation from INL activities and ascertain if this dose is within the historical trends for the applicable areas.

The simple conceptual model for this study is that direct exposure can occur due to radioactive material either within the air pathway or to radioactivity that builds up on the soil surface due to deposition from the air pathway. This potential exposure can occur to members of the public and non-involved INL workers within Site boundaries and in the area surrounding the Site. Non-involved workers are workers who are not part of the ongoing radiological work at the Site. This analysis establishes the dose trend for specified areas and compares semi-annual dose measurements to these trends to determine whether measurements are outside of the expected range of values for that area.

3. STEP 2: IDENTIFY THE GOALS OF THE STUDY

The second step in the DQO process is to identify the decisions and the potential actions that will be affected by the data collected. This is done by specifying principal study questions (PSQs) and alternative actions that could result from resolution of the PSQs, and combining the PSQs and alternative actions into decision statements (DSs). Four PSQs were identified for Environmental Direct Radiation Monitoring Program for INL.

PSQ1: What is the background radiation dose profile for the region under investigation and within each of the areas associated with the region?

DS1: Establish the background dose profile for the area under investigation as a whole and for specified areas, and determine whether the background dose appears to be changing over time. The dose profile includes a trend analysis based on historical data and the development of an expected range of background doses for specified areas.

PSQ2: Is the current radiation dose in each area within the range of historical doses measured for that area or is the radiation dose outside of the range of normal doses for that area?

DS2: Determine whether the current radiation dose in each area is within the historical trend of dose for that area or if further investigative measures are necessary for that area.

PSQ3: Does the current dose at identified background locations indicate that background dose levels for the Snake River Plain have changed?

DS3: Determine the historical dose trend at multiple areas in the Snake River Plain that are unaffected by INL activities that can be used as background locations. Determine whether the current dose at these areas is within the normal trend for these areas or if the current dose indicates that the radiation due to sources other than INL may differ from previous years.

PSQ4: What process should be used to establish new dose monitoring locations within the boundaries of the Site or in the areas surrounding the Site?

DS4: Develop a comprehensive methodology for establishing dosimetry monitoring at new locations. Determine what should be used to ensure the area is adequately monitored for the specifications, locations, and activities in that area.

4. STEP 3: IDENTIFY INFORMATION INPUTS

Inputs needed to resolve the DSs include the following:

- Quantification of the radiation doses within the region being studied
- Historical radiation doses for the region being studied
- Pertinent historical information for each area
- Wind patterns within the region to identify the area most likely to be exposed to radioactive fallout from Site activities

- Possible locations for human exposure around the perimeter of the Site, or the perimeter of INL facilities located in Idaho Falls
- Location of population centers in the regional vicinity of the Site
- Location of areas within Site boundaries where the public or non-involved Site workers may be present
- Locations of areas within the Site boundaries where radiological activities may take place
- Identification of features in an area that may affect where elevated doses may be observed.

The historical information obtained from the area of interest will be used to establish localized trend information. It is known that the natural level of radiation can vary considerably within the region that is being examined. Therefore, the historical dose information and Site history information will be obtained and analyzed to determine the appropriate background levels for each localized region and to establish a trend for each area. This will provide the necessary basis for determining if measurements obtained from the Site in the future exceed the expected variation of doses for that area. Site information for each area can shed light on the measured doses in the area to ensure that dose readings are consistent with what is expected based on historical measurements.

Another part of these DQOs is to establish criteria for setting up dosimetry monitoring at new areas. Information regarding the public and non-involved workers, changes in area activities, and other information will be used to determine whether a new area should be established and monitored. Knowledge of historical and new activities that take place at the new area can aid in determining the number and location of dosimeters that will be placed at the Site. The wind pattern, geological characteristics, accessibility, and other Site features can also aid in determining dosimeter locations.

5. STEP 4: DEFINE THE BOUNDARIES OF STUDY

This study is primarily interested in the radiation dose in areas where members of the public and non-involved INL workers may be present inside of Site boundaries and in areas surrounding the Site. The boundaries are defined to provide pertinent information for these two groups. The boundaries include both the physical and temporal boundaries of the study. One of the primary tasks in Step 4 is to determine the population of interest for the study. It may seem that the public and non-involved workers are the population, but it is actually the dose relating to these persons. Therefore, the population of interest is the radiation dose in the areas where the public and non-involved workers may be present. Because this monitoring effort is in relation to dose from INL activities, the area of interest is limited to areas within the Site boundaries and a 50-mile radius extending from the Site boundaries per DOE guidance (DOE 2015) (see Figure 1). This region has been divided into three primary regions and then further divided into areas within each of the primary regions to ensure that any concerning dose measurements are properly identified. The three primary regions are:

- The area within Site boundaries and INL facilities located in Idaho Falls (see Figure 2)
- The area near the Site boundary
- The area outside of the Site boundary, but within a 50-mile radius of the Site.

Each of the regions is discussed in the paragraphs below along with an identification of the areas within each primary region. Table 1 shows the areas that are part of each of the primary regions. The INL areas are divided into those facilities that are within the Site boundaries and those that are in Idaho Falls.

The area within Site boundaries and INL facilities in Idaho Falls does not include the area inside facility boundaries because those areas are monitored by the INL Radiological Control program and are outside of the scope of this monitoring program. The radiation doses at the outer facility perimeter fence and in the areas surrounding these facilities are under the umbrella of this study. Several INL buildings are located in Idaho Falls. These buildings are monitored in the same manner as facilities within the Site boundary. Table 1 shows the areas that are part of the primary regions.

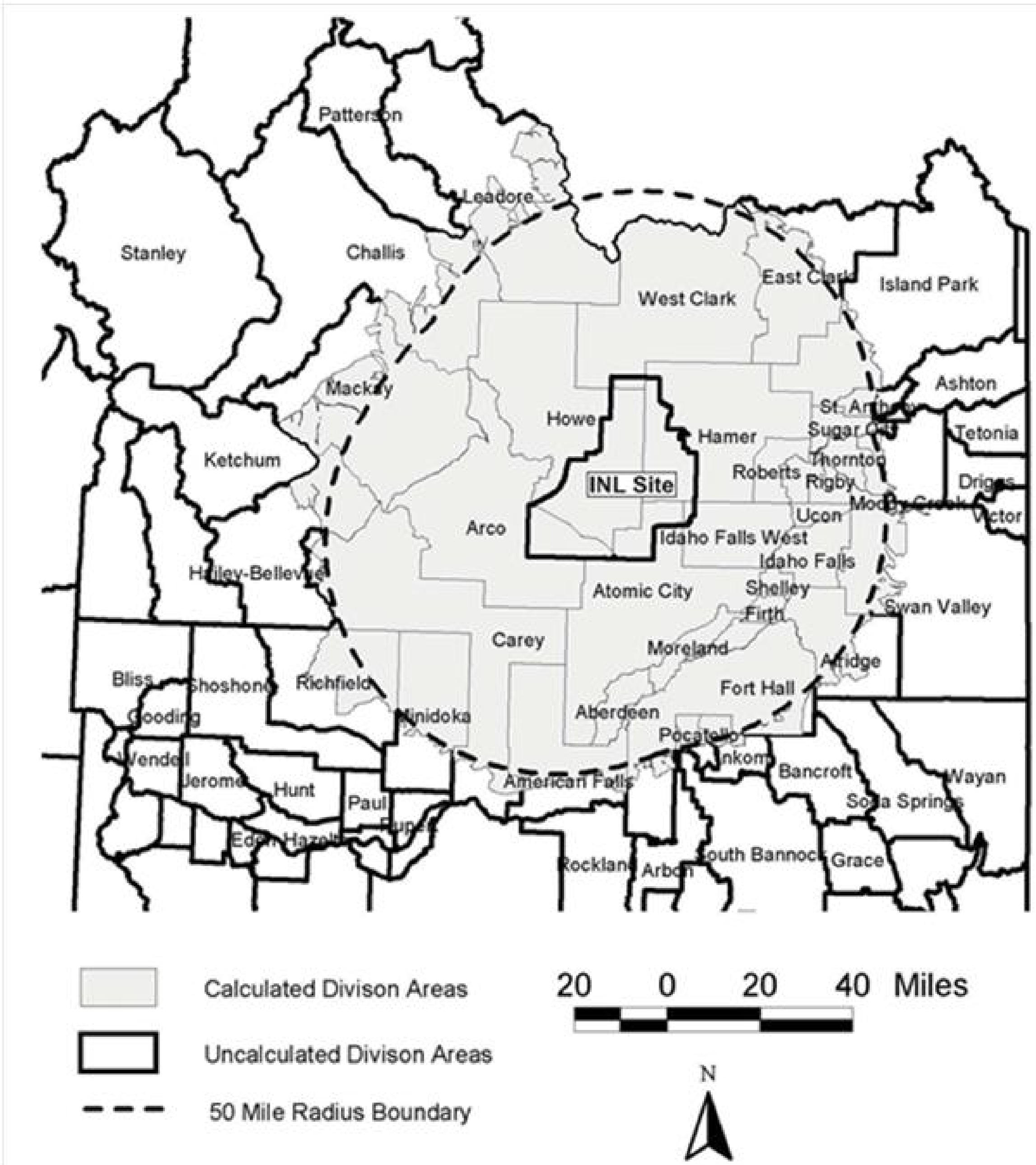

Figure 1. Region within 50 miles of Site facilities.

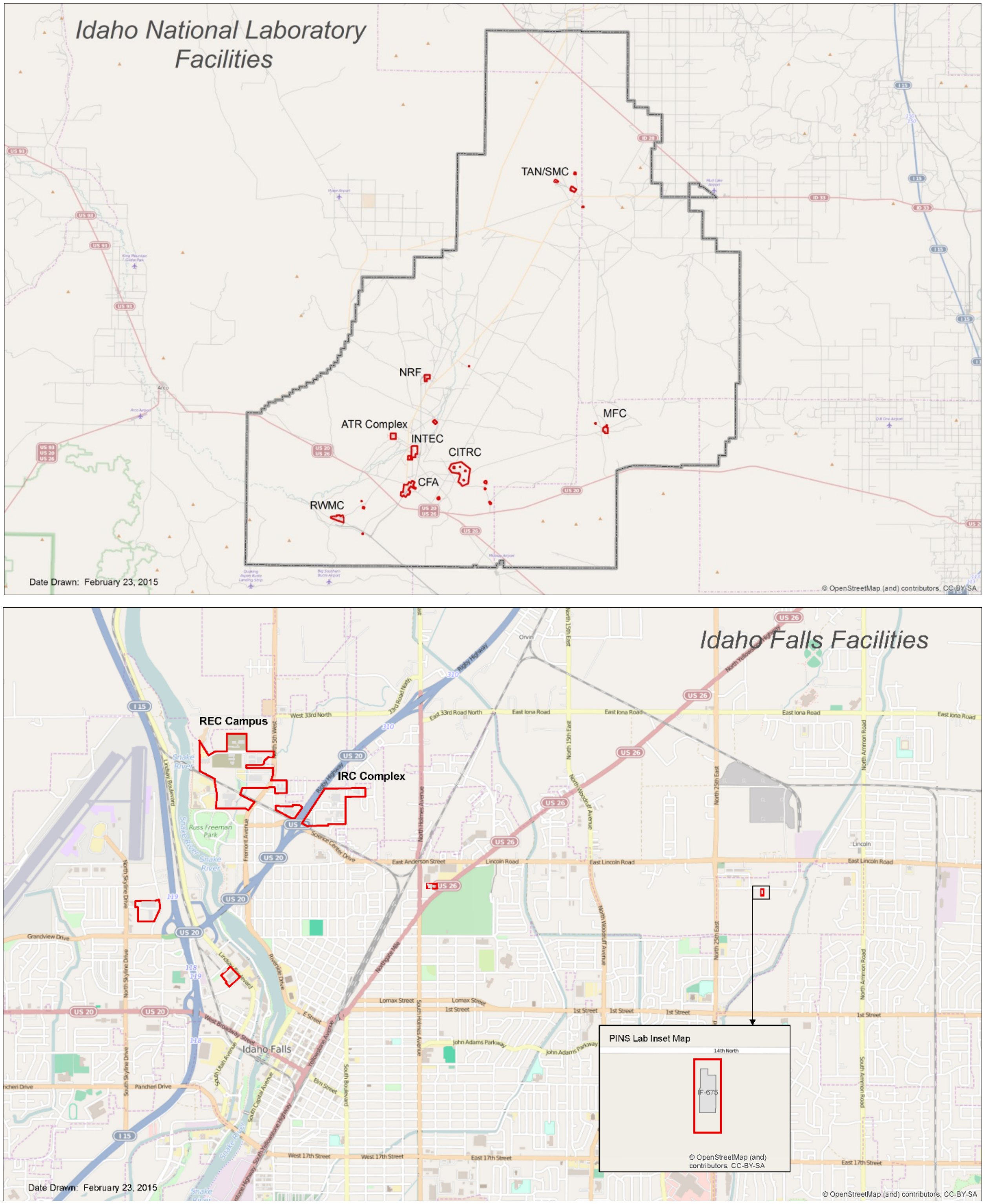

Figure 2. Areas included within the Site boundaries and in INL facilities in Idaho Falls facility region.

Table 1. Areas within each of the three primary sampling regions.

Areas Within the Site Boundary and in Idaho Falls	Areas Near the Site Boundary	Areas Outside of the Site Boundary
ATR	Arco	Aberdeen
CFA	Atomic City	Blackfoot
INTEC	Birch Creek Hydro[c]	Craters of the Moon[d]
MFC	Blue Dome	Dubois
NRF	Howe	Idaho Falls[d]
RWMC	Monteview	Jackson
SMC	Mud Lake	Minidoka[e]
TREAT[a]	RRL3 Frenchman's Cabin[a]	Roberts
ARA	RRL5 East Butte[a]	Sugar City
EBRI	RRL6 Grant Road[a]	
EFS O-1	RRL17 Monteview[a]	
Haul E[a]	RRL24 Howe[a]	
Haul W[a]		
Highway 20		
Highway 22		
Highway 28		
Highway 33		
Lincoln Boulevard		
PBF		
IF-670 (BCTC) [a,b]		
IF-603 (IRC)[b]		
IF-616 (WCB)[b]		
IF-627 (SAF)[b]		
IF-638 (Physics Bldg)[b]		
IF-665 (CAES)[b]		
IF-675 (PINS)[b]		
IF-IRC[b]		

a. Site has not yet been monitored
b. Facility located in Idaho Falls
c. Also known as Reno Ranch
d. Background location
e. Also known as the Idaho Youth Ranch

The temporal boundaries for the sampling include the time from when dose measurements are collected at a facility, which may go back as far as the 1960s, up until the dose is no longer measured under this program, which will continue as long as the Site is operational under DOE. This may be as far as 100 years in the future. However, the number of monitoring locations at a specific area and the length of time that a particular area is measured can vary depending on activities in that area.

Step 4 of the DQO process is also where the unit of decision is defined. This varies for each area. Although a single measurement from any area can result in additional investigation, an action will likely not be taken based on a single measurement. Rather, the measurements collected from dosimeters surrounding a high dose measurement and readings obtained in the past will determine whether more action is needed. Likely, decisions will be made on a per area basis.

6. STEP 5: DEVELOP THE ANALYTICAL APPROACH

Step 5 is where the analytical approach is defined. The analytical approach requires that the population parameters that will be used for decision making are defined as well as the action levels and appropriate estimators. The analytical approach is varied and involved. A comprehensive discussion of the approach is dependent on the statistical methods that are used to develop action limits and analyze data as it is obtained. Appendix B contains the details of the statistical analysis involved in the analytical approach while this section provides a high-level overview of the approach.

The analytical approach for the dosimetry monitoring involves examining the trend of the radiation doses over time so that it can be verified that data obtained from individual sampling events are within the expected range of doses. A background dose was also established for each area to provide context for individual measurements collected at that area. Historical data was used to establish both the background dose and the appropriate limits on the dose trends. Background doses and a trend analysis will be performed for areas where insufficient historical data are available when sufficient data are obtained. Background values and trend limits will be reevaluated every 5 years to ensure that they remain relevant to the areas.

The individual measurements obtained from a single sampling event will be compared to the background dose for that area. This background dose is an action level for individual measurements obtained from a specific area. It is anticipated that 5% of the measurements will exceed the background dose. Therefore, if a single measurement is greater than the background dose, it does not necessarily mean that there is an unusually high amount of radiation in the area. However, if a value exceeds the background dose, that measurement in question will be compared to other values in the area and to historical data to determine if the results may indicate further action is needed and if so, determine what that action should be. Table 2 shows the background doses that will be used for monitoring at each of the areas. The appropriate method for computing the background value is the upper tolerance limit (UTL) (EPA 2009). The UTLs were computed with the ProUCL software developed by EPA (EPA 2013) using all available data in the area since 2007. Appendix B contains further details on the computation and use of UTLs for this monitoring effort.

Table 2. Six-month background levels for each area.

Area	Background Value (mrem)	Area	Background Value (mrem)
Within INL Site Boundaries and in Idaho Falls			
ARA	85.4	INTEC	102
ATR	95.53	Lincoln Blvd	81.91
CFA	80.91	MFC	80.42
EBR I	68.79	NRF	81.2
EFS O-1	N/A[a]	PBF	77.08
Haul E	N/A[a]	RWMC	85.78
Haul W	N/A[a]	RWMC O-41	131.3
Highway 20	74.53	SMC	137
Highway 22	N/A[a]	TREAT	N/A[a]
Highway 28	N/A[a]	IF-665 (CAES)	N/A[a]
IF-603 (IRC)	63.9	IF-670 (BCTC)	N/A[a]
IF-627 (SAF)	N/A[a]	IF-IDA	N/A[a]
IF-638 (Physics)	68.02	IF-IRC	N/A[a]
IF-616 (WCB)	N/A[a]	IF-675 (PINS)	65.54
Highway 33	N/A[a]		
INL Site Perimeter	(mR)		(mR)
Arco	71.53	Mud Lake	75.05
Atomic City	71.50	RRL3 Frenchman's Cabin	N/A[a]
Birch Creek Hydro[b]	61.00	RRL5 East Butte	N/A[a]
Blue Dome	58.21	RRL6 Grant Road	N/A[a]
Howe	66.82	RRL17 Monteview	N/A[a]
Monteview	65.74	RRL24 Howe	N/A[a]
Outside of INL Site Boundaries	(mR)		(mR)
Aberdeen	69.71	Jackson	56.06
Blackfoot	61.81	Minidoka[c]	63.87
Craters of the Moon	69.55	Roberts	83.90
Dubois	58.35	Sugar City	N/A[a]
Idaho Falls	68.50		

a. Sufficient data are not yet available to compute a background value.
b. Site also known as Reno Ranch
c. Site is also referred to the Idaho Youth Ranch

A certain amount of variation is expected from sampling event to sampling event. Thus, the trend in dose will also be examined so that it can be determined if the doses from individual sampling events are within the normal range of doses for that area. Historical data was used to establish limits for the trend analysis that will indicate when measurements from a sampling event are outside of the normal trend.

These limits are the action levels for trend analysis. The mean dose for each sampling event is plotted against time and the limits are placed on the graph as reference lines. If the mean for a particular sampling event exceeds the limit it indicates that the doses from that sampling event are outside of the normal range of variation for that area. If this occurs, the graphs for surrounding monitoring areas will be examined to determine if the unexpected dose was observed in other areas. Areas where a single-dose measurement is collected will have limits constructed that are appropriate for evaluating single values. The comparisons and actions are the same for areas with a single measurement although the methods for computing control limits are different. Two background locations, Craters of the Moon and Idaho Falls, can be used to determine if an increase in dose may be due to INL activities or may be attributed to some factor independent of INL. Trends among all of the areas that are monitored will be compared to each other to determine any Sitewide impacts.

Tables 3 and 4 show the trend limits for each of the areas. The limits were computed according to the specifications outlined in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance* (EPA 2009). Although the guidance is written specifically for groundwater monitoring, the methods outlined in the guidance are appropriate for all monitoring efforts regardless of media. Further information on the mechanics of these limits and their use in this monitoring program can be found in Appendix B.

A second set of trend limits for the standard deviation can be seen in Table 3. The variability is also tracked for areas with three or more sampling locations. These limits are used in a similar manner as the limits for the mean. The standard deviation for each of the sampling events is plotted against time and the trend limits for standard deviation are also plotted on the graph as reference lines. If the standard deviation for a sampling event exceeds either the upper or lower limit it indicates that the variability for that sampling event is unusually large or unusually small. If this occurs, the sampling event will be closely examined to determine if something occurred during the sampling and/or analysis that can explain the unusual variability.

Table 3. Control limits for areas with three or more dosimeters.

Area	Number of Sampling Locations in Area	Lower Trend Limit for the Mean	Upper Trend Limit for the Mean	Lower Trend Limit for the Standard Deviation	Upper Trend Limit for the Standard Deviation
MFC	15	63.2	73.8	2.51	9.54
INTEC	17	69.2	90.3	5.09	17.29
NRF	9	64.64	76.22	0.86	6.70
RWMC	17	47.87	125.99	12.31	41.82
TAN	8	58.90	73.26	2.67	28.89
TREAT	8	N/A[a]	N/A[a]	N/A[a]	N/A[a]
ATR Complex	24	68.93	109.15	11.73	31.29
Lincoln Road	5	61.6	78.2	-0.63	10.50
HWY20	6	58.6	70.4	0.02	12.99
IF-603 (IRC)	4	48.09	58.21	N/A[a]	N/A[a]
IF-638 (Physics)	4	49.71	61.43	N/A[a]	N/A[a]
IF-670 (BCTC)	5	N/A[a]	N/A[a]	N/A[a]	N/A[a]
IF-675 (PINS)	4	48.85	61.41	N/A[a]	N/A[a]

a. Sufficient data are not available to compute the appropriate limits. Limits will be computed once a sufficient amount of data is collected for the area.

Table 4. Control limits for areas with two or fewer dosimeters.

Area	Number of Sampling Locations in Area	Lower Control Limit	Upper Control Limit
Within Site Boundary and Idaho Falls Facilities			
ARA	1	39.59	96.34
CFA	2	36.06	97.87
EBRI	1	45.28	76.63
EFS	1	N/A[a]	N/A[a]
Haul E	1	N/A[a]	N/A[a]
Haul W	1	N/A[a]	N/A[a]
HWY22	1	N/A[a]	N/A[a]
HWY28	1	N/A[a]	N/A[a]
HWY33	1	N/A[a]	N/A[a]
PBF	1	44.05	91.13
IF-IDA (NOAA Station)	1	N/A[a]	N/A[a]
IF-616 (WCB)	1	N/A[a]	N/A[a]
IF-627 (SAF)	1	N/A[a]	N/A[a]
IF-665 (CAES)	1	N/A[a]	N/A[a]
IF-IRC	1	N/A[a]	N/A[a]
Near Site Boundary			
Arco	1	35.01	71.35
Atomic City	1	40.23	69.41
Birch Creek Hydro[b]	1	35.23	60.88
Blue Dome	1	36.21	55.36
Howe	1	36.28	65.40
Monteview	1	36.24	64.47
Mud Lake	1	39.64I	74.02
RRL3 Frenchman's Cabin	1	N/A[a]	N/A[a]
RRL5 East Butte	1	N/A[a]	N/A[a]
RRL6 Grant Road	1	N/A[a]	N/A[a]
RRL17 Monteview	1	N/A[a]	N/A[a]
RRL24 Howe	1	N/A[a]	N/A[a]

Table 4. (continued).

Area	Number of Sampling Locations in Area	Lower Control Limit	Upper Control Limit
Outside of Site Boundary			
Aberdeen	1	46.94	64.51
Blackfoot	1	37.78	58.56
Craters of the Moon	1	31.80	71.37
Dubois	1	32.85	56.58
Idaho Falls	1	42.39	64.58
Jackson	1	31.68	55.15
Minidoka[c]	1	31.54	65.79
Roberts	1	35.82	81.33
Sugar City	1	N/A[a]	N/A[a]

a. Sufficient data are not available to compute the appropriate limits. Limits will be computed once a sufficient amount of data is collected for the area.
b. Also referred to as Reno Ranch
c. Also referred to as Idaho Youth Ranch

DOE Order 458.1 provides a third set of action levels for the project. It sets a regulatory dose limit for the members of the public of the effective dose equivalent (EDE) of 100 mrem annually from all DOE activities and all environmental exposure pathways. The public dose limit applies to members of the public located off DOE sites and on DOE sites outside of controlled areas. However, this monitoring program will use this limit as a threshold for more comprehensive investigation. Because sampling occurs every 6 months, the measured doses will be compared to a value that is 50 mrem above the background dose for that area. If a measurement is obtained from a dosimeter that is more than 50 mrem greater than this background during a 6-month sampling cycle, it will alert additional investigation.

If one or more measured doses exceed the background dose for the area, if the trend limits are exceeded, or if a measured dose is greater than 50 mrem than the background dose for the area, further investigation will occur. Investigation will include the following as appropriate:

- Use sampling methodology and controls to determine if activities associated with sampling may have affected the readings
- Compare dose(s) to those measured in the same area
- Compare dose(s) to those obtained from nearby areas
- Contact the INL Radiological Control Program to determine whether there were activities that occurred inside the facility during the time period that could have contributed to elevated measurements outside the facility.
- Investigate data obtained annual facility perimeter gamma surveys
- If a dose obtained from a 6-month measurement is more than 50 mrem greater than the background dose for that area, take additional actions to address the cause as needed.

This list is not comprehensive and all of the activities may not be necessary every time a background dose or trend limit is exceeded depending on the circumstances surrounding the measurement.

The population parameters of interest in the monitoring effort are the mean radiation dose and the 95th percentile of the doses at individual sampling locations. The trend analysis is concerned with the mean dose in the area over time. The background dose comparison is concerned with the 95th percentile of the doses in an area. Appendix B contains further explanation of the parameters and how they were chosen.

Neutron monitoring is performed around the Idaho Falls IF-675 Portable Isotopic Neutron Spectroscopy (PINS) facility, at IF-670 Bonneville County Technology Center (BCTC), and adjacent to the IF-638 (Physics Laboratory) building. Neutron monitoring is also present at IF-IRC along the south perimeter fence and at the Idaho Falls O-10 background location. A background level for neutrons is zero, so any detectable neutron dose would be considered a reason for further investigation. The current neutron dosimeters have a detection limit of 10 mrem. Therefore, if any neutron dosimeter measures a neutron dose above the detection limit it will be considered above background and further investigation will be warranted. Neutron dosimeters are placed near dosimeters at areas where neutron presence is a concern.

7. STEP 6: SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

This step defines the decision rules that are associated with this monitoring program. The methods outlined in the analysis plan in Section 6 have hypotheses associated with them that should be specified to assure that the methods are implemented correctly. These hypotheses are called the null and alternative hypotheses and they are bound to the type of analysis that is used to assess the monitoring data. The null hypothesis for the monitoring program is that the radiation doses for a sampling event are within the normal range in that area. The alternative hypothesis is that the radiation doses are not within the normal range of doses for that area. Appendix B expounds on the methodology behind determining appropriate null and alternative hypotheses and provides justification for their selection.

Decision errors and other sampling errors are also defined in this step as well as acceptable limits on uncertainty. The level of confidence for the background doses was chosen to be 95% and the other uncertainties were minimized by ensuring that sufficient data are collected at each area and that best sampling practices are implemented. Although every sampling project has a chance of committing a decision error, this program has numerous checks and balances in place such as historical data, sampling conducted under other programs, and monitoring of other media such as air and biota. These additional safeguards ensure that the chance of missing an authentic increase in radiation from INL is negligible.

8. STEP 7: DEVELOP THE DETAILED PLAN FOR OBTAINING DATA

Step 7 of the DQO process is where a detailed plan is laid out for obtaining data of sufficient quality to answer the primary questions of the study. It is important that the data are collected in a manner that meets the requirements of the statistical methods that will be used to analyze the data. This study obtains data from several areas. The location, history, and purpose of each of these areas differ so data requirements are not the same for all areas. Areas that are adjacent to facilities where radiological activities are taking place require multiple sampling locations to ensure that an increase in dose from these facilities would be detected. Areas that are not in the vicinity of radiological activities correspondingly require fewer monitoring locations.

Statistical methods typically require that sampling locations are determined using a probability sampling design. That is a random method is used to determine sampling locations. However, data have been collected over years from the same locations at many of these areas and it is more valuable to continue monitoring at the same locations rather than assign a random location at this time. Therefore, future monitoring areas will implement a random design in determining sample locations. Practical constraints will be incorporated in location selection, such as predominant wind directions, accessibility, and facility features, while still maintaining a sufficient amount of randomness to meet the requirements of the statistical methods.

This section outlines the general reasoning behind the number of monitoring locations at each area, the frequency of sampling, the methodology for selecting monitoring locations, how monitoring locations and data analysis for new areas will be accomplished, and lastly provides a detailed explanation for selecting sampling locations at the Site, at Idaho Falls facilities, and in the regional area.

8.1 Methodology for the Number of Monitoring Locations

This subsection provides a detailed justification for the number of monitoring locations at a specific area and for the frequency of sample collection. The general guidelines for each type of area are discussed along with area features that assist in determining the locations of dosimeters and the number that is needed in a specific area.

The purpose of the monitoring program is to determine the radiation dose in areas where the public and non-affected workers may be present and potentially affected by radiation from INL activities. Because the primary concern is about radiation that comes from INL, facilities within the Site that perform radiological activities are where monitoring activities will be most concentrated. Some of the areas are small and will not require as many dosimeters as the larger facilities solely because of size. There are also areas within the Site boundaries and outside of the Site boundaries that are not in close proximity to radiological activities. Fewer monitoring locations are needed in these areas because of their distance from the potential sources of INL radiation. The sample size criterion considers the proximity of an area to radiological activities when determining the minimum number of samples to be collected.

The criteria for determining sample size consider the proximity of the area to radiological activities, the ability to compute appropriate statistical measures, and the physical characteristics of the area. Areas are separated into three main categories: large facility areas, small facility areas, and non-facility areas. Large facility areas are facilities within the Site boundaries where radiological activities are taking place. Small facility areas are INL facilities located in Idaho Falls. Non-facility areas may be inside INL Site boundaries, along the Site boundary, or outside of the Site boundary. These include areas where no radiological activities take place.

Large facility areas will require a minimum of eight sampling locations, not including duplicates. This is because a UTL will need to be computed and maintained for the area every 5 years to ensure it remains relevant because it is possible that radiation levels could change at those locations due to facility activities. Site characteristics or other motivators may indicate that more than eight monitoring locations are warranted.

Small facility areas require a minimum of four monitoring locations. As with the larger facilities, it may be warranted to place more than four dosimeters around the facility due to physical characteristics of the area or other reasons.

Non-facility areas may be maintained with one monitoring location. It may be appropriate to place more than one dosimeter at such areas because of physical characteristics, historical information, public interest, or other reasons. Fewer samples are required at such areas because of their distance from an INL activity-based source. However, a trend analysis can be maintained with one sample location. It is also possible to use data acquired over time to compute area-specific background doses because the doses at the Site have not previously exhibited evidence of increased dose from INL radiological activities.

The Handbook guidance allows for surveillance monitoring as infrequently as every 5 years if the projected annual effective dose to the public is less than 0.1 mrem per year, which is the case for INL. However, given the benefit to public assurance, semi-annual monitoring will be continued. Semi-annual monitoring supports long-term trending and integration of data from other media.

8.2 Methodology for Dosimetry Monitoring Locations

The previous section provides a minimum number of monitoring locations for each type of area, but it does not indicate where the dosimeters should be located or how to determine whether more than the minimum number is warranted. The Handbook states:

> *Selection of the indicator locations for external exposure monitoring should be based on expected sources of external radiation—noble gas plumes, soil-deposited atmospheric particulates released from the site, onsite radiation-generating facilities or large radiation sources, or potential routes of waste transport from the site—and the local population distribution and prevailing wind directions.*

This section provides guidelines for incorporating this approach in determining the location of specific monitoring locations for an area. The guidelines consist of knowledge of the location of sources of external radiation that are to be monitored, natural conditions that may affect the spread of radiation, the location of air monitoring locations, the area of elevated simulated air concentrations, and stakeholder concern.

<u>Proximity to potential source of radiation</u>. One of the most important factors in determining the location of dosimeters is where the potential sources of radiation are located. Radiation decreases with the inverse square of the distance. Therefore, it is vital to measure the dose close to the radiation source. The monitoring program does not measure inside of the outer fence of any INL facility; the INL Radiological Control program is responsible for monitoring those areas. Therefore, this monitoring program places many of the monitors on or near the fence surrounding these facilities to ensure that the areas of highest dose are measured.

<u>Prevailing wind directions</u>. The Handbook guidance states that dosimeters should be placed in the prevailing wind directions. In most INL locations the predominant wind direction is from the southwest, but there is also a significant component of wind from the northeast. For this reason dosimeters will be placed both to the northeast and the southwest of facilities where there are activation products (AP), fission products (FP), and/or neutron sources. These potential AP/FP/neutron source locations are identified in INL/MIS-15-34621. These dosimeter monitoring locations are placed as close to the outer facility fence lines as is practical. The exception to this is monitoring locations for emissions from stacks at the Materials and Fuels Complex (MFC), Idaho Nuclear Technology and Engineering Center (INTEC), and Advanced Test Reactor (ATR) Complex, which are the stacks with potential radioactive emissions that are evaluated annually for National Emission Standards for Hazardous Air Pollutants (NESHAPs). These locations have estimated optimal azimuth and directions that may result in dosimeters being placed farther away than the facility fence lines. The estimated distances result from simulations using the Gaussian plume model and area-specific wind rose information averaged from 3 years (2006–2008). These simulations are summarized in Appendix A. For each simulated optimum location, three dosimeter

locations are indicated: one dosimeter at the simulated optimum and one dosimeter in each direction along the arc described by the radius at approximately 11 degrees from the optimum direction. The use of three locations as a “triplet” is statistically beneficial as it allows calculating rudimentary statistics. Due to the very low likelihood of detection of radioactivity from these plumes, only the most optimum downwind direction is considered. Where one or more of the “triplet” points is located inside a facility fence, the actual location used is the closest practical location at the facility fence.

Low-Volume Air Monitoring Locations. Dosimeters were placed at low-volume air monitoring locations for data integration purposes. This provides measured air concentrations and direct radiation doses that can be compared to simulated air concentrations that are predicted for the Annual Site Environmental Reports. As an example, the off-Site regional monitoring location direct radiation measurements are averaged and compared to the calculated effective dose from natural background sources (see Table 7-6 in DOE-ID [2014]).

Areas of Elevated Simulated Air Concentration. In addition to the low-volume air sampling locations, additional emphasis was given to dosimeter locations within the maximum isoline of elevated simulated unit-activity time-integrated concentrations (*TICu*). The *TICu* results in Figure 3 are from Rood and Sondrup (2014) and show combined results for INL sources from 2013 and meterological data from 2006. The results are typical of other years. Having dosimeters located within the region of this maximum isoline allows comparison of measured doses to calculated doses from simulated air concentrations. In the logic presented in the following sections, where monitoring locations are within this maximum isoline, they are specifically called out with the exception of those monitoring locations for ATR Complex and INTEC in which every location is within the maximum isoline.

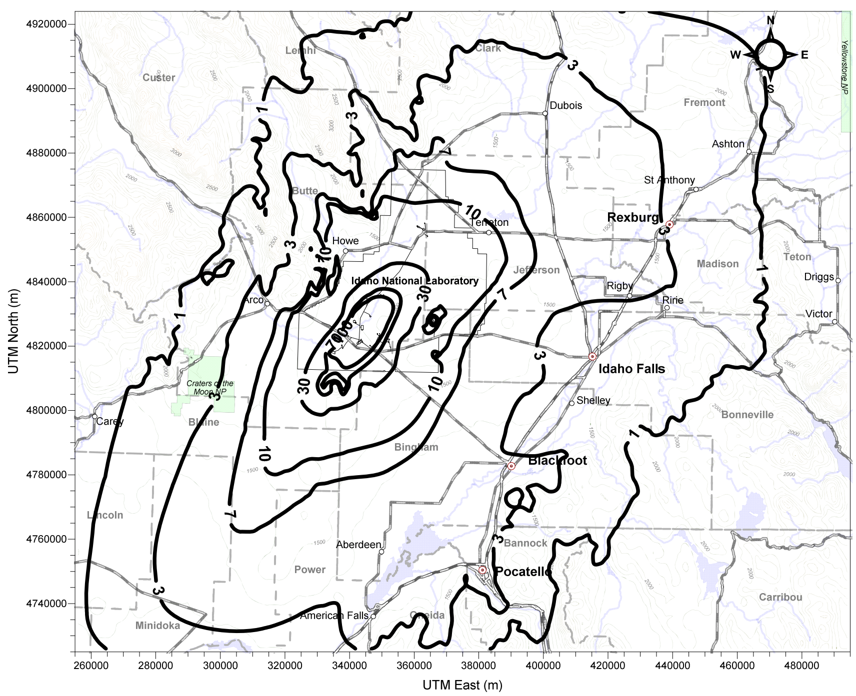

Figure 3. Simulated 2006 annual *TICu* ($hr^2\ m^{-3}$). Values are multiplied by 10^9 for plotting (from INL/EXT-14-33194).

Transportation Routes. Dosimeters were placed along Site transportation routes to monitor for external exposure to shipments of waste and spent fuel along roadways on the Site.

Stakeholder concerns. In some cases, dosimeters were placed to alleviate concerns by public stakeholders. This is generally the case for dosimeters located around INL facilities in Idaho Falls and in regional population centers. Monitoring at these locations demonstrates that measured direct radiation at these locations is indistinguishable from background radiation.

Site Boundary and Distant. Dosimeters were placed at locations around the Site boundary, and at locations distant from the Site. This allows for dose measurements in areas that are not part of INL activities, but may be affected by INL activities. This includes areas within 50 miles of the Site boundary. These locations allow the monitoring program to determine whether these areas may be receiving dose from INL activities. Certain areas that are outside of the range of INL influence but have similar geology and elevation are also monitored to provide an appropriate background comparison.

8.3 Addition of New Sites

Additional areas may be added to the current list as new programs are added at INL. Existing areas may change in terms of activities taking place in the area. The criteria stated above for the sample size justification and location will be used for additional areas or for the reassessment of new areas. For example, if a larger facility is added to INL, a minimum of eight monitoring locations will be placed around the fence of the new facility. The activities and characteristics of the facility will dictate where the dosimeters will be placed and if more than eight locations are needed. If a new building or small facility is added to INL, a minimum of four dosimeters will be added using the criteria previously mentioned to determine where to place the dosimeters and if more than four dosimeters are needed. Areas within the Site boundary that are not close to radiological activities, areas near the INL boundary, and areas outside of the Site boundary that are designated as new monitoring areas will have a minimum of one dosimeter placed at the area using the proximity to the Site, accessibility, wind direction, etc., to aid in determining an appropriate location for the dosimeter. When the activities of an area at INL change, such as adding new radiological activities or ceasing radiological activities on a permanent basis, the area will be reassessed to determine whether the number and location of dosimeters should be altered. As with all other cases, the adjustments in dosimetry monitoring will be determined using the criteria outlined above.

When a new area is added to the list of monitored areas, no previous monitoring data exists. Thus, doses must be measured over several years to establish a background profile for the area. Once 5–8 observations are collected, rudimentary UTLs can be computed to establish a basic level of background comparison. However, the UTLs should be updated every year until a sufficient amount of measurements are obtained to compute UTLs using the criteria outlined in the analytical plan. Control charts should have a minimum of 8–10 sampling events worth of data before they can be constructed. Until a sufficient number of measurements for a new location are obtained to compute a UTL, measurements from a nearby location can be used for comparison if deemed necessary. However, such a comparison should be used to help develop a background profile and not to initiate action.

8.4 Area Specific Monitoring Locations

This subsection discusses the specific monitoring locations for each of the areas. The characteristics of the facility that affect the placement and number of direct radiation measurement locations are discussed and shown in Figures 4 through 15 and in Tables 2 through 14. Each figure shows the dosimetry locations that are selected in this DQO for use in direction radiation monitoring. These locations are designated with a blue circle. The areas that are addressed in this subsection are ATR Complex, CFA, INTEC, MFC, Naval Reactors Facility (NRF), Radioactive Waste Management Complex (RWMC), Specific Manufacturing Capability (SMC), Transient Reactor Test (TREAT) Facility, Site Roads, Research and Education Campus (REC), Off-Site Regional, and Resident Receptor locations.

8.4.1 ATR Complex

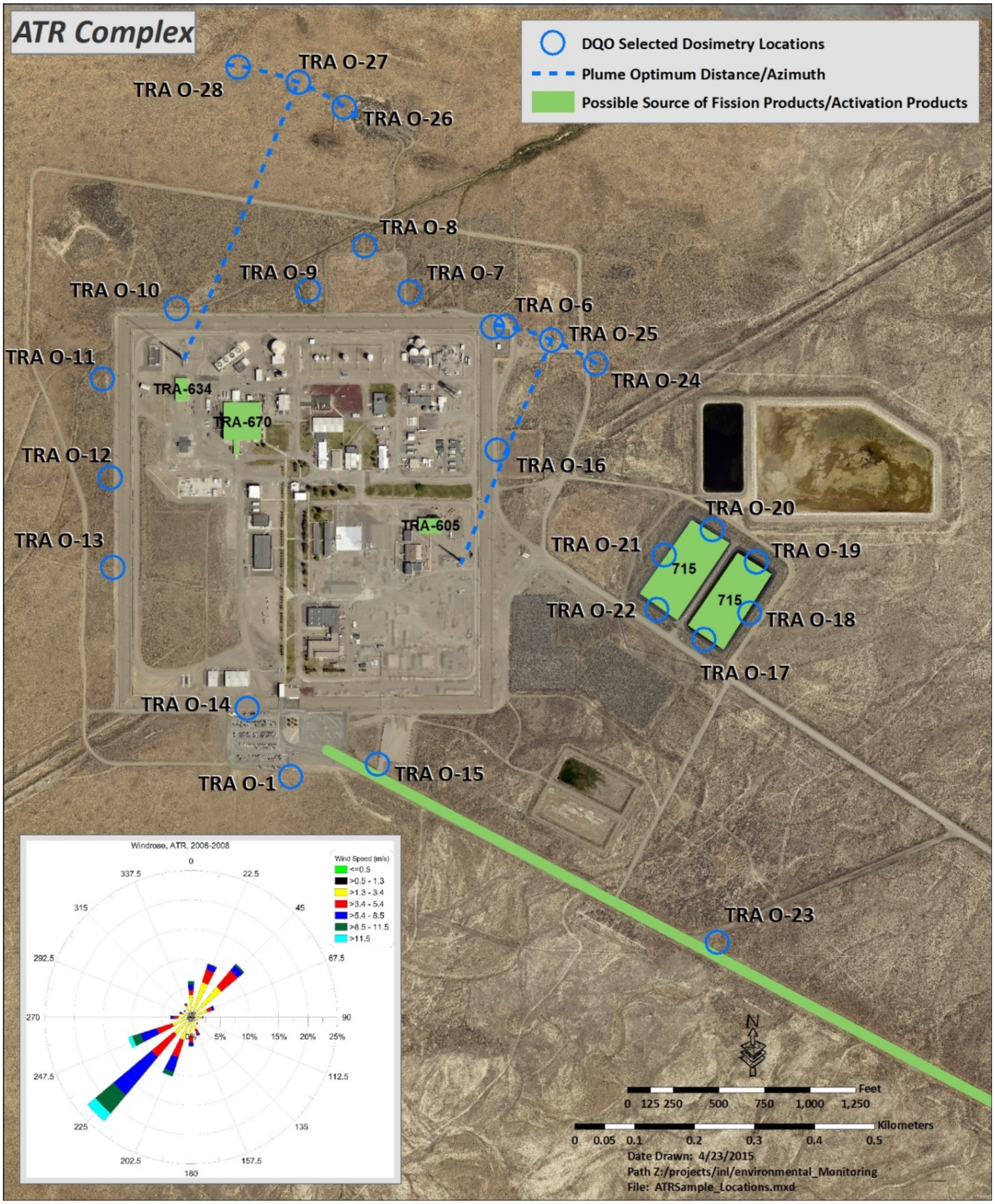

Figure 4. ATR Complex dosimetry monitoring locations. Wind rose data is from the NOAA station at 50-m elevation. The green-shaded locations are taken from INL/MIS-15-34621 and are possible sources of fission products and activation products that have a nuclear facility Hazard Category 3 or above assessment level. The optimum azimuth/distances from stacks TRA-710 and TRA-770 are from simulation results presented in Appendix A.

Table 5. Basis for external radiation monitoring locations for ATR Complex.

Direct Radiation Monitoring Location	Basis
TRA O-1	In SW downwind direction from TRA-605, historical monitoring location; some continuity after the break in monitoring from 2008 to present.
TRA O-6	Historical continuity; co-located with low-volume air monitor (RTC); also sufficiently close to serve as one of the simulated optimum 400-m distance locations along the 22.5-degree azimuth from MTR stack (see TRA O-24 – O-25 below).
TRA O-7	In NE downwind direction from TRA-670, historical monitoring location.
TRA O-8	In NE downwind direction from TRA-634, and close to NE downwind direction from TRA-670, historical continuity.
TRA O-9	In NE downwind direction from TRA-634, and close to NE downwind direction from TRA-670, historical monitoring location.
TRA O-10	Historical continuity; this location had slightly elevated external radiation measurement in 2014 (203.7 mrem). A statistical comparison of ATR-C measured values from 2014 to 2013 values did not show a statistical significance. This location is a good candidate for further evaluation with the Control Chart/UTL analysis.
TRA O-11	Historical continuity; another location with slightly elevated external radiation measurement in 2014 (194.3 mrem), which was decreasing relative to mean of the previous 3 years' measurements at this location (271.4 mrem).
TRA O-12	In the SW downwind location from TRA-634, historical monitoring location.
TRA O-13	In the SW downwind location from TRA-670, historical continuity.
TRA O-14	In the SW downwind location from TRA-605 and Stack TRA-710, co-located with low-volume air monitor (TRA).
TRA O-15	Transportation route monitoring location, selected to be located close to shipment initiation.
TRA O-16	In the NW downwind direction from TRA-605.
TRA O-17	In the SW downwind direction from Evaporation Pond cell, all these new Evaporation Pond locations will be on the perimeter fence on top of the berm to provide maximum proximity. The potential pathway of resuspension exists when the ponds are dry during reconstruction.
TRA O-18	Offwind direction from Evaporation Pond, but selected to ensure coverage around pond perimeter.
TRA O-19	In the NE downwind direction from Evaporation Pond cell.
TRA O-20	In the NE downwind direction from Evaporation Pond cell.
TRA O-21	Offwind direction from Evaporation Pond, but selected to ensure coverage around pond perimeter.
TRA O-22	In the SW downwind direction from Evaporation Pond cell.
TRA O-23	Transportation route monitoring location, selected to be along shipment route.
TRA O-24 – O-25	At simulated optimum 400-m distance along 22.5–degree azimuth from MTR stack (TRA-710), centered and 12.5-degrees to each side (width of wind sector). TRA O-6 is the third member of this triplet.
TRA O-26 – O-28	At simulated optimum 500-m distance along 22.5-degree azimuth from ATR stack (TRA-770), centered and 12.5-degrees to each side (width of sector).

8.4.2 CFA

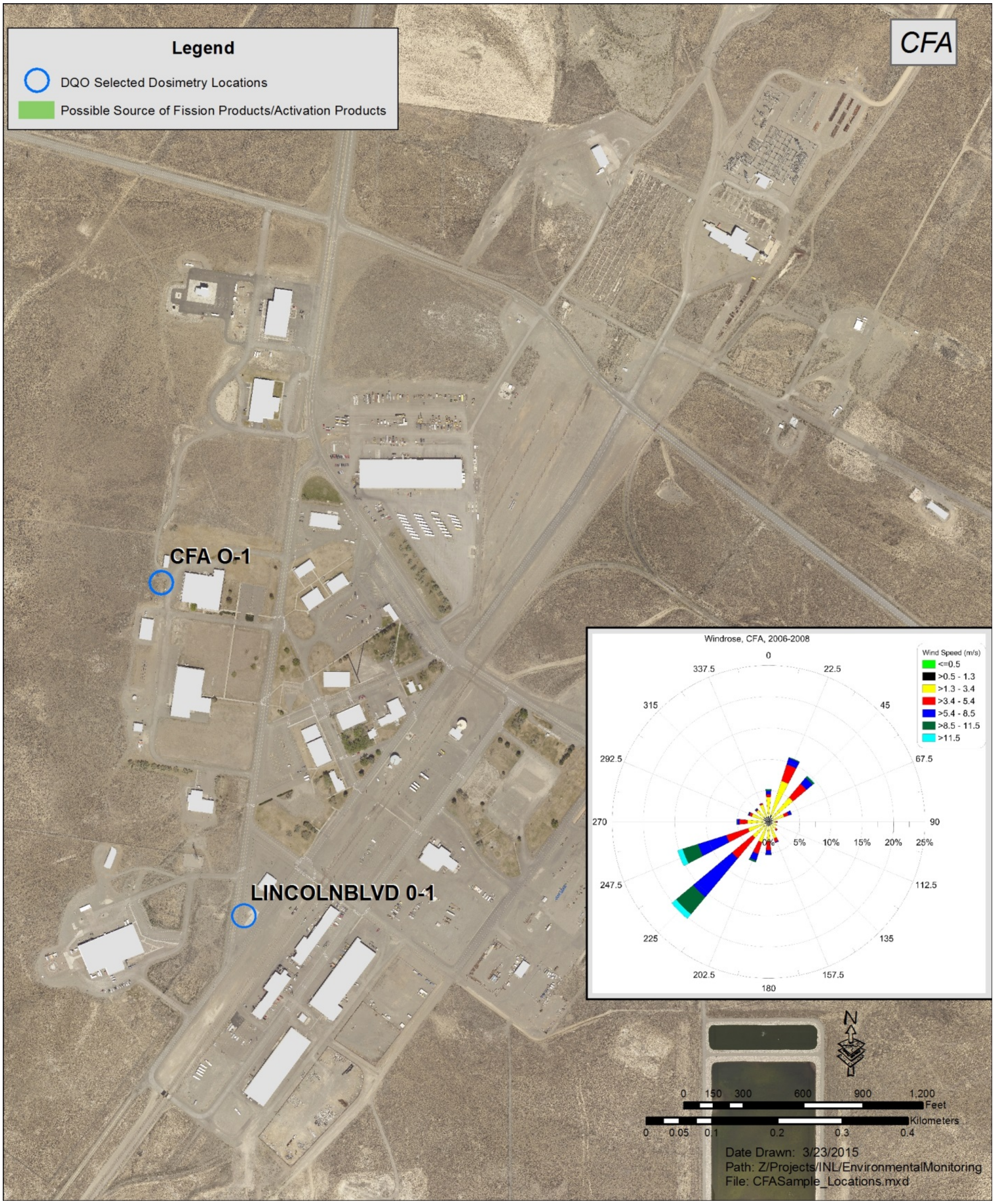

Figure 5. CFA dosimetry monitoring locations. Wind rose data is from the CFA NOAA station at 50-m elevation. No green-shaded locations exist for CFA from INL/MIS-15-34621.

Table 6. Basis for external radiation monitoring locations for CFA.

Direct Radiation Monitoring Location	Basis
CFA O-1	Historical continuity; also serves as proximity location to low-volume air monitor CFA; within area of maximum projected air concentrations (Rood and Sondrup 014),
LINCOLNBLVD O-1	Historical continuity; transportation route monitoring location; within area of maximum projected air concentrations (Rood and Sondrup 014).

8.4.3 INTEC

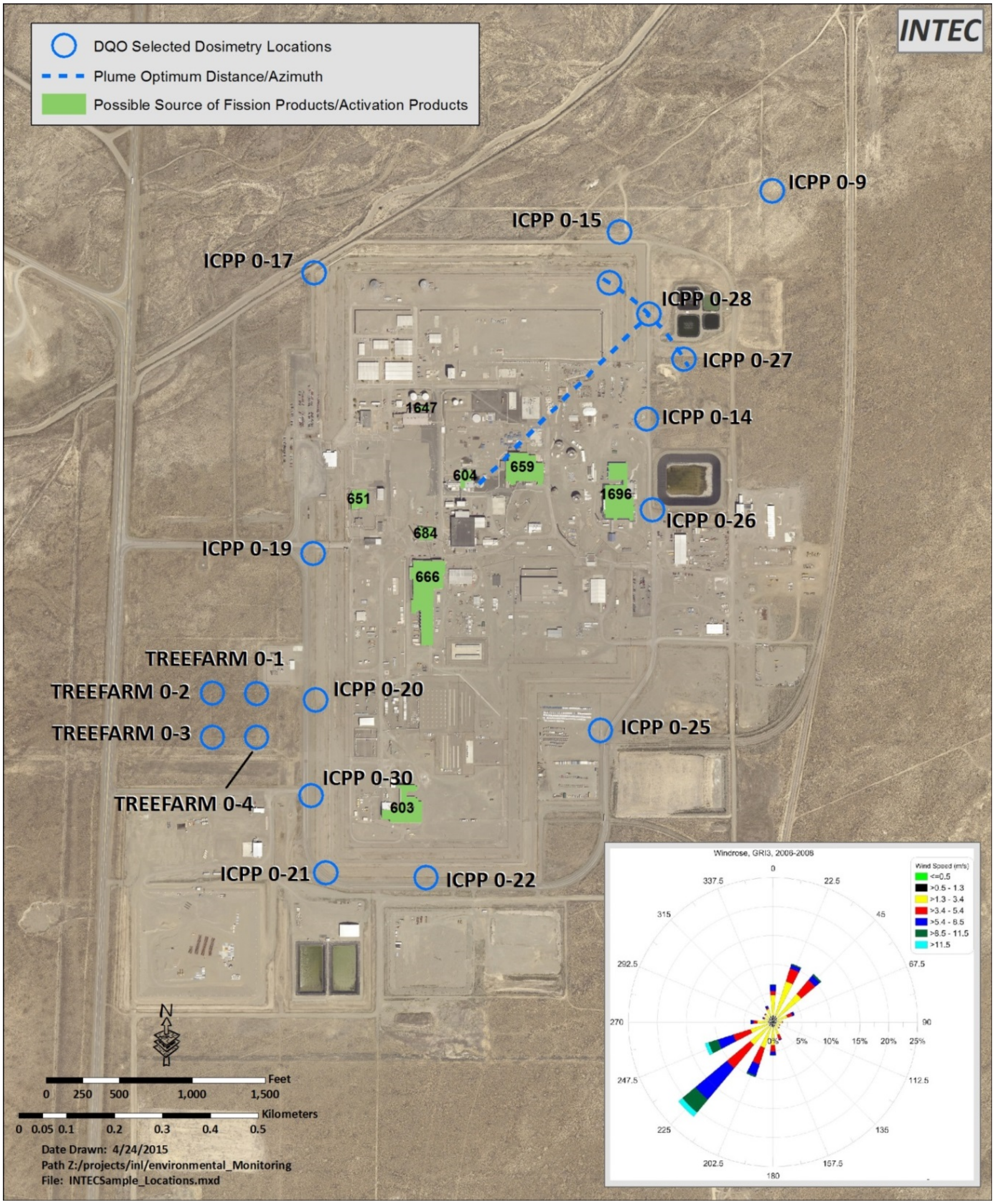

Figure 6. INTEC dosimetry monitoring locations. Wind rose data is from the nearby GRI3 NOAA station at 50-m elevation. The green-shaded locations are taken from INL/MIS-15-34621 and are possible sources of fission products and activation products that have a nuclear facility Hazard Category 3 or above assessment level. The optimum azimuth/distance from stack CPP-708 is from simulation results presented in Appendix A.

Table 7. Basis for external radiation monitoring locations for INTEC.

Direct Radiation Monitoring Location	Basis
ICPP O-9	Historical continuity; in NE downwind direction from multiple possible AP/FP sources; also in area NE of facility that historically has slightly elevated direct radiation measurements.
ICPP O-15	Historical continuity; in NE downwind direction from multiple possible AP/FP sources; in area NE of facility that historically has slightly elevated direct radiation measurements; also serves as proximity location to low-volume air monitor INTEC; lastly, also serves as close as possible to the triplet of simulated optimum 500-m distance along the 45-degree azimuth from stack CPP-708 without being inside the outer facility fence.
ICPP O-17	Historical continuity; offwind direction.
ICPP O-19	Historical continuity; SW downwind direction from CPP-651; also serves as proximity location to low-volume air monitor CPP.
ICPP O-20	Historical monitoring location so some continuity after the break in monitoring from 2008 to present; in the SW downwind direction from multiple AP/FP sources.
ICPP O-30	In the downwind SW direction from multiple AP/FP sources; improve coverage.
ICPP O-21	Historical continuity; in SW downwind direction from CPP-603.
ICPP O-22	Historical monitoring location; improve coverage along southern boundary.
ICPP O-25	Historical continuity; offwind direction.
ICPP O-26	Historical continuity; in NE downwind direction from CPP-749.
ICPP O-14	Historical monitoring location; in NE downwind direction from CPP-1696.
ICPP O-27	In NE downwind direction from multiple possible AP/FP sources; simulated optimum 500-m distance along the 45-degree azimuth from stack CPP-708.
ICPP O-28	In NE downwind direction from multiple possible AP/FP sources; simulated optimum 500-m distance along the 45-degree azimuth from stack CPP-708.
ICPP TREEFARM O-1	Historical monitoring location; area of elevated direct radiation measurements.
ICPP TREEFARM O-2	Historical monitoring location; area of elevated direct radiation measurements.
ICPP TREEFARM O-3	Historical continuity; area of elevated direct radiation measurements.
ICPP TREEFARM O-4	Historical monitoring location; area of elevated direct radiation measurements.

8.4.4 MFC

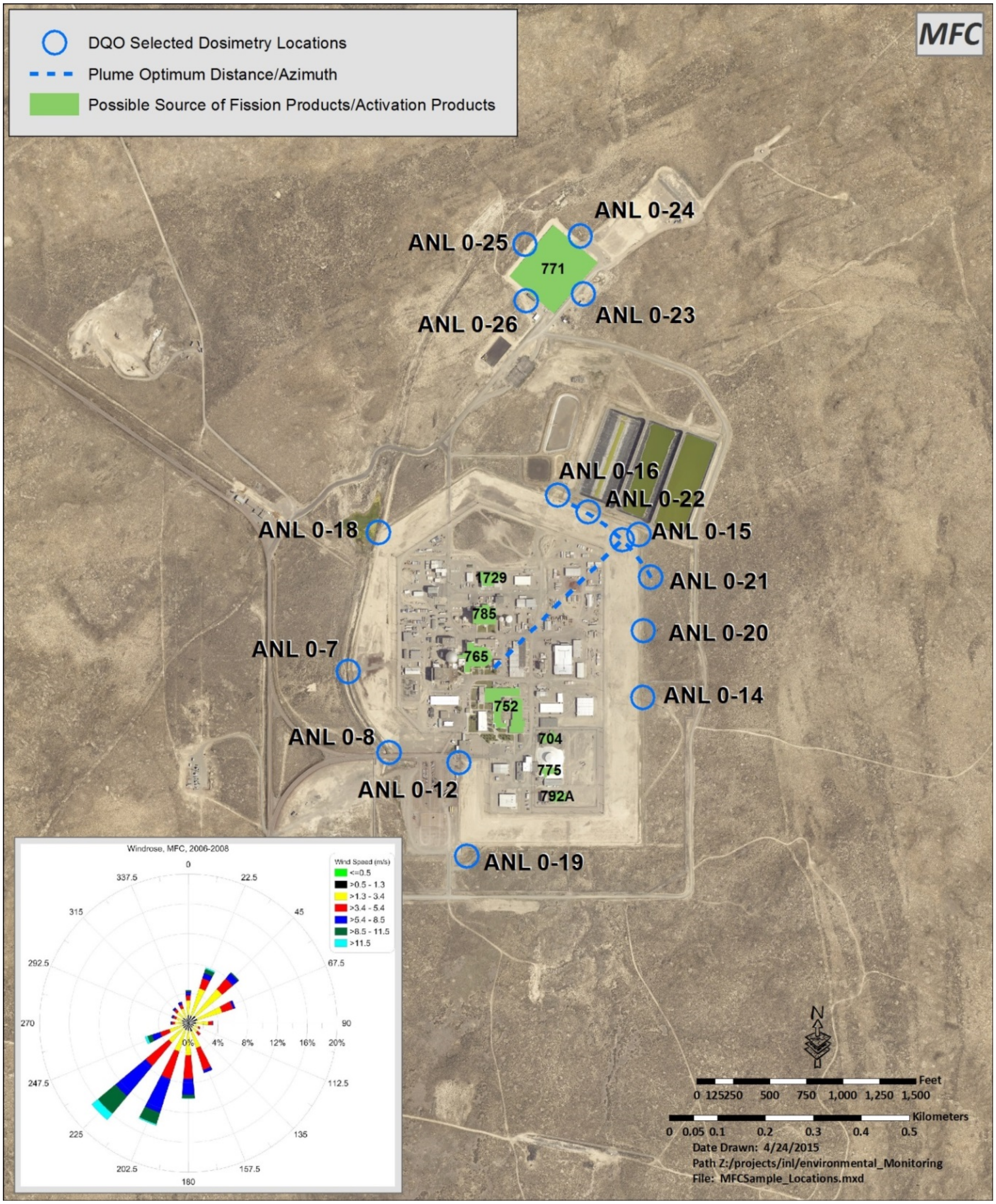

Figure 7. MFC dosimetry monitoring locations. Wind rose data is from the MFC NOAA station at 50-m elevation. The green-shaded locations are taken from INL/MIS-15-34621 and are possible sources of fission products and activation products that have a nuclear facility Hazard Category 3 or above assessment level. The optimum azimuth/distance from stack MFC-764 is from simulation results presented in Appendix A.

Table 8. Basis for external radiation monitoring locations for MFC.

Direct Radiation Monitoring Location	Basis
ANL O-18	Historical continuity.
ANL O-7	Historical continuity; in SW downwind direction from multiple possible AP/FP sources.
ANL O-8	Historical monitoring location so some continuity after the break in monitoring from 2008 to present; in SW downwind direction from multiple possible AP/FP sources.
ANL O-12	Historical continuity; in SW downwind direction from multiple possible AP/FP sources.
ANL O-19	In SW downwind direction from multiple possible AP/FP sources.
ANL O-14	Historical monitoring location; in NE downwind direction from multiple possible AP/FP sources; serves as proximity location with low-volume air monitor (MFC).
ANL O-20	In NE downwind direction from multiple possible AP/FP sources.
ANL O-21	In NE downwind direction from multiple possible AP/FP sources; also is one of the triplets for the simulated optimum 375-m distance along the 45-degree azimuth from stack MFC-764.
ANL O-15	Historical continuity; in NE downwind direction from multiple possible AP/FP sources; also serves as close as possible to the simulated optimum 375-m distance along the 45-degree azimuth from stack MFC-764 without being inside the outer facility fence.
ANL O-22	In NE downwind direction from multiple possible AP/FP sources; also is one of the triplets for the simulated optimum 375-m distance along the 45-degree azimuth from stack MFC-764.
ANL O-16	Historical monitoring location; in NE downwind direction from multiple possible AP/FP sources.
ANL O-23	Offwind direction from Radioactive Scrap and Waste Facility, selected to ensure coverage around perimeter.
ANL O-24	In NE downwind direction from Radioactive Scrap and Waste Facility.
ANL O-25	Offwind direction from Radioactive Scrap and Waste Facility, selected to ensure coverage around perimeter.
ANL O-26	In SW downwind direction from Radioactive Scrap and Waste Facility.

8.4.5 NRF

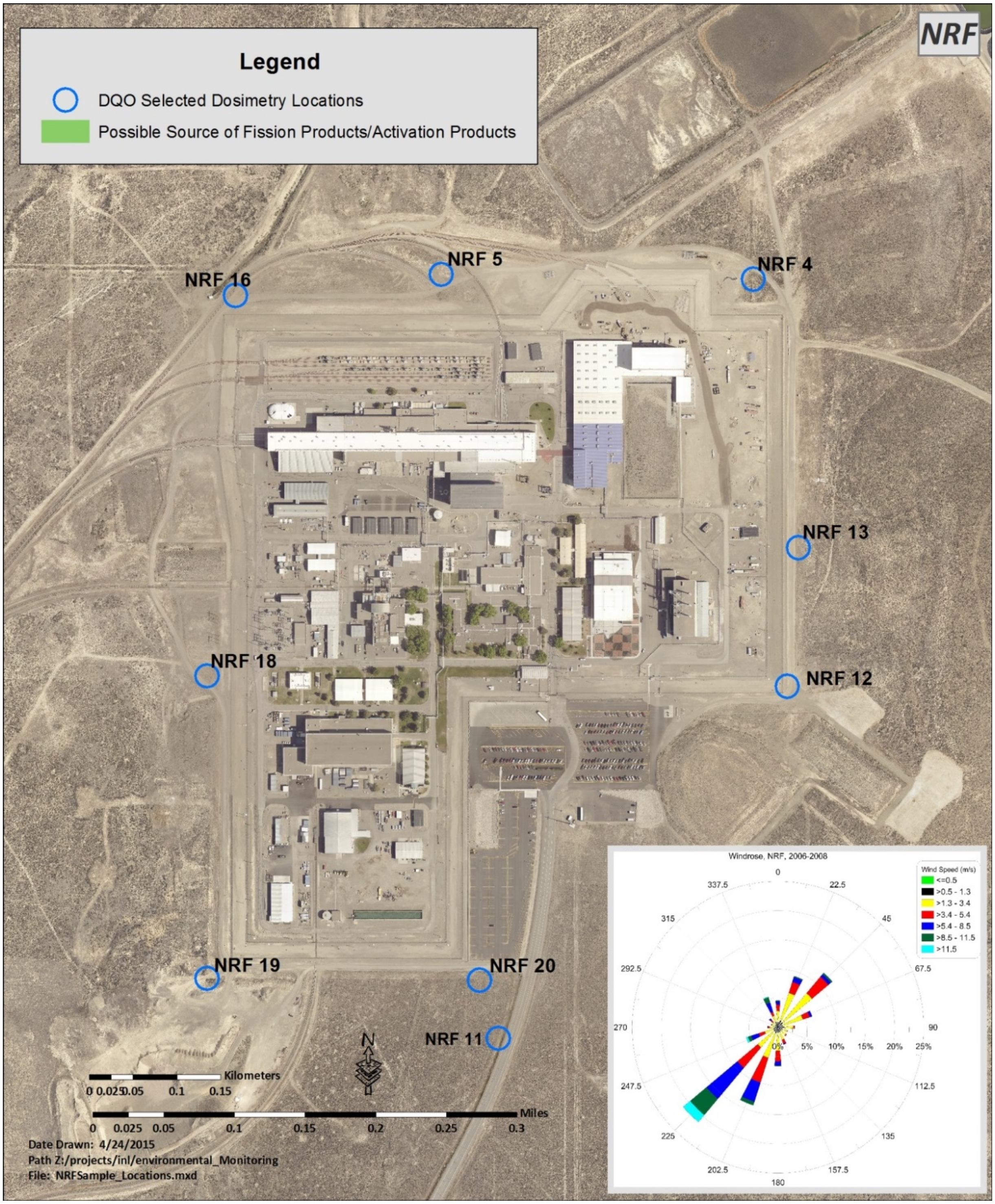

Figure 8. NRF dosimetry monitoring locations. Wind rose data is from the NRC NOAA station at 50-m elevation. The green-shaded source locations for NRF are not provided. Instead the dosimetry locations are approximately equally spaced around the facility to provide coverage. Eight dosimetry locations are indicated to match the minimum required for UTL statistical determination.

Table 9. Basis for external radiation monitoring locations for NRF.

Direct Radiation Monitoring Location	Basis
NRF O-4	Historical continuity; in NE downwind direction from facility; minimum of eight locations needed to use Upper Threshold Limit statistics.
NRF O-5	Historical continuity; in NE downwind direction; minimum of eight locations needed to use UTL statistics.
NRF O-16	Historical continuity; minimum of eight locations needed to use UTL statistics.
NRF O-18	Historical monitoring location so some continuity after the break in monitoring from 2008 to present; in SW downwind direction from facility; minimum of eight locations needed to use UTL statistics.
NRF O-19	Historical continuity; in SW downwind direction from facility; minimum of eight locations needed to use UTL statistics.
NRF O-20	Historical continuity; minimum of eight locations needed to use UTL statistics; sufficiently close to serve as co-located with low-volume air monitor (NRF).
NRF O-11	Historical monitoring location; transportation route monitoring location.
NRF O-12	Historical continuity; minimum of eight locations needed to use UTL statistics.
NRF O-13	Historical monitoring location; minimum of eight locations needed to use UTL statistics.

8.4.6 RWMC

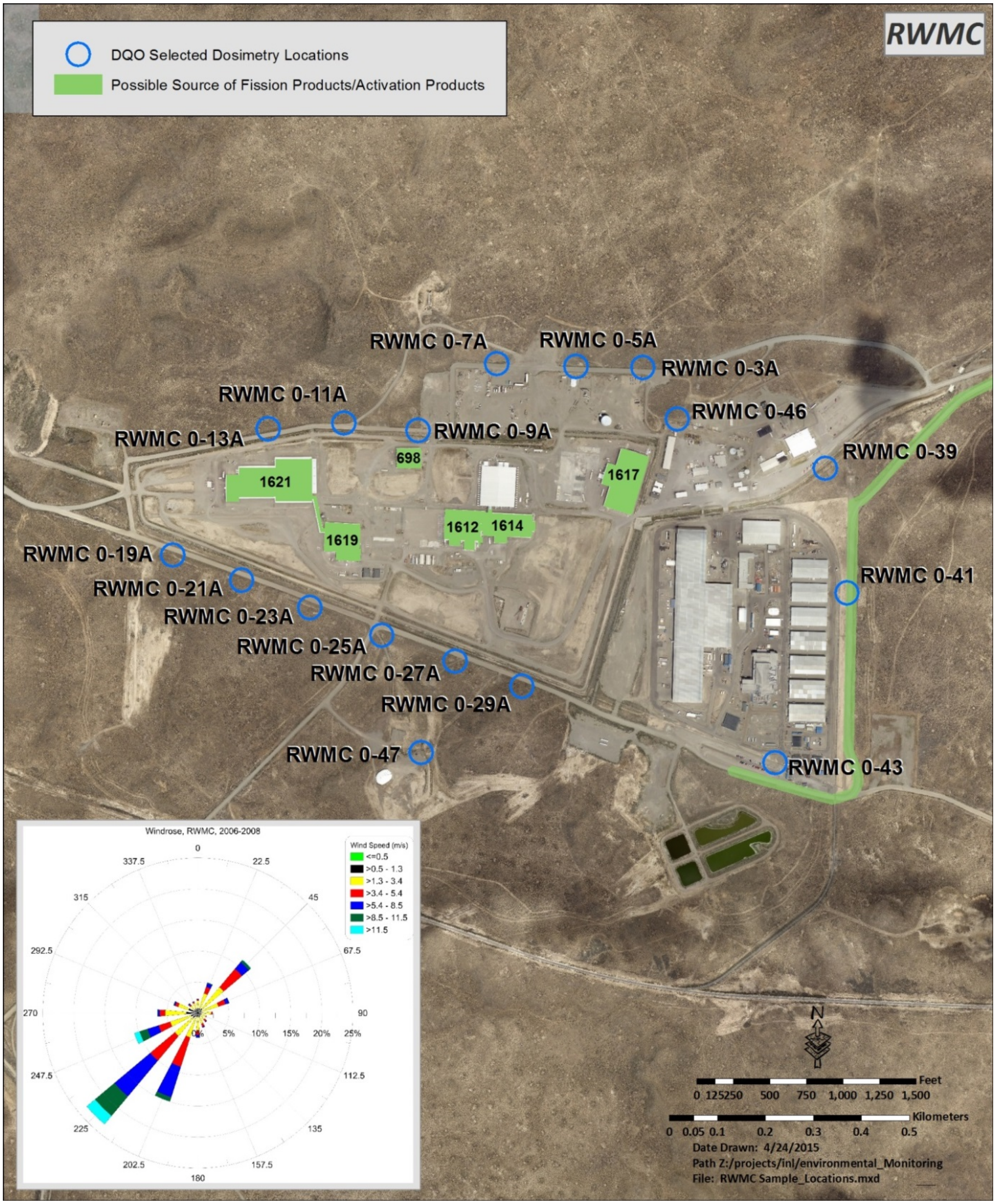

Figure 9. RWMC dosimetry monitoring locations. Wind rose data is from the RWMC NOAA station at 50-m elevation. The green-shaded locations are taken from INL/MIS-15-34621 and are possible sources of fission products and activation products that have a nuclear facility Hazard Category 3 or above assessment level.

Table 10. Basis for external radiation monitoring locations for RWMC.

Direct Radiation Monitoring Location	Basis
RWMC O-19A	Historical monitoring location so some continuity after the break in monitoring from 2008 to present; in SW downwind direction from multiple AP/FP sources.
RWMC O-21A	Historical continuity; in SW downwind direction from multiple AP/FP sources.
RWMC O-23A	Historical monitoring location; in SW downwind direction from multiple AP/FP sources.
RWMC O-25A	Historical continuity; in SW downwind direction from multiple AP/FP sources.
RWMC O-27A	Historical monitoring location; in SW downwind direction from multiple AP/FP sources.
RWMC O-29A	Historical continuity.
RWMC O-43	Historical continuity; transportation route monitoring location
RWMC O-41	Historical continuity; transportation route monitoring location.
RWMC O-39	Historical continuity.
RWMC O-46	Historical continuity; in NE downwind direction from multiple AP/FP sources; serves as co-located with low-volume air monitor RWMC.
RWMC O-3A	Historical monitoring location; in NE downwind direction from multiple AP/FP sources.
RWMC O-5A	Historical monitoring location; in NE downwind direction from multiple AP/FP sources.
RWMC O-7A	Historical monitoring location; in NE downwind direction from multiple AP/FP sources.
RWMC O-9A	Historical continuity; in NE downwind direction from multiple AP/FP sources.
RWMC O-11A	Historical monitoring location; in NE downwind direction from multiple AP/FP sources.
RWMC O-13A	Historical continuity; in NE downwind direction from multiple AP/FP sources.
RWMC O-47	Location of new low-volume air monitor that will be southwest of the RWMC.

8.4.7 SMC

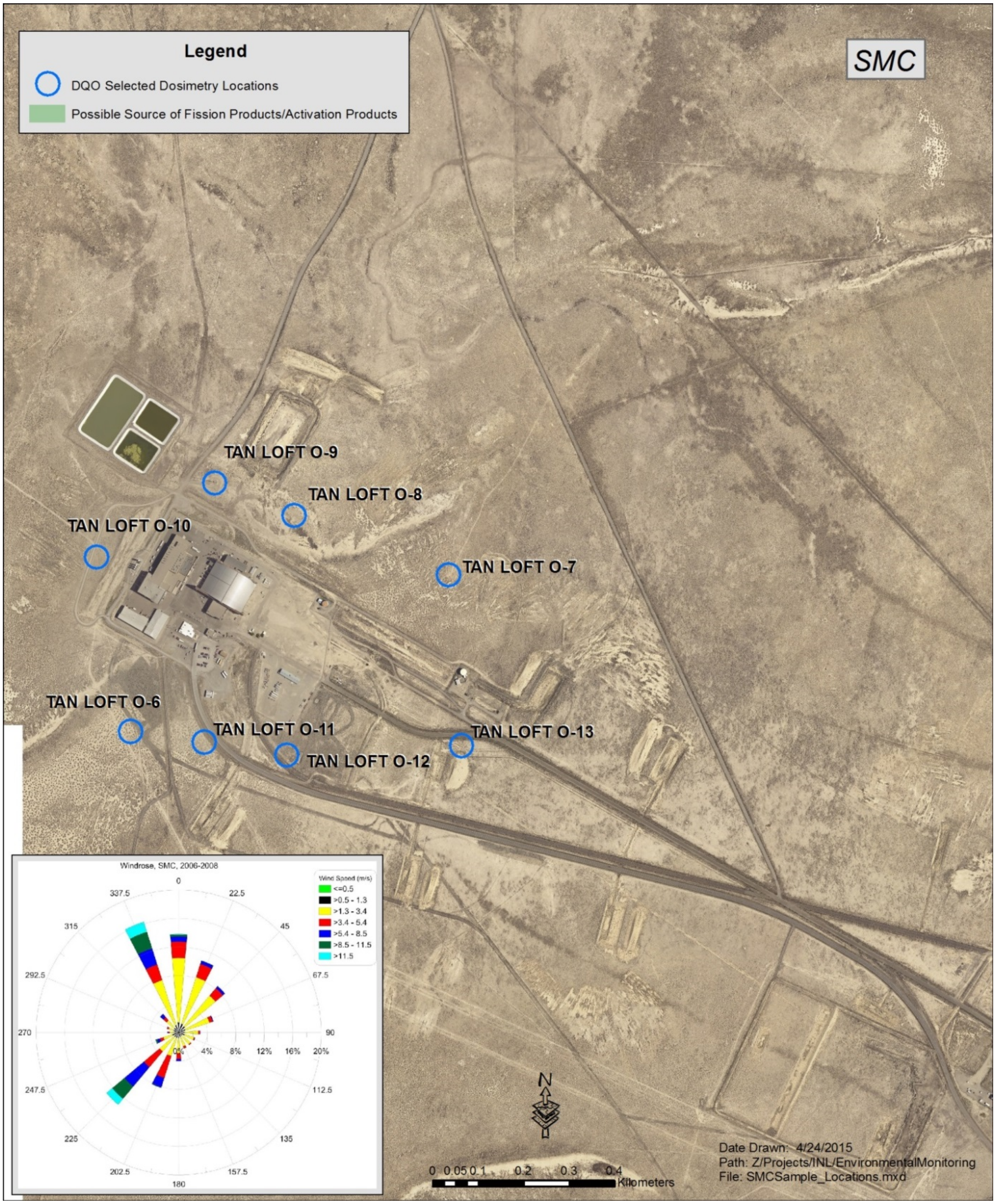

Figure 10. SMC dosimetry monitoring locations. Wind rose data is from the SMC NOAA station at 50-m elevation. The green-shaded source locations for SMC are not provided. Instead the dosimetry locations are approximately equally spaced around the facility to provide coverage. Eight dosimetry locations are indicated to match the minimum required for UTL statistical determination.

Table 11. Basis for external radiation monitoring locations for SMC.

Direct Radiation Monitoring Location	Basis
TAN LOFT O-7	Historical continuity; spatial coverage around SMC.
TAN LOFT O-8	In NE downwind direction.
TAN LOFT O-9	Co-located with low-volume air monitor SMC.
TAN LOFT O-10	Spatial coverage around SMC facility to result in a total of eight locations for statistical purposes.
TAN LOFT O-6	Historical continuity; spatial coverage around SMC.
TAN LOFT O-11	In SE downwind direction.
TAN LOFT O-12	In SE downwind direction.
TAN LOFT O-13	Spatial coverage around SMC facility to result in a total of eight locations for statistical purposes.

8.4.8 TREAT

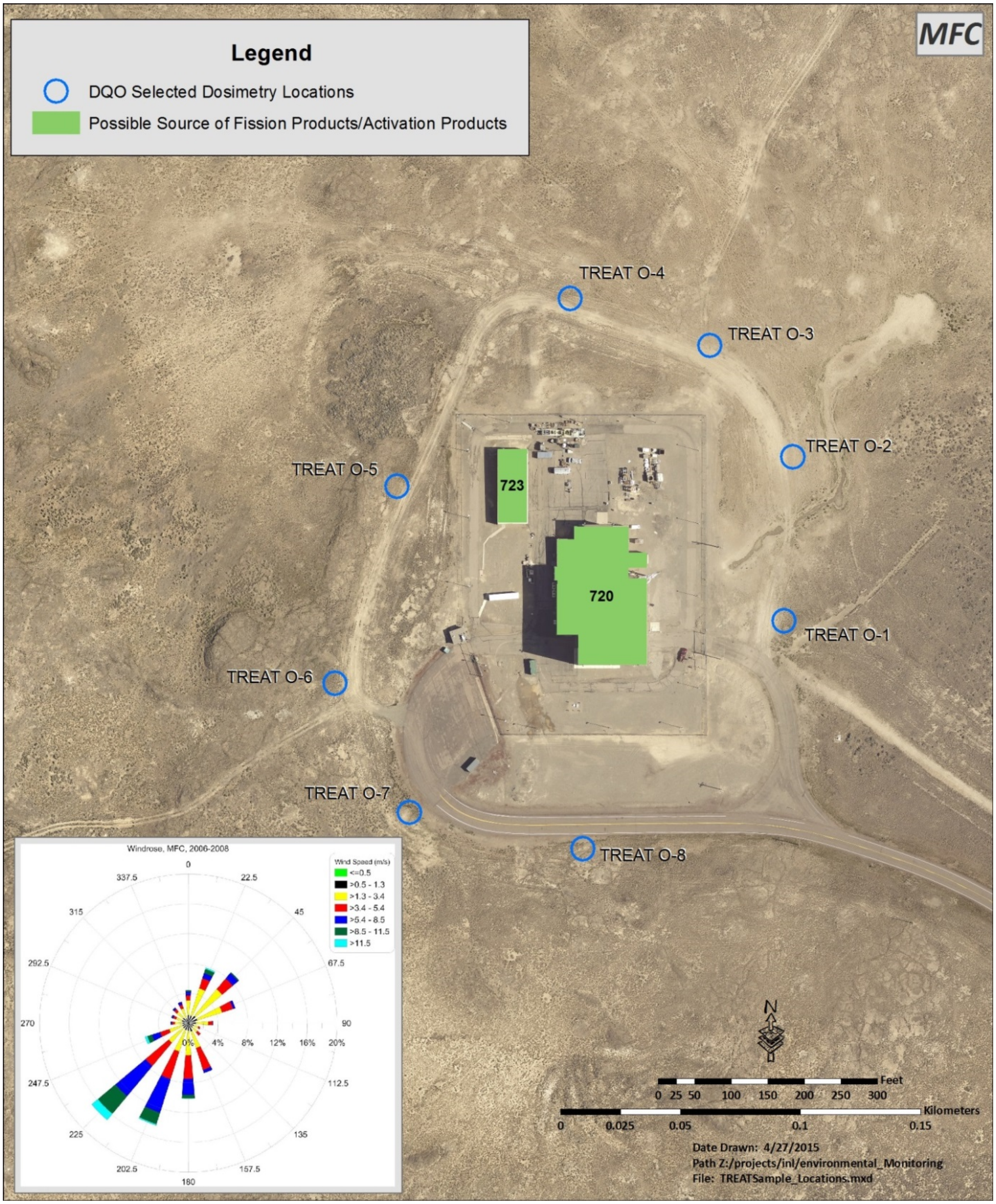

Figure 11. TREAT dosimetry monitoring locations. Wind rose data is from the MFC NOAA station at 50-m elevation. The green-shaded locations are taken from INL/MIS-15-34621 and are possible sources of fission products and activation products that have a nuclear facility Hazard Category 3 or above assessment level.

Table 12. Basis for external radiation monitoring locations for TREAT.

Direct Radiation Monitoring Location	Basis
TREAT O-1	Preoperational monitoring to determine changes from current levels to levels during operation; Minimum of eight locations needed to use Upper Threshold Limit statistics.
TREAT O-2	In NE downwind direction; preoperational monitoring; minimum of eight locations needed to use UTL statistics.
TREAT O-3	In NE downwind direction; preoperational monitoring; minimum of eight locations needed to use UTL statistics.
TREAT O-4	In NE downwind direction; preoperational monitoring; minimum of eight locations needed to use UTL statistics.
TREAT O-5	Preoperational monitoring; minimum of eight locations needed to use UTL statistics.
TREAT O-6	In SW downwind direction; preoperational monitoring; minimum of eight locations needed to use UTL statistics.
TREAT O-7	In SW downwind direction; preoperational monitoring; minimum of eight locations needed to use UTL statistics.
TREAT O-8	Preoperational monitoring; minimum of eight locations needed to use UTL statistics.

8.4.9 Site Roads

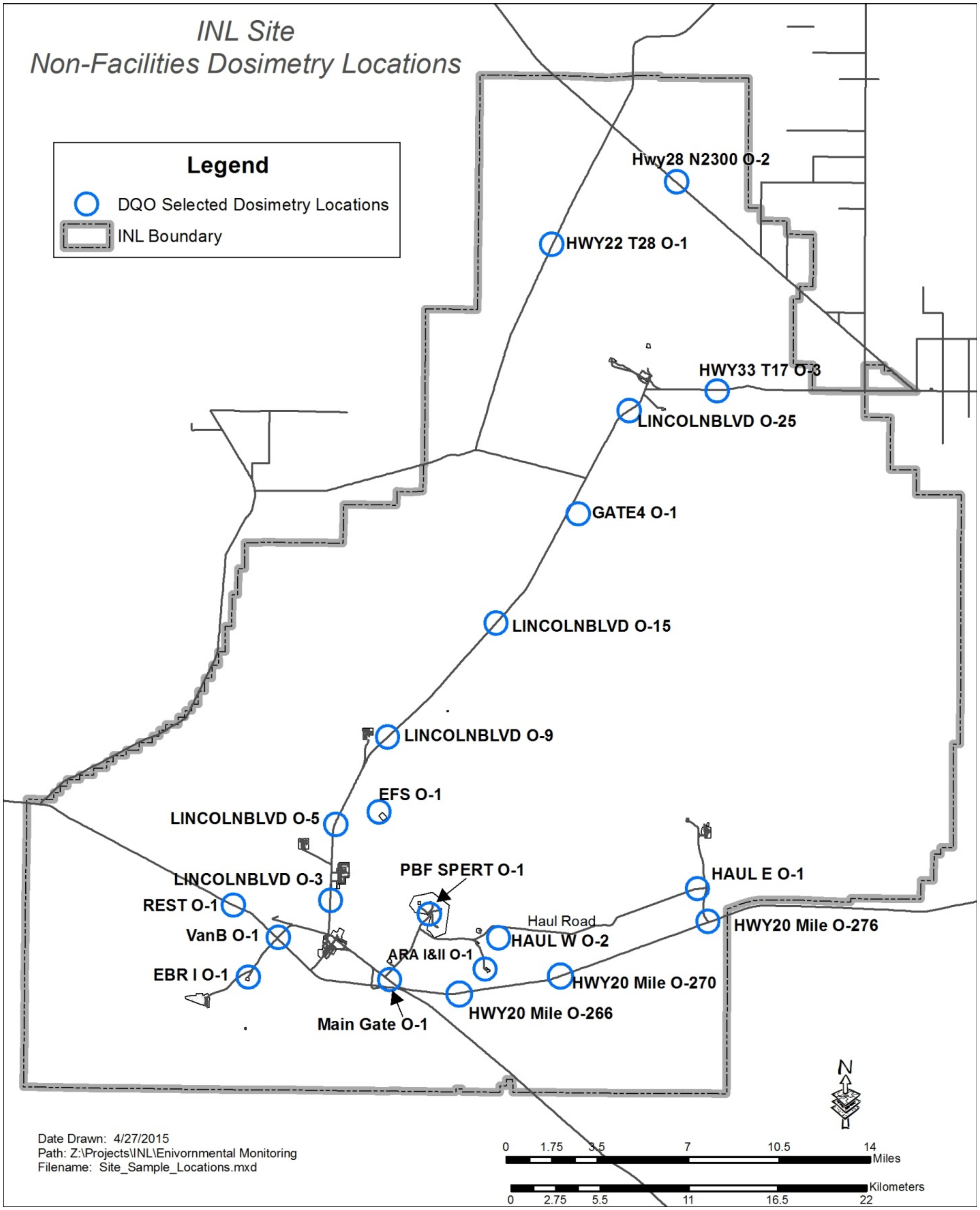

Figure 12. Site roads and non-facility dosimetry monitoring locations.

Table 13. Basis for external radiation monitoring locations for Site roads and non-facility dosimetry monitoring locations.

Direct Radiation Monitoring Location	Basis
ARA I&II O-1	Historical continuity; serves as co-located with low-volume air monitor ARA.
EBR1 O-1	Historical continuity; tourist attraction; serves as co-located with low-volume air monitor EBR1; within area of maximum projected air concentrations (Rood and Sondrup 2014).
EFS O-1	Co-located with low-volume air monitor EFS; within area of maximum projected air concentrations (Rood and Sondrup 2014).
PBF SPERT O-1	Historical continuity; serves as co-located with low-volume air monitor PBF; within area of maximum projected air concentrations (Rood and Sondrup 2014).
GATE 4 O-1	Co-located with low-volume air monitor GATE 4.
Haul E O-1	Transportation route monitoring.
Haul W O-2	Transportation route monitoring.
Hwy20 Mile O-266	Historical monitoring location: transportation route monitoring.
Hwy20 Mile O-270	Historical monitoring location: transportation route monitoring.
Hwy20 Mile O-276	Historical monitoring location: transportation route monitoring.
Hwy22 T28 O-1	Historical continuity.
Hwy28 N2300 O-2	Historical continuity.
Hwy33 T17 O-3	Historical continuity.
LINCOLNBLVD O-3	Historical continuity; transportation route monitoring location; within area of maximum projected air concentrations (Rood and Sondrup 2014).
LINCOLNBLVD O-5	Historical continuity; transportation route monitoring location; within area of maximum projected air concentrations (Rood and Sondrup 2014).
LINCOLNBLVD O-9	Historical continuity; transportation route monitoring location.
LINCOLNBLVD O-15	Historical monitoring location; transportation route monitoring.
LINCOLNBLVD O-25	Historical continuity; transportation route monitoring location.
Main Gate O-1	Historical continuity; transportation route monitoring location; within area of maximum projected air concentrations (Rood and Sondrup 2014).
REST O-1	Co-locating with low-volume air monitor REST; within area of maximum projected air concentrations (Rood and Sondrup 2014).
VanB O-1	Historical continuity; transportation route monitoring location, co-located with low-volume air monitoring VANB; within area of maximum projected air concentrations (Rood and Sondrup 2014).

8.4.10 REC (w/o PINS)

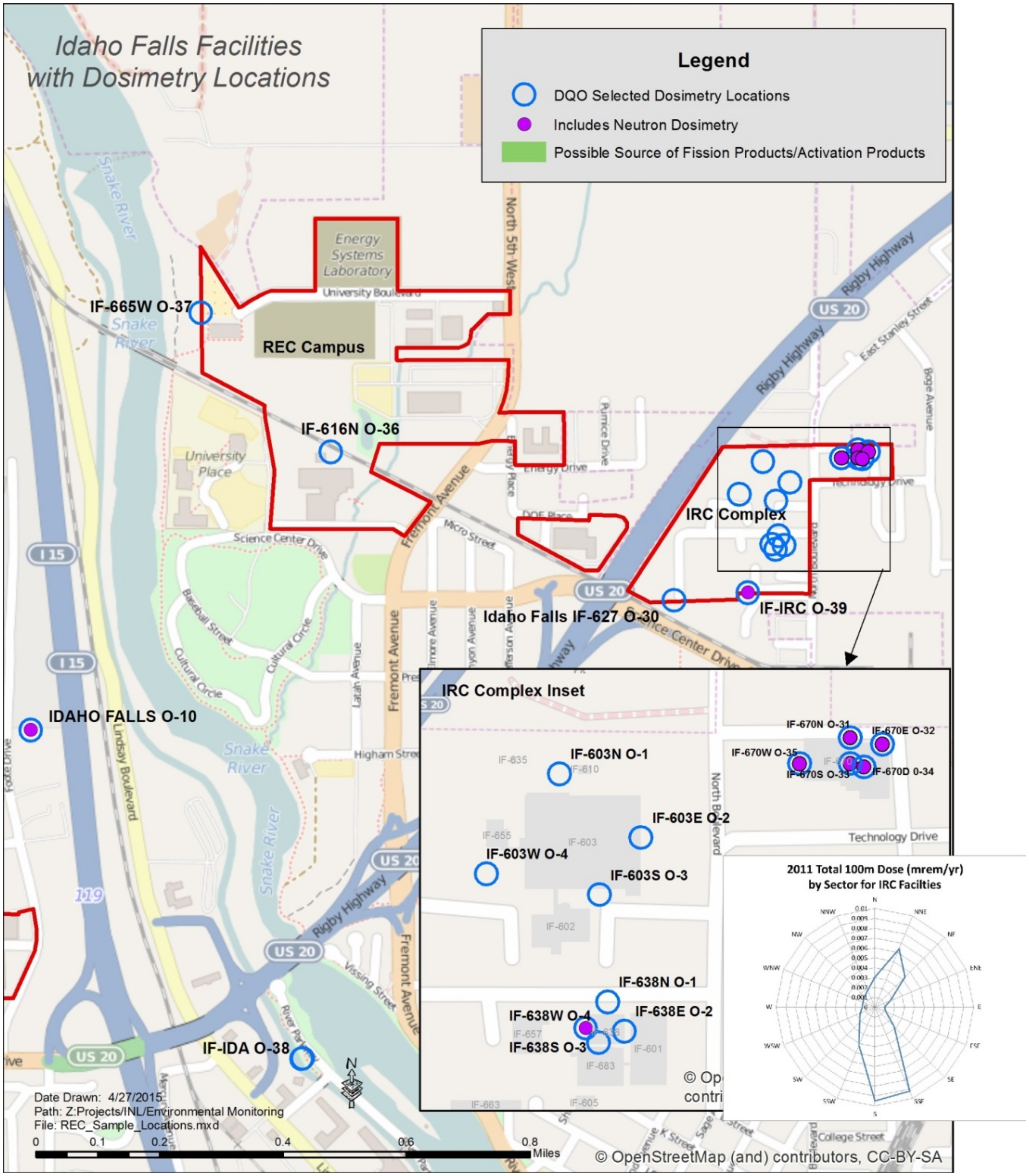

Figure 13. REC dosimetry monitoring locations. Wind rose data is from the MFC NOAA station at 50-m elevation. The inset radar-plot shows the 2011 NESHAPs estimated total dose (mrem/yr) for each of 16 directional sectors for the combined IRC Facilities release (DOE-ID 2012). As can be seen, the Maximally Exposed Individual is due south, which explains the emphasis on monitoring locations along the southern boundary of the IRC complex.

Table 14. Basis for external radiation monitoring locations for REC.

Direct Radiation Monitoring Location	Basis
IDAHO FALLS O-10	Historical continuity; co-located with low-volume air monitor IF; background location for both OSLD and neutron dosimetry.
IF-IDA O-38	Stakeholder interest location at Idaho Falls NOAA river greenbelt monitoring location IDA.
IF-665W O-37	Stakeholder interest location.
IF-616N O-36	Stakeholder interest location.
IF-627 O-30	Stakeholder interest location on the south perimeter of IRC Complex in direction of close public proximity such as the elementary school south of Science Center Drive.
IF-IRC O-39	Stakeholder interest location on south perimeter of IRC complex in direction of close public proximity such as the elementary school south of Science Center Drive; both OSLD and neutron dosimetry.
IF-638N O-1	Stakeholder interest location.
IF-638E O-2	Stakeholder interest location.
IF-638S O-3	Stakeholder interest location; sufficiently close to serve as co-located with low-volume air monitor IRC.
IF-638W O-4	Stakeholder interest location; both OSLD and neutron dosimetry.
IF-603N O-1	Stakeholder interest location.
IF-603E O-2	Stakeholder interest location.
IF-603S O-3	Stakeholder interest location.
IF-603W O-4	Stakeholder interest location.
IF-670N O-31	Stakeholder interest location; both OSLD and neutron dosimetry.
IF-670E O-32	Stakeholder interest location; both OSLD and neutron dosimetry.
IF-670S O-33	Stakeholder interest location; both OSLD and neutron dosimetry.
IF-670D O-34	Stakeholder interest location; both OSLD and neutron dosimetry, duplicate.
IF-670W O-35	Stakeholder interest location; both OSLD and neutron dosimetry.

8.4.11 REC (PINS only)

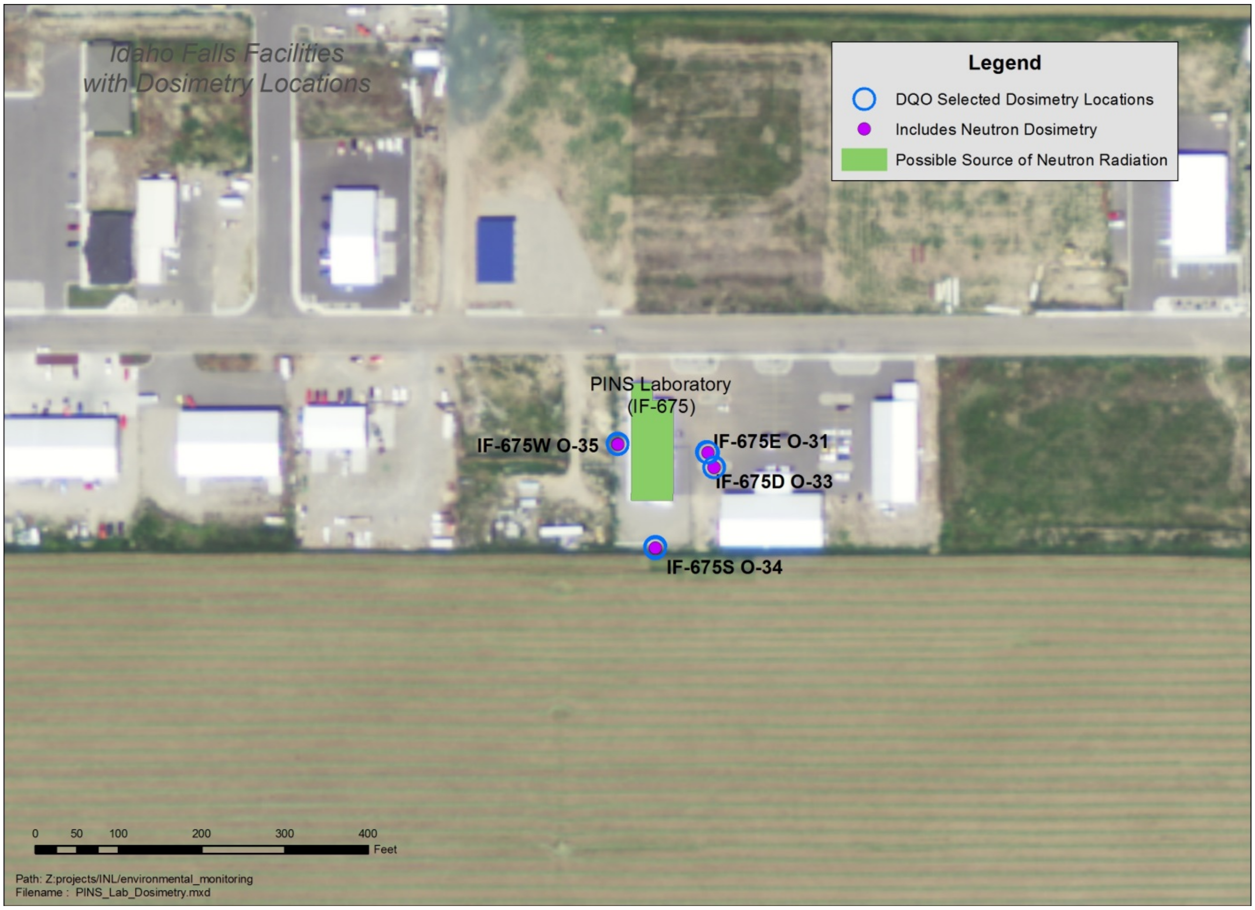

Figure 14. PINS dosimetry monitoring locations. The green-shaded locations are taken from INL/MIS-15-34621 and are possible sources for neutron radiation that have a nuclear facility Hazard Category 3 or above assessment level.

Table 15. Basis for external radiation monitoring locations for PINS.

Direct Radiation Monitoring Location	Basis
IF-675E O-31	Historical continuity; both OSLD and neutron dosimetry location; stakeholder interest location.
IF-675D O-33	Historical continuity; both OSLD and neutron dosimetry location; duplicate location; stakeholder interest location.
IF-675S O-34	Historical continuity; both OSLD and neutron dosimetry location; stakeholder interest location.
IF-675W O-35	Historical continuity; both OSLD and neutron dosimetry location; stakeholder interest location.

8.4.12 Off-Site Regional

DOE guidance (DOE 2015) for offsite radiation measurement locations directs that offsite radiation measurement locations should include background or control location, Site perimeter or boundary locations, and locations in nearby communities (within a pre-determined distance from the Site to include communities in the predominant transport regions). Considering this guidance, as well as historical continuity and community interest, the final locations for the off-Site regional monitoring network are presented in Table 13. Many of the stations are background locations and are included because they provide continuity with historical measurements and are located at various altitudes and geographical locations, which can influence external exposure. In the *INL Site Annual Report* (DOE/ID 2014), an average of these measurements is used to represent the regional background dose that an individual might receive living in the area. Other stations are located in communities within the 50-mile radius to provide assurance to the public that the dose received from exposure to the environment is not influenced by INL. In all cases, continuity with historical measurements was considered for trending purposes.

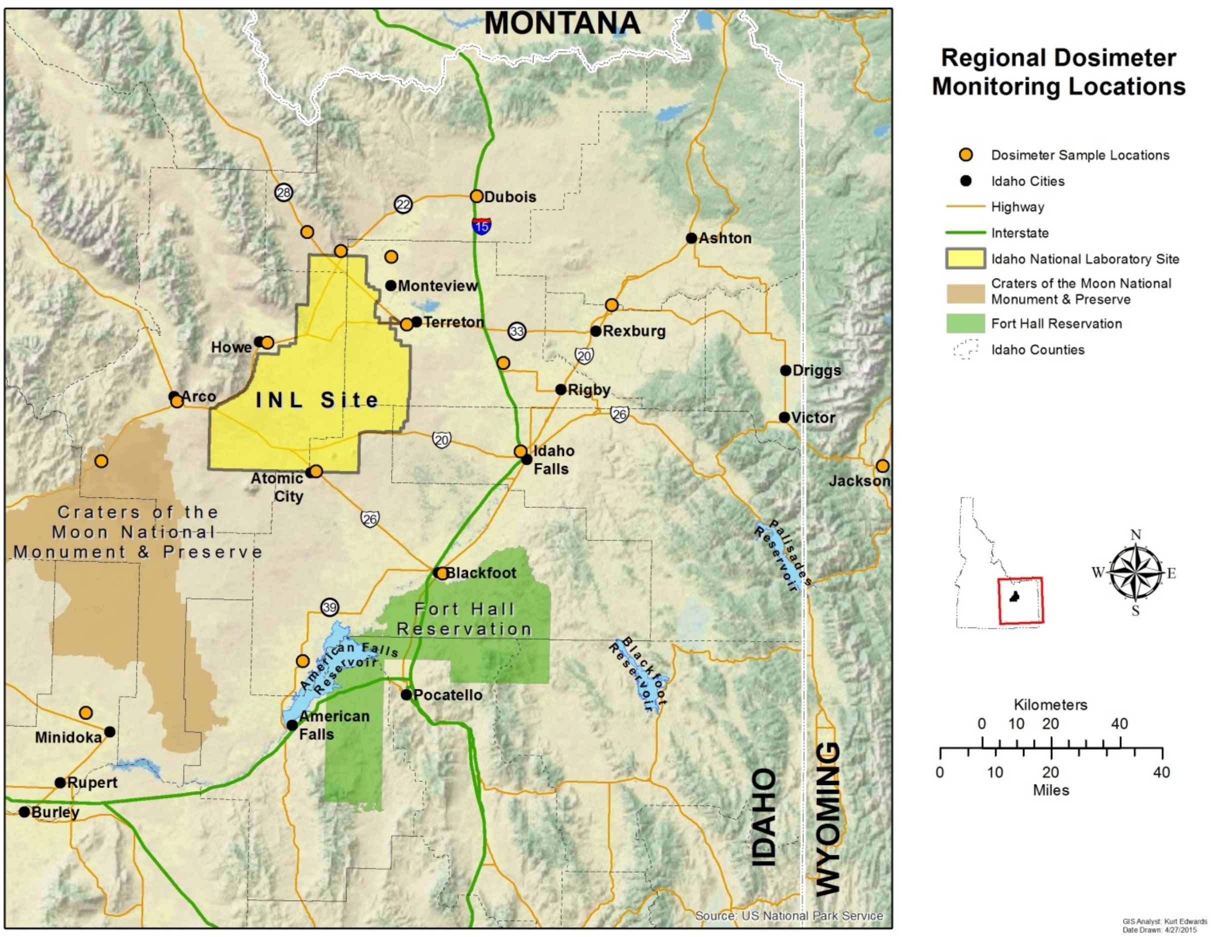

Figure 15. Off-Site Regional dosimeter locations.

Table 16. Basis for external radiation monitoring locations for Off-Site Regional.

Direct Radiation Monitoring Location	Basis
Aberdeen	Background location, uninfluenced by Site releases, within 50 miles of the Site. Provides continuity with historical data for trending purposes. Community interest.
Arco	Nearby offsite community. Provides continuity with historical data for trending purposes. Community interest.
Atomic City	Only southern boundary population which may be impacted by Site releases.
Birch Creek Hydro	Only northern boundary location. Provides continuity with historical data for trending purposes.
Blackfoot (Mountain View School)	Background location, uninfluenced by Site releases, within 50 miles of the Site. Provides continuity with historical data for trending purposes. Community interest.
Blue Dome	Background location, uninfluenced by Site releases, within 50 miles of the Site. Provides continuity with historical data for trending purposes.
Craters of the Moon	Background location, uninfluenced by Site releases, within 50 miles of the Site. Provides continuity with historical data for trending purposes. National Park of interest to community.
Dubois	Background location, uninfluenced by Site releases, within 50 miles of the Site. Provides continuity with historical data for trending purposes. Community interest.
Howe	Only western boundary population which may be impacted by Site releases.
Idaho Falls	Location of highest estimated population dose (because of population size). Co-located with EPA RadNet monitor.
Jackson	Stakeholder interest. Outside of 50-mile radius.
Minidoka	Background location, uninfluenced by Site releases, within 50 miles of the Site. Provides continuity with historical data for trending purposes. National Park of interest to community.
Monteview	Northwest boundary community which downwind of Site. Provides continuity with historical data for trending purposes. Community interest.
Mud Lake	Northwest boundary community which downwind of Site. Provides continuity with historical data for trending purposes. Community interest.
Roberts	Background location, uninfluenced by Site releases, within 50 miles of the Site. Provides continuity with historical data for trending purposes. Community interest.
Sugar City	Background location, uninfluenced by Site releases, within 50 miles of the Site. Provides continuity with historical data for trending purposes. Community interest.

8.4.13 Resident Receptor Locations

In simulations of air transport supporting *Data Quality Objectives Supporting Radiological Air Surveillance Monitoring for the INL Site* (in press), 27 residential receptor locations (RRLs) surrounding the Site were evaluated on a facility-specific emission basis to determine, which RRL location had the most likelihood of being an maximally exposed individual (MEI) for each facility. Overall six RRLs were identified (see Table 18). These six RRLs are shown in Figure 16.

To provide a comparison direct radiation measurement to the calculated dose at each of these possible MEI locations, dosimeters will be placed at or close to each of the six locations indicated in the table. The Atomic City location (RRL4) already has a dosimeter. The dosimeters for RRL3, RRL6, RRL17, and RRL24 will be located as close as possible to these RRL locations but will be within the Site boundary to avoid private property accessibility issues. Moving these locations toward the facility sources at the Site is conservative in that the likelihood of detection increases in that direction. The specific dosimetry locations corresponding to RRL3, RRL6, RRL17, and RRL24 are shown in Figures 17, 18, 19, and 20. RRL5 is East Butte, which is on the Site and will have a dosimeter placed in proximity. RRL4 is Atomic City, which already has a dosimetry monitoring location.

Table 17. Location of reference resident for a 168-hr release (1-week) that results in 0.0192 mrem (1.0mrem/yr) (from INL/EXT-15-34927, Table 11).

Facility	RRL Number
ATR Complex	3
CFA-625	3
CITRC	4
CPP-1774	3
CPP-708	3
MFC-764	5
MFC-774	6
NRF	24
RWMC	3
TAN-679	17
TRA-770	3

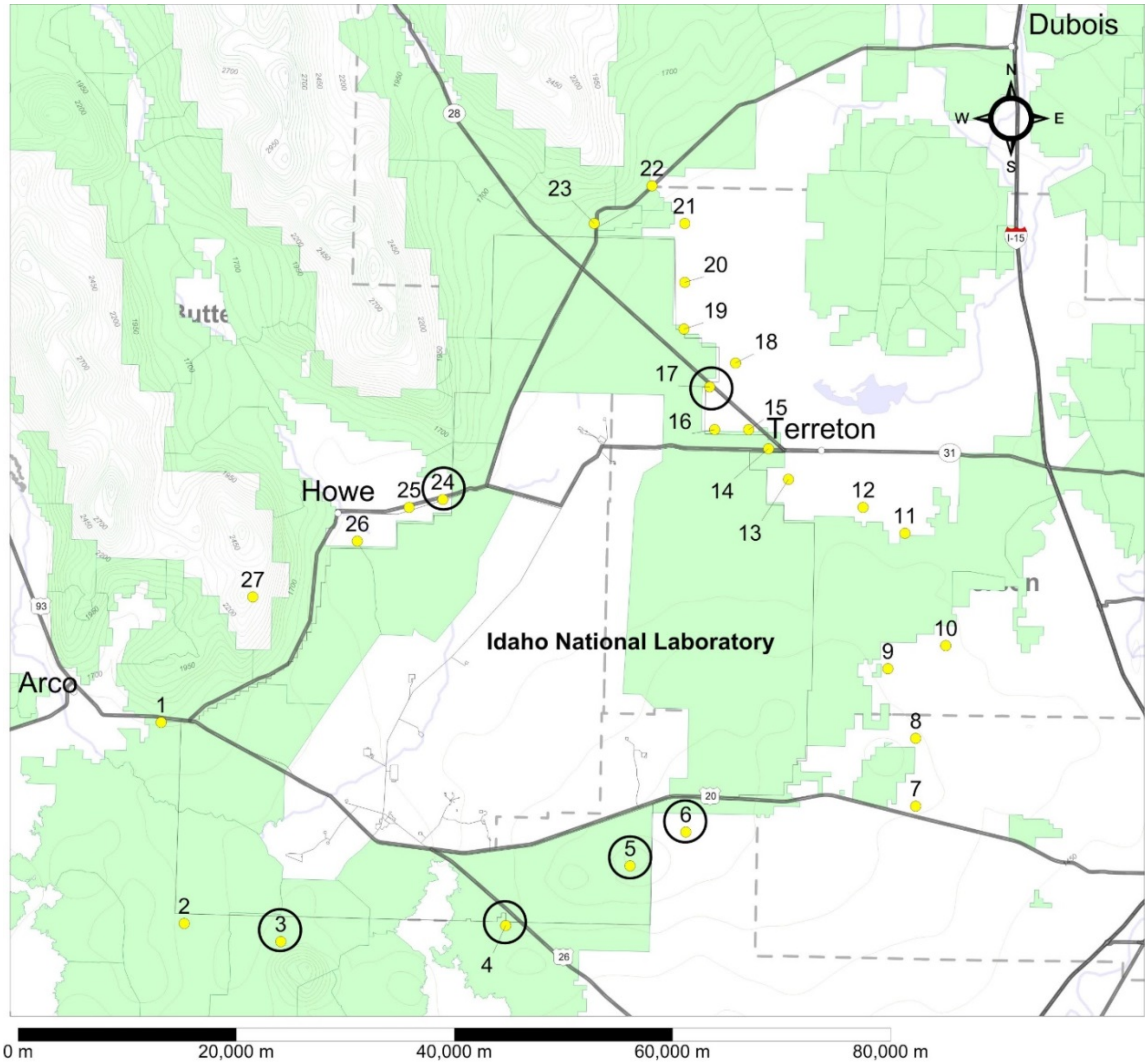

Figure 16. Twenty-seven potential resident receptor locations used in the Radiological Air Surveillance Monitoring DQO transport simulations (from INL/EXT-15-34927). The six circled locations were those RRLs identified as having the most likelihood of being an MEI for specific facilities and at which dosimeters were located.

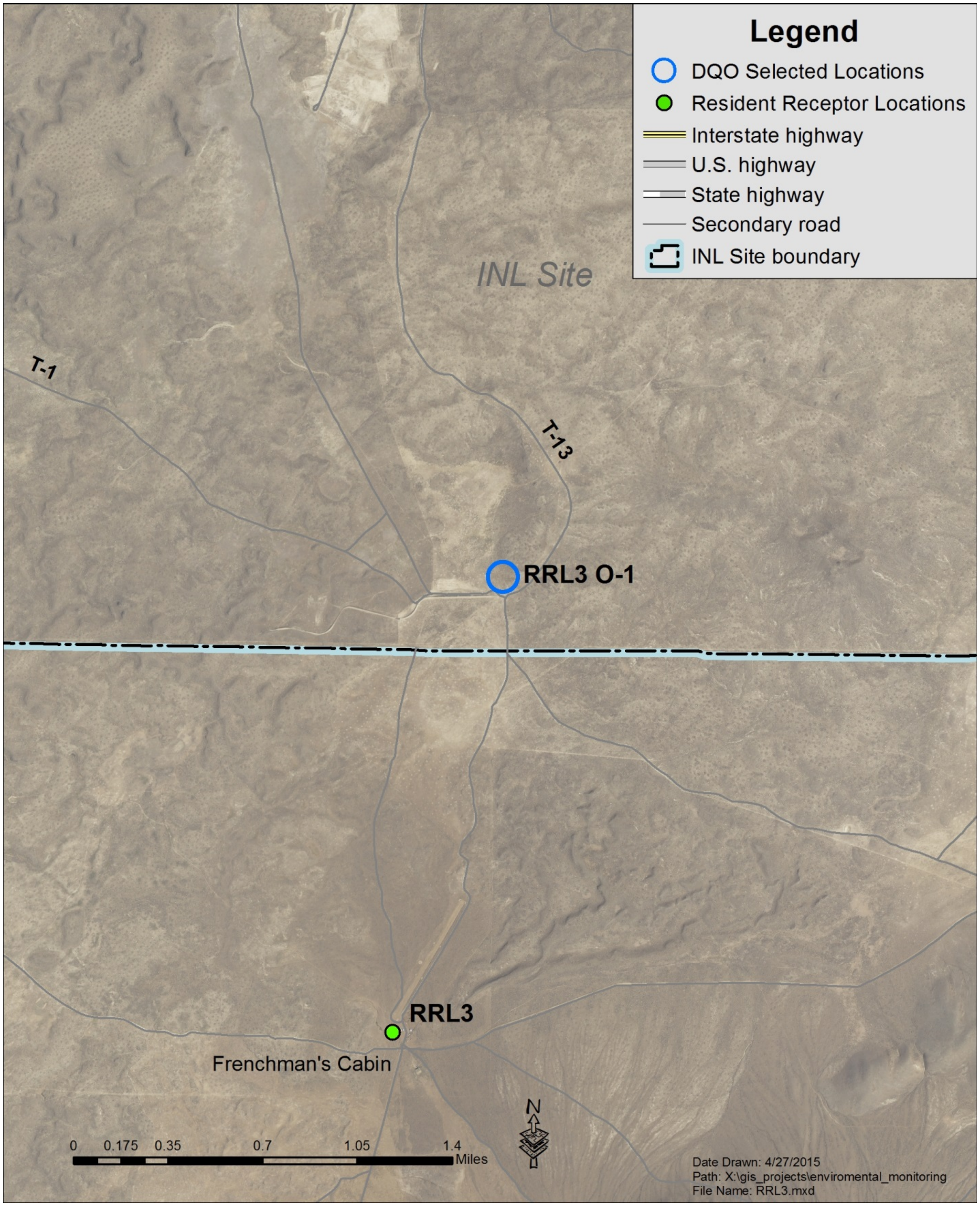

Figure 17. New dosimeter location RRL3 O-1 to correspond to RRL3 (Frenchman's Cabin).

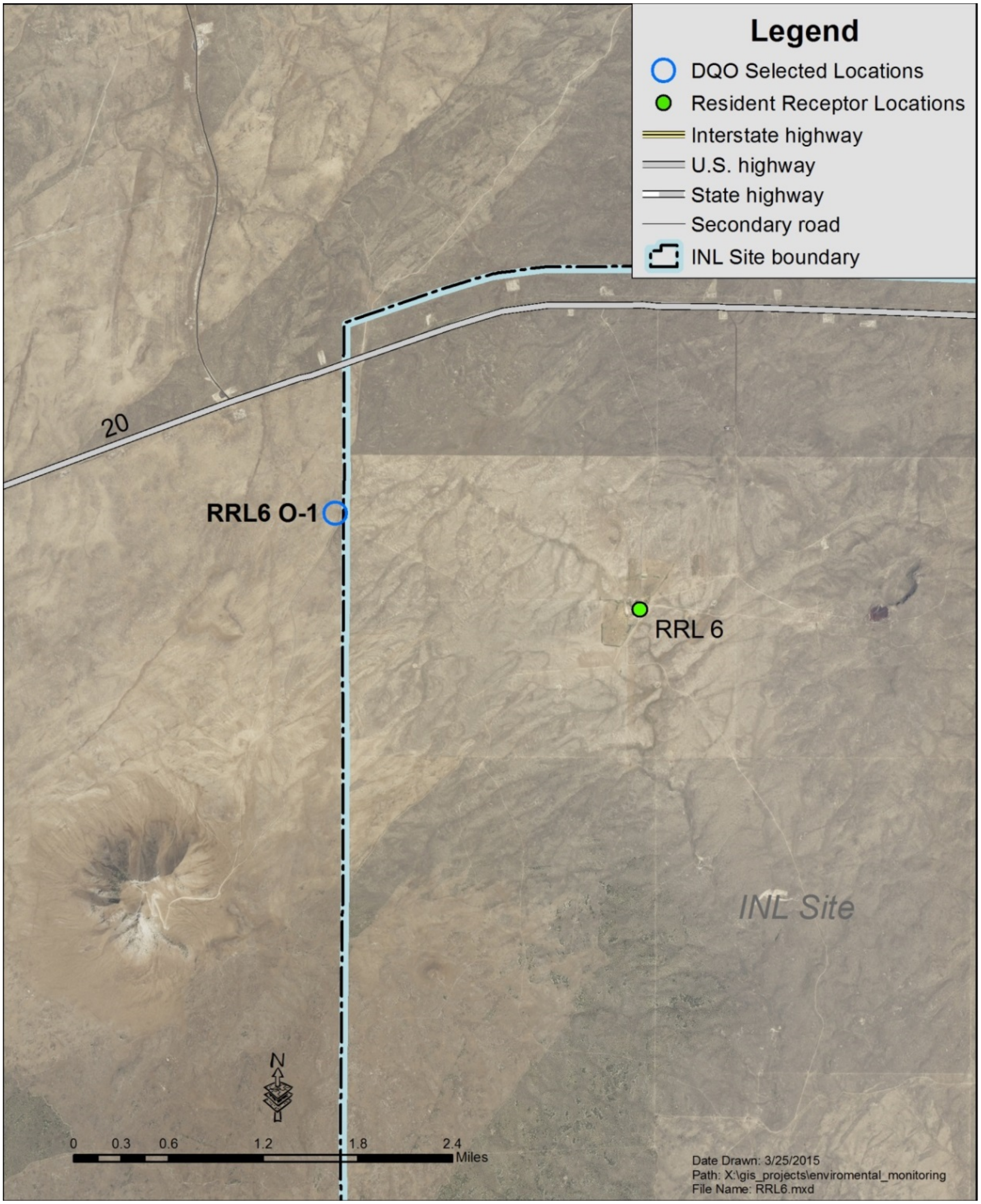

Figure 18. New dosimeter location RRL6 O-1 to correspond to RRL6.

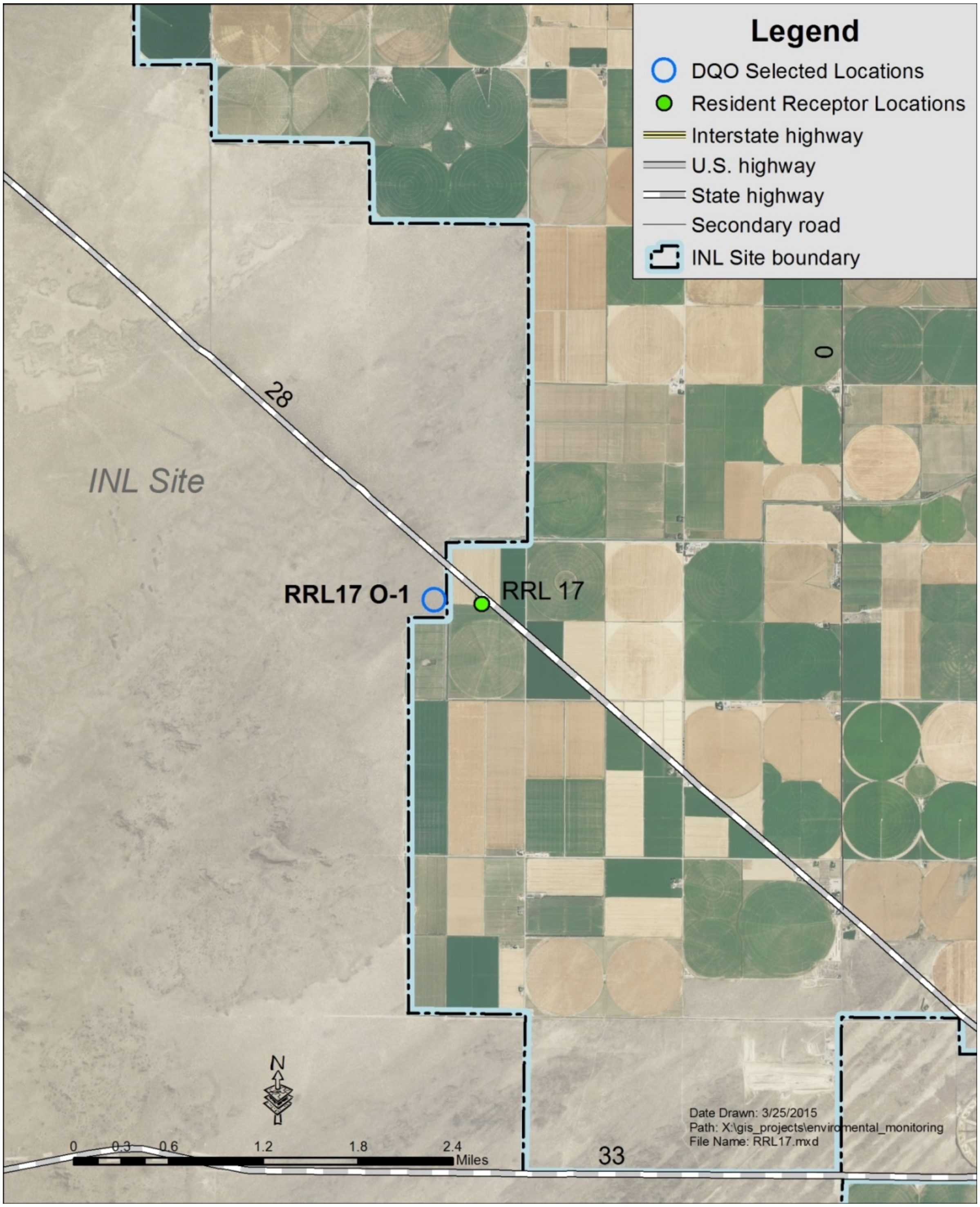

Figure 19. New dosimeter location RRL17 O-1 to correspond to RRL17.

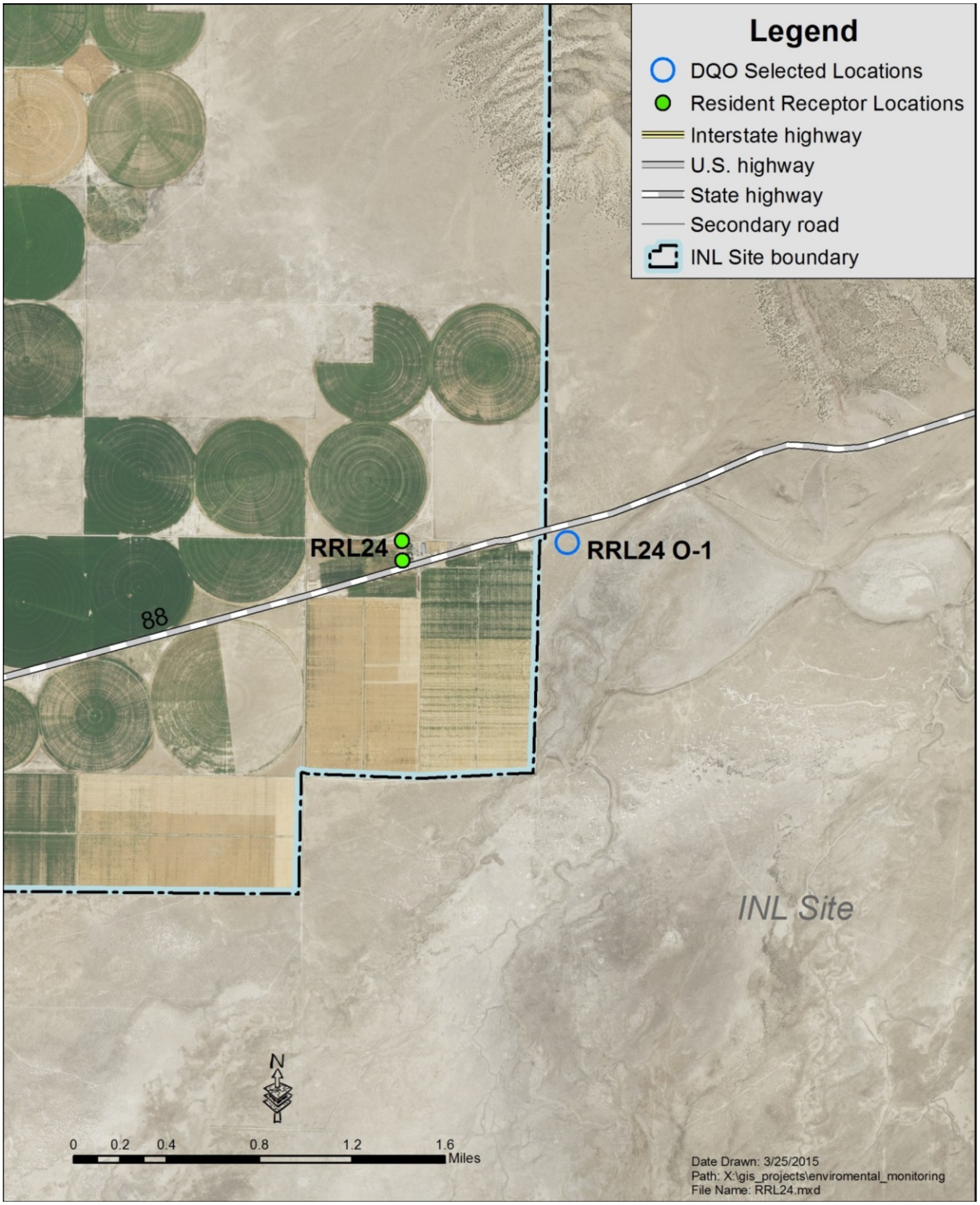

Figure 20. New dosimeter location RRL24 O-1 to correspond to RRL24.

Table 18. Basis for external radiation monitoring locations for MEI Locations.

Direct Radiation Monitoring Location	Basis
RRL3 O-1	Frenchman's Cabin area facility-specific MEI and the overall MEI; however, no electrical power here for air sampler. A dosimeter would be the only continual environmental measurement here.
RRL5 O-1	East Butte area facility-specific MEI.
RRL6 O-1	Grant Road to East Butte facility-specific MEI.
RRL17 O-1	Monteview area facility-specific MEI.
RRL24 O-1	Howe area facility-specific MEI.

9. CONCLUSIONS

Current and future activities in relation to dosimetry monitoring at the Site and in the surrounding areas will proceed in accordance to the DQOs outlined in this document. These DQOs provide a technical explanation and justification for the process used to select sampling locations, analyze results, and make decisions based on acquired data. The number and location of dosimeters at each area may change as INL activities change. However, as long as changes are made within the guidelines set out in this DQO, such changes will not be in violation of the DQO parameters.

10. REFERENCES

These first three references are cited in the text as "in press": They are being completed concurrently with this DQO.

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11. APPENDIXES

Appendix A, Methodology to Determine Dosimetry Placement to Optimally Monitor Plumes Emanating from Stacks for INL Site Facilities

Appendix B, Statistical Analysis Associated with Dosimetry Monitoring Data Quality Objectives

Appendix C, Data Used for Decision Limits

Appendix A

Methodology to Determine Dosimetry Placement to Optimally Monitor Plumes Emanating from Stacks for INL Site Facilities

Dosimeters are placed by the Environmental Direct Radiation Monitoring Program to measure ionizing radiation. This appendix describes the simulation methodology that was used to determine the optimum placement of dosimeters to maximize the likelihood of monitoring exposure from plumes emanating from stacks at INL facilities.

In the Environmental Direct Radiation Monitoring Program dosimeters are set out for a period of 6 months before being collected and measured in the laboratory. The optimum placement of the dosimeters where exposure would be maximized would depend on the location where the maximum annual time-integrated concentration (TIC) occurred.

To calculate the location of maximum TIC, a Gaussian plume model was employed that incorporates the stack height and plume rise (INL/EXT-15-34927, in press). Sixteen receptors were placed 22.5 degrees apart surrounding the stack at four different radial distances that were 25 m apart (64 receptors). The TIC values for a unit release rate (1 pCi s^{-1}) were calculated hourly for each hour of meteorological data. The TICs were then summed across all simulated hours for each receptor and the maximum was determined. This procedure was run iteratively until the maximum occurred at an interior receptor (i.e., at a receptor not at the smallest or largest distance) such that the maximum was bracketed. Thus, the true maximum is located within 25 m ÷ 2 = 12.5 m from the observed maximum location.

The unit TIC is expressed as a normalized value as given by:

$$TICu = \frac{TIC}{Q} \tag{1}$$

where TICu = unit time-integrated concentration (hr^2 m^{-3}), *TIC* = time integrated concentration (Ci-hr m^{-3}) for a 1-hr release, and *Q* = the release rate (Ci hr^{-1}). The annual *TICu* is the sum of the hourly *TICu* for all the hours in the dataset (1-year of data will have 8,760 hours). The four stacks that were evaluated in this assessment are presented in Table A-1 and the results are presented in Table A-2. These optimal azimuth and distances are used in Step 7 to aid in selecting dosimetry locations.

Table A-1. Stacks evaluated for optimum location of dosimeter detectors.

Stack	Height (m)	Diameter (m)	Exit Velocity (m s–1)	Flow rate (m3 s–1)	Elevation (m)
CPP-708	76.2	1.83	10.65	28.06	1497.6
TRA-770	76.2	1.524	10.03	18.33	1507.7
TRA-710	76.2	1.524	0.977	1.78	1504.9
MFC-764	60	1.524	9.081	16.59	1569.4

Table A-2. Location of maximum TIC for the four stacks.

Stack	Distance 1 (m)	Distance 2 (m)	Distance 3 (m)	Distance 4 (m)	Maximum Distance (m)	Azimuth (degrees)	Maximum unit TIC (hr2 m–3)
CPP-708	475	500	525	550	500	45	1.75E-06
TRA-770	475	500	525	550	500	22.5	2.89E-06
TRA-710	350	375	400	425	400	22.5	4.04E-06
MFC-764	325	350	375	400	375	45	2.14E-06

Appendix B

Statistical Analysis Associated with Dosimetry Monitoring Data Quality Objectives

The Data Quality Objectives (DQOs) reference a great deal of statistical concepts and techniques because decision limits were computed using statistical methods. This section provides a detailed explanation of the methods used to obtain the threshold values, justification for their selection, and information on how to use and update them. The two primary statistical methods that are used in these DQOs are background levels and trend limits. The following sections discuss each of these methods separately.

B-1. BACKGROUND LEVELS

Background levels were computed for each of the areas that are sampled under the monitoring program. Area-specific background levels are necessary for this program because radiation dose can vary widely in each area since background radiation levels differ at each area. Thus, historical data obtained from each of the sites was used to compute an upper tolerance limit (UTL) for each area that can be used as a background level.

B-1.1 Use of Background Levels

The background level is computed using a 95%/95% UTL. The 95%/95% UTL is a value such that 95% of the data are less than the UTL with 95% confidence. Thus, a UTL computed using background data is designed to cover all but a small percentage of the background population measurements (EPA 2009). Thus, it is an appropriate measure for providing an upper threshold on measurements obtained from an area and is often used to construct a background level for the area. It is used by comparing individual measurements to the UTL. If the UTL is exceeded, that measurement may be indicative of an unusually high dose for that area.

Approximately 5% of the doses are expected to be greater than the UTL when there is no actual increase in dose. Therefore, when a measured dose exceeds the UTL it should not be immediately assumed that radiation levels have increased. Rather, the dose should be compared to other doses in the area and to doses previously obtained from that sampling location to provide context. The UTL provides a threshold that allows identification of doses that may alert the monitoring program to a potential release, but an exceedance does not always indicate an increase in dose for that area.

It is important that background levels remain relevant to the area in which they describe. Therefore, UTLs should be updated approximately every 5 years to ensure the background levels remain relevant to current area dose. Data should be carefully examined to ensure that the data used to construct the UTL are indicative of current site conditions.

B-1.2 Computation of Background Levels

UTLs were computed using ProUCL Version 5.0.0 (EPA 2013). The data were assessed to determine if they were normally distributed, gamma distributed, or did not have a discernable distribution (non-parametric). The appropriate UTL was selected based on the distribution of the data. The ProUCL Technical Guide (EPA 2013) contains the details on how UTLs are computed and selected. Data were also examined for outliers or other trends that may bias the UTL in a manner that is not indicative of the true background for the area. All data obtained from 2007 to 2014 were used to construct the UTLs unless it was determined that certain data points should be omitted or data from those years are not available.

Doses are based on a 6-month dose measurement. If a sampling event does obtain measurements for a period that is different than 6 months, the measurements will need to be adjusted to a 6-month equivalent dose. For example, the November 2013 sampling event measured doses for 1 year rather than 6 months. Therefore, one-half of the measured dose was used for calculations.

UTLs require a minimum of 8 data points to be computed. Thus, areas where fewer than 8 dose measurements are available since 2007 did not have background levels computed. UTLs will need to be computed for those areas once a minimum of 8 data points are available.

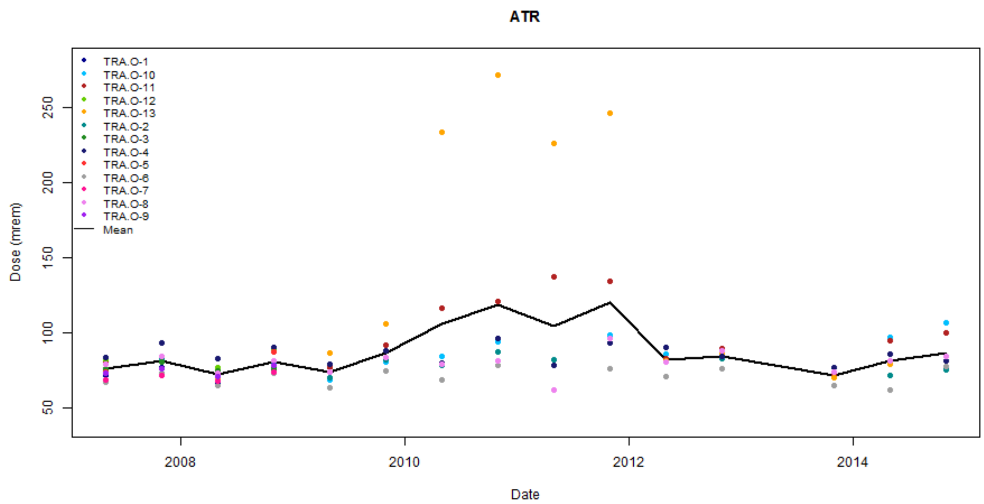
Data were visually inspected to determine if the data contained outliers. None of the areas appeared to have outliers with the exceptions of ATR, INTEC, and RWMC. Figures B-1, B-2, and B-3 show the data from these three sampling locations plotted against time.

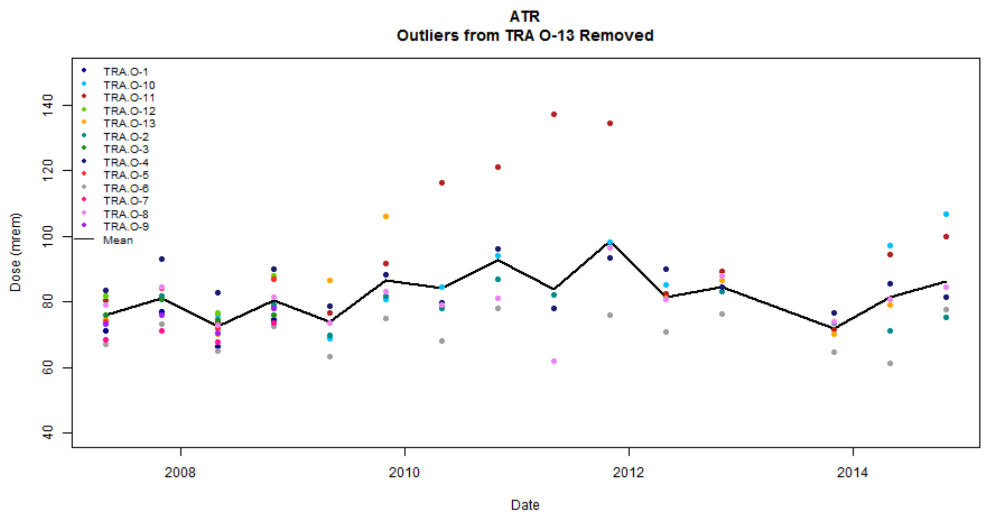
Figure B-1 shows the data from TRA. It can be seen that four measurements obtained from location TRA O-13 are significantly larger than the other data points. Once these four points were removed from the data set, it can be seen that four points from location TRA O-11 are also notably larger than the other doses. Thus, they were also removed from the UTL computations to ensure that the background level is not biased high.

Figure B-2 shows the data from INTEC. The doses measured at location ICPP O-20 in 2007 are much higher than any other doses observed in the data set. The measurements obtained from locations ICPP O-22 and ICPP O-25 in November 2007 are also unusually high. These four values were removed from UTL calculations to ensure that the background level is representative of current dose levels at INTEC.

Figure B-3 shows the data from RWMC. It can be seen that many of the locations had doses in 2007 and 2008 that are much higher than those seen near the facility since that time. Therefore, the UTLs were computed using the data from 2009 to 2014 to ensure that the background values are not biased by doses that are much different than those currently seen at RWMC. When the data from 2009 to 2014 is examined, it is apparent that doses at location RWMC O-41 are markedly higher than the doses measured at the other locations. It was determined that the data obtained from location RWMC O-41 would not be used to compute the UTL for RWMC. However, the doses obtained from RWMC O-41 would consistently exceed the UTL. This may result in data users disregarding high dose measurements from this location because of regular exceedances, which could result in the monitoring program failing to recognize a dose from this location that may indicate a release. Therefore, a UTL was developed for this location to ensure that doses measured at RWMC O-41 can be compared to a background level appropriate to that specific location.

The UTLs for each of the areas are listed in Table B-1. The table also lists how many points were used to compute the background level for that area. If sufficient data were not available to compute a UTL, it is noted on the table along with the number of doses currently available for that area. Summary statistics and the distribution of the data are also listed in the table.





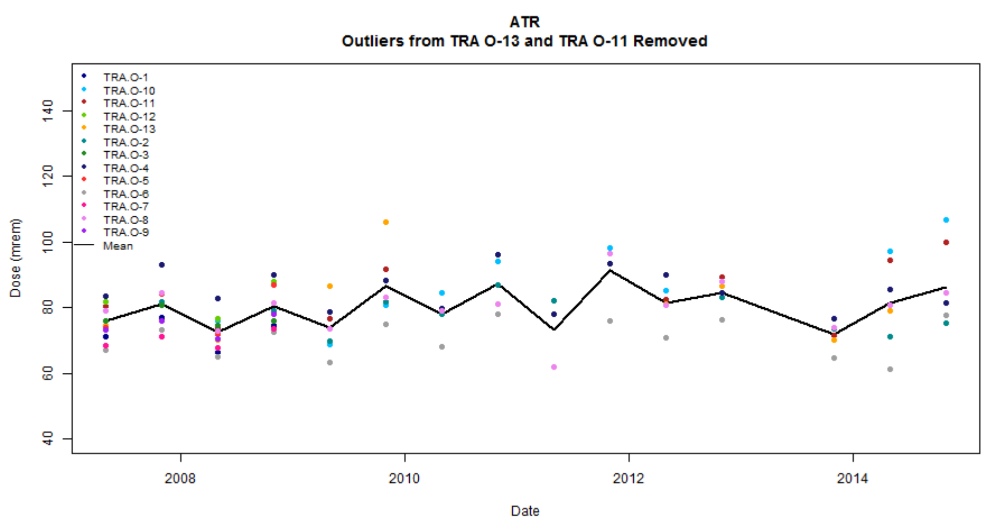
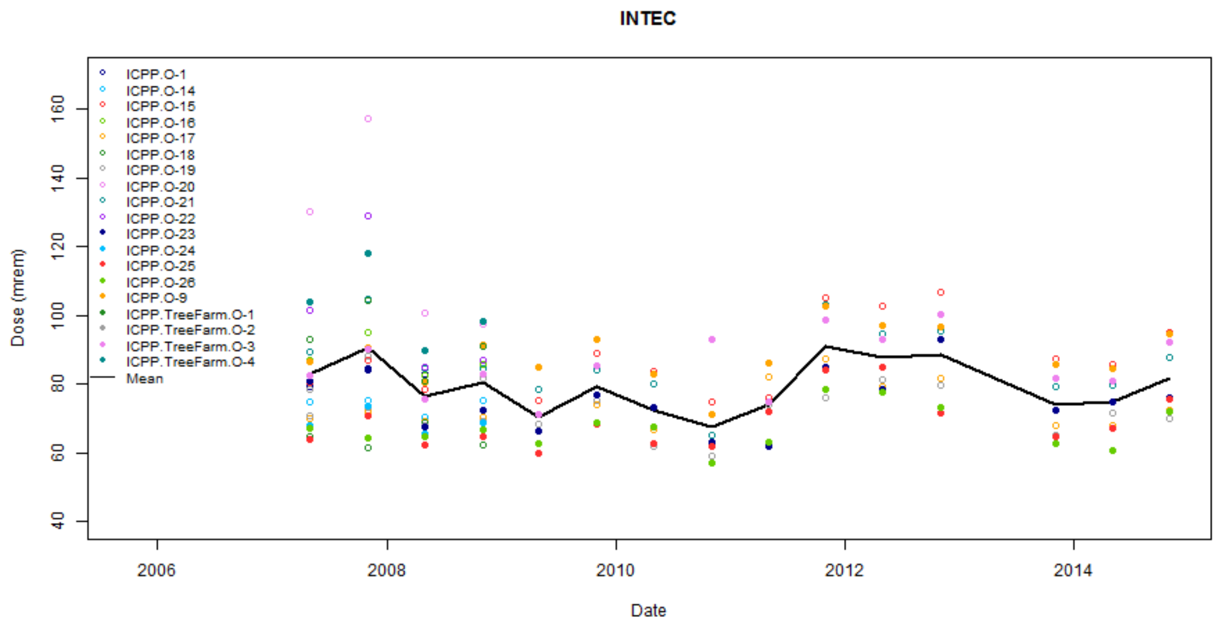


Figure B-1. Time plots for ATR data from 2007 to 2014.



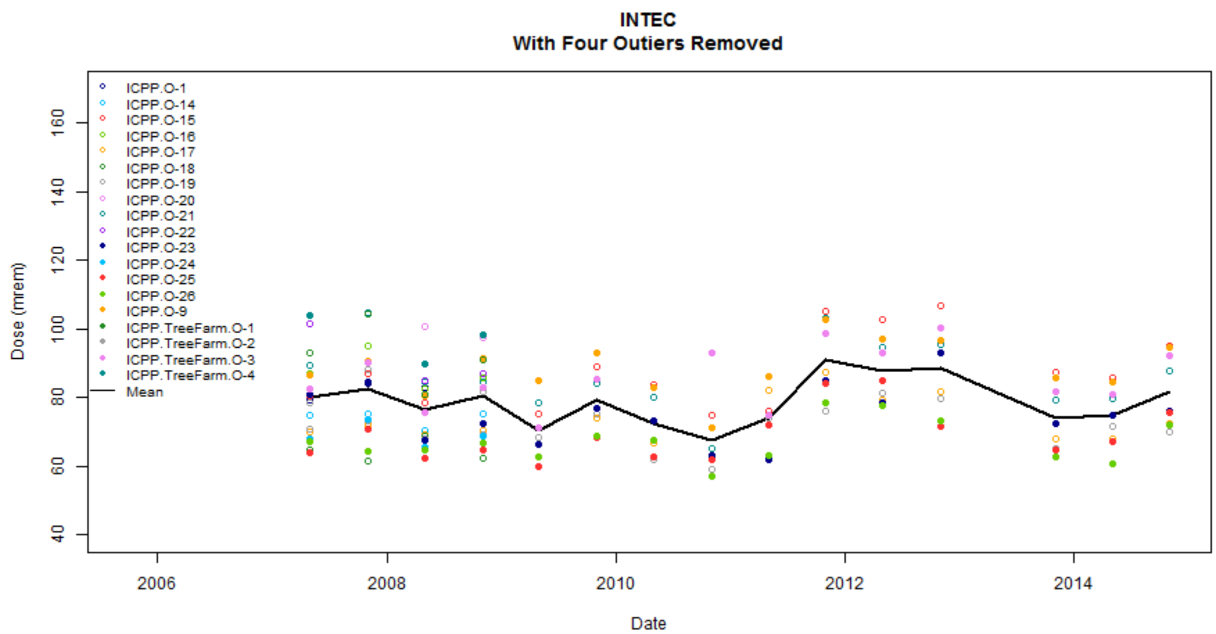


Figure B-2. Time plots for INTEC data from 2007 to 2014.

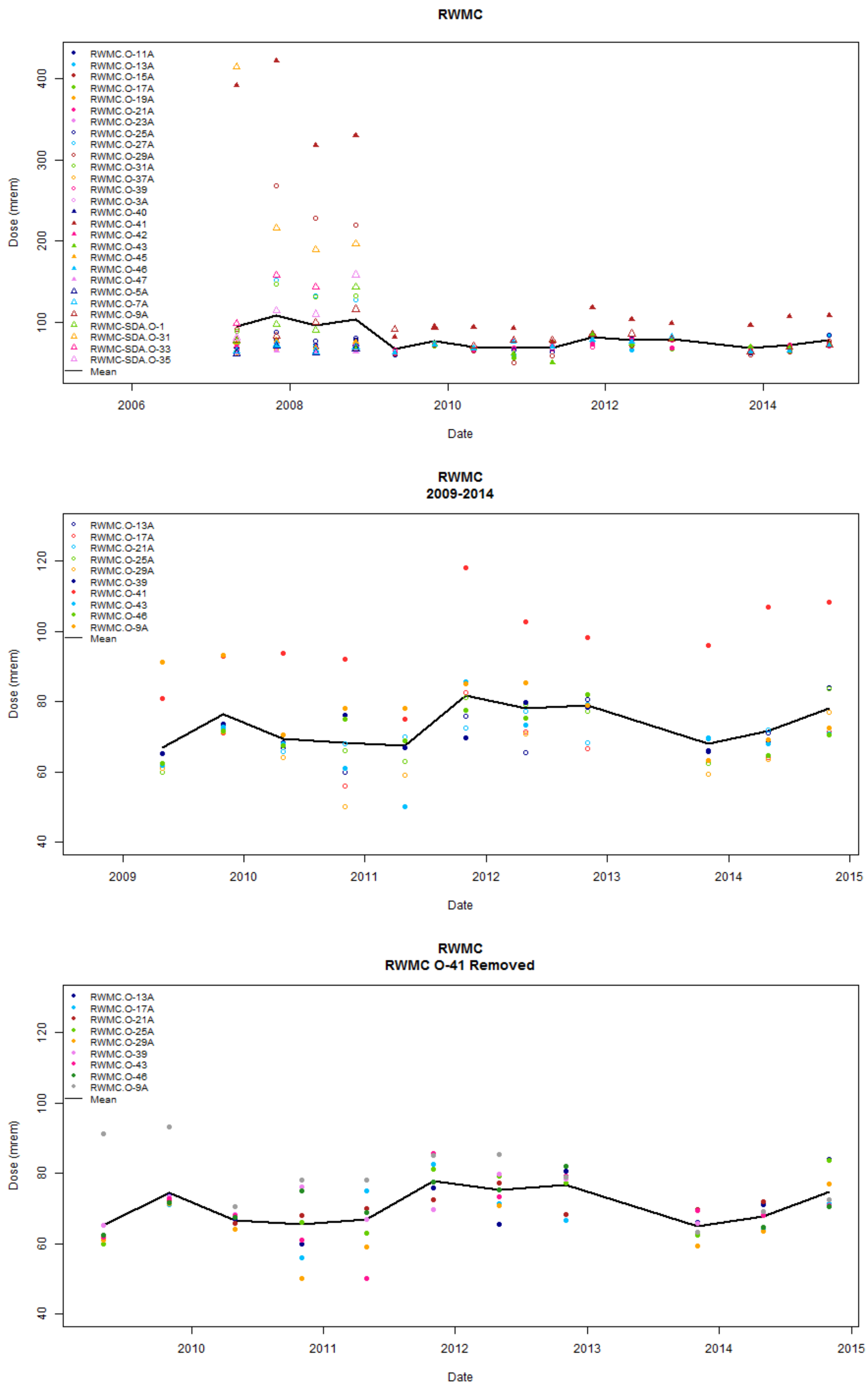


Figure B-3. Time plots for RWMC data from 2007 to 2014.

Table B-1. Background levels for dosimetry monitoring program by area.

Area	N	Mean	Standard Deviation	Background Level (UTL)	Distribution
Within Site Boundaries		(mrem)	(mrem)	(mrem)	
ARA	18	67.59	5.983	85.40	Non-Parametric
ATR	136	78.72	8.94	95.53	Normal
CFA	42	61.51	6.37	80.91	Normal
EBR I	15	60.75	3.134	68.79	Normal
EFS O-1	2	N/A[a]	N/A[a]	N/A[a]	N/A[a]
Haul E	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]
Haul W	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]
Highway 20	48	64.59	4.804	74.53	Normal
Highway 22	4	N/A[a]	N/A[a]	N/A[a]	N/A[a]
Highway 28	5	N/A[a]	N/A[a]	N/A[a]	N/A[a]
Highway 33	5	N/A[a]	N/A[a]	N/A[a]	N/A[a]
INTEC	170	78.95	11.79	102.0	Gamma
Lincoln	92	70.1	6.096	81.91	Normal
MFC	121	67.29	6.925	80.42	Normal
NRF	101	70.16	5.746	81.20	Normal
PBF	63	67.57	4.742	77.08	Normal
RWMC	99	70.54	7.917	85.78	Normal
RWMC O-41	11	96.82	12.24	131.3	Normal
SMC	137	77.24	29.31	137.0	Non-Parametric
TREAT	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]
IF-603 (IRC)	8	53.15	3.376	63.90	Normal
IF-627 (SAF)	5	N/A[a]	N/A[a]	N/A[a]	N/A[a]
IF-638 (IRC Physics)	8	55.57	3.908	68.02	Normal
IF-675 (PINS)	17	55.13	4.187	65.54	Normal
IF-616 (WCB)	1	N/A[a]	N/A[a]	N/A[a]	N/A[a]
IF-665 (CAES)	1	N/A[a]	N/A[a]	N/A[a]	N/A[a]
IF-670 (BCTC)	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]

Table B-1. (continued).

Area	N	Mean	Standard Deviation	Background Level (UTL)	Distribution
IF-IDA	1	N/A[a]	N/A[a]	N/A[a]	N/A[a]
IF-IRC	1	N/A[a]	N/A[a]	N/A[a]	N/A[a]
Site Perimeter		(mR)	(mR)	(mR)	
Arco	16	61.83	3.842	71.53	Normal
Atomic City	16	63.69	3.093	71.50	Normal
Birch Creek Hydro[b]	15	56.01	2.639	61.00	Non-Parametric
Blue Dome	16	53.19	1.987	58.21	Normal
Howe	16	59.22	3.013	66.82	Normal
Monteview	16	58.74	2.775	65.74	Normal
Mud Lake	16	66.31	3.464	75.05	Normal
RRL3 Frenchman's Cabin	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]
RRL5 East Butte	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]
RRL6 Grant Road	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]
RRL17 Monteview	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]
RRL24 Howe	0	N/A[a]	N/A[a]	N/A[a]	N/A[a]
Outside of Site Boundaries		(mR)	(mR)	(mR)	
Aberdeen	16	64.45	2.083	69.71	Normal
Blackfoot	16	55.86	2.359	61.81	Normal
Craters of the Moon	16	60.28	3.676	69.55	Normal
Dubois	16	52.08	2.484	58.35	Normal
Idaho Falls	16	61.96	2.591	68.50	Normal
Jackson	16	50.71	2.122	56.06	Normal
Minidoka[c]	16	57.08	2.693	63.87	Normal
Roberts	15	68.19	5.254	83.90	Non-Parametric
Sugar City	2	N/A[a]	N/A[a]	N/A[a]	N/A[a]

a. Sufficient data are not yet available to compute a background value.
b. Site also known as Reno Ranch
c. Site is also referred to the Idaho Youth Ranch

B-2. TREND ANALYSIS

A trend analysis will also be done for each area so that the natural variation of that area over time is known. This analysis provides context for the program to determine if doses measured during a sampling event are within the natural variation for that area or if doses obtained from a sampling event indicate something unusual may be happening. Shewhart control charts are an appropriate statistical tool for establishing limits on the trend of individual values, the mean, and the standard deviation to determine if the current data set is consistent with historical trends (Gilbert 1987). Control charts were initially developed in manufacturing for quality control purposes. However, they are well suited to other types of monitoring programs and have been adopted as a fundamental tool for environmental surveillance and compliance monitoring programs (EPA 2009). The type of control limit that is computed is dependent on the nature of the data that are obtained from an area. If more than two dosimeters are present in an area, x-bar and s-charts are used to examine trends. If one or two dosimeters are present in an area, a Shewhart control chart designed for individual data points is used. The next two subsections address the methodology and use of the types of control charts used in the dosimetry monitoring program. The third subsection addresses the computation of control limits using historical data for the program and how they are to be used.

B-2.1 Control Charts for Areas with Three or More Dosimeters

Areas with two or more dosimeters will use x-bar and s-charts to establish a historical trend for the area. The x-bar chart plots show the trend of the mean dose for each of the sampling events. The control limits will alert the program to mean doses that may be outside of the normal range for that area. The s-chart tracks the trend of variability seen at an area. An unusual increase or decrease in variability during a sampling event can indicate that something unusual occurred even if the mean dose appears to be within the acceptable limits.

The x-bar chart is developed by determining the mean for all of the data that are to be used in establishing the trend and then using the mean and variability to determine limits of what is considered to be a normal sample mean for an event. The limits are dependent on the number of doses that are measured in an area. The upper control limit (UCL) and the lower control limit (LCL) are computed using the following formulae:

$$LCL = \bar{\bar{X}} - \frac{3\hat{\sigma}}{\sqrt{n}}$$

$$UCL = \bar{\bar{X}} + \frac{3\hat{\sigma}}{\sqrt{n}}$$

where

$\bar{\bar{X}}$ = the mean of the sample means from each sampling event

$\hat{\sigma}$ = process standard deviation

n = the number of doses measured during each sampling event.

The centerline for the control charts is $\bar{\bar{X}}$. It is the mean of all of the means from each of the k sampling events and is computed using the formula:

$$\bar{\bar{X}} = \frac{1}{k}\sum_{i=1}^{k}\bar{X}_i$$

The process standard deviation, $\hat{\sigma}$, is computed using the mean of the standard deviations for each of the *k* sampling event and a factor called *c(n)*. The factor c(n) is dependent on the number of doses measured during each sampling, *n*, event and can be found in *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987).The quantity $\hat{\sigma}$, is computed using the formulae:

$$\hat{\sigma} = \bar{S} / c(n)$$

$$\bar{S} = \frac{1}{k}\sum_{i=1}^{k} S_i$$

S-charts are used to determine the trend of variability of doses in the area. If the standard deviation of the doses for a sampling event is unusually large or small it can indicate that something unusual occurred during that event. The LCL and the UCL for the s-chart are computed using the formulae:

$$LCL = \bar{S} - 3\hat{\sigma}_s$$

$$UCL = \bar{S} + 3\hat{\sigma}_s$$

where

$\bar{S}$ = mean of the standard deviations for each sampling event

$\hat{\sigma}_s$ = estimate of the standard deviation of S

The estimate of the standard deviation of S, $\hat{\sigma}_s$, is computed using the formula:

$$\hat{\sigma}_s = \frac{\bar{S}}{c(n)\sqrt{2(n-1)}}$$

Both types of control charts are used in a similar manner. The LCL and UCL are drawn on the graph along with the centerline as reference lines. The sample means for each of the sampling events, $\bar{X}_i$, are plotted on the x-bar chart and the individual standard deviations for each of the sampling events, S_i, are plotted on the s-chart. If any of the individual means or standard deviations exceeds the LCL or UCL for their respective charts, it indicates that the mean or standard deviation for that sampling event is not within the historical trend.

The run length is also important for these charts. The run length is the number of points in a row that are above (or below) the centerline. Too many points in a row on the same side of the centerline indicate that the process is not random and an outside source may be influencing the dose measurements. The number of points on the same side of the centerline indicates that a non-random process varies depending on the number of dose measurements obtained from an area. However, a good rule of thumb is a run of seven or more points in a row above (or below) the centerline indicates a non-random process. Another indication of a non-random process is six or more consecutive points increasing or decreasing (Kenet, et al. 1998).

B-2.2 Control Charts for Areas with One or Two Dosimeters

Areas that have one or two dosimeters for monitoring will be assessed using a Shewhart control chart designed for assessing individual data points. A summary of these types of control charts can be found in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance* (EPA 2009). An LCL and UCL are computed for the control chart as is done with the charts in the previous subsection. However, the individual values are plotted on the chart rather than the mean or standard deviation. The LCL and UCL for these charts are computed using the formulae:

$$LCL = \bar{X} - h \cdot s$$

$$UCL = \bar{X} + h \cdot s$$

where

$\bar{X}$ = mean of all of the data values used to establish the control limits

h = decision internal value. A value of 5 was selected (EPA 2009)

s = standard deviation of all of the doses used to establish the control limits.

The LCL and UCL for this type of chart assume that the data are normally distributed. This is true for most of the areas, but it is not true for all of the areas and it may not always be true when control limits are recalculated in the future. When the data are not normally distributed an alternative control limit can be established. In the case of this monitoring effort, the maximum observed dose obtained during the time period will be used as the UCL, and the minimum dose will be used as the LCL. If the data set contains one or more outlier during that time interval, the largest non-outlier will not be used to establish the UCL.

As with x-bar and s-charts, too many points above (or below) the centerline can indicate that the process is non-random and thus some outside force may be affecting the dose measurements. The same rules mentioned in the previous subsection apply to these charts as well. However, because these charts plot single measurements rather than means or standard deviations, longer runs are more likely to occur than with the x-bar and s-charts.

B-2.3 Trend Limits for Dosimetry Monitoring

Historical data obtained from the dosimetry monitoring program from 2007 to 2014 were used to establish the trend limits for each of the areas included in the monitoring program. Trend limits were established for areas that had a minimum of five sampling events if more than two dosimeters are in that area, and for eight sampling events if one or two dosimeters are monitoring the area. Tables B-2 and B-3 list the trend limits for each of the areas. Areas that have insufficient data to construct a control limit at the time that these DQOs were written will have trend limits computed when sufficient data are available. The trend limits for all areas will be reassessed every 5 years to ensure that they remain relevant to current conditions.

The data for each of the areas was examined to ensure that outliers were removed and that the data meet the distributional requirements for the type of control limits that are used. The graphs in Figures B-1, B-2, and B-3 are applicable to the control limit calculations as well as the UTLs. Thus, the same data sets that were used to compute the UTLs for ATR, INTEC, and RWMC were used for the control charts. This means that sampling location RWMC O-41 has its own control chart separate from the other RWMC data, and doses measured from that location should not be used to compute means or standard deviations on the main RWMC trend charts. No other outliers were observed in the data. The data from ARA, Roberts, and Birch Creek Hydro are not normally distributed. Thus, the minimum and maximum observed doses for each of those areas are used as the LCL and UCL, respectively. Figure B-4 shows the control charts for RWMC and RWMC O-41 to demonstrate how they are constructed and used.

It is important to note that the trend limits are based on 6-month dose readings. If a dose measurement spans a time frame that is different than 6 months, the dose must be adjusted to reflect a 6-month equivalent. For example, the doses measured within the Site boundaries during the November 2013 sampling event were dose measurements for 1 year. Thus, the one-half of the measurement was used for calculations. It is also important to note that the sites did not have the same number of dosimeters every year. The trend limits listed in Table B-2 were computed using the number of dosimeters that will be located at the areas beginning in 2015. Therefore, control charts appear to show sampling events with unusually high doses for sampling events prior to 2015. This is not because the doses were actually high during that time, but rather because fewer dose measurements were obtained for that sampling event. The data user is cautioned to only consider means and standard deviations obtained in 2015 and later when determining if a mean or standard deviation is unusual.

Table B-2. Trend limits for areas with more than two dosimeters. Limits are compared to the mean dose for the sampling event and to the standard deviation for the sampling event.

Area	Number of Sampling Locations in Area	Lower Trend Limit for the Mean (mrem)	Upper Trend Limit for the Mean (mrem)	Lower Trend Limit for the Standard Deviation (mrem)	Upper Trend Limit for the Standard Deviation (mrem)
ANLW	15	62.5	72.1	2.51	9.54
ICPP	17	71.3	86.6	4.63	15.72
Highway 20	6	40.57[a,b]	88.61b	N/A[b]	N/A[b]
Lincoln	6	63.99	76.21	0.01	9.48
NRF	9	66.26	74.06	0.86	6.70
RWMC	16	65.93	75.15	2.68	9.41
TAN	8	59.89	94.59	2.67	28.89
TRA	21	73.7	83.7	3.79	11.00
TREAT	8	N/A[b]	N/A[b]	N/A[b]	N/A[b]
IF-603 (IRC)	4	36.27[a,b]	70.03[a,b]	N/A[b]	N/A[b]
IF-638 (Physics)	4	36.03[a,b]	75.11a,b	N/A[b]	N/A[b]
IF-670 (BCTC)	5	N/A[b]	N/Aa	N/A[b]	N/A[b]
IF-675 (PINS)	4	34.20[a,b]	76.07a,b	N/A[b]	N/A[b]

a. Insufficient data were available for computing x-bar and s-charts. The Shewhart control chart limits for individual values were used to provide trend limits until sufficient data are available to compute the appropriate limits. The individual doses should be plotted against these limits, not the sample means.
b. Sufficient data are not available to compute the appropriate limits. Limits will be computed once a sufficient amount of data is collected for the area.

Table B-3. Trend limits for areas with one or two dosimeters. Limits are compared to individual values.

Area	Number of Sampling Locations in Area	Lower Trend Limit	Upper Trend Limit
Within Site Boundaries		(mrem)	(mrem)
ARA	1	59.00[a]	85.40[a]
CFA	2	29.66	93.36
EBR I	1	45.08	76.42
EFS	1	N/A[b]	N/A[b]
Haul E	1	N/A[b]	N/A[b]
Haul W	1	N/A[b]	N/A[b]
Highway 22	1	N/A[b]	N/A[b]
Highway 28	1	N/A[b]	N/A[b]
Highway 33	1	N/A[b]	N/A[b]
PBF	1	43.86	91.28
RWMC O-41	1	35.62	158.02
IF-IDA (NOAA Station)	1	N/A[b]	N/A[b]
IF-616 (WCB)	1	N/A[b]	N/A[b]
IF-627 (SAF)	1	N/A[b]	N/A[b]
IF-665 (CAES)	1	N/A[b]	N/A[b]
IF-IRC	1	N/A[b]	N/A[b]
Site Perimeter		*(mR)	(mR)
Arco	1	42.62	81.04
Atomic City	1	48.23	79.16
Birch Creek Hydro[c]	1	53.50	61.00
Blue Dome	1	43.26	63.13
Howe	1	44.16	74.29
Monteview	1	44.87	72.62
Mud Lake	1	48.99	83.63
RRL3 Frenchman's Cabin	1	N/A[b]	N/A[b]
RRL5 East Butte	1	N/A[b]	N/A[b]
RRL6 Grant Road	1	N/A[b]	N/A[b]
RRL17 Monteview	1	N/A[b]	N/A[b]
RRL24 Howe	1	N/A[b]	N/A[b]
Outside of Site Boundaries		(mR)	(mR)
Aberdeen	1	54.04	74.87
Blackfoot	1	44.07	67.66
Craters of the Moon	1	41.90	78.66
Dubois	1	39.66	64.50
Idaho Falls	1	49.01	74.92
Jackson	1	40.10	61.32
Minidoka[d]	1	43.62	70.55
Roberts	1	60.90[a]	83.90[a]
Sugar City	1	N/A[b]	N/A[b]

a. Minimum and maximum values were used as trend limits.
b. Sufficient data are not available to compute the appropriate limits. Limits will be computed once a sufficient amount of data is collected for the area.
c. Site also known as Reno Ranch
d. Site is also referred to the Idaho Youth Ranch

Figure B-4 shows how control charts are used by displaying the current control charts for RWMC. It should be noted that the control limits are slightly different than those in Table B-2 because the means and standard deviations in the chart were computed using nine data points instead of the 16 data points that will be used in future sampling events. The LCL and UCL for the x-bar and s-charts are dependent on the number of doses measured during each sampling event, so this adjustment was necessary to ensure the charts can be interpreted correctly for this demonstration. It can be seen that the November 2011 sampling event has a mean that is slightly outside of the control limits. This warrants some investigation, but it is sufficiently close to the UCL to indicate the increase in dose is not worrisome. The s-chart indicates that the standard deviation is within the normal trend. The Shewhart control chart for location RWMC O-41 shows that none of the doses measured at that location are unusually high.

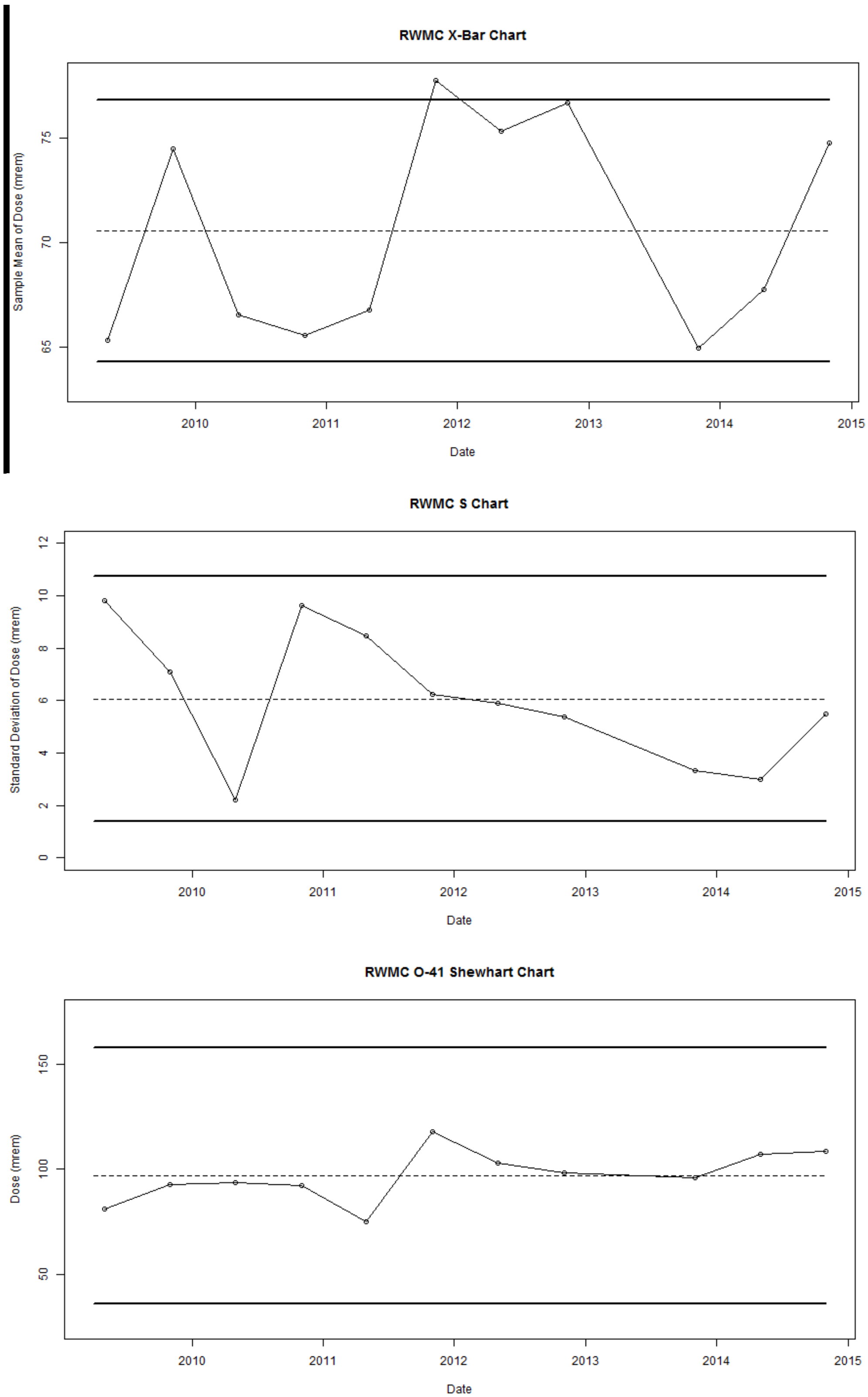


Figure B-4 Control charts for RWMC.

Appendix C

Data Used for Decision Limits

Tables C-1 and C-2 contain the dosimetry measurements that were used in the decision limit analysis. The values in Table C-1 prior to November 2010 are from TLDs in units of mR and the values beginning with November 2010 are primarily from OSLDs in units of mrem. Given the small difference resulting from conversion (1.03 mrem/mR) is within the measurement uncertainty, no conversions were applied. The values in Table C-2 are primarily from TLDs in units of mR. Some OSLDs in units of mrem are used where they are the only measurement collected.

Table C-1. Doses from within Site boundaries from 2007 to 2014.

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
MFC	ANL W EBR II O-12	52.4	54.8	56.3	55.6	64.6	56.9	56.8	53	—	73.6	61.3	65.8	—	108.5	55.6	61.2
MFC	ANL W EBR II O-13	63.4	67.4	63.6	66.5	55.2	70.2	64.9	65	68	80.7	68.7	69.8	—	129.1	64.9	73
MFC	ANL W EBR II O-14	58.9	64	59.4	63.2	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-15	65.4	68.2	63.8	67.1	61.8	72.4	66.4	74	65	75.9	—	78.5	—	149.7	78	—
MFC	ANL W EBR II O-16	71.9	73.4	66.1	71.6	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-17	60	65.6	59.5	65.6	57.3	68.8	61.8	57	69	70.3	70.3	69.9	—	122.4	65	66.5
MFC	ANL W EBR II O-18	70.5	72.6	67	71	65.3	70.7	65.1	64	53	76.9	74.4	75.9	—	126.4	64.6	69.3
MFC	ANL W EBR II O-19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W EBR II O-7	65.2	72	66.4	70.7	65.2	73.8	68.9	67	54	81.9	75.6	77.2	—	132.5	64.9	74
MFC	ANL W EBR II O-8	59.9	64.6	63	64	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W TREAT O-10	64.8	68	64	66.5	—	—	—	—	—	—	—	—	—	—	—	—

Table C-1. (continued).

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
MFC	ANL W TREAT O-11	68.8	69.1	65	69.9	—	—	—	—	—	—	—	—	—	—	—	—
MFC	ANL W TREAT O-9	71.4	73.1	67.6	—	63.7	78.6	76.4	81	71	85.6	79.5	82	—	147.7	73.8	74.8
TREAT	TREAT O-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TREAT	TREAT O-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TREAT	TREAT O-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TREAT	TREAT O-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TREAT	TREAT O-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TREAT	TREAT O-6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TREAT	TREAT O-7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TREAT	TREAT O-8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ARA	ARA I&II O-1	67.6	69.6	67.2	67.3	64.2	71.3	65.4	78	59	85.4	67.1	—	—	125.9	61.6	67.3
ARA	ARA I&II O-2	65.4	66.4	64.5	66.4	—	—	—	—	—	—	—	—	—	—	—	—
ARA	ARA I&II O-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ARA	ARA I&II O-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CFA	CFA O-1	67	69.4	66.2	68.7	63.9	71.1	68.1	56	62	78.6	74.2	76.1	—	133.4	71.8	77.8
CFA	CFA O-2	59.1	53.9	61.7	60	—	—	—	—	—	—	—	—	—	—	—	—
CFA	CFA O-3	69.1	72.1	66.2	71.7	—	—	—	—	—	—	—	—	—	—	—	—
CFA	CFA O-4	65.3	62.7	63.6	64.9	—	—	—	—	—	—	—	—	—	—	—	—
CFA	Lincoln Blvd O-1	65.1	69.7	66.5	68.3	63.6	70.5	66.4	58	76	82.7	78.9	72.8	—	127.8	60.2	64.9
EBR-1	EBR I O-1	59	60.7	62.2	59.3	58.8	64.3	59.2	63	62	66.9	61.6	62.4	—	111	54.8	61.5
EFS	EFS O-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	63.3	66.4
HAUL E	HAUL E O-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
HAUL W	HAUL W O-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Highway 20	Hwy 20 Mile O-264	63.1	67.9	65.1	69.7	—	—	—	—	—	—	—	—	—	—	—	—
Highway 20	Hwy 20 Mile O-266	60	62.8	60.2	63.5	—	—	—	—	—	—	—	—	—	—	—	—
Highway 20	Hwy 20 Mile O-268	63.2	68	61.5	68.5	—	—	—	—	—	—	—	—	—	—	—	—
Highway 20	Hwy 20 Mile O-270	64.6	72	63.3	68.3	—	—	—	—	—	—	—	—	—	—	—	—

Table C-1. (continued).

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
Highway 20	Hwy 20 Mile O-272	58.2	66.4	58.8	63.3	—	—	—	—	—	—	—	—	—	—	—	—
Highway 20	Hwy 20 Mile O-274	53	60.5	53.3	59.1	—	—	—	—	—	—	—	—	—	—	—	—
Highway 20	Hwy 20 Mile O-276	62.9	67.1	58.4	67.9	57	67.9	63.1	61	61	76.4	64.7	66.6	—	122	59.8	62.7
Highway 20	Van B O-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	63.5	68.5
Highway 20	Main Gate O-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	70.3	67.4
Highway 20	REST O-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Highway 22	Hwy 22 T28 O-1	—	—	—	—	—	—	—	—	—	—	—	59.7	—	100.9	57.1	56.8
Highway 28	Hwy 28 N2300 O-2	—	—	—	—	—	—	—	—	—	—	52.6	62.2	—	101.1	53.6	51.6
Highway 33	Hwy 33 T17 O-3	—	—	—	—	—	—	—	—	—	—	60	66.2	—	106.9	58.4	59.9
INTEC	ICPP O-1	79.1	84.2	82.9	90.8	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-14	75	75.2	70.3	75.1	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-15	80.4	87	78.3	87.1	75.4	88.8	83.6	75	76	105.3	102.5	106.8	—	174.6	85.8	95.1
INTEC	ICPP O-16	86.9	94.9	82.5	85.8	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-17	70	71.8	69.1	70.3	66.4	74	66.9	62	82	87.3	79.1	81.6	—	135.8	67.9	72.4
INTEC	ICPP O-18	64.7	61.4	68.8	62.4	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-19	70.9	73.4	67.8	69.1	68.4	75.2	61.9	59	74	76	81.2	79.6	—	130	71.7	69.8
INTEC	ICPP O-20	130.1	157.1	100.6	97.6	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-21	89.3	104.6	84.4	84.7	78.4	84.1	80.1	65	75	103.3	94.8	95.5	—	158.7	79.7	87.9
INTEC	ICPP O-22	101.6	129	85.1	87.1	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-23	80.7	84.5	67.7	72.4	66.3	76.7	73.3	63	62	84.8	78.3	93.1	—	144.9	74.9	75.9
INTEC	ICPP O-24	67.8	73.6	65.5	68.8	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-25	64.1	70.6	62.2	64.8	59.9	68.3	62.9	62	72	84	85.1	71.5	—	129.6	67.1	75.5
INTEC	ICPP O-26	67.2	64.3	64.9	66.6	62.8	68.8	67.6	57	63	78.5	77.8	73.1	—	125.2	60.6	72
INTEC	ICPP O-27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP O-9	86.5	90.4	80.6	91.3	85	92.8	82.8	71	86	102.6	97	96.6	—	171.4	84.6	94.8

Table C-1. (continued).

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
INTEC	ICPP Tree Farm O-1	92.8	104.3	80.9	91.1	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP Tree Farm O-2	78.4	88	75.8	81.5	—	—	—	—	—	—	—	—	—	—	—	—
INTEC	ICPP Tree Farm O-3	82.5	90.2	75.7	83	71	85.3		93	75	98.8	93	100.3	—	163.6	80.7	92.1
INTEC	ICPP Tree Farm O-4	103.8	118.1	89.6	98.1	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	GATE-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-11	69.2	71.3	64.4	70.1	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-13	71.1	70.5	66.2	74	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-15	72.1	71.5	67.9	72.7	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-17	70.2	73.7	67.3	74.8	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-19	67.1	65.9	65	67	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-21	61.4	65.2	63.3	66.5	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-23	64.1	63.4	65.6	66.7	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-25	67.1	67	64.2	68.3	62.4	70.2	64.3	55	52	76	75.6	64	—	126.7	69.4	63
Lincoln Blvd	Lincoln Blvd O-3	75	77.3	70.6	74.5	66.8	77	71.3	72	73	84.9	87	80.6	—	134.9	71.4	77.9
Lincoln Blvd	Lincoln Blvd O-5	71.9	75.6	67.5	75.9	64.2	73.7	68.2	81	68	81.8	80.5	82.1	—	136.4	69	71.1
Lincoln Blvd	Lincoln Blvd O-7	70.7	73.8	67.2	73.4	—	—	—	—	—	—	—	—	—	—	—	—
Lincoln Blvd	Lincoln Blvd O-9	71.2	73.8	66.2	72.3	64.1	73.1	71.3	61	56	75.8	78.8	70.6	—	137.7	72.5	73.2
NRF	NRF O-11	67.1	72.4	67.6	70.3	—	—	—	—	—	—	—	—	—	—	—	—
NRF	NRF O-12	62.7	68.4	66.1	67.9	60.1	74	65.2	59	67	70.7	77.4	78.2	—	129.5	68.2	75
NRF	NRF O-13	65.3	72.6	66.6	69.1	—	—	—	—	—	—	—	—	—	—	—	—
NRF	NRF O-16	67.1	72.3	67.7	69	65.8	74.5	66.7	52	69	71.9	69.2	78.4	—	132.3	65.8	69.6
NRF	NRF O-17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NRF	NRF O-18	67.8	73.2	67.2	72.2	—	—	—	—	—	—	—	—	—	—	—	—
NRF	NRF O-19	69.1	73.5	70.9	72	65.9	79.5	69.7	73	54	87.6	79.7	—	—	133.3	69.4	74.1
NRF	NRF O-20	66.5	73.6	67.4	71.2	63.1	76	68.2	68	67	83.6	75.8	77.5	—	133.5	63.8	74.9
NRF	NRF O-21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NRF	NRF O-4	67.1	71.8	67.6	70	71.2	75.1	67.2	71	59	81.2	70.7	84.8	—	128.7	68.8	72.5

Table C-1. (continued).

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
NRF	NRF O-5	69.6	74.3	69.1	72.9	66.9	78.4	69.5	76	72	77	77.4	61.2	—	138.5	70.3	70.1
PBF	PBF SPERT O-1	63	67.7	66.8	83.1	62.8	68.7	65.4	70	67	79	72.3	62.9	—	129.3	58.5	66.4
PBF	PBF SPERT O-2	65.5	70.9	65.4	65.8	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF SPERT O-3	65.7	70.8	67	68.7	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF SPERT O-4	67.7	74	68	72.3	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF SPERT O-5	65.7	71.6	66.7	69.2	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF SPERT O-6	68.5	76	70.2	72.1	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF WERF O-1	64.3	71	68.9	68	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF WERF O-2	56.8	60.8	59.7	58.8	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF WERF O-3	62.1	68.8	63.6	67.6	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF WERF O-4	66.5	78	68.1	68.6	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF WERF O-5	64.9	70.9	65.6	67.3	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF WERF O-6	62.2	65.4	63.8	65.2	—	—	—	—	—	—	—	—	—	—	—	—
PBF	PBF WERF O-7	67.1	73.1	68.4	71.3	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-11A	68.4	77.2	71.7	77.6	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-13A	66.9	74.9	70.2	70.1	62.2	73.6	66.8	60	70	75.9	65.5	80.5	—	132.1	71.1	83.9
RWMC	RWMC O-15A	64.4	70.4	63.3	68.1	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-17A	64.7	73.5	64	70.2	62.3	71.1	64.1	56	75	82.5	71.5	66.6	—	131.4	64.2	71.3
RWMC	RWMC O-19A	62.1	67.1	61.9	66.2	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-21A	66.5	75.1	64.8	73.9	61.9	72	65.9	68	70	72.5	77.2	68.4	—	139.5	72	70.9
RWMC	RWMC O-23A	64.3	75	67	70.9	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-25A	66.2	87.2	76	79.7	60	71.4	64.2	66	63	81.2	79.2	77.3	—	124.7	68.4	83.7
RWMC	RWMC O-27A	73.1	151.9	132.4	127.3	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-29A	90.7	268.1	228.5	219.2	61	71.3	64	50	59	69.8	70.8	78.4	—	118.7	63.5	77
RWMC	RWMC O-31A	89.2	147.3	130.6	132.3	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-37A	62.5	66.5	61.7	66.9	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-39	67.2	72.6	67.3	71	65.3	73.3	68.2	76	67	69.7	79.7	78.4	—	131.4	68.8	72.4

Table C-1. (continued).

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
RWMC	RWMC O-3A	63.5	70.3	65	70.8	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-40	69.6	76.6	69.8	73.6	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-42	70.1	75.2	68.7	71.5	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-43	64	70.7	65.7	67.8	61.9	72.7	68.1	61	50	85.7	73.2	79.2	—	138.6	67.9	70.9
RWMC	RWMC O-45	74.5	77.2	68.2	75.4	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-46	61.8	70.6	65.7		62.3	71.7	67.4	75	69	77.5	75.2	82.1	—	126.7	64.8	70.5
RWMC	RWMC O-47	61.7	64.6	61.8	63.4	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-5A	61.4	70.2	62.5	67.3	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-7A	64.1	72.2	63.9	69.2	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC O-9A	77.6	82.3	99.2	116	91.3	93.2	70.4	78	78	85	85.5	78.9	—	126.7	69.1	72.4
RWMC	RWMC-SDA O-1	76.8	97.1	90	143.1	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC-SDA O-31	415.1	216.2	189.6	196.8	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC-SDA O-33	98.1	157.5	142.8	—	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC-SDA O-35	80.8	114.1	109.8	158.4	—	—	—	—	—	—	—	—	—	—	—	—
RWMC	RWMC-SDA O-37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RWMC O-41	RWMC O-41	391.8	421.6	317.9	329.5	81	92.8	93.8	92	75	118	102.8	98.2	—	192.2	106.9	108.4
SMC	TAN LOFT O-1	64	68.9	66.1	70.6	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-2	69	74.8	77.9	73.8	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-3	54.1	58.9	61	59	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-4	55.5	60.1	56.8	59	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-5	61.7	62	59.5	62.7	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-6	69.9	71.6	70	71.8	67.6	73.7	68.6	86	69	73.8	69.4	73.7	—	132.5	68.3	74.3
SMC	TAN LOFT O-7	70.3	72.2	70.1	73.9	68.6	73.7	70	74	58	79.9	76.7	77.7	—	135.8	72	64.7
SMC	TAN LOFT O-8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table C-1. (continued).

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
SMC	TAN LOFT O-12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN LOFT O-13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN TSF O-1	54.8	57.7	58.1	54.8	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN TSF O-2	65.5	70	69.1	69.6	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN TSF O-3	54	59.2	57.2	61.8	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN TSF O-4	62.5		63.7	76.4	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN WRRTF O-1	63.9	65.1	64.5	66.1	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN WRRTF O-2	61.6	63.3	59.9	62	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN WRRTF O-3	61.1	63.3	62	60.9	—	—	—	—	—	—	—	—	—	—	—	—
SMC	TAN WRRTF O-4	58.7	63.2	60.3	62.5	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-1	71.2	77	66.5	74.6	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-10	79	80.9	76	—	68.7	80.7	84.4	94	82	98.3	85.3	83.1	—	142.9	97	106.7
ATR	TRA O-11	80.5	84	73.9	87.1	76.5	91.6	116.2	121	137	134.4	82.5	89.3	—	143.2	94.4	99.9
ATR	TRA O-12	81.6	81.7	76.6	87.9	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-13	74.7	84.4	70.1	78.3	86.6	106.1	233	271	226	246	81.2	86.6	—	140.1	78.9	77.7
ATR	TRA O-2	79.2	81.8	72.5	79	69.7	81.7	78.1	87	82	93.3	80.6	83	—	147.2	71.2	75.4
ATR	TRA O-3	75.8	80.7	74.7	76.1	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-4	83.4	93	82.7	90	78.6	88.1	79.6	96	78	93.3	89.9	84.5	—	153.5	85.4	81.3
ATR	TRA O-5	73.8	84.3	72	86.9	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-6	67.2	73.3	65.1	72.6	63.3	74.8	68.2	78	62	76	70.7	76.3	—	129.5	61.4	77.6
ATR	TRA O-7	68.5	71.3	67.6	73.6	—	—		—	—	—	—	—	—	—	—	—
ATR	TRA O-8	79	84.5	72.9	81.5	73.5	83.3	78.9	81	62	96.4	80.6	87.8	—	147.9	80.8	84.4
ATR	TRA O-9	73.1	76.1	70.4	78	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table C-1. (continued).

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
ATR	TRA O-18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-24-O-25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATR	TRA O-26-O-28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IF-603	IF-603E O-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	49.5	53.7
IF-603	IF-603N O-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	52.46	57.3
IF-603	IF-603S O-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	51.4	52.1
IF-603	IF-603W O-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	49.8	58.9
IF-627	IF-627 O-30	—	—	—	—	—	—	—	—	—	—	57.1	61.7	—	101.9	49.91	55.4
IF-638	IF-638E O-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	49.42	52.7
IF-638	IF-638N O-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55.7	55.8
IF-638	IF-638S O-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	54.9	55.8
IF-638	IF-638W O-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	57	63.2
PINS	IF-675D O-33	—	—	—	—	—	—	—	—	—	—	—	58.5	—	99.5	49.69	54.3
PINS	IF-675E O-31	—	—	—	—	—	—	—	—	—	—	54.5	56.6	—	97.1	52.27	52.6
PINS	IF-675S O-34	—	—	—	—	—	—	—	—	—	—	—	62.9	—	110.9	56.96	56.2
PINS	IF-675W O-35	—	—	—	—	—	—	—	—	—	—	—	63.8	—	106.9	54.2	57.5
IF-616	IF-616N O-36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60
IF-665	IF-665W O-37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	56.3
IF-670	IF-670N O-31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IF-670	IF-670E O-32	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IF-670	IF-670S O-33	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IF-670	IF-670D O-34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table C-1. (continued).

Area	Sample Location	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013[a]	Nov 2013[1]	May 2014	Nov 2014
IF-670	IF-670W O-35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NOAA Station	IF-IDA O-38	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	56.3
IRC	IF-IRC O-39	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60.3

a. No data were collected during May 2013. The November 2013 measurements are one year doses. One half of the measurement was used for calculations.

Table C-2. Doses from the Site perimeter and outside of the Site boundaries from 2007 to 2014.

Area	May 2007	Nov 2007	May 2008	Nov 2008	May 2009	Nov 2009	May 2010	Nov 2010	May 2011	Nov 2011	May 2012	Nov 2012	May 2013	Nov 2013	May 2014	Nov 2014
Aberdeen	62.9	66.1	63.7	64.4	61.9	68.4	62.6	67.2	63.3	63	67.1	61.6	63.5	65.5	66.6	63.4
Arco	62.6	63.9	55.4	63.5	56.3	65	61.5	66.3	60.7	61.3	65.1	61.1	58.2	69.6	56.8	62
Atomic City	63.7	65.2	61.3	64.3	57.2	65.2	62.1	65.1	59.1	62.2	68.1	64.1	62.8	66.3	69.6	62.8
Birch Creek Hydro	57.1	53.5	55	55.1	53.6	58.6	—	54.5	54.8	53.9	59.5	53.7	54.5	60.6	61	54.7
Blackfoot	54.8	54	55.3	54.6	53.9	56.2	57.1	55.8	57.7	54.7	60.2	52.3	55.7	58.7	60	52.7
Blue Dome	52.4	51.6	51	54.5	52.8	54.4	52	52.8	52.9	52.4	56.1	50.5	52.4	56.7	57	51.6
Craters	58.9	61	55.3	60.6	54.7	65.3	56.3	65.1	57.2	61.6	62.4	59.8	55.7	65.2	64.6	60.7
Dubois	51.1	50	49.6	50.8	49.8	53.5	51.3	52.8	48.5	51.8	56	51.3	52	56.8	56.5	51.4
Howe	59.5	58.6	55.9	60.8	57.3	58.9	58.1	59.2	56.3	54.8	64.9	56.6	58.9	62.6	65.4	59.7
Idaho Falls	59.5	63.8	58.7	62.3	55.7	64.2	60.8	63.7	61.5	62.2	65.2	61.9	60	65.4	64.3	62.1
Jackson	48.9	47.8	51	50.7	49.6	52.5	51.7	50.4	50.9	50	55	47.2	50.4	53.3	53.4	48.5
Minidoka	53.9	55.3	53.8	55.6	52.8	58	56.3	58.2	59.1	56.8	60.1	54.8	61	59.8	61.5	56.2
Monteview	58.1	57.3	56	59.3	54.1	61.5	58.7	60.7	54.3	57.7	63.4	58.8	57.9	60.1	63.9	58
Mud Lake	64.5	63.1	62.7	65.5	59.7	70	66	67.8	68.2	65.3	72.8	65.4	64.7	69.2	71.8	64.2
Roberts	68.4	68.6	62.1	67.3	60.9	69	—	70.9	67.2	66.3	72.1	66.7	64.7	83.9	68.9	65.8
RRL3 Frenchman's Cabin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RRL5 East Butte	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RRL6 Grant Road	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RRL17 Monteview	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RRL24 Howe	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sugar City	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80.3	76