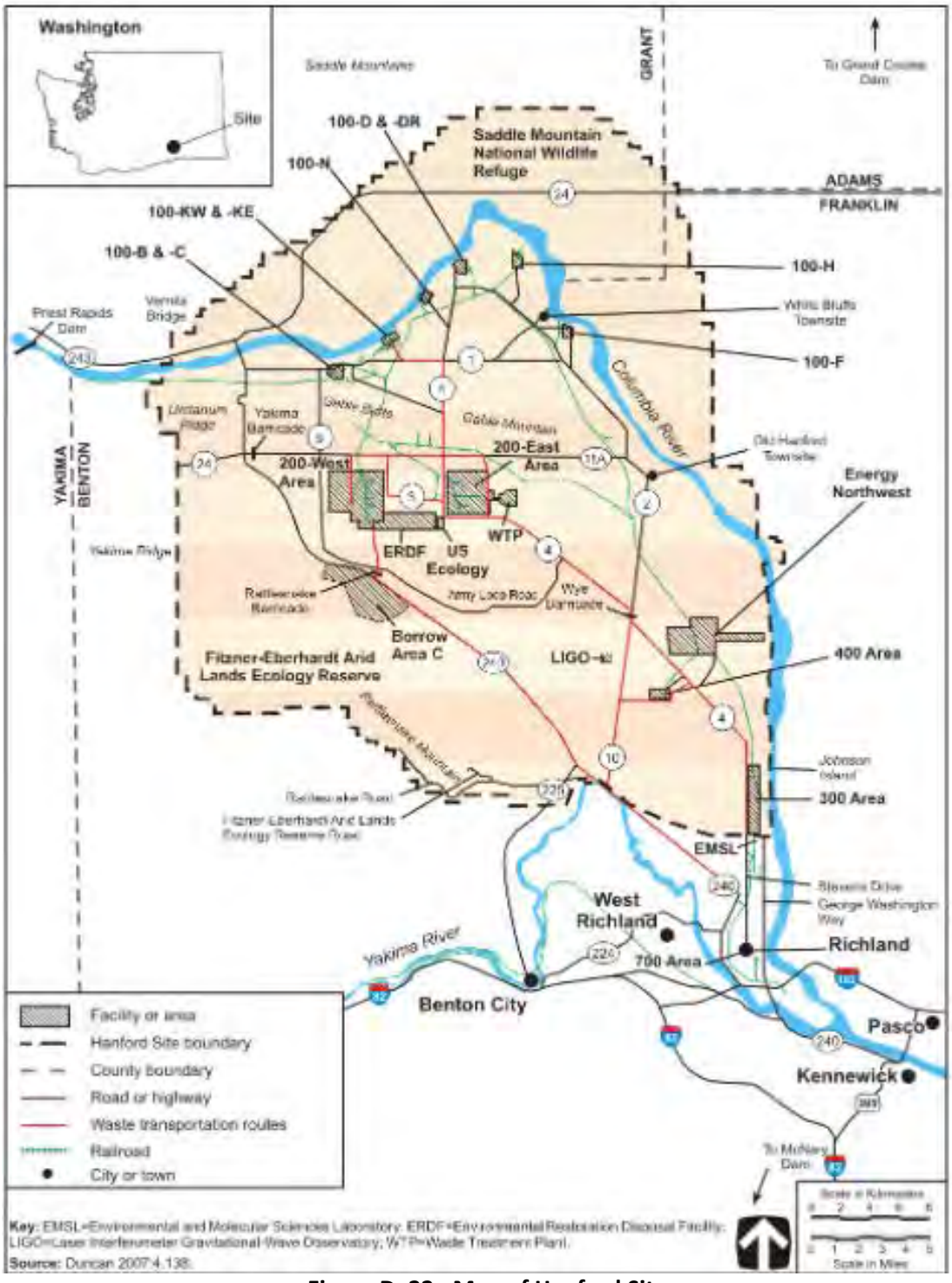

Figure D–32. Map of Hanford Site

(Source: EIS-0391, Volume 1[45])

[45]DOE (U.S. Department of Energy) 2012, *Final Environmental Impact Statement, Hanford Tank Closure and Waste Management, Hanford Site*, DOE-EIS-0391, Washington, DC, May, obtained from http://www.hanford.gov/page.cfm/FinalTCWMEIS.

Figure D–33. Google map of Hanford Plant

Map is approximately 13 miles E-W and 6.5 miles N-S.

D.13 Idaho National Laboratory

Surrounding population: Population within 5 miles of the Central Facilities Area (CFA) is zero, see **Figure D–34**. The population within 50 miles is approximately 330,000.[46] Data from the University of Missouri Census Data Center[47] confirm zero population within 5 miles, but assign only approximately 179,000 people within 50 miles.

Nearest centers of population:[48]

- Howe, ID (population approximately 220) approximately 16 miles N of CFA.
- Arco, ID/Butte City, ID (population approximately 1,000), approximately 20 miles WNW.
- Blackfoot, ID (population approximately 12,000), approximately 40 miles SE.
- Idaho Falls, ID (population approximately 57,000), approximately 50 miles E.

Nature of surroundings within 5 miles: See Figure D–34 and **Figure D–35**. Essentially unpopulated, no industrial activity except for the site itself.

Size of site: 890 square miles (approximately 570,000 acres) from https://energy.gov/em/idaho-national-laboratory. CFA is approximately 6 miles from the closest site boundary.

Most likely wind direction: Assuming the new pit production facility would be built in the general area of CFA, the predominant wind direction is from the southwest and so does not blow toward any of the population centers listed above. See **Figure D–36**.

Initial Subjective Assessment of Public External Individual and Societal Risk in the event that pit production is relocated to INL: Low because of large distances to population centers, sparse population within 5 miles of CFA, very large site, and predominant wind direction not toward population centers.

Policy Risk: Extreme remoteness and a large site should mitigate public concerns. However, INL is currently operating under a consent decree with the State of Idaho that may make it difficult to establish new activities that require bringing plutonium onsite. On balance, the policy risk is moderate.

[46] DOE (U.S. Department of Energy) 2013, *Draft Supplement Analysis for the Nuclear Infrastructure Programmatic Environmental Impact Statement for Pu-238 Production for Radioisotope Power Systems,* DOE/EIS-0310-SA-02, Washington DC, September, obtained from http://www.id.doe.gov/insideNEID/PDF/Pu-238_Supplement_Analysis.pdf.

[47] http://mcdc.missouri.edu/websas/caps10c.html.

[48] Distances estimated using Google Maps and Figure 2: populations mainly obtained from https://suburbanstats.org/population/.

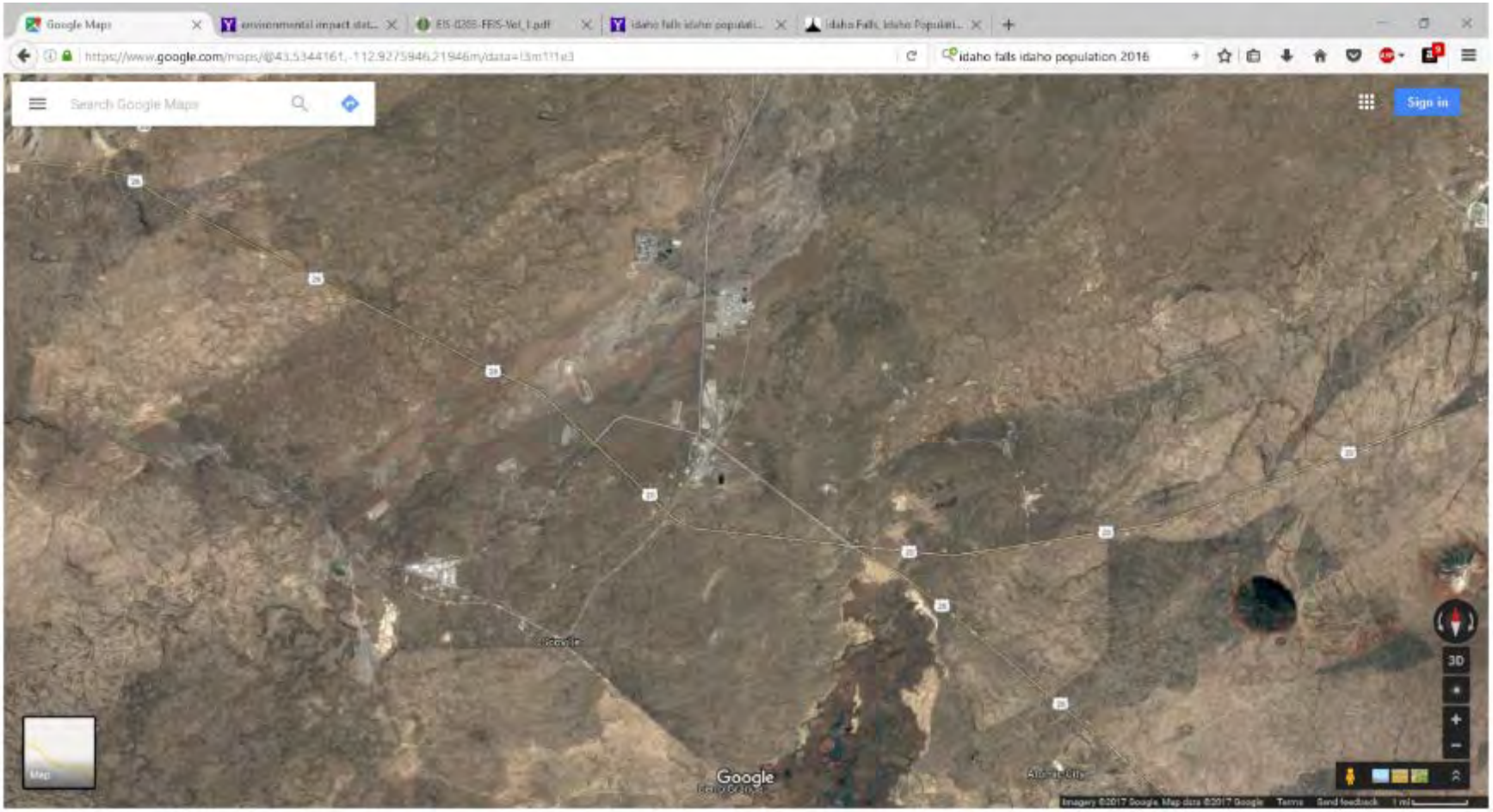

Figure D–34. Google map of INL and vicinity

INL is in center; map is approximately 25 miles E-W and 12 miles N-S.

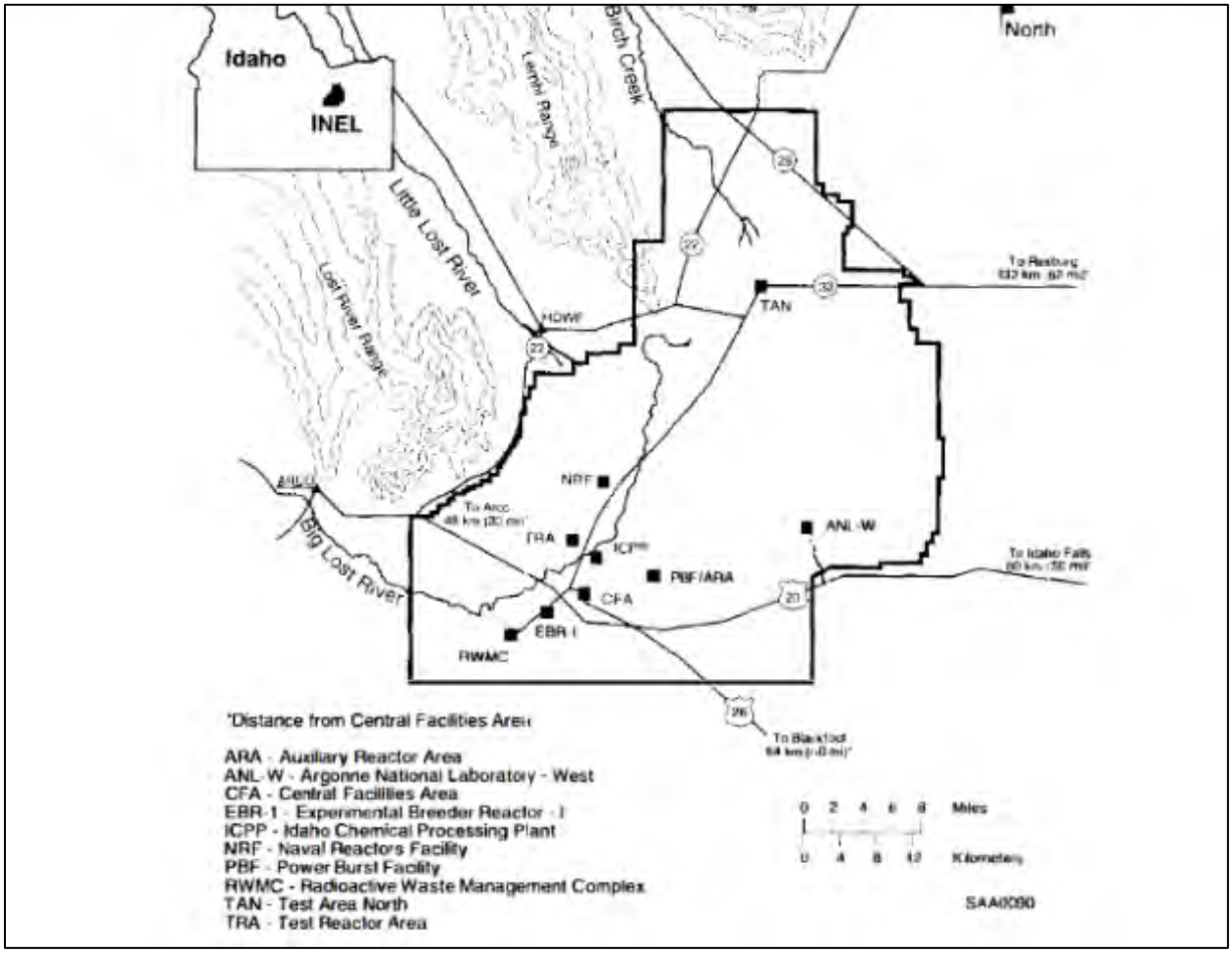

Figure D–35. Map of INL

Screenshot from FEIS,[49] Figure 4-9

[49] DOE (U.S. Department of Energy) 1996, *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Restoration and Waste Management Programs Final Environmental Impact Statement,* DOE/EIS-0203-F, Washington DC, April, obtained from https://energy.gov/nepa/downloads/eis-0203-programmatic-final-environmental-impact-statement.

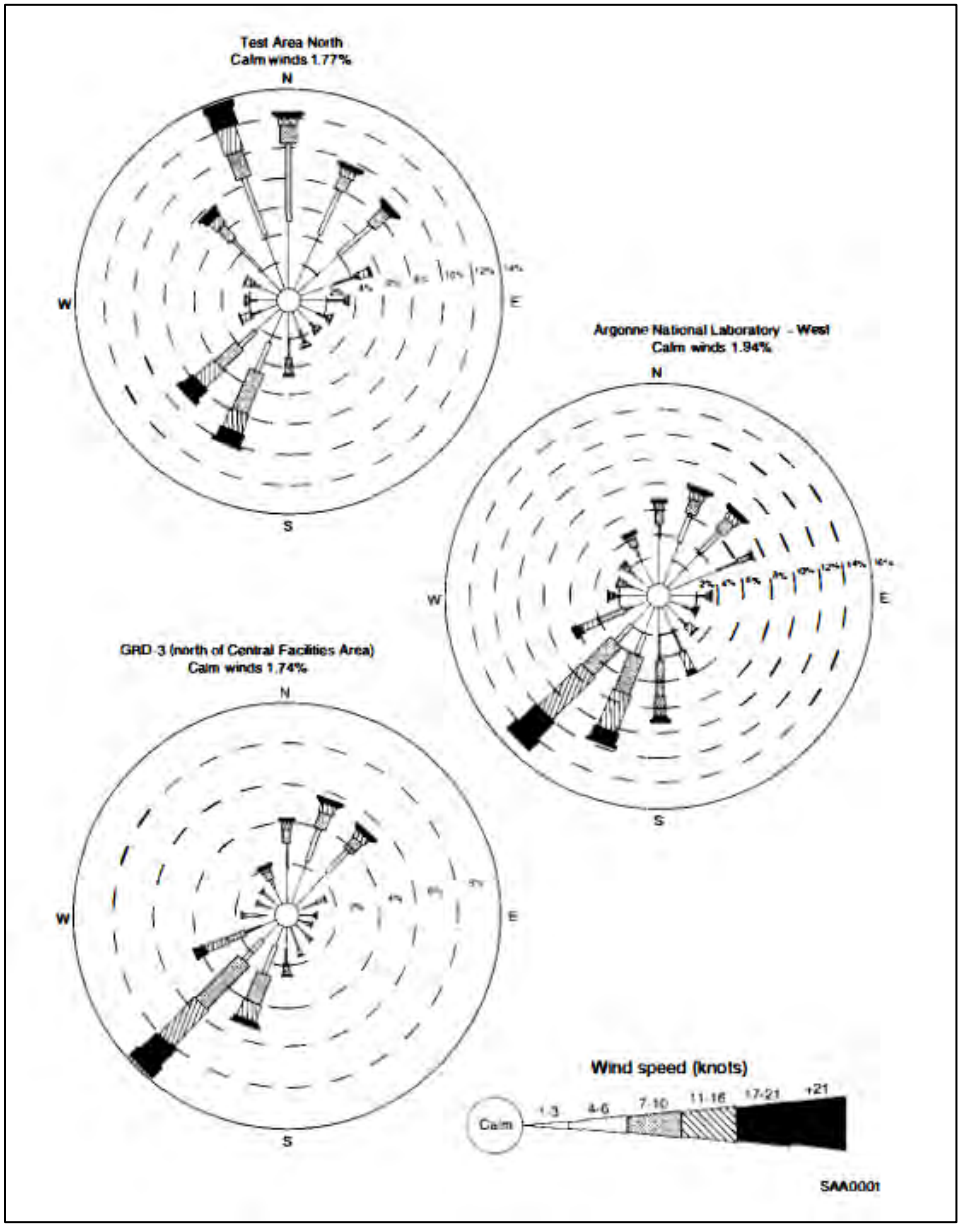

Figure D–36. Wind roses at INL

(Source: DOE/EIS-0203/F, Volume 2, Figure 4.7-1)

The wind rose at Test Area North is clearly influenced by terrain, since it is at the mouth of a valley oriented roughly NNW-SSE (see Figure D–35). For CFA and Argonne National Laboratory-West, the predominant wind direction is from the SW, which means it does not blow toward any of the population centers listed above.

D.14 Brookhaven National Laboratory

Surrounding population: Population within 1 mile of the site is 13,460 as of 2007, see **Figure D–37**.[50] That within 5 miles is 67,000 and within 50 miles is approximately 6,200,000 based on 2010 census.[51]

Nearby centers of population: Brookhaven Township, which surrounds the site, occupies an area of about 530 square miles and has a population of approximately 486,000.[52]

Nature of surroundings within 5: Numerous villages within Brookhaven Township, see **Figures D–38** and **D–39**.

Size of site: Approximately 8 square miles (approximately 5,000 acres).[53]

Most likely wind direction: Winds at BNL are predominantly from westerly directions.[54] This is away from the largest centers of population, but cannot be said to be toward lightly populated areas.

Initial Subjective Assessment of Public Individual and Societal Risk in the event that pit production is relocated to WIPP: High because of the relatively small site and its location on heavily populated Long Island.

Policy Risk: Assessed to be high – considering the controversy that surrounded the construction of the Shoreham nuclear reactor on Long Island, leading to its eventual cancellation.

[50] http://www.longisland.com/population.html.
[51] http://mcdc.missouri.edu/websas/caps10c.html.
[52] https://en.wikipedia.org/wiki/Brookhaven,_New_York.
[53] DOE (U.S. Department of Energy) 2009, *Environmental Assessment for BP Solar Array Project, Brookhaven National Laboratory, Upton, New York*, DOE/EA-1663, Washington DC, December, obtained from https://www.bnl.gov/community/docs/pdf/final%20final%20ea%20-%20bp%20solar%20project.pdf.
[54] BNL (Brookhaven National Laboratory) 2013, *Meteorological Services Annual Data Report for 2012*, BNL-100629-2013-IR, Upton, NY, obtained fromhttps://www.bnl.gov/envsci/pubs/pdf/2013/BNL-100629-2013-IR.pdf.

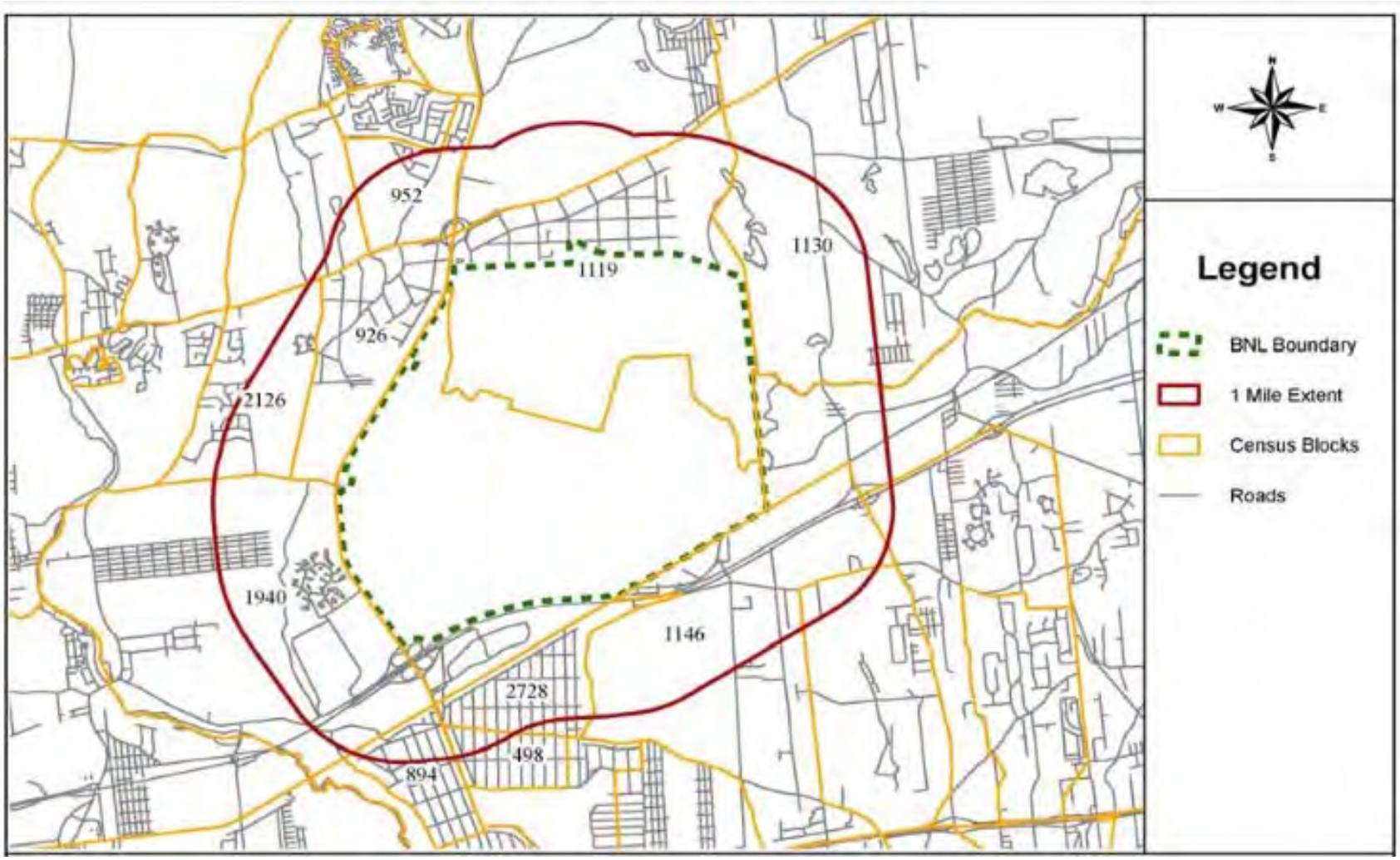

Figure D–37. Map of BNL with population within 1 mile of site boundary

(Source: DOE/EA-1663, Figure 6)

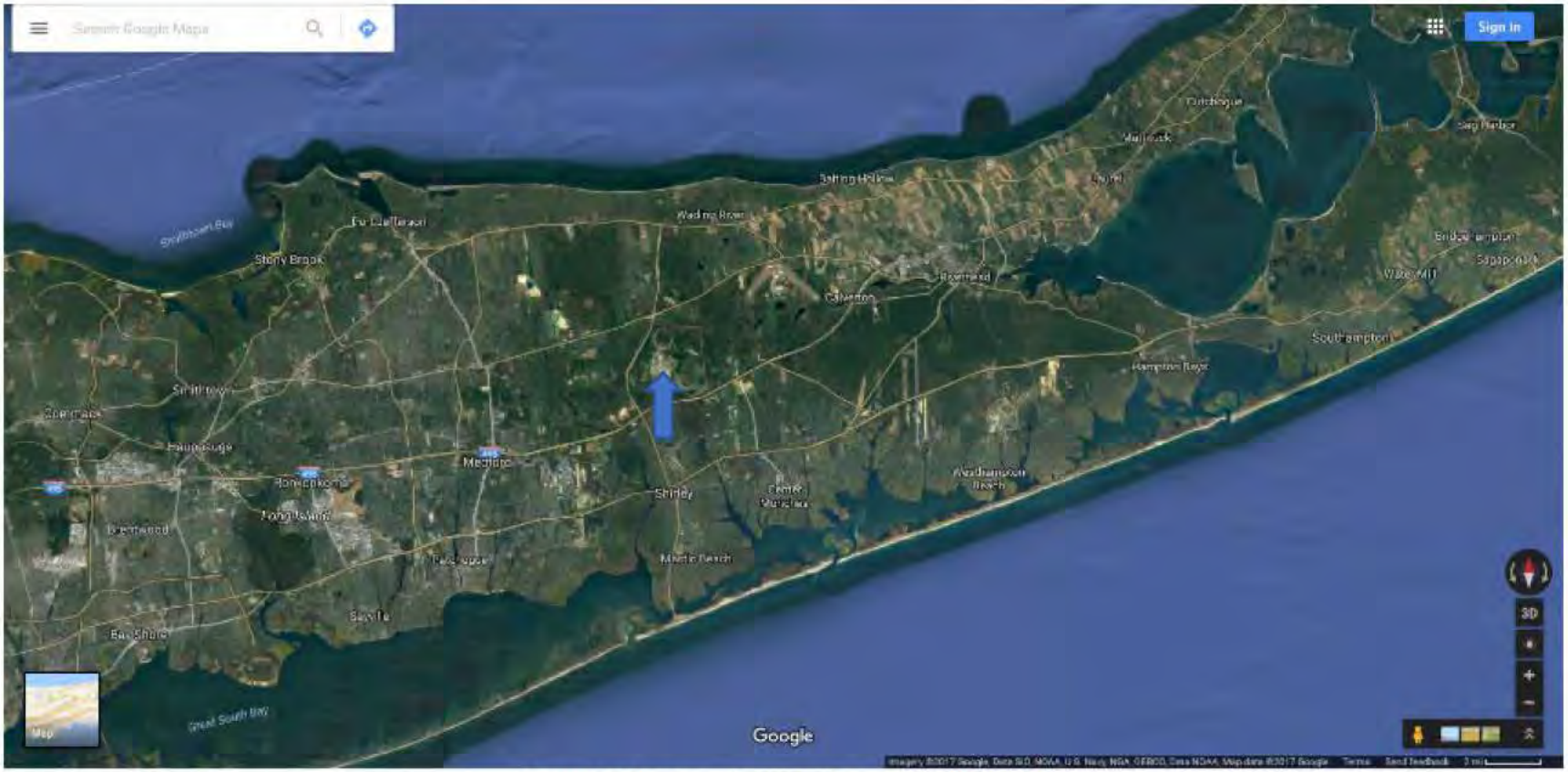

Figure D–38. Google map of part of Long Island

Map is approximately 60 miles E-W and 30 miles N-S.

BNL is approximately at tip of blue arrow.

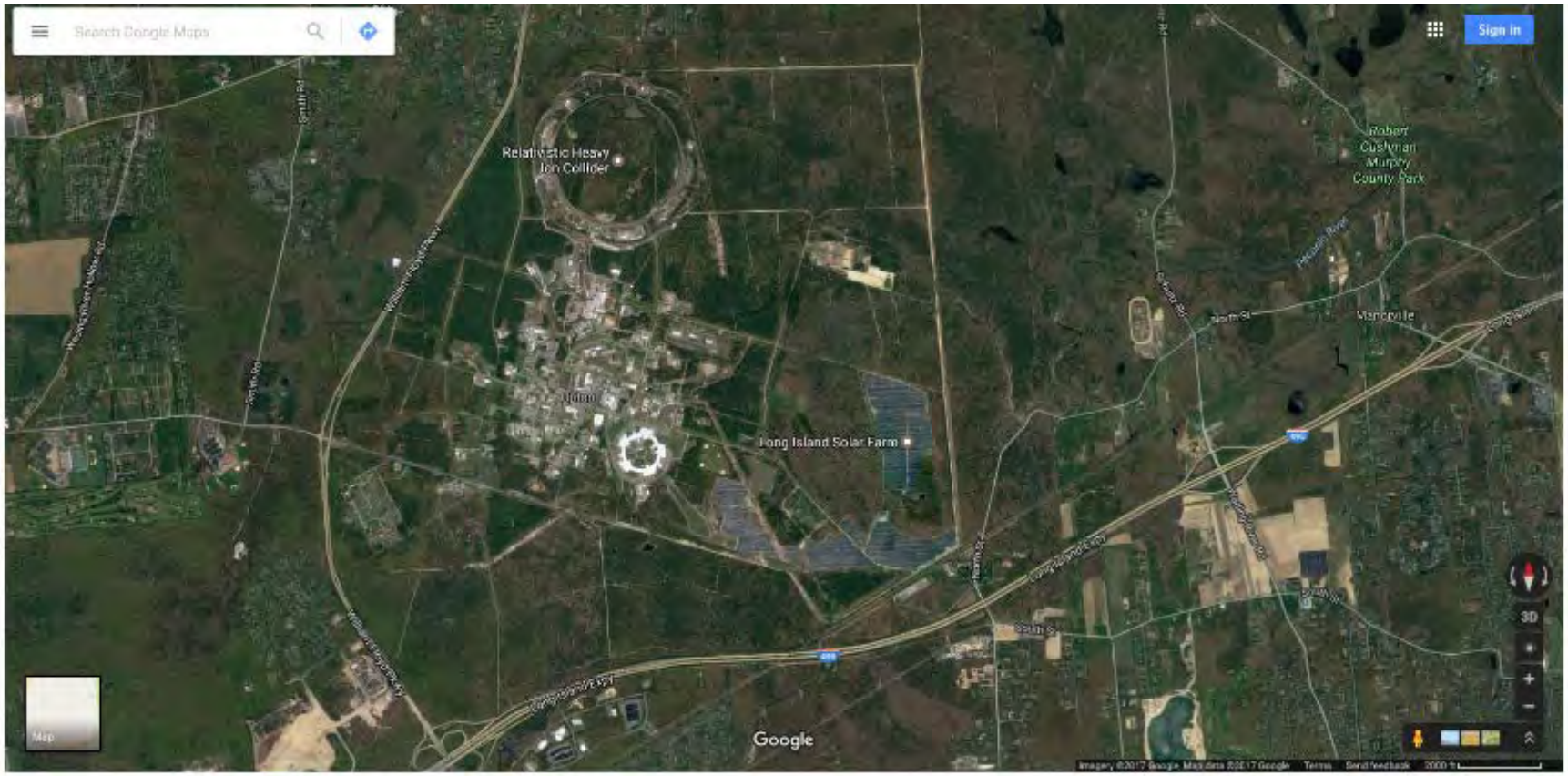

Figure D–39. Google map of BNL and immediate vicinity

Map is approximately 7 miles E-W and 3.5 miles N-S.

D.15 Kansas City Nuclear Security Campus

Surrounding population:[55] Population within 5 miles is approximately 98,000, that within 50 miles is approximately 2,200,000, based on 2010 census data. See **Figure D–40**.

Representative nearby centers of population:[56]

- Grandview, MO (population approximately 24,400) approximately 2 miles NNE (nearest houses approximately 0.9 miles).
- Belton City, MO (population approximately 23,000) approximately 5 miles SSE (nearest houses approximately 2 miles).
- Kansas City, MO (population approximately 460,000) approximately 20 miles N.

*Nature of surroundings within 5 miles of KCNSC: C*onsiderable populations to E and W, relatively unpopulated in a N-S swathe (see **Figure D–41** and **D–42**).

Size of site: 0.29 square miles (approximately 186 acres).[57]

Most likely wind direction: The 2003 monthly wind rose data for Kansas City Airport[58] show the predominant wind direction strongly from the south during March – November and about equally from the NW or SW/SSW in December – March. On average, through the whole year, the predominant wind direction is from the south and blows towards Kansas City.

Initial Subjective Assessment of Public External Individual and Societal Risk in the event that pit production is relocated to KCNSC: High because of the very small site, close-by cities, large population within 50 miles, and predominant wind direction towards Kansas City.

Policy Risk: High, because the site has not previously handled special nuclear material.

[55] http://mcdc.missouri.edu/websas/caps10c.html.

[56] Distances from KCNSC estimated using Google Maps, see Figures D–40 through D–42: populations obtained from https://suburbanstats.org/population/.

[57] http://www.ssoe.com/wp-content/uploads/GOVT-NNSA.pdf.

[58] https://www.wcc.nrcs.usda.gov/ftpref/downloads/climate/windrose/missouri/kansas_city/.

Figure D–40. Google map close-up view of KCNSC

Map is approximately 1.9 miles E-W and 0.85 miles N-S.

Figure D–41. Google map of KCNSC and nearby areas

Map is approximately 15 miles E-W and approximately 7.5 miles N-S.

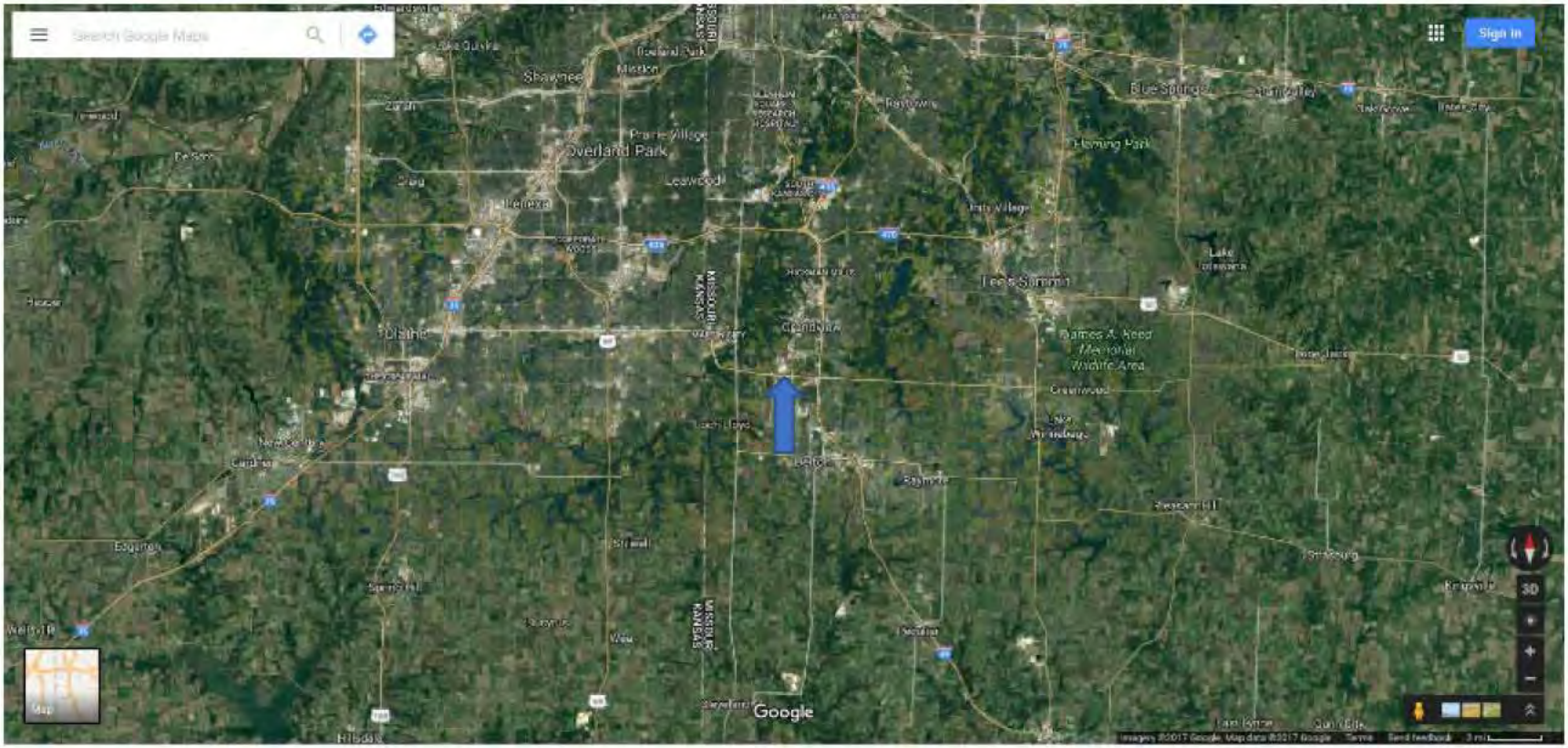

Figure D–42. Smaller scale view of KCNSC and environs

Map is approximately 60 miles E-W and approximately 30 miles N-S.

Plant is approximately at tip of blue arrow.

D.16 Sandia National Laboratories

Surrounding population distribution:[59] Population within 5 miles is approximately 25,000, and that within 50 miles is approximately 910,000, based on 2010 census data. The distances are measured from TA-V (chosen because it is relatively far from the site boundaries).

Nearby centers of population:[60]

- Albuquerque, NM (population approximately 546,000) approximately 7 miles NNW (nearest houses approximately 3 miles NNE).
- South Valley, NM (population approximately 41,000) approximately 8 miles W.

Nature of surroundings within 5 miles of SNL/TA-V: Unpopulated except to the N beyond approximately 3 miles (see **Figures D–43**, **D–44**, and **D–45**).

Size of site: 13.4 square miles (approximately 8,600 acres)[61] that is split into approximately 2,900 acres owned by DOE and 5,700 acres permitted from the United States Air Force, all within 80 square miles (approximately 51,000 acres) occupied by Kirtland Air Force Base.

Most likely wind direction: **Figure D–46** shows 3 wind roses on the SNL Site. They differ considerably due (presumably) to terrain effects. That closest to TA-V shows a preponderance of winds from the E to SE, i.e., toward the Rio Grande Valley and southwestern portions of the Albuquerque metropolitan area.

Initial Subjective Assessment of Public External Individual and Societal Risk in the event that pit production is relocated to SNL: Moderate because of the large site, somewhat offset by closeness to Albuquerque, and predominant wind directions towards south western portions of the Albuquerque metropolitan area.

Policy Risk: Reassigning pit production to SNL would require a considerable increase in the MAR permitted at that site, whereas the trend in recent years has been toward a reduction. The policy risk is assessed as moderate.

[59] http://mcdc.missouri.edu/websas/caps10c.html.

[60] Distances estimated from TA-V using Google Maps, see Figures A.12-2 and A.12-3: populations obtained from https://suburbanstats.org/population/.

[61] SNL (Sandia National Laboratories) 2015, *2014 Annual Site Environmental Report for Sandia National Laboratories,* SAND2015-6048R, Albuquerque, NM, obtained from http://www.sandia.gov/news/publications/environmental_reports/_assets/documents/2014_ASER_SNL-NM_CD_ALL.pdf.

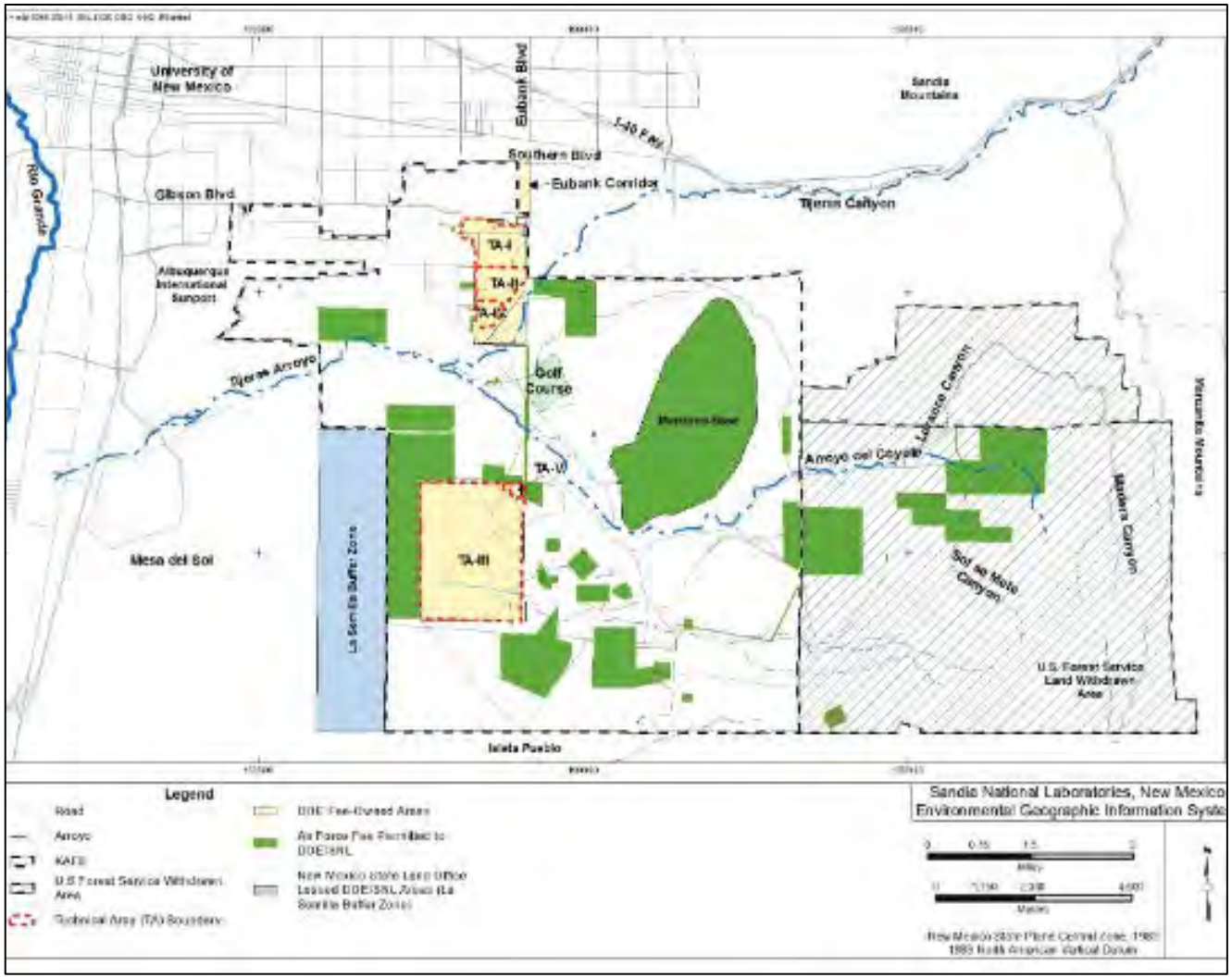

Figure D–43. Map of SNL

(Source: *2014 Annual Site Environmental Report for Sandia National Laboratories*, Figure 1-1)

Figure D–44. Google map of SNL relative to Albuquerque

Map is approximately 30 miles E-W and 15 miles N-S.

TA-V is approximately at tip of blue arrow.

Figure D–45. Smaller scale Google map of Albuquerque area

Map is approximately 60 miles E-W and 30 miles N-S.

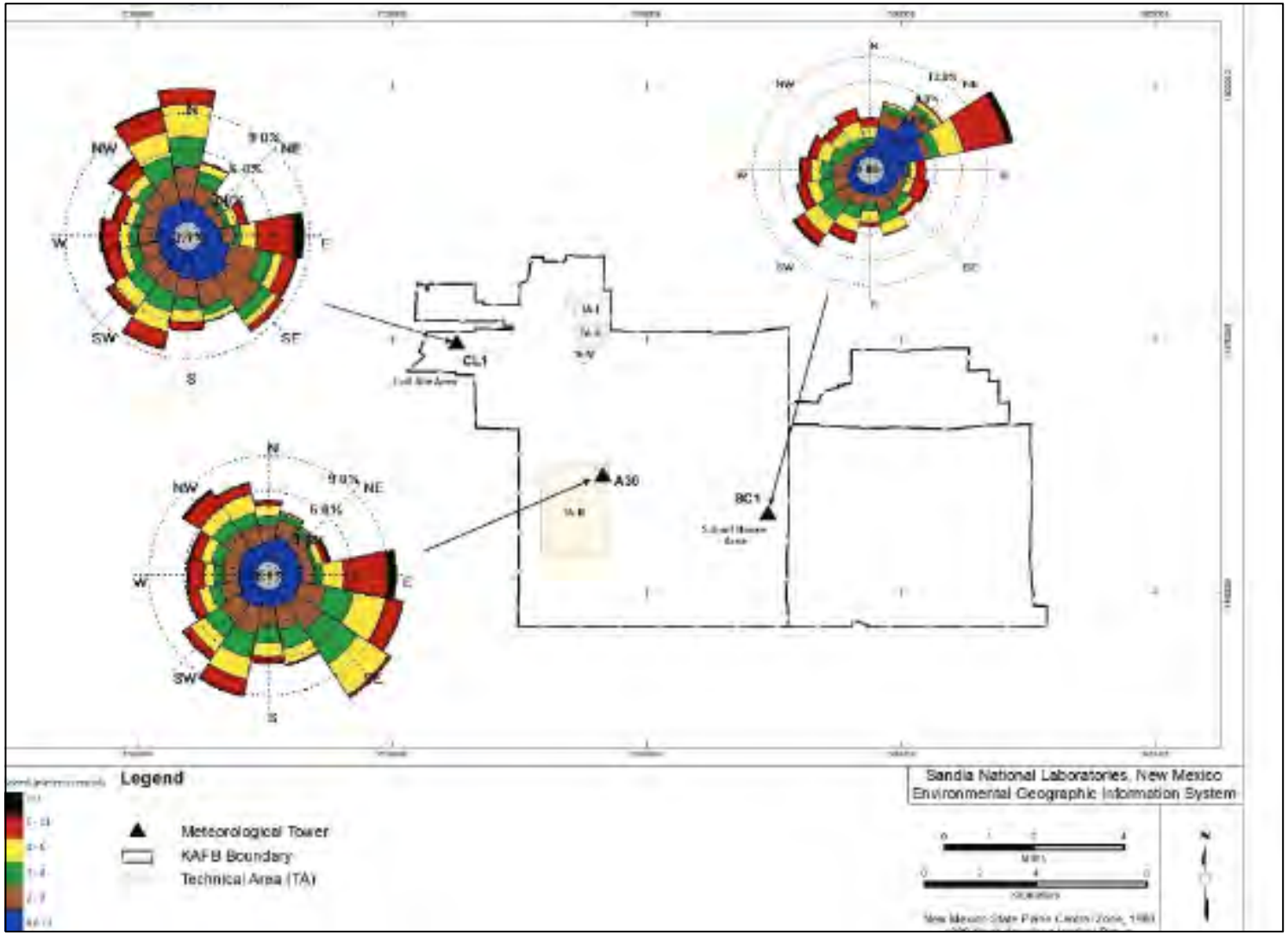

Figure D–46. Wind roses at various locations on Sandia Site

(Source: 2014 Annual Site Environmental Report for Sandia National Laboratories, Figure 5-2)

Bottom left wind rose is closest to TA-V.

D.17 Paducah, KY

Surrounding population: Population within 1 mile of the center of the site is 0, within 5 miles, 600, and within 50 miles approximately 534,000, based on the 2010 census.[62] **Figure D–47** shows a map of the site.

Nearby centers of population:[63] See **Figure D–48**.

- Metropolis, IL (population approximately 6,500) approximately 5 miles NE of center of plant.
- Paducah, KY (population approximately 25,000) approximately 7 miles ESE of center of plant.

Nature of surroundings within 5 miles: Predominantly farming, see Figure D–48. The Ohio River runs within 2 miles.

Size of site: Approximately 5.6 square miles (approximately 3,556 acres) of which approximately 1.2 square miles (750 acres) is within the fenced area.[64]

Most likely wind direction: From the SW, toward Metropolis. See **Figure D–49**.[65]

Initial Subjective Assessment of Public External Individual and Societal Risk in the event that pit production is relocated to Paducah: Moderate (not high) because relatively few people within 5 miles and there are no nearby large cities.

Policy Risk: Assessed to be high because the site is being shut down and (presumably) there would be resistance to the idea of introducing large amounts of hazardous radioactive material to the site.

[62] http://mcdc.missouri.edu/websas/caps10c.html.

[63] Populations obtained from https://suburbanstats.org/population/. Distances measured to outskirts using Google maps.

[64] https://www.energy.gov/pppo/paducah-site-description.

[65] DOE (U.S. Department of Energy) 2004, Final Environmental Impact Statement - Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site, DOE/EIS-0359, Washington DC, June, obtained from https://energy.gov/sites/prod/files/EIS-0359-FEIS-FiguresTables-2004.pdf.

Figure D–47. Map of Paducah Site

(Source: https://www.energy.gov/pppo/paducah-site-description)

Scale approximately 1" = ½ miles

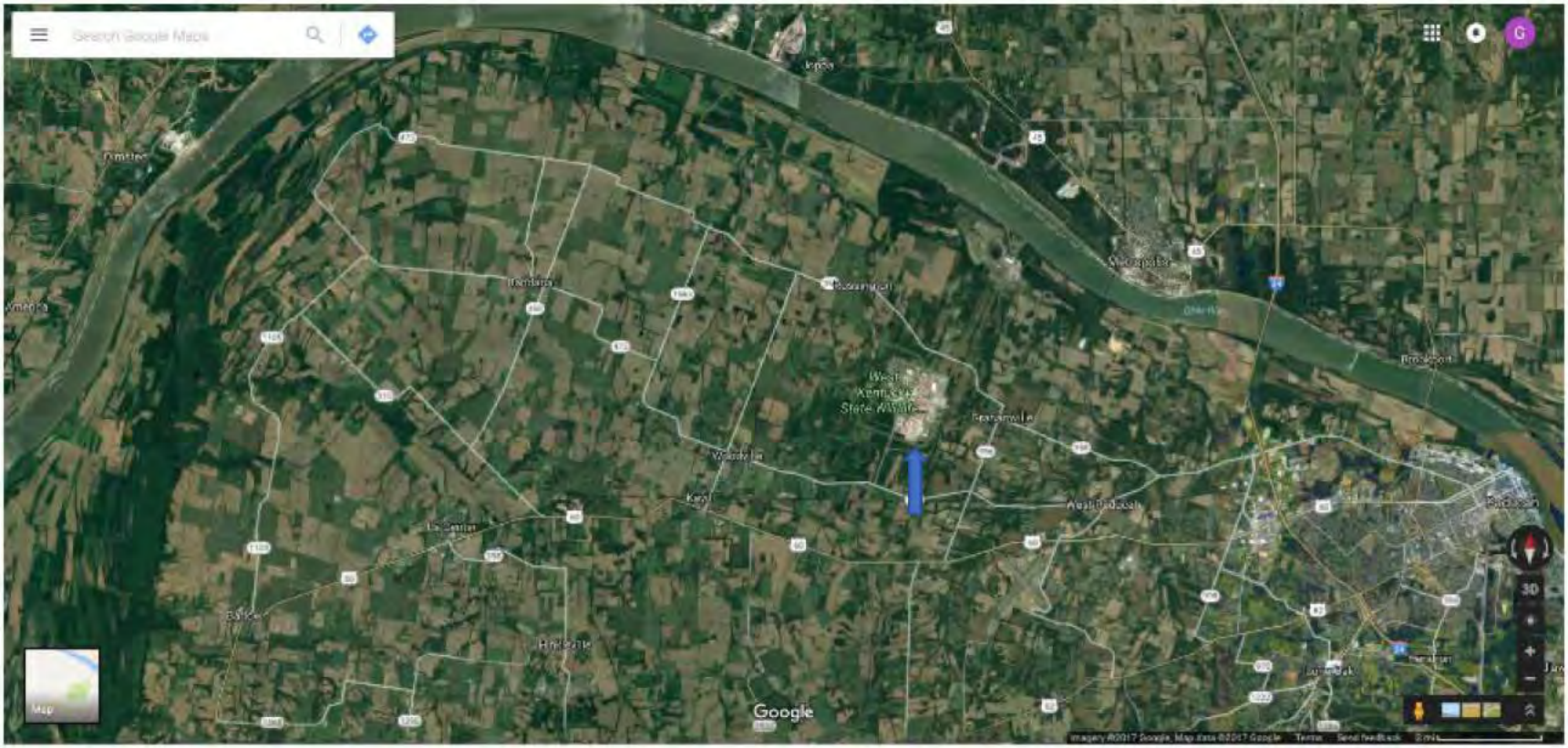

Figure D–48. Google map of Paducah Site and vicinity

Map is approximately 30 miles E-W and 15 miles N-S.

Site is approximately at tip of blue arrow.

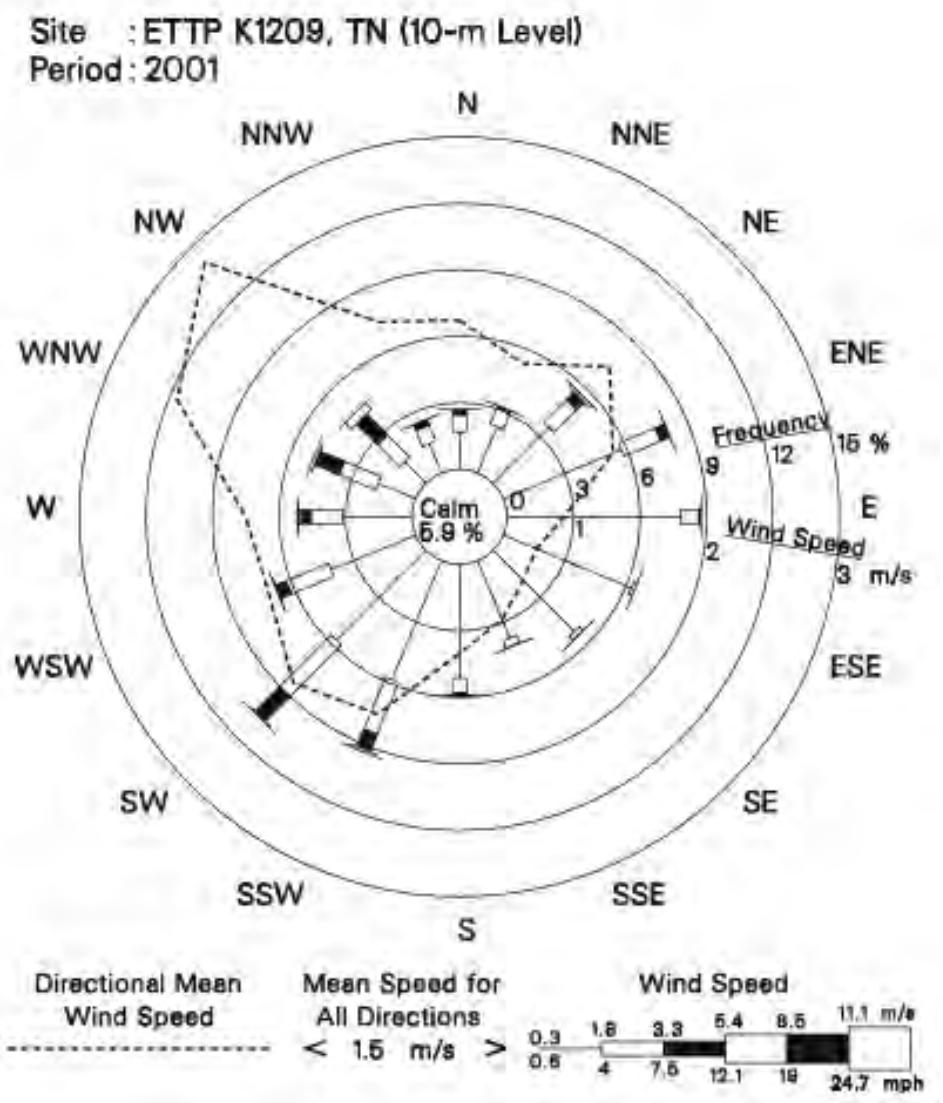

Figure D–49. Wind rose for Paducah Site

(Source: https://energy.gov/sites/prod/files/EIS-0359-FEIS-FiguresTables-2004.pdf)

D.18 Portsmouth, OH

Surrounding population: Population within 1 mile of the center of site is 91, within 5 miles approximately 6,200, and within 50 miles approximately 691,000 based on the 2010 census.[66] **Figure D–50** shows a map of site.

Nearby Centers of population:[67] See **Figure D–51**.

- Piketon, OH (population approximately 2,200) approximately 2.5 miles NNW of center of plant.
- Portsmouth, OH (population approximately 20,000) approximately 17 miles S of center of plant.

Nature of surroundings within 5 miles: Mainly wooded, some farming. See Figure D–51.

Size of site: Approximately 5.9 square miles (approximately 3,780 acres) of which approximately 1.9 square miles (1,200 acres) is occupied by the former diffusion plant.[68]

Most likely wind direction: From SW-S,[69] not toward any population center. See **Figure D–52**.

Initial Subjective Assessment of Public External Individual and Societal Risk in the event that pit production is relocated to Portsmouth: Moderate because relatively few people live within 5 miles and there are no nearby large cities.

Policy Risk: Assessed to be high because the site is being shut down and (presumably) there would be resistance to the idea of introducing large amounts of hazardous radioactive material to the site.

[66] http://mcdc.missouri.edu/websas/caps10c.html.

[67] Populations obtained from https://suburbanstats.org/population/. Distances measured to outskirts using Google maps.

[68] https://energy.gov/pppo/portsmouth-site.

[69] DOE (U.S. Department of Energy) 2017, *Conveyance of Real Property at The Portsmouth Gaseous Diffusion Plant in Pike County, Ohio*, DOE/EA-1856, Washington DC, January, obtained from https://energy.gov/sites/prod/files/2017/01/f34/EA-1856_Draft_EA_2017.pdf.

Figure D–50. Map of Portsmouth Site

(Source: Google Maps)

Scale approximately 1" = 2.3 miles

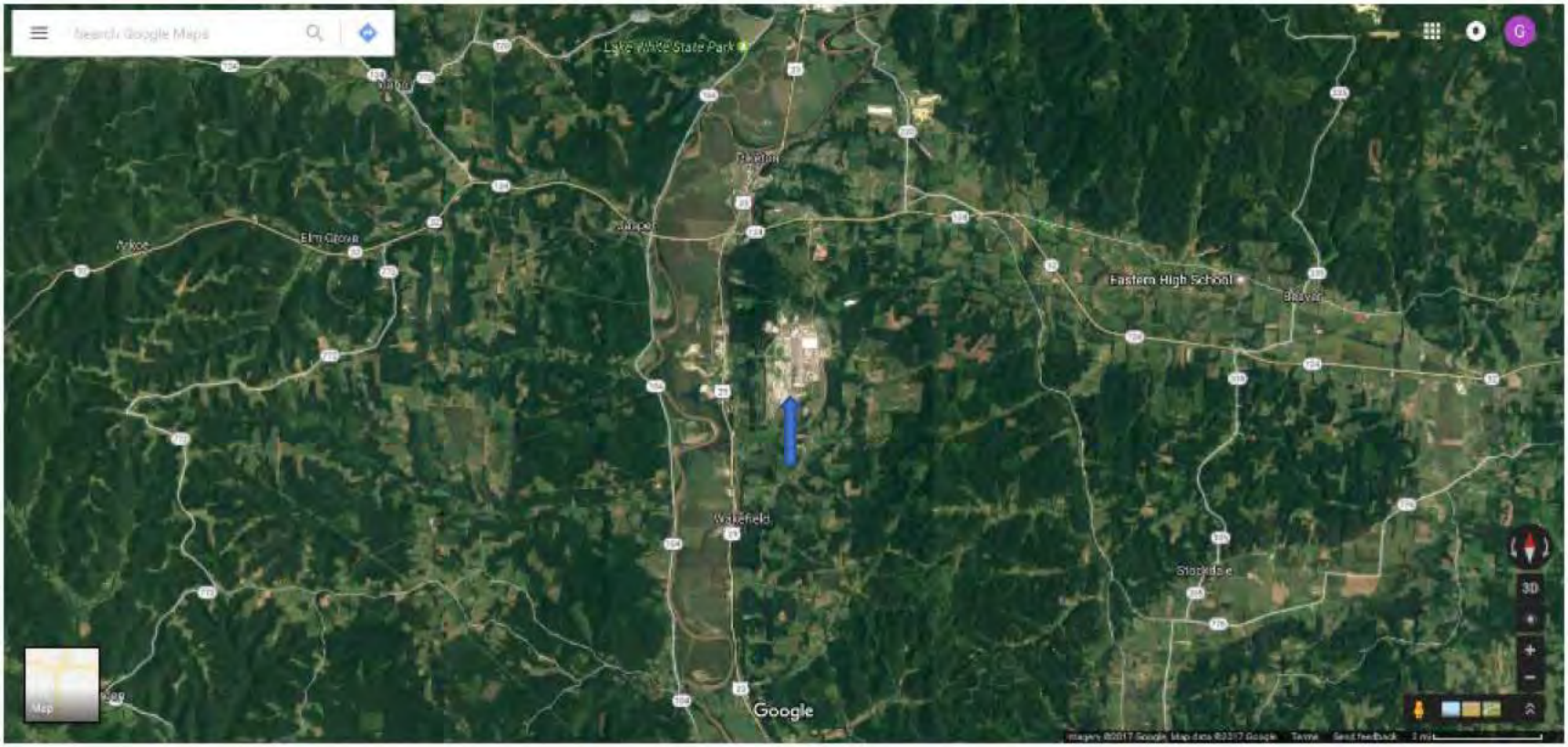

Figure D–51. Google map of Portsmouth Site and vicinity

Map is approximately 30 miles E-W and 15 miles N-S.

Site is approximately at tip of blue arrow.

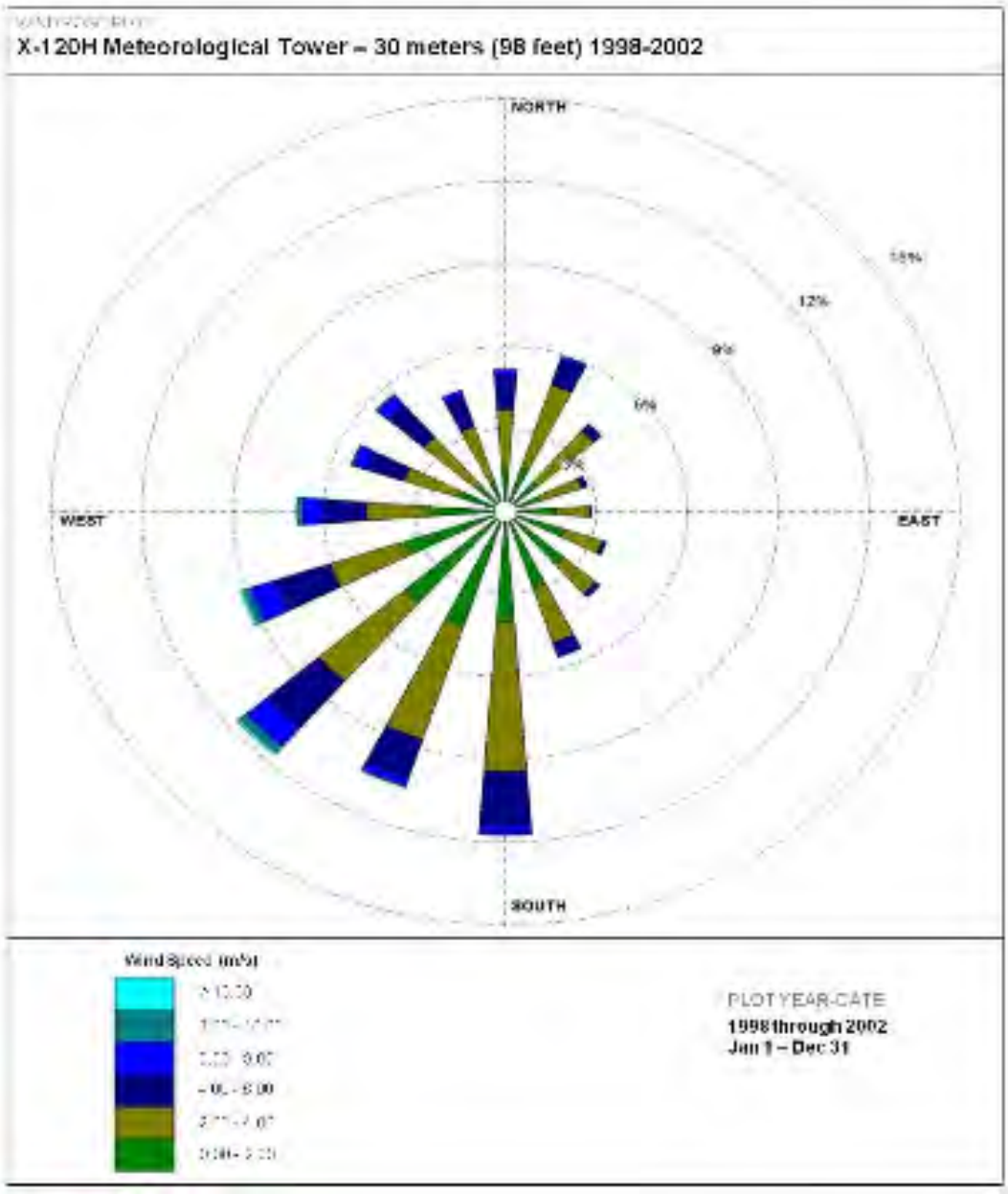

Figure D–52. Wind rose for Portsmouth Site

(Source: https://energy.gov/sites/prod/files/2017/01/f34/EA-1856_Draft_EA_2017.pdf)

Appendix E. Qualitative Risk Assessment

E.1 Overview

The Analysis of Alternatives (AoA) team performed a qualitative risk assessment of the alternatives that were identified and described in Chapter 5. This appendix is organized as follows:

- Development of a list of threats, one for the period of construction up to startup and one for the following period of routine operation (Tables E–1 and E–2)
- Introduction and discussion of the risk matrix, including the definition of probability ranges (Table E–3)
- Development of two tables of consequence guidance, one for the period of construction up to startup and one for the following period of routine operation (Tables E–4 and E–5)
- Brief summary of the initial long list of alternatives that the AoA team developed (Table E–6)
- Assignment of probability, consequence, and risk level for each pairing of threat and alternative
- Summary tables of the results of the risk assessment for alternatives at Los Alamos National Laboratory (LANL) (Table E–7), Savannah River Site (SRS) (Table E–8), and Idaho National Laboratory (INL) (Table E–9)
- Summary table of the risks for the final short list of six alternatives developed by the AoA team for presentation to senior management ("PF-4 Reuse," defined below; 80 pits per year [ppy] in new construction at LANL; 80 ppy in the Mixed Fuel Fabrication Facility [MFFF] or new construction at SRS; and 80 ppy in the Fuel Processing Facility [FPF] or new construction at LANL (Table E–10)
- Summary table for the final short list of alternatives with the risks presented in order from those that are the most discriminating between alternatives to those that are least discriminating between alternatives (Table E–11)

E.2 Lists of Threats

The AoA team first developed two lists of threats. The first list is applicable to the period of construction up to the point at which the facility begins the routine production of 80 ppy. These threats are listed in Table E–1. For purposes of calculating the probability that a certain threat will actually occur during this period, the team assumed that the duration of construction and startup will be approximately 10 years. The second list, provided in Table E–2, is applicable to the operating lifetime of the facility, assumed to be 50 years.[1]

The AoA team developed the lists of threats by first consulting other AoAs, such as that for tritium(DOE 2017f) and surplus plutonium disposition (DOE 2017g). Team members brainstormed and refined these lists during a meeting in November 2016. As the potential alternatives became clearer, the list was further refined, and threats specific to the 80-ppy manufacturing capability were identified. For example, these threats included some that were specific to one alternative (e.g., K-reactor or MFFF) and others that apply

[1] Per verbal communication from the Deputy TA-55 Facility Operations Director that the facility was originally designed with the intention that its lifetime would be 50 years. It seems reasonable to make the same assumption for an 80-ppy manufacturing facility.

to all alternatives, such as the potential for disruption of the ability to ship solid transuranic (TRU) waste to the Waste Isolation Pilot Plant (WIPP).

Table E–1. Brief description of threats during construction and startup

Identifier	Brief Description of Threat
C-1	National Environmental Policy Act: environmental impact statement or additional environmental reviews cause delays and extra costs.
C-2	National and/or local political/public opposition results in delays and extra costs.
C-3	National and/or local political/public opposition results in project cancellation.
C-4	Sufficient line item funds are not available (either in individual fiscal years or in total), resulting in a delay to completion of construction and startup.
C-5	Intra-agency and/or inter-agency disputes delay the project and introduce extra costs or unwanted restrictions on the project. Note that disputes arising from the transfer of the Mixed Oxide Fuel Fabrication Facility licensing basis from the Nuclear Regulatory Commission to the Department of Energy are considered separately under threat C-24.
C-6	Program requirements change (e.g., weapon types or numbers).
C-7	Functional performance requirements change (e.g., a requirement is introduced for computerized tomography).
C-8	More stringent interpretations of safety requirements and/or new safety requirements during design and construction require significant facility structural or service system upgrades.
C-9	Additional security provisions (e.g., clearances, escorts, fences, changes in the design basis threat) beyond planned are imposed.
C-10	Construction or repair and modifications impact ongoing site or facility operations or ongoing site or facility operations impact construction or repair and modifications.
C-11	Existing facilities require more work than planned to meet applicable codes and standards (e.g., latent conditions may unexpectedly come into play). Equivalently, unforeseen conditions in existing facilities during repair or upgrades result in more work than planned.
C-12	Material characterization capability is insufficient to support the schedule for the nonrecurring testing and analysis required to develop and qualify the manufacturing parameters for the W87 production process.[a]
C-13	Unexpected underground site conditions are encountered (e.g., geotechnical, buried pipelines, or buried waste).
C-14	Project design issues occur during construction, modifications, or repair work.
C-15	There are issues with process qualification and/or design agency approval.
C-16	There are issues with worker hiring, clearing, and/or training of qualified workers.
C-17	A seismic event occurs during construction, damaging site infrastructure.
C-18	A seismic event occurs during construction, causing damage to the facility.
C-19	A tornado or other high-wind event occurs during construction.
C-20	An external flood occurs during construction.
C-21	An external fire occurs during construction.
C-22	Any other external event occurs during construction.
C-23	Savannah River Site only: If the Mixed Oxide Fuel Fabrication Facility is chosen for the pit manufacturing facility, potential difficulties arise while unraveling the project with Areva.
C-24	Savannah River Site only: Difficulties arise while transferring the Mixed Oxide Fuel Fabrication Facility licensing basis from the Nuclear Regulatory Commission to the Department of Energy.

[a] This threat was included because, during the IST's visit to LANL, laboratory personnel expressed concern that that material characterization capabilities would be insufficient to handle the projected workload during development and qualification.

Table E–2. Brief description of threats during the operating lifetime

Identifier	Brief Description of Threat
O-1	Pit manufacturing adversely affects other site or facility projects, or other site or facility projects adversely affect pit production.
O-2	The facility is unable to hire, clear, train, and/or retain sufficient skilled personnel to support ongoing plutonium operations
O-3	Low level waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.
O-4	TRU waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.
O-5	WIPP shuts down for an extended period of time (months or years) so that TRU-waste storage capability reaches its limit and pit production ceases.
O-6	When WIPP comes back on line after a shutdown, additional regulatory and safety constraints mean that it accepts shipments at a rate that is insufficient to process waste generated by an 80-ppy program.
O-7	WIPP becomes full and is no longer able to accept solid TRU waste, and no other repository is available.
O-8	Analytical chemistry or materials characterization capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.
O-9	Any other support infrastructure capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.
O-10	Inability to obtain spare/replacement parts for failed equipment increases potential shutdown durations, impacting mission.
O-11	Supplier(s) of essential and unique equipment go out of business, refuse to take the job, or deliver poor quality.
O-12	Aircraft impact damages the facility.
O-13	A hazardous material release elsewhere onsite or at a nearby industrial facility or from a transportation accident affects operators and causes a facility shutdown; subsequent decontamination may be required.
O-14	Transportation capacity for shipping pits and plutonium feedstock is insufficient to meet demands from all Department of Energy sites.
O-15	A seismic event occurs during the operating lifetime.
O-16	A tornado or other high-wind event occurs during the operating lifetime.
O-17	An external flood occurs during the operating lifetime.
O-18	An external fire occurs during the operating lifetime.
O-19	Any other external event occurs during the operating lifetime.

Key:
ppy = pits per year; TRU = transuranic; WIPP = Waste Isolation Pilot Plant.

E.3 Risk Matrix

The AoA team assessed the magnitude of the risk corresponding to each of the threats in Tables E–1 and E–2 making use of the risk matrix methodology described in the Department of Energy's (DOE's) *Risk Management Guide* (DOE 2011). The risk matrix is reproduced in Table E–3, with some minor changes. The probabilities are assigned numbers from 1 through 5, with 1 being very high and 5 being very low. The consequences are also labeled from 1 through 5, with 1 being the highest consequence (crisis) and 5 being the lowest consequence (negligible).

In the text of this appendix, every time a combination of probability and consequence is identified it is noted as probability/consequence/risk for the convenience of the reader so that it is not necessary to refer back to the risk matrix. For example, a very high probability (1) and a significant consequence (3) correspond to a high risk (H); this is represented by the notation "1/3/H." Similarly, a high probability (2)

and a significant consequence (3) correspond to a moderate risk (M), or 2/3/M for short. Likewise, a low probability (4) and a negligible consequence (1) correspond to a low risk (L), or 4/1/L.

Table E–3. Risk matrix for Plutonium Pit Production Analysis of Alternatives

		Consequences				
		Negligible (5)	Marginal (4)	Significant (3)	Critical (2)	Crisis (1)
Probability	Very high (1) >90%	Low (L)	Moderate (M)	High (H)	High (H)	High (H)
	High (2) 75% to 90%	Low (L)	Moderate (M)	Moderate (M)	High (H)	High (H)
	Moderate (3) 26% to74%	Low (L)	Low (L)	Moderate (M)	Moderate (M)	High (H)
	Low (4) 10% to25%	Low (L)	Low (L)	Low (L)	Moderate (M)	Moderate (M)
	Very low (5) <10%	Low (L)	Low (L)	Low (L)	Low (L)	Moderate (M)

Matrix and probabilities from the Department of Energy (DOE) *Risk Management Guide*, DOE G 413.3-7 (DOE 2011).

Numbers 1-5 against probability and consequences added for the purposes of this AoA.

Probability of occurrence:

Construction: calculated during the period from Critical Decision-2 to startup (assume 10 years).

Operation: calculated during the lifetime of facility beginning at startup (assume 50 years).

Note that, if the probability is very low (5), the maximum risk allowed by the risk matrix is moderate, i.e., 5/1/M. Some of the threats listed in Tables E–1 and E–2 have extremely low recurrence intervals, sometimes in the thousands or tens of thousands of years. Over the period of construction and startup or during the operating lifetime, the probability of occurrence is very low. Regarding the risks discussed below, when considering these very low probability threats, the AoA team sometimes conservatively assumed that the risk would be moderate (i.e., 5/1/M), especially when it was expected that the risk would not prove to be a discriminator between the alternatives or a factor in decision making. The conservative nature of this assignment was acknowledged by adding a (C), thus 5/1/M (C).

E.4 Guidelines for Determining Consequence Levels

The DOE *Risk Management Guide* contains only very high-level guidelines for determining the consequence level associated with each threat. The team, therefore, developed PMA AoA-specific guidelines, one for construction and startup (Table E–4) and one for operation (Table E–5).

Table E–4. Guidelines for assigning consequences – construction and startup

Consequence Magnitude	Threshold Criteria
Negligible	– Delay in achieving plutonium sustainment goal of 30 ppy by ≤ 3 months – Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in one or more of those programs to be missed by ≤ 3 months or annual costs to increase by not more than 0.5 percent – Delay in achieving 80-ppy startup by ≤ 3 months – Revised cost estimate at any stage up to startup of 80-ppy manufacturing capacity not more than 0.5 percent of the CD-2 estimate
Marginal	– Delay in achieving plutonium sustainment goal of 30 ppy by >3 months but ≤ 1 year – Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in those programs to be missed by >3 months but ≤ 1 year and/or annual costs to increase by > 0.5 percent but ≤ 2.5 percent – Delay in achieving 80-ppy startup by >3 months but ≤ 1 year – Revised cost estimate at any stage up to startup of 80-ppy manufacturing capacity 0.5 percent but ≤ 2.5 percent of the CD-2 estimate – Political sensitivity/publicity at the local level
Significant	– Delay in achieving plutonium sustainment goal by >1 year but ≤ 2 years – Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in those programs to be missed by >1 year but ≤ 2 years and/or annual costs to increase by > 2.5 percent but ≤ 10 percent – Delay in achieving 80-ppy startup by >1 year but ≤ 2 years – Revised cost estimate at any stage up to startup of 80-ppy manufacturing capacity 2.5 percent but ≤ 10 percent of the CD-2 estimate – Political sensitivity/publicity at the state level or requiring NNSA Headquarters intervention
Critical	– Delay in achieving plutonium sustainment goal of 30 ppy by >2 years but ≤ 4 years – Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in those programs to be missed by >2 years but ≤ 4 years and/or annual costs to increase by > 10 percent but ≤ 25 percent – Delay in achieving 80-ppy startup by >2 years but ≤ 4 years – Revised cost estimate at any stage up to startup of 80-ppy manufacturing capacity 10 percent but ≤ 25 percent of the CD-2 estimate – Political sensitivity/publicity at the national public level or requiring congressional intervention
Crisis	– Delay in achieving plutonium sustainment goal of 30 ppy by > 4 years – Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in those programs to be missed by > 4 years and/or annual costs to increase by > 25 percent – Delay in achieving 80-ppy startup by >4 years – Revised cost estimate at any stage up to startup of 80-ppy manufacturing capacity 25 percent of the CD-2 estimate – Threat to national security – Mission abandoned

Key:

ARIES = Advanced Recovery and Integrated Extraction System; CD = critical decision; NNSA = National Nuclear Security Administration; ppy = pits per year.

Table E–5. Guidelines for assigning consequences – pit manufacturing facility in operation

Consequence Magnitude	Threshold Criteria
Negligible	– Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in one or more of those programs to be missed by ≤ 3 months and/or annual costs to increase by not more than 0.5 percent – Underrun of the 80-ppy requirement by ≤ 2 pits in a single year – Annual operating costs of the 80-ppy program exceed estimated costs by not more than 0.5 percent
Marginal	– Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in those programs to be missed by > 3 months but ≤ 1 year and/or annual costs to increase by > 0.5 percent but ≤ 2.5 percent – Underrun of the 80-ppy requirement by > 2 pits but ≤ 10 pits in a single year – Annual operating costs of the 80-ppy program exceed estimated costs by > 0.5 percent but ≤ 2.5 percent – Political sensitivity/publicity at the local level or requires NA-12 Headquarters intervention – May require minor facility design change or repair, minor environmental remediation onsite, or first aid/minor medical intervention for workers
Significant	– Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in one or more of those programs to be missed by > 1 year but ≤ 2 years and/or annual costs to increase by > 2.5 percent but ≤ 10 percent – Underrun of the 80-ppy requirement by > 10 pits but up to 40 pits in a single year or underrun of the 80-ppy requirement by up to 10 pits for > 1 year but ≤ 4 years – Exceedance of estimated annual operating costs of the 80-ppy program by > 2.5 percent but ≤ 10 percent – Political sensitivity/publicity at the state level or requiring NNSA Headquarters intervention. – Requirement of some facility design changes or repair or significant environmental remediation onsite or causing injury requiring medical treatment onsite, minor environmental remediation offsite, or first aid/minor medical intervention for members of the public
Critical	– Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in one or more of those programs to be missed by > 2 years but ≤ 4 years and/or annual costs to increase by > 10 percent but ≤ 25 percent – Inability to meet the 80-ppy requirement for a whole year, or consistent underrun of the 80-ppy requirement by at least 10 pits for > 4 years – Exceedance of estimated annual operating costs of the 80-ppy program by > 10 percent but ≤ 25 percent – Political sensitivity/publicity at the national public level or that requires congressional intervention – Requiring major design efforts or facility rebuilding, extensive environmental remediation onsite, or intensive medical care for life-threatening injury onsite or significant environmental remediation offsite or causing injury to members of the public requiring medical treatment
Crisis	– Interference with other plutonium missions (e.g., ARIES, plutonium-238, science), causing deadlines in one or more of those programs to be missed by > 4 years and/or annual costs to increase by > 25 percent – Inability to meet the 80-ppy requirement for two or more years – Annual operating costs of the 80-ppy program exceed estimated costs by > 25 percent – Requiring extensive environmental remediation offsite, intensive medical care for life-threatening injuries to members of the public, or significant environmental remediation offsite or causing injury to members of the public – Threat to national security

Key

ARIES = Advanced Recovery and Integrated Extraction System; CD = critical decision; NNSA = National Nuclear Security Administration; ppy = pits per year.

E.5 Detailed Analysis of Threats and Risks

This section contains an analysis of each of the threats listed in Tables E–1 and E–2. For the convenience of the reader, the alternatives being considered are summarized below in Table E–6.

E.5.1 Threats During Construction and Startup

This section details the assignment of probability, consequence, and risk to each pairing of threats listed in Table E–2 (i.e., threats applicable during construction and startup) and alternatives listed in Table E–6.

C-1: National Environmental Policy Act (NEPA): environmental impact statement (EIS) or additional environmental reviews cause delays and extra costs.

After preliminary discussions with personnel from the Office of the General Counsel (NA-GC), it appears that every alternative at every site will conservatively require an EIS. DOE Order 451.1B (*National Environmental Policy Act Compliance Program*) establishes DOE's internal requirements and responsibilities for implementing the National Environmental Policy Act of 1969, the Council on Environmental Quality Regulations Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations Parts 1500-1508), and the DOE NEPA Implementing Procedures (10 Code of Federal Regulations Part 1021). The order states that it is the responsibility of all participants to control the cost and time for the NEPA process while maintaining its quality and that "For an environmental impact statement, the schedule, absent extraordinary circumstances, will provide for completion of a final environmental impact statement within 15 months of the issuance of the Notice of Intent." In addition, the schedule sub-team for this AoA determined that the NEPA process is not on the critical path, even if it takes 5 years. Therefore, there should be at most a low probability (4) of marginal (4) consequences, corresponding to a low risk (4/4/L) that is the same for all alternatives at all sites.

Table E–6. Summary of alternatives considered in the risk analysis

Alt Name	Capabilities in PF-4	Capabilities Outside PF-4	Alternatives[a]			
0 – Status Quo	Pu science and certification + metal preparation and 30 ppy	None	LANL 0			
1 – Split Production	Pu science and certification + metal preparation and 30 ppy	Production 50 ppy at LANL	LANL 1-A (new)			
		Production 50 ppy at SRS	SRS 1-A (MFFF)	SRS 1-B (K-Area)	SRS 1-C (WSB)	SRS 1-D (new)
		Production 50 ppy at INL	INL 1-A (FPF)	INL 1-B (new)		
	Pu science and certification + metal preparation and maximize production by moving out other functions	Production various at new construction at LANL	LANL 1-B (ARIES and ^{238}Pu stay)	LANL 1-C (ARIES stays, ^{238}Pu goes)	LANL 1-D (ARIES goes, ^{238}Pu stays)	LANL 1-Dmax[b] / LANL 1-E (ARIES and ^{238}Pu both go)
2 – Move Production and Metal Preparation	Pu science and certification	Metal preparation and 80 ppy at LANL	LANL 2 (new)			
		Metal preparation and 80 ppy at SRS	SRS 2-A (MFFF)	SRS 2-B (K-area)	SRS 2-C (WSB)	SRS 2-D (new)
		Metal preparation and 80 ppy at INL	INL 2-A (FPF)	INL 2-B (new)		
3 – Move Production	Pu science and certification + metal preparation	80 ppy at LANL	LANL 3 (new)			
		80 ppy at SRS	SRS 3-A (MFFF)	SRS 3-B (K-area)	SRS 3-C (WSB)	SRS 3-D (new)
		80 ppy at INL	INL 3-A (FPF)	INL 3-B (new)		
4 – Move Metal Preparation	Pu science and certification and 80 ppy	Metal preparation at LANL	LANL 4 (new)			
		Metal preparation at SRS	SRS 4-A (MFFF)	SRS 4-B (K-area)	SRS 4-C (WSB)	SRS 4-D (new)
		Metal preparation at INL	INL 4-A (FPF)	INL 4-B (new)		

[a] After the risk assessment was under way, some of the alternatives in Table E–6 were eliminated. For example, alternatives requiring that ^{238}Pu be removed from PF-4 are infeasible because the impact on the schedule for startup of the 80-ppy manufacturing process is too great. Alternatives in WSB were eliminated because it is too small, and K-reactor was eliminated because of the difficulty of working inside a PIDADS and because it was thought that modifications would likely encounter significant contamination. However, the AoA team decided to document the risk assessment of all the alternatives in Table E–6 for completeness.

[b] LANL 1-Dmax is LANL 1-D with excursions for multiple shifts.

Key:

ARIES = Advanced Recovery and Integrated Extraction System; FPF = Fuel Processing Facility; INL = Idaho National Laboratory; LANL = Los Alamos National Laboratory; MFFF = Mixed Fuel Fabrication Facility; PF-4 = Plutonium Facility; ppy = pits per year; Pu = plutonium; SRS = Savannah River Site; WSB = Waste Solidification Building.

C-2: National and/or local political/public opposition results in delays and extra costs.

The risk associated with this threat differs from site to site but does not distinguish between alternatives at any specific site.

LANL: There are organizations that will object to any expansion of onsite plutonium activities and/or pit manufacturing, such as the Los Alamos Study Group (www.lasg.org) and Nuclear Watch New Mexico (www.nukewatch.org). These organizations include both local and national groups. However, this opposition will be counterbalanced by support from members of the public who see LANL as a source of jobs and revenue. In addition, LANL is not subject to such severe political pressure as SRS (e.g., a lawsuit by the State of South Carolina) or INL (operating under the conditions of a consent decree and subject to a lawsuit). The AoA team considers that the political risk at LANL should be somewhat lower than at INL or SRS, for which sites it was assessed as high probability (2) with significant consequences (3), with a corresponding moderate risk (2/3/M) (see below). For LANL, the probability of significant consequences is assessed to be lower (moderate [3]), leading to a lower risk (3/3/M), which, however, is still moderate and applies to all alternatives at LANL.

SRS: In February 2016, the State of South Carolina sued over the MOX project, asserting in court documents that the federal government has failed to live up to obligations of either completing the MOX project or disposing of 1 metric ton of plutonium waste per year until the MOX building is finished. Settlement talks are under way at the time of publication; as yet, the outcome of these talks is unknown.

In general, the State of South Carolina is concerned that SRS will become a "dumping ground" for plutonium. Therefore, there will be a need to convince the State that the pit manufacturing program will not lead to the continuous accumulation of plutonium at the site. In addition, there are organizations such as Savannah River Site Watch (http://www.srswatch.org/) that will work diligently to try to prevent construction of any type of nuclear facility. On the other hand, state and local people would like to see additional jobs at SRS and, potentially, a use for MFFF. On balance, there is a high probability (2) of significant (3) consequences, with a corresponding moderate risk (2/3/M) that is the same for all alternatives at SRS.

INL: there is a consent decree, dated 10/16/95, which, among other things, places restrictions on bringing spent commercial nuclear fuel onto the site and requires transuranic waste to be removed. There is an ongoing lawsuit against DOE (Governor Andrus vs. DOE) brought by an organization known as Advocates for the West to do with alleged violations of the consent decree. Although the ultimate outcome of the case is still pending, there have already been rulings against DOE. In addition, it is reasonable to assume that Advocates for the West, with numerous member groups from across the western United States, will take a potentially adverse interest in any efforts by DOE to build further nuclear facilities at INL. This could delay the project and cause additional expense and/or lead to unwanted restrictions on the project. The probability that there will be significant consequences (3) is likely high (2). The corresponding risk is moderate (2/3/M) and applies equally to all alternatives at INL.

C-3: National and/or local political /public opposition results in project cancellation.

Because the pit manufacturing mission is critical to national security, the AoA team considers that there is a very low probability (5) that political opposition at any site would be sufficient to cause complete cancellation, i.e., crisis (1). The corresponding risk is moderate (5/1/M) for all alternatives at all sites.

C-4: Sufficient line item funds are not available (either in individual fiscal years or in total), resulting in a delay to completion of construction and startup.

The construction and startup period will likely extend over at least three administrations. There is potentially a high probability (2) that there will be changes in direction and funding leading to critical (2) consequences (e.g., the escalation in the cost of MFFF). The corresponding risk is high (2/2/H) and applies to all alternatives at all sites.

C-5: Intra-agency and/or inter-agency disputes delay the project and introduce extra costs or unwanted restrictions on the project.

LANL is a National Nuclear Security Administration (NNSA) site. There is a very low probability (5) that intra-agency or inter-agency disputes will lead to more than marginal (4) consequences. The corresponding risk is low (5/4/L) and applies equally to all alternatives at LANL.

SRS is operated by DOE's Office of Environmental Management and NNSA is the tenant, so there is potential for intra-agency friction. In addition, there may be some inter-agency friction involving (for example) the Corps of Engineers (which may become involved if wetlands are affected by any proposed construction, which does not apply to either LANL or INL). There is potentially a moderate probability (3) of significant consequences (3), with a corresponding moderate risk (3/3/M) that affects all alternatives at SRS equally.

INL is operated by DOE's Office of Nuclear Energy and has a limited track record of working with NNSA. The AoA team has limited information on the risk associated with intra-agency interactions at INL but considers that the likelihood and consequence are potentially similar to those at SRS: there is potentially a moderate probability (3) of significant consequences (3). The risk is moderate (3/3/M) and affects all alternatives at INL equally.

C-6: Program requirements change (e.g., weapon types or numbers).

This is a possibility that cannot be ruled out as administrations change and/or new external threats arise. Over the assumed 10-year construction period, the probability of this is likely high (2), but if the threat materializes, the consequences may vary over a wide range of unknown factors. It is not possible to plan by including mitigating measures in the design of the manufacturing facility. Therefore, of the four methods that the DOE *Risk Management Guide* propounds for handling risk (accept, avoid, transfer, or mitigate), acceptance is essentially the only feasible alternative. The AoA team assumes that the consequences could be significant (3). The corresponding risk is moderate (2/3/M) and applies equally to all alternatives at all sites.

C-7: Functional performance requirements change (e.g., a requirement is introduced for computerized tomography [CT]).

If functional requirements change, the facility design may have to change (*e.g.,* to accommodate CT). The cost of resultant changes to the facility could be very high—perhaps at the crisis consequence level (2). The AoA team has included this risk because, in conversations with DOE HQ and personnel at LANL, it appears that the issue of what should be included in the pit manufacturing facility is not yet settled. One assumes that it will be settled before construction begins, so that the probability that this threat will materialize is low (4). However, it is a moderate risk (4/2/M) that needs to be addressed. It applies equally to all alternatives at all sites.

C-8: More stringent interpretations of safety requirements and/or new safety requirements during design and construction require significant facility structural or service system upgrades.

There is a very high probability (1) of significant consequences (3) or a high probability (2) of critical consequences (2), based on the history of ratcheted safety requirements. These combinations of probability and consequence are both high risk (1/3/H or 2/2/H) and apply equally to all alternatives at all sites.

C-9: Additional security provisions (e.g., clearances, escorts, fences, changes in the design basis threat [DBT]) beyond planned are imposed.

There is a very high probability (1) of significant consequences (3) or a high probability (2) of critical consequences (2), based on the history of ratcheted security requirements. These combinations of probability and consequence are both high risk (1/3/H or 2/2/H) and apply equally to all alternatives at all sites.

C-10: Construction or repair and modifications impact ongoing site or facility operations, or ongoing site or facility operations impact construction or repair and modification.

LANL – High Risk: Alternatives LANL 1-B, 1-C, 1-D, and 1E and LANL 4 all require construction, repair, and/or modifications in PF-4. There is, therefore, a very high probability (1) that ongoing operations in PF-4 will be affected at the significant (3) or critical (2) level, with the same levels of probability and consequence for ongoing activities in PF-4 affecting construction and/or repair and modification. The corresponding risks are high (1/3/H or 1/2/H).

Note that, after the completion of plutonium sustainment, PF-4 will be needed to produce 30 ppy for several years until the 80 ppy capability is up and running. Following the AoA team's discussions with LANL personnel, it is clear that the construction associated with establishing the 80-ppy manufacturing capability will require equipment to be installed in the same areas as will be used for the ongoing 30-ppy manufacturing process. This will inevitably cause disruption.

LANL – Low Risk: For LANL 2 (80 ppy including metal preparation in new construction) there should be no effect on operations in PF-4 or vice versa, with a very low probability (5) of marginal consequences (5), i.e., the risk is low (5/5/L).

LANL – Moderate Risk: For alternative LANL 3, with 80 ppy outside PF-4, and only science, certification and metal preparation left in PF-4, a subjective judgement is that, with only metal preparation requiring modifications in PF-4, there may be effects on other operations in PF-4, but these would be less disruptive than when installing a full 80-ppy capability, say, a moderate probability (3) of significant (3) consequences, leading to a moderate risk (3/3/M). Likewise, there will be the same moderate risk (3/3/M) that ongoing operations in PF-4 will affect metal preparation construction.

For alternative LANL 1-A, with 50 ppy outside PF-4, and 30 ppy plus science and certification plus metal preparation in PF-4, the assumption is that the 30 ppy will be provided by the Plutonium Sustainment Program. Therefore, work on the metal preparation to provide sufficient capacity for the additional 50 ppy in another facility could potentially affect ongoing operations in PF-4. For the same reason as outlined in the paragraph immediately above, the risk is assessed to be moderate (3/3/M).

SRS – High Risk: K-reactor has ongoing activities (e.g., plutonium storage and dilute and dispose). Regarding Alternatives SRS 1-B, 2-B, 3-B, and 4-B, there is a very high probability (1) that ongoing

operations in K-reactor will be affected by construction at the significant (3) level or a high probability (2) of effects at the critical (2) level, or vice versa. This corresponds to a high risk (1/3/H or 2/2/H). Alternatives that involve metal preparation in a separate facility (SRS 4-A, 4-C, and 4-D) are associated with the production of 80 ppy at LANL and require construction, repair, and/or modifications in PF-4. There is a high probability (1) that ongoing operations in PF-4 will be affected at the significant (3) or critical (2) level, or vice versa. These are high risks (1/3/H or 2/2/H).

SRS – Low Risk: Production of 80 ppy with metal preparation at SRS in MFFF, the Waste Solidification Building (WSB), or new construction (SRS 2-A, 2-C, and 2-D) should not affect ongoing site or facility operations, or vice versa, and will have a low risk (5/5/L).

SRS – Moderate Risk: for all alternatives with 80 ppy outside PF-4, with only science, certification and metal preparation left in PF-4 (SRS 3-A, 3-C, and 3-D), a subjective judgement is that, with only metal preparation requiring modifications in PF-4, there may be effects on other operations in PF-4, but these will be less disruptive than when installing a full 80-ppy capability, say a moderate probability (3) of significant (3) consequences with a corresponding moderate risk (3/3/M). Likewise, there will be a moderate risk (3/3/M) that ongoing site or facility activities will affect construction or repair and modifications.

For all alternatives with 50 ppy outside PF-4 and 30 ppy plus science and certification plus metal preparation in PF-4 (SRS 1-A, 1-C, and 1-D), the assumption is that the 30 ppy will be provided by the Plutonium Sustainment Program. Therefore, work on the metal preparation to provide sufficient capacity for the additional 50 ppy in another facility could potentially affect ongoing operations in PF-4, or vice versa. For the same reason as outlined in the paragraph immediately above, the risk is assessed to be moderate (3/3/M).

INL – High Risk: Alternatives that have metal preparation in a separate facility (INL 4-A and 4-B) are associated with 80 ppy at LANL and require construction, repair, and/or modifications in PF-4. There is a high probability (1) that ongoing operations in PF-4 will be affected at the significant (3) or critical (2) level, or vice versa. Both of these combinations of probability and consequence are high risk (1/3/H or 1/2/H).

INL – Low Risk: Production of 80 ppy with metal preparation at SRS in FPF or new construction (INL 2-A and 2-B) should not affect ongoing site or facility operations or vice versa and will have a low risk (5/5/1).

INL – Moderate Risk: For all alternatives with 80 ppy outside PF-4, with only science, certification and metal preparation left in PF-4 (INL 3-A and 3-B), a subjective judgement is that, with only metal preparation requiring modifications in PF-4, there may be effects on other operations in PF-4, or vice versa, but these will be less disruptive than when installing a full 80-ppy capability, say a moderate probability (3) of significant (3) consequences, 3/3/M.

For all alternatives with 50 ppy outside PF-4 and 30 ppy plus science and certification plus metal preparation in PF-4 (INL 1-A and 1-B), the assumption is that the 30 ppy will be provided by the Plutonium Sustainment Program. However, work on the metal preparation to provide sufficient capacity for the additional 50 ppy in another facility could potentially affect ongoing operations in PF-4, or vice versa. For the same reason as outlined in the paragraph immediately above, the risk is assessed to be moderate (3/3/M).

C-11: Existing facilities require more work than planned to meet applicable codes and standards (e.g., latent conditions may unexpectedly come into play). Equivalently, unforeseen conditions in existing facilities during repair or upgrades result in more work than planned.

LANL: Any of the alternatives that require modifications in PF-4 (all except LANL 2) may require more work than planned, with a moderate probability (3) of significant consequences (3) and a corresponding moderate risk (3/3/M). This threat is not applicable to alternative LANL 2.

SRS: For K-reactor, an old facility with potential contamination, there will be a high probability (2) that this threat will be actualized, with significant (3) consequences and a corresponding moderate risk (2/3/M). For MFFF or WSB, there will be a low probability (4) (because these facilities are new) of significant consequences (3) with a corresponding low risk (4/3/L). This threat is not applicable to new construction.

INL: Use of the Fuel Processing Facility (FPF), a building constructed in the 1990s, may require more work than expected, with a high probability (2) of significant consequences (3) and a corresponding moderate (2/3/M) risk. Note that this is higher than for MFFF (4/3/L) because MFFF is a much newer and recently designed facility and higher than PF-4 (3/3M) because PF-4, though old, has been in essentially continuous operation. This risk is not applicable to new construction.

C-12: Material characterization (MC) capability is insufficient to support the schedule for the nonrecurring testing and analysis required to develop and qualify the manufacturing parameters for the W87 production process.

LANL: This risk is included because, during a visit to LANL by the infrastructure sub-team for this AoA, LANL personnel expressed concern about a potential shortfall in MC capability based on their extensive effort during the W-88 pit production and qualification process, compounded by the uncertainty of working for a different design agency (Lawrence Livermore National Laboratory [LLNL]). In addition, the current low limit on MAR in RLUOB (38.6 grams plutonium) places severe restrictions on the rate at which samples can be processed. However, because there is ample time during the construction period to address and rectify this concern, the AoA team assesses that there is low probability (4) but that the consequences could be significant (3). However, the risk remains low (4/3/L) for all alternatives at LANL.

SRS: During a recent visit to SRS, the AoA team discovered that SRS has limited capability to support MC needs for an 80-ppy manufacturing facility. The necessary facilities to accomplish the MC task would have to be designed, costed, and constructed as part of the overall pit manufacturing effort, taking into account the potential for some of the work to be done elsewhere, such as at LLNL or perhaps LANL.

It should also be noted that if either the MFFF or K-reactor facilities are utilized for pit manufacturing there would be sufficient Hazard Category 1 space available to accommodate a Material Characterization Laboratory need of approximately 8,000 square feet. Such space could also be designed into new construction but would be infeasible in WSB. Given the decade or so of construction and startup time, the AoA team considers that there is a low probability (4) of significant consequences (3) in MFFF, K-reactor, and new construction, with a higher probability (3) of significant consequences (3) for WSB, based on the latter's relative smallness. These risks are low (4/3/L) and moderate (3/3/M), respectively.

INL: MC capability is available in the Fuels and Applied Science Building (FASB) (a 6,000-square foot radiological facility), the Electron Microscope Laboratory (a 2,000-square foot radiological facility),

and the Irradiated Materials Characterization Laboratory (an 11,000-square foot of Hazard Category 2 space) at the Materials and Fuels Complex (MFC). Per discussions at LANL, the AoA team learned that MC has 5,700 square feet of Hazard Category 2 space in PF-4 and is requesting another 200 square feet. It also has 1,900 square feet of Hazard Category 3 space in RLUOB. INL can match this space, which is sufficient to sustain production but may not be enough for activities in the nonrecurring development phase. However, there should be ample time during the construction phase to address these issues, so the team assesses a low probability (4) of significant consequences (3), i.e., the risk is low (4/3/L).

C-13: Unexpected underground site conditions are encountered (e.g., geotechnical, buried pipelines, or buried waste).

LANL: There is negligible (low) risk of this for existing facilities (5/5/L). The site is well studied, so there is a low probability (4) that significant consequences (3) will result from this cause for new construction, corresponding to a low risk (4/3/L). Note that all LANL alternatives may require new construction, currently not exactly defined for LANL 1-B, 1-C, 1-D, and 1-E, so the risk for all LANL alternatives is conservatively 4/3/L.

SRS: As at LANL, there is negligible risk of this for existing facilities (5/5/1) (K-reactor, MFFF, and WSB). The site has been well studied, so there is a low probability (4) that significant consequences (3) will result from this cause when constructing a new building, i.e., the risk is low (4/3/L).

INL: This is not expected to be a problem with FPF, for which the risk should be low (5/5/L). The site is well studied, so there should be a low probability (4) that significant consequences (3) will arise from this cause during new construction. The corresponding risk is low (4/3/L).

C-14: Project design issues occur during construction, modifications, or repair work.

This could be an issue for any alternative. There is a moderate probability (3) of significant consequences (3), corresponding to a moderate risk (3/3/M).

C-15: There are issues with process qualification and/or design agency approval.

The AoA team assesses that there is a moderate probability (3) of marginal consequences (4), i.e., the risk is low (3/4/L). This is not a discriminator between alternatives and sites. The risk may be somewhat lower at LANL than at SRS or INL because the design agency is local, but because the risk is already low, the team did not attempt to estimate how much lower that risk might be.

C-16: There are issues with worker hiring, clearing, and/or training of qualified workers.

During the construction and startup phase, the main concern would be hiring, clearing, and training enough qualified people to staff the initial development and qualification process and then to staff the startup. After considerable discussion, the AoA team concluded that this is not a high risk and assessed a moderate probability (3) of marginal consequences (4), i.e., the risk is low (3/4/L) at all sites and for all alternatives.

C-17: A seismic event occurs during construction, damaging site infrastructure.

A Modified Mercalli Intensity (MMI) level IX earthquake (which corresponds to a peak ground acceleration [PGA] of 250 to 500 gals) causes sufficient damage to the surroundings to delay construction.

LANL: The return period of such earthquakes at LANL is approximately 1,000 years (Wong et al. 2007). The probability over the assumed 10-year construction period is approximately 0.01, which is very low (5). The maximum risk associated with a very low probability (per the risk matrix) is moderate (5/1/M). This is probably conservative (designated by a (C), as in 5/1/M [C]). See above for further discussion on assuming a default conservative estimate of moderate risk for very low frequency events.

SRS: The return period of such earthquakes at SRS is approximately once every 2,000 years (Williams, Carey, and Amin 2014). The corresponding probability over the assumed 10-year construction period is less than 10 percent, i.e., very low (5). The corresponding maximum risk (per the risk matrix) is moderate (5/1/M). This is probably conservative, designated by a (C) (5/1/M [C]).

INL: The return period of such earthquakes at INL is approximately once every 4,000 years (Coleman et al. 2016). The probability over the assumed 10-year construction period is approximately 0.0025, i.e., very low (5). The maximum risk (per the risk matrix) is moderate, which is probably conservative, designated by 5/1/M (C).

C-18: A seismic event occurs, causing damage to the facility under construction.

An MMI level IX earthquake (PGA 250 to 500 gals) causes sufficient damage to the facility to require extensive reconstruction. As noted above, the probability of such an earthquake at any of the three sites over the assumed 10-year construction period is very much less than 10 percent, which is very low (5). As discussed above, the maximum risk (per the risk matrix) is moderate, which is probability conservative and is designated by 5/1/M (C) for all alternatives at all sites.

C-19: A tornado or other high-wind event occurs during construction.

The AoA team conservatively assumes that a wind speed of 100 miles per hour (mph) will be sufficient either to damage the facility under construction or to damage the surrounding infrastructure sufficiently to delay construction, in each case with significant consequences (3). Coats and Murray (1985) derive plots of the return period versus wind speed for all DOE sites (as of 1985). For straight-line 100-mph winds, those return periods are approximately 1,000 years (LANL), 1,000 years (SRS, including hurricanes), and 10,000 years (INL). These correspond to probabilities of approximately 0.01, 0.01, and 0.001, respectively, over the assumed 10-year period of construction, i.e., very low (5). The corresponding risk at all sites is low (5/3/L).

Coats and Murray also show that the return period of tornados with winds of 100 mph or more is once in 500,000 years at LANL, once in 10,000 years at SRS, and once in a million years at INL. These return periods are much longer than those for straight-line winds.

C-20: An external flood occurs.

LANL: In September 2013, Los Alamos was subject to precipitation with an estimated 1,000-year return period (Walterschied 2013). Damage in canyons was extensive, but there was little damage to facilities on the mesa. The probability that such an event will occur again during the assumed 10-year period of construction is approximately 0.01, i.e. very low (5), maybe leading to restricted access to the site for a short while but causing less than or no greater than significant damage (3). The corresponding risk is low (5/3/L).

SRS: The frequencies of flooding at A-, K-, L-, C-, F-, E-, S-, H-, Y- and Z-Areas are significantly less than 10^{-05} per year (Chen 2000), or a very low (5) probability of 0.0001 over a 10-year construction period. The projected consequences depend on the nature of the building. For example, if a building has

below ground levels that could flood, the consequences could be critical (2) or crisis (1). Conservatively, the risk is moderate (5/1/M [C]) but could be significantly less if the chosen facility does not have underground levels.

INL: In PNNL Publication 20029, Skaggs et al. 2010 show that, using the most conservative assumptions for the probable maximum flood (PMF) (i.e., all culverts at the MFC and the diversion ditch located upstream of the MFC are blocked), flood levels exceeding floor elevations could potentially occur at eight locations ranging from 3.20 feet at MFC Building 774 to 0.1 foot at MFC Building 767 (EBR-II Reactor Plant Building). The flood resulting from the 10,000-year precipitation event, assuming the culverts and the diversion ditch were open (i.e., unblocked), could potentially exceed floor elevations at two locations—the MFC Building 785 (Hot Fuel Examination Facility) by 0.1 foot and MFC Building 786 (Hot Fuel Examination Facility substation) by 0.03 feet.

An analysis was also conducted for the Transient Reactor Experiment and Test (TREAT) Facility site, located in a separate drainage area approximately 4,700 feet northwest of the MFC. Results indicate that flows generated by the PMP will produce a maximum water-surface elevation at the TREAT site of only approximately 5,115 feet, approximately 7 feet below the floor elevation of the TREAT Warehouse (MFC Building 723) and over 9 feet below the floor elevation of the TREAT reactor building (MFC Building 720).

Assumption: Neither a new facility nor FPF will be affected by a flood at anything less than the 10,000-year return period. Thus, the probability in an assumed 10-year construction period is approximately 0.001, i.e., very low (5). The maximum risk (per the risk matrix) is moderate, which is probably conservative, designated by 5/1/M (C).

Note: If a flood does reach FPF, most of the building could flood because the building is largely underground. Thus, a critical level consequence (2) or even a crisis level (1) is not totally out of the question. The same would be true for a new building if it were largely underground.

C-21: An external fire occurs.

LANL: There has been a fire at Los Alamos that approached TA-55 (the Cerro Grande fire of May 2000). A forest fire could restrict access to the site but is unlikely to damage plutonium facilities. The AoA team assesses a moderate probability (3) that a fire could approach the pit manufacturing facility and/or PF-4 during the period of construction and startup, with marginal (4) delays or extra costs for pit manufacturing construction. The corresponding risk is low (3/4/L).

SRS: SRS is a heavily forested site. However, areas around K-reactor, MFFF, WSB, and any conceivable new construction are generally clear of any significant combustible vegetation. A forest fire at SRS could restrict access to construction sites for a period of days or weeks. The probability of large forest fire is conservatively moderate (3) during the assumed 10-year period of construction with marginal consequences (4) for pit manufacturing construction. The corresponding risk is low (3/4/L).

INL: The INL site has very little vegetation (see Figure D-34) fire has a very low probability (5) and at most a marginal impact on pit manufacturing facility construction (4), i.e., the risk is low (5/4/L).

C-22: Any other external event occurs.

The AoA team discussed various other external events (e.g., heavy snow, volcanic activity) and suggests a low probability (4) of marginal consequences (4) at all sites, i.e., the risk is low (4/4/L).

C-23: SRS only: if the Mixed Oxide Fuel Fabrication Facility (MFFF) is chosen for the pit manufacturing facility, potential difficulties arise while unraveling the project with Areva.

Unravelling the contract while NNSA and CB&I/Areva are in dispute will be a lengthy process. The contract cannot simply be terminated because then the design basis will be lost—a settlement must be reached in a difficult environment. This is an ongoing dispute; therefore, the probability is very high (1). This state of affairs could cause a delay of between 1 and 2 years in completion of construction and startup (significant [3]). This combination of probability/consequence (1/3) corresponds to a high risk (1/3/H).

C-24: SRS only: difficulties arise while transferring the MFFF facility licensing basis from the Nuclear Regulatory Commission (NRC) to the Department of Energy (DOE).

This has never been done before. It is doable, but there will need to be some individual or organization within NNSA that will accept that a facility that was deemed licensable by NRC also meets DOE standards and requirements. Potentially, this could require a large amount of reanalysis and safety studies. Currently, the AoA team is unable to assess the amount or duration of work that might be involved. This risk will be exacerbated if installing the pit manufacturing facility in MFFF should require structural alterations. The probability that there will be some difficulties in the transfer of the licensing basis is high (2). It is possible that this could cause a delay of between 1 and 2 years in completion of construction and startup (significant -3). This combination of probability/consequence corresponds to a moderate risk (2/3/M).

E.5.2 Threats During the Operating Lifetime

This section details the assignment of probability, consequence, and risk to each pairing of threats listed in Table E–3 (*i.e.*, threats applicable during the facility's operating lifetime) and alternatives listed in Table E–6.

O-1: Pit manufacturing adversely affects other site or facility projects, or other site or facility projects adversely affect pit production.

LANL – High Risk: any alternative that requires pit manufacturing to be done in the same facility and with the same equipment as science and certification runs the risk that the requirement to produce 80 WR pits per year will clash with the needs of other programs or that the needs of other programs will affect the ability to produce 80 ppy. This observation applies to any alternative that includes the manufacture of between 30 ppy and 80 ppy in PF-4. The AoA team judges that there will be a very high probability (1) of significant (3) or critical (4) consequences for all LANL 1 alternatives and LANL 4. This corresponds to a high risk (1/3/H or 1/2/H).

LANL – Low Risk: For alternative LANL 2, there is no potential conflict between pit production and the needs of other programs, so there is a very low probability (5) of marginal consequences (5), with a corresponding low risk (5/5/L).

LANL – Moderate Risk: For alternative LANL 3, with only metal preparation in PF-4, the team judges that there is a moderate probability (3) of significant (3) consequences, with a corresponding moderate risk (3/3/M).

SRS – High Risk: As noted above for LANL, any alternative that requires pit manufacturing to be done in the same facility and with the same equipment as science and certification runs the risk that the requirement to produce 80 WR pits per year will clash with the needs of other programs, or that the needs of other programs will affect the ability to produce 80 ppy. This includes all alternatives in

which a minimum of 30 ppy up to a maximum of 80 ppy are manufactured in PF-4. At SRS, this includes all SRS 1 and SRS 4 alternatives. In addition, K-reactor alternatives SRS 2-B and SRS 3-B have pit production in potential conflict with other activities such as dilute and dispose or plutonium storage. All of these alternatives are assessed to have a very high probability (1) that ongoing operations adversely affect the ability to produce 80 ppy or vice versa at the significant (3) or critical (2) level, corresponding to high levels of risk (1/3/H or 1/2/H).

SRS – Low Risk: For 80 ppy with metal preparation at SRS in MFFF, WSB, or new construction (SRS 2-A, 2-C, and 2-D), there will be no interaction with operations in PF-4, conservatively a very low probability (5) of minimal consequences (5) during operation. The corresponding risk is low (5/5/1).

SRS – Moderate Risk: For all alternatives with 80 ppy outside PF-4, with only science, certification and metal preparation left in PF-4 (SRS 3-A, 3-C, and 3-D), a subjective judgement is that, with only metal preparation remaining in PF-4, there would only be a moderate risk that metal preparation activities supporting 80 ppy manufacturing would adversely affect other programs in PF-4 or vice versa, say a probability (3) of significant (3) consequences. The corresponding risk is moderate (3/3/M).

INL – High Risk: As noted above for LANL and SRS, any alternative that requires pit manufacturing to be done in the same facility and with the same equipment as science and certification runs the risk that the requirement to produce 80 WR pits per year will clash with the needs of other programs or that the needs of other programs will affect the ability to produce 80 ppy. This includes all alternatives in which a minimum of 30 ppy up to a maximum of 80 ppy are manufactured in PF-4. This includes alternatives INL 1-A, 1-B, 4-A, and 4-B. All of these alternatives are assessed to have a very high probability (1) that ongoing operations adversely affect the ability to produce 80 ppy or vice versa at the significant (3) or critical (2) level, corresponding to high risks (1/3/H or 1/2/H).

INL – Low Risk: For 80 ppy with metal preparation at INL in FPF or new construction (INL 2-A and 2-B), there will be no interaction with operations in PF-4, conservatively a very low probability (5) of minimal consequences (5) during operation, corresponding to a low risk (5/5/L).

INL – Moderate Risk: For all alternatives with 80 ppy outside PF-4, with only science, certification and metal preparation left in PF-4 (INL 3-A and 3-B), a subjective judgement is that, with only metal preparation remaining in PF-4, there would only be a moderate risk that metal preparation activities supporting 80 ppy manufacturing would adversely affect other programs in PF-4 or vice versa, say a probability (3) of significant (3) consequences, corresponding to a moderate risk (3/3/M).

O-2: The facility is unable to hire, clear, train, and/or retain sufficient skilled personnel to support ongoing plutonium operations.

During operation, the main concern would be retaining, clearing, hiring, and training enough qualified people to staff the ongoing production process.

LANL: The AoA team is aware that there have been difficulties in hiring qualified staff at LANL but ultimately concluded that this is not a high risk and assessed a moderate probability (3) of marginal consequences (4), i.e., the risk is low (3/4/L).

SRS: The AoA team concluded that this is not a high risk and, as for LANL, assessed a moderate probability (3) of marginal consequences (4), i.e., the risk is low (3/4/L).

INL: Note that, when the AoA team visited INL, they were told that INL has very little difficulty hiring qualified staff. The team ultimately concluded that this is not a high risk and again assessed a moderate probability (3) of marginal consequences (4), i.e., the risk is low (3/4/L).

O-3: Low level waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.

LANL: During a visit to LANL, the infrastructure sub-team for this AoA determined that LANL has a new low level liquid waste treatment facility that has ample capacity for dealing with the waste from 80 ppy manufacturing and other sources at LANL. In addition, the sub-team determined that there is ample capacity and potential workarounds for handling and disposing of solid low level waste. There is a very low probability (5) of marginal consequences (4), i.e., the risk is low (5/4/L).

SRS: During a visit to SRS, the infrastructure sub-team determined that SRS has ample capacity for both low-level liquid and solid waste treatment and disposal. There is a very low probability (5) of marginal consequences (4), i.e., the risk is low (5/4/L).

INL has adequate capabilities and capacity to handle both liquid and solid low level waste generated by the manufacturing of 80 ppy, as established by INL's response to a questionnaire. The AoA team assessed a very low probability (5) of marginal consequences (4), i.e., the risk is low (5/4/L).

O-4: TRU waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.

LANL: during a visit to LANL, the infrastructure sub-team determined that LANL will shortly have a new liquid TRU waste facility that has ample capacity for dealing with liquid TRU waste from an 80-ppy manufacturing facility and other sources at LANL. In addition, LANL has the capacity to store up to 2 years' worth of TRU waste in 55-gallon drums. Absent external factors (see below), LANL will be able to manage the TRU waste packaging and disposition associated with 80 ppy manufacturing. There is a very low probability (5) of a marginal consequence (4), i.e., the risk is low (5/4/L).

SRS: During a visit to SRS, the infrastructure sub-team determined that SRS has ample capacity for dealing with liquid TRU waste from an 80-ppy manufacturing facility and other sources at SRS. In addition, SRS has the capacity to store more than 5 years' worth of solid TRU waste in 55-gallon drums. Absent external factors (see below) SRS will be able to manage the TRU waste packaging and disposition associated with 80 ppy manufacturing. There is a very low probability (5) of a marginal consequence (4), i.e., the risk is low (5/4/L).

INL: As established by INL's response to a questionnaire, the AoA team determined that INL has a facility that can process approximately 140 cubic meters (m^3) of liquid TRU waste per year. Manufacturing 80 ppy will produce liquid TRU-waste in the range 3 m^3/year (MPF) to 30 m^3/year (LANL). Either of these is well within the capacity of the INL facility.

INL is currently capable of processing 250 m^3/month of solid TRU waste. The amount of solid TRU waste generated by the manufacture of 80 ppy would be in the range of 130 m^3/year (MPF) to 220 m^3/year (LANL). The INL facility is currently fully utilized, but its current mission is scheduled to end in 2021. Assuming that the facility would then be retained for future missions, its capacity is more than adequate to handle solid TRU waste from an 80-ppy manufacturing facility. The AoA team assesses a very low probability (5) of marginal consequences (4), i.e., the risk is low (5/4/L).

O-5: WIPP shuts down for an extended period of time (months or years) so that TRU waste storage capability reaches its limit and pit production ceases.

WIPP recently shut down for 3 years. Another shutdown of WIPP over the assumed 50-year life of the pit manufacturing program would seem to be at least moderately probable (3).

LANL: If WIPP shuts down again for 3 or more years, LANL would not have enough capacity to store all of the solid TRU waste produced over that time. This would require the construction of more storage space. Spread over a few years of operation, this would likely be a marginal consequence (4). The corresponding risk is low (3/4/L).

SRS: As noted above, SRS has ample capacity to store TRU waste for several years. There would be some costs associated with this increased storage, perhaps at the marginal level (4). This corresponds to a low risk (3/4/L).

The IST for this AoA was unable to establish **INL's** capacity to store TRU waste in the event that transportation of TRU-waste to WIPP is interrupted. However, it is anticipated that costs associated with this increased storage, if needed at all, would be marginal (4). The corresponding risk is low (3/4/L).

O-6: When WIPP comes back on line after a shutdown, additional regulatory and safety constraints mean that it accepts shipments at a rate that is insufficient to process waste generated by an 80-ppy program.

This threat is a slow-motion version of threat O-5. The chosen site (whether LANL, SRS, or INL) will generate TRU waste at a rate that is greater than the allowable rate of shipment to WIPP, so that gradually available storage capacity is filled and more will be needed. It is actually the case that, now that the recent shutdown is over, WIPP is accepting shipments at a reduced rate. In addition, there are restrictions that mean that some TRU waste is more dilute than in the past: *i.e.*, more drums are required for a given amount of TRU waste. The probability of occurrence of this scenario is very high (1) at all sites, with marginal consequences (4) related to the building over time of additional solid TRU waste storage space. The corresponding risk is moderate (1/4/M).

O-7: WIPP becomes full and is no longer able to accept solid TRU waste, and no other repository is available.

The U.S. Governmental Accountability Office (GAO) has published a report (GAO-17-390), *Proposed Dilute and Dispose Approach Highlights Need for More Work at the Waste Isolation Pilot Plant*, that states that "DOE does not have sufficient space at WIPP to dispose of all defense TRU waste. DOE's current plan is to fill the existing disposal space in WIPP by 2026, and additional space will need to be excavated to dispose of all the waste included in DOE's current TRU waste inventory report." However, one assumes that this risk will be mitigated by construction of further storage capacity at WIPP if needed. Therefore, the AoA team assesses a low probability (4) that the ability to dispose of TRU waste at WIPP will be permanently halted. There might be delays that would necessitate building further TRU waste storage capacity over time, with marginal consequences (4) at any of the sites. The corresponding risk is low (4/4/L).

O-8: *Analytical chemistry (AC) or materials characterization (MC) capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.*

LANL: During a visit to LANL, the infrastructure sub-team for this AoA determined that there are a number of uncertainties associated with LANL's ability to provide AC support to the 80-ppy manufacturing program. Among these are limitations on MAR in CMRR and how much AC work will

be required to support other programs such as ARIES. However, given that it will be a decade or so before 80 ppy manufacturing is up and running, there appears to be ample time to solve problems, build additional space, or identify workarounds. Therefore, it would seem that there is a low probability (4) of significant consequences (3). Similar considerations apply to MC. This is a low risk (4/3/L).

SRS: During a visit to SRS, the infrastructure sub-team discovered that there are a number of uncertainties associated with SRS's ability to provide AC support to the 80-ppy manufacturing program. Among these are 200-gram plutonium limitations on MAR in the buildings in which AC work is performed. However, given that it will be a decade or so before 80 ppy manufacturing is up and running, there appears to be ample time to solve problems, build additional space, or identify workarounds. Therefore, as at LANL, it would seem that there is a low probability (4) of significant consequences (3). Similar considerations apply to MC. The corresponding risk is low (4/3/L).

INL currently has the capability needed to meet the AC needs of 80 ppy manufacturing, according to answers provided in a questionnaire but would need to upgrade capacity. This capability is currently housed in Hazard Category 3 buildings, with a plan to upgrade to Hazard Category 2. Given the expected decade-long construction and startup phase, the AoA team considers that there is ample time to enhance capacity and develop workarounds, with a low probability (4) of significant consequences (3). Similar considerations apply to MC. The corresponding risk is low (4/3/L).

O-9: Any other support infrastructure capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.

Other needed infrastructure capabilities include classified stainless-steel machining, classified graphite machining, classified beryllium machining, coating, and standards and calibration. There is a low probability (4) that these will be unavailable and lead to significant consequences (3), *i.e.*, the risk is low (4/3/L) at all three sites.

O-10: Inability to obtain spare/replacement parts for failed equipment increases potential shutdown durations, impacting mission.

There is a high probability (2) that one or more items of equipment become obsolete and replacement parts are unavailable. However, workarounds are always possible, at marginal cost (4). The corresponding risk is moderate (2/4/M) and is the same for all alternatives at all three sites.

O-11: Supplier(s) of essential and unique equipment go out of business, refuse to take the job, or deliver poor quality.

Across the NNSA complex, there have been several examples of suppliers going out of business, refusing to take jobs, or delivering poor quality. There is a moderate probability (3) that this will occur during the operating lifetime of the pit manufacturing facility. There are workarounds (e.g., NNSA making equipment or materials itself) but at possibly significant cost (3), i.e., the risk is moderate (3/3/M) for all alternatives at all three sites.

O-12: Aircraft impact damages the facility.

Typical calculated aircraft crash frequencies into buildings, using standard DOE methodology, are very conservatively approximately 10^{-5}/year. This equates to a very low probability (5) of a crash over a 50-year lifetime. Per the risk matrix, the maximum risk is moderate and probably conservative (5/1/M [C]) and applies to all alternatives at all three sites. If, in the future, the need should arise to

refine this conservative analysis, it will be necessary to obtain aircraft crash analyses for facilities at each of the sites.

O-13: A hazardous material release elsewhere onsite or at a nearby industrial facility or from a transportation accident affects operators and causes a facility shutdown; subsequent decontamination may be required.

The principal concern here is that a release of hazardous material could result in contamination of the manufacturing facility such that extensive decontamination is required. This could be a consequence at a crisis level (2). However, the probability is very low (5) at any of the sites, so that the risk is also low (5/2/L).

O-14: Transportation capacity for shipping pits and plutonium feedstock is insufficient to meet demands from all DOE sites.

The 80-ppy program will require a very small number of shipments per year. The probability that transportation would not be available when needed is very low (5). The consequences could be significant (3), but the risk is low (5/3/L).

O-15: A seismic event occurs during operation

Assume that the facility is designed or upgraded to withstand an earthquake with a return period of 10,000 years, or a probability of 0.005 in a 50-year operating life. This is a very low probability (5). Therefore, per the risk matrix, the highest risk is moderate. This is probably conservative (5/1/M [C]). This conclusion applies to all alternatives at all sites.

For all sites, the probability that an earthquake occurs that is severe enough to damage infrastructure and surroundings to the extent that the facility may have to be shut down for a time is also very low (5) with a maximum moderate risk, probably conservative (5/1/M [C]); see discussion for C-17.

O-16: A tornado or other high-wind event occurs.

Assume that the facility is designed or upgraded to withstand straight-line winds with a return period of 2,500 years, hurricanes with a return period of 2,500 years (noting that no hurricanes occur at LANL or INL), and/or tornadoes with a return period of 50,000 years for a WDC-3 SSC, per DOE-STD-1020-2016 (DOE 2016). Over a 50-year operating life, the probability of winds stronger than this is < 0.075, i.e., very low (5). Per the risk matrix, the maximum risk is moderate. This is probably conservative, designated by 5/1/M (C), and applies to all alternatives at all sites.

O-17: An external flood occurs.

LANL: As discussed above, in September 2013, Los Alamos was subject to precipitation with an estimated 1,000-year return period. Damage in canyons was extensive, but there was little damage to facilities on the mesa. The probability that such an event will occur again during the assumed 50-year period of construction is 0.05, *i.e.,* very low (5), causing no greater than significant damage (3). The corresponding risk is low (5/3/L).

SRS: As discussed above, the frequencies of flooding at A-, K-, L-, C-, F-, E-, S-, H-, Y-, and Z-Areas are significantly less than 10^{-05} per year (WSRC-TR-2000-00206), or a very low (5) probability of 5×10^{-04}/year over a 50-year operating lifetime. If flooding occurs, the projected consequences could be at a crisis (5) level (e.g., if a facility is largely underground and could be completely flooded). A conservative upper bound on the risk is moderate (5/1/M [C]).

INL: Assume that new construction is designed or FPF is upgraded to the requirements of DOE-STD-1020-2016, FDC-3 SSCs subject to submersion not flooded more often than once in 10,000 years, and FDC-3 SSCs not subject to immersion not flooded more than once in 2,500 years. The probability of such severe floods during a 50-year operating lifetime is <0.075, i.e., very low. Per the risk matrix, the maximum risk is moderate. This is probably conservative, designated by 5/1/M (C).

O-18: An external fire occurs.

LANL: As discussed above, there has been a fire at Los Alamos that approached TA-55, the Cerro Grande fire of May 2000. A forest fire could restrict access to the site but is unlikely to damage facilities. The AoA team suggests a moderate probability (3) that a fire will approach the pit manufacturing facility and/or PF-4, with marginal (4) delays or extra costs for pit manufacturing operations. The corresponding risk is low (3/4/L).

SRS is a heavily forested site. However, areas around K-reactor, MFFF, WSB, and any conceivable new construction are generally clear of any significant combustible vegetation. A forest fire at SRS could restrict access to construction sites for a period of days or weeks. The probability of large forest fire over a 50-year operating lifetime is assessed to be moderate (3) with marginal consequences (4) for the pit manufacturing operation. This corresponds to a low risk (3/4/L).

INL: The INL site has very little vegetation (see Figure D-34). The probability of external fire approaching FPF or new construction is very low (5), with at most marginal impact on pit manufacturing facility construction (4). The corresponding risk is low (5/4/L).

O-19: Any other external event occurs.

The AoA team discussed various other external events (e.g., heavy snow, volcanic activity) and suggests a low probability (4) of marginal consequences (4), i.e., the risk is low (4/4/L) for all alternatives at all sites.

E.6 Summary

This section has two parts. The first is a tabular summary of the discussion in the foregoing. The second is a summary of the results for the alternatives that were finally chosen for presentation to senior management.

E.6.1 Tabular Summary

The discussion above is summarized in Tables E–7 (LANL), E–8 (SRS), and E–9 (INL).

Table E–7. Summary of results of risk assessment for LANL alternatives

ID#	Brief Description of Threat	LANL 1-A	LANL 1-B	LANL 1-C	LANL 1-D	LANL 1-Dmax	LANL 1-E	LANL 2	LANL 3	LANL 4
C-1	NEPA: EIS or additional environmental reviews cause delays and extra costs.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L
C-2	National and/or local political/public opposition results in delays and extra costs.	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
C-3	National and/or local political /public opposition results in project cancellation.	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M
C-4	Sufficient line item funds are not available (either in individual fiscal years or in total), resulting in a delay to completion of construction and startup.	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H
C-5	Intra-agency and/or inter-agency disputes delay project and introduce extra costs or unwanted restrictions on the project.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
C-6	Program requirements change (e.g., weapon types or numbers).	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M
C-7	Functional performance requirements change (e.g., requirement introduced for computerized tomography).	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M
C-8	More stringent interpretations of safety requirements during design and construction require significant facility structural or service system upgrades.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
C-9	Additional security provisions (e.g., clearances, escorts, fences, changes in the design basis threat) beyond planned are imposed.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
C-10	Construction or repair and modifications impact ongoing site or facility operations, or ongoing operations impact construction and/or repairs and modifications.	3/3/M	1/3/H or 1/2/H	1/3/H or 1/2/H	1/3/H or 1/2/H	1/3/H or 1/2/H	1/3/H or 1/2/H	5/5/L	3/3/M	1/3/H or 1/2/H
C-11	Existing facilities require more work than planned to meet applicable codes and standards (e.g., latent conditions may unexpectedly come into play). Equivalently, unforeseen conditions in existing facilities during repair or upgrades result in more work than planned.	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	N/A	3/3/M	3/3/M

ID#	Brief Description of Threat	LANL 1-A	LANL 1-B	LANL 1-C	LANL 1-D	LANL 1-Dmax	LANL 1-E	LANL 2	LANL 3	LANL 4
C-12	Material characterization (MC) capability is insufficient to support the schedule for the nonrecurring testing and analysis required to develop and qualify the manufacturing parameters for the W87 production process.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
C-13	Unexpected underground site conditions (e.g., geotechnical, buried pipelines, or buried waste) are encountered.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/I	4/3/L	4/3/L	4/3/L	4/3/L
C-14	Project design issues occur during work (construction/modifications/repairs).	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
C-15	There are issues with process qualification and/or design agency approval.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-16	There are issues with worker training and hiring of qualified workers.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-17	A seismic event occurs during construction, damaging site infrastructure.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-18	A seismic event occurs, causing damage to facility under construction.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-19	A tornado or other high-wind event occurs during construction.	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L
C-20	An external flood occurs during construction.	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L
C-21	An external fire occurs during construction.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-22	Any other external event occurs during construction.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L
O-1	Pit manufacturing adversely affects other site or facility projects, or other site or facility projects adversely affect pit production.	1/3/H or1/2/H	1/3/H or1/2/H	1/3/H or1/2/H	1/3/H or1/2/H	1/3/H or1/2/H	1/3/H or1/2/H	5/5/L	3/3/M	1/3/H or1/2/H
O-2	The facility is unable to hire, train, and/or retain sufficient skilled personnel to support ongoing plutonium operations.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
O-3	Low level waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
O-4	TRU waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
O-5	WIPP shuts down for an extended period of time (months or years) so that TRU waste storage capability reaches its limit.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L

ID#	Brief Description of Threat	LANL 1-A	LANL 1-B	LANL 1-C	LANL 1-D	LANL 1-Dmax	LANL 1-E	LANL 2	LANL 3	LANL 4
O-6	When WIPP comes back on line after a shutdown, additional regulatory and safety constraints mean that it accepts shipments at a rate that is insufficient to process waste generated by an 80-ppy program.	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M
O-7	WIPP becomes full and is no longer able to accept solid TRU waste, and no other repository is available.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L
O-8	Analytical chemistry or materials characterization capabilities are insufficient to support the 80-ppy manufacturing effort.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
O-9	Any other support infrastructure capabilities deteriorate, become overwhelmed, or are unavailable for an extended period.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
O-10	Inability to obtain spare/replacement parts for failed equipment increases potential shutdown durations, impacting mission.	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M
O-11	Supplier(s) of essential and unique equipment and/or materials go out of business, refuse to take the job, or deliver poor quality.	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
O-12	Aircraft impact damages the facility.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-13	A hazardous material release elsewhere onsite or at a nearby industrial facility or from a transportation accident affects operators and causes facility shutdown; subsequent decontamination may be required.	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L
O-14	Transportation capacity for shipping pits and plutonium feedstock is unavailable when needed.	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L
O-15	A seismic event occurs during operation.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-16	A tornado or other high-wind event occurs during operation.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-17	A flood occurs during operation.	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L
O-18	An external fire occurs during operation.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
O-19	Any other external event occurs during operation.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L

Key:
EIS = environmental impact statement; LANL= Los Alamos National Laboratory; NEPA = National Environmental Policy Act; ppy = pits per year; TRU = transuranic; WIPP = Waste Isolation Pilot Plant.

Table E–8. Summary of results of risk assessment for SRS alternatives

ID#	Brief Description of Threat	SRS 1-A	SRS 1 B	SRS 1-C	SRS 1-D	SRS 2-A	SRS 2-B	SRS 2-C	SRS 2-D	SRS 3-A	SRS 3-B	SRS 3-C	SRS 3-D	SRS 4-A	SRS 4-B	SRS 4-C	SRS 4-D
C-1	NEPA: EIS or additional environmental reviews cause delays and extra costs.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L
C-2	National and/or local political/public opposition results in delays and extra costs.	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M
C-3	National and/or local political /public opposition results in project cancellation.	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M
C-4	Sufficient line item funds are not available (either in individual fiscal years or in total), resulting in a delay to completion of construction and startup.	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H
C-5	Intra-agency and/or inter-agency disputes delay project, introduce extra costs or unwanted restrictions on the project.	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
C-6	Program requirements change (e.g., weapon types or numbers).	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M
C-7	Functional performance requirements change (e.g., requirement introduced for computerized tomography).	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M
C-8	More stringent interpretations of safety requirements during design and construction require significant facility structural or service system upgrades.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H

ID#	Brief Description of Threat	SRS 1-A	SRS 1 B	SRS 1-C	SRS 1-D	SRS 2-A	SRS 2-B	SRS 2-C	SRS 2-D	SRS 3-A	SRS 3-B	SRS 3-C	SRS 3-D	SRS 4-A	SRS 4-B	SRS 4-C	SRS 4-D
C-9	Additional security provisions (e.g., clearances, escorts, fences, changes in the design basis threat) beyond planned are imposed.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
C-10	Construction or repair and modifications impact ongoing site or facility operations, or ongoing site or facility activities impact construction or repair and modifications.	3/3/M	1/3/H or 2/2/H	3/3/M	3/3/M	5/5/L	1/3/H or 2/2/H	5/5/L	5/5/L	3/3/M	1/3/H or 2/2/H	3/3/M	3/3/M	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
C-11	Existing facilities require more work than planned to meet applicable codes and standards (i.e., latent conditions may unexpectedly come into play). Equivalently, unforeseen conditions in existing facilities during repair or upgrades result in more work than planned.	4/3/L	2/3/M	4/3/L	N/A	4/3/L	2/3/M	4/3/L	N/A	4/3/L	2/3/M	4/3/L	N/A	4/3/L	2/3/M	4/3/L	N/A
C-12	Material characterization (MC) capability is insufficient to support the schedule for the nonrecurring testing and analysis required to develop and qualify the manufacturing parameters for the W87 production process.	4/3/L	4/3/L	3/3/M	4/3/L	4/3/L	4/3/L	3/3/M	4/3/L	4/3/L	4/3/L	3/3/M	4/3/L	4/3/L	4/3/L	3/3/M	4/3/L
C-13	Unexpected underground site conditions are encountered (e.g., geotechnical, buried pipelines, or buried waste).	5/5/L	5/5/L	5/5/L	4/3/L	5/5/L	5/5/L	5/5/L	4/3/L	5/5/L	5/5/L	5/5/L	4/3/L	5/5/L	5/5/L	5/5/L	4/3/L

ID#	Brief Description of Threat	SRS 1-A	SRS 1 B	SRS 1-C	SRS 1-D	SRS 2-A	SRS 2-B	SRS 2-C	SRS 2-D	SRS 3-A	SRS 3-B	SRS 3-C	SRS 3-D	SRS 4-A	SRS 4-B	SRS 4-C	SRS 4-D
C-14	Project design issues occur during work (construction/ modifications/repairs).	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
C-15	There are issues with process qualification and/or design agency approval.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-16	There are issues with worker training and hiring of qualified workers.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-17	A seismic event occurs during construction, damaging site infrastructure.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-18	A seismic event occurs, causing damage to facility under construction.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-19	A tornado or other high-wind event occurs during construction.	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L
C-20	An external flood occurs during construction.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-21	An external fire occurs during construction.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-22	Any other external event occurs during construction.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L
C-23	If MFFF is chosen for the pit manufacturing facility, potential difficulties arise while unraveling the project with Areva.	1/3/H	N/A	N/A	N/A	1/3/H	N/A	N/A	N/A	1/3/H	N/A	N/A	N/A	1/3/H	N/A	N/A	N/A
C-24	Difficulties arise while transferring the MFFF facility licensing basis from NRC to DOE.	2/3/M	N/A	N/A	N/A	2/3/M	N/A	N/A	N/A	2/3/M	N/A	N/A	N/A	2/3/M	N/A	N/A	N/A
O-1	Pit manufacturing adversely affects other site or facility projects, or other site or facility projects adversely affect pit production.	1/3/H or 1/2/H	1/3/H or 1/2/H	1/3/H or 1/2/H	1/3/H or 1/2/H	5/5/L	1/3/H or 1/2/H	5/5/L	5/5/L	3/3/M	1/3/H or 1/2/H	3/3/M	3/3/M	1/3/H or 1/2/H	1/3/H or 1/2/H	1/3/H or 1/2/H	1/3/H or 1/2/H

ID#	Brief Description of Threat	SRS 1-A	SRS 1 B	SRS 1-C	SRS 1-D	SRS 2-A	SRS 2-B	SRS 2-C	SRS 2-D	SRS 3-A	SRS 3-B	SRS 3-C	SRS 3-D	SRS 4-A	SRS 4-B	SRS 4-C	SRS 4-D
O-2	The facility is unable to hire, clear, train, and/or retain sufficient skilled personnel to support ongoing plutonium operations.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
O-3	Low level waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
O-4	TRU waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
O-5	WIPP shuts down for an extended period of time (months or years) so that TRU waste storage capability reaches its limit and pit production ceases.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
O-6	When WIPP comes back on line after a shutdown, additional regulatory and safety constraints mean that it accepts shipments at a rate that is insufficient to process waste generated by an 80-ppy program.	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M
O-7	WIPP becomes full and is no longer able to accept solid TRU waste, and no other repository is available.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L

ID#	Brief Description of Threat	SRS 1-A	SRS 1 B	SRS 1- C	SRS 1- D	SRS 2- A	SRS 2- B	SRS 2- C	SRS 2- D	SRS 3- A	SRS 3- B	SRS 3- C	SRS 3- D	SRS 4- A	SRS 4- B	SRS 4- C	SRS 4- D
O-8	Analytical chemistry or material characterization capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
O-9	Any other support infrastructure capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
O-10	Inability to obtain spare/replacement parts for failed equipment increases potential shutdown durations, impacting mission.	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M
O-11	Supplier(s) of essential and unique equipment go out of business, refuse to take the job, or deliver poor quality.	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
O-12	Aircraft impact damages the facility.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-13	Hazardous material release elsewhere onsite or at a nearby industrial facility or from a transportation accident affects operators and causes a facility shutdown; subsequent decontamination may be required.	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L
O-14	Transportation capacity for shipping pits and plutonium feedstock is insufficient to meet needs.	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L
O-15	A seismic event occurs during operation.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)

ID#	Brief Description of Threat	SRS 1-A	SRS 1 B	SRS 1-C	SRS 1-D	SRS 2-A	SRS 2-B	SRS 2-C	SRS 2-D	SRS 3-A	SRS 3-B	SRS 3-C	SRS 3-D	SRS 4-A	SRS 4-B	SRS 4-C	SRS 4-D
O-16	A tornado or other high wind event occurs during operation.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-17	An external flood occurs during operation s.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-18	An external fire occurs during operation.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
O-19	Any other external event occurs during operation.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L

Key:

EIS = environmental impact statement; MFFF = Mixed Fuel Fabrication Facility; NEPA = National Environmental Policy Act; NRC = Nuclear Regulatory Commission; ppy = pits per year; SRS = Savannah River Site; TRU = transuranic; WIPP = Waste Isolation Pilot Plant.

Table E–9. Summary of results of risk assessment for INL alternatives

ID#	Identifier	INL 1-A	INL 1-B	INL 2-A	INL 2-B	INL 3-A	INL 3-B	INL 4-A	INL 4-B
C-1	NEPA: EIS or additional environmental reviews cause delays and extra costs.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L
C-2	National and/or local political/public opposition results in delays and extra costs.	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M
C-3	National and/or local political/public opposition results in project cancellation.	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M
C-4	Sufficient line item funds are not available, resulting in a delay to completion of construction and startup.	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H
C-5	Intra-agency and/or inter-agency disputes delay project and introduce extra costs or unwanted restrictions on the project.	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
C-6	Program requirements change (e.g., weapon types or numbers).	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M
C-7	Functional performance requirements change (e.g., requirement introduced for computerized tomography).	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M
C-8	More stringent interpretations of safety requirements during design and construction require significant facility structural or service system upgrades.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
C-9	Additional security provisions (e.g., clearances, escorts, fences, changes in the design basis threat) beyond planned are imposed.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
C-10	Construction or repair and modifications impact ongoing site or facility operations, or ongoing operations impact construction or repair and modifications.	3/3/M	3/3/M	5/5/L	5/5/L	3/3/M	3/3/M	1/3/H or 2/2/H	1/3/H or 2/2/H
C-11	Existing facilities require more work than planned to meet applicable codes and standards (e.g., latent conditions may unexpectedly come into play). Equivalently, unforeseen conditions in existing facilities during repair or upgrades result in more work than planned.	2/3/M	N/A	2/3/M	N/A	2/3/M	N/A	2/3/M	N/A
C-12	Material characterization (MC) capability is insufficient to support the schedule for the nonrecurring testing and analysis required to develop and qualify the manufacturing parameters for the W87 production process.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
C-13	Unexpected underground site conditions (e.g., geotechnical, buried pipelines, or buried waste) are encountered.	5/5/L	4/3/L	5/5/L	4/3/L	5/5/L	4/3/L	5/5/L	4/3/L

ID#	Identifier	INL 1-A	INL 1-B	INL 2-A	INL 2-B	INL 3-A	INL 3-B	INL 4-A	INL 4-B
C-14	Project design issues occur during work (construction/modifications/repairs).	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
C-15	There are issues with process qualification and/or design agency approval.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-16	There are issues with hiring, clearing, and/or training qualified workers.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-17	A seismic event occurs during construction, damaging site infrastructure.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-18	A seismic event occurs, causing damage to facility under construction.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-19	A tornado or other high-wind event occurs during construction.	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L
C-20	An external flood occurs during construction.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-21	An external fire occurs during construction.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
C-22	Any other external event occurs during construction.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L
O-1	Pit manufacturing adversely affects other site or facility projects, or other site or facility projects adversely affect pit production.	1/3/H or 1/2/H	1/3/H or 1/2/H	5/5/L	5/5/L	3/3/M	3/3/M	1/3/H or 1/2/H	1/3/H or 1/2/H
O-2	The facility is unable to hire, train, clear, and/or retain sufficient skilled personnel to support ongoing plutonium operations	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
O-3	Low level waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
O-4	TRU waste treatment capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
O-5	WIPP shuts down for an extended period of time (months or years) so that TRU waste storage capability reaches its limit and pit production ceases.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
O-6	When WIPP comes back on line after a shutdown, additional regulatory and safety constraints mean that it accepts shipments at a rate that is insufficient to process waste generated by an 80-ppy program.	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M	1/4/M
O-7	WIPP becomes full and is no longer able to accept solid TRU waste, and no other repository is available.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L

ID#	Identifier	INL 1-A	INL 1-B	INL 2-A	INL 2-B	INL 3-A	INL 3-B	INL 4-A	INL 4-B
O-8	Analytical or materials characterization capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
O-9	Any other support infrastructure capabilities deteriorate, become overwhelmed, or are unavailable for an extended period, impacting mission.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
O-10	Inability to obtain spare/replacement parts for failed equipment increases potential shutdown durations, impacting mission.	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M	2/4/M
O-11	Supplier(s) of essential and unique equipment go out of business, refuse to take the job, or deliver poor quality.	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
O-12	Aircraft impact damages facility.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-13	A hazardous material release elsewhere onsite or at a nearby industrial facility or from a transportation accident affects operators and causes facility shutdown; subsequent decontamination may be required.	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L	5/2/L
O-14	Transportation capacity for shipping pits and plutonium feedstock is insufficient to meet demands from all DOE sites.	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L	5/3/L
O-15	A seismic event occurs during operation.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-16	A tornado or other high-wind event occurs during operation.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-17	An external flood occurs during operation.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
O-18	An external fire occurs during operation.	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L	5/4/L
O-19	Any other external event occurs.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L

Key:

EIS = environmental impact statement; INL = Idaho National Laboratory; NEPA = National Environmental Policy Act; ppy = pits per year; TRU = transuranic; WIPP = Waste Isolation Pilot Plant.

E.6.2 Summary of Risks Associated with Short List of Alternatives

Of the alternatives listed in Table E–6, the following were eliminated:

- Alternatives in K-reactor for three reasons: (1) working inside an existing PIDADS adds considerable delay and expense; (2) it was thought likely that any construction work inside K-reactor will encounter contamination left over from its time as an operating reactor; and (3) there are other operations inside K-reactor that will interfere with construction and/or operation of the pit manufacturing facility, or vice versa (e.g., surplus plutonium disposition and plutonium storage). These alternatives are SRS 1-B, SRS 2-B, SRS 3-B, and SRS 4-B.
- Alternatives in WSB, because this building is simply too small. These alternatives are -A, SRS 3-B, SRS 3-C, and SRS 3-D.
- Alternatives with metal preparation in a separate building, because rough order of magnitude costs show that this would add excessive expense to the construction of the 80-ppy manufacturing capability. These are alternatives LANL 4, SRS 4-A and 4-D, and INL 4-A and 4-B.

The five alternatives that remain are 80 ppy with metal preparation in LANL 2 (new construction), SRS 2-A (MFFF), SRS 2-D (new construction), INL 2-A (FPF), and INL 2-B (new construction).

Alternatives that rely on PF-4 to reliably deliver part or all of the required 80 ppy are considered high risk. This is because it was felt that conflict between the other activities in PF-4 and either construction of the 80-ppy capability or its operation, or vice versa (see the discussions above of threats C-10, C-11, and O-1 in the context of LANL), would be inevitable. This eliminates LANL 1-A, 1-B, 1-C, 1-D, and 1-E; SRS 1-A and 4-A; and INL 1-A and 1-B. However, these alternatives have been collected under one generic heading, "PF-4 reuse," and are included in the following analysis for comparison.

The risk information about each of the five alternatives identified above and PF-4 reuse is summarized below in Table E–10.

Table E–11 displays the same information as Table E–10 but in a different order. At the top of the table are risks for which (a) the risk is high for at least one alternative and (b) the risk discriminates between alternatives. This is followed by risks that are high for all alternatives. After that, there are risks for which (a) no risk is high, (b) at least one risk is moderate, and (c) the risk discriminates between alternatives. The next group is of those risks that are all moderate and do not discriminate between alternatives. The final grouping is of the remaining risks, which are all low. This allows the reader to see at a glance which high risks are true discriminators.

Table E–10. Summary of results of risk assessment for short list of alternatives

ID#	Brief Description of Threat	PF-4 Reuse	LANL 2	SRS 2-A	SRS 2-D	INL 2-A	INL 2-B
C-1	NEPA: EIS or additional environmental reviews cause delays and extra costs.	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L	4/4/L
C-2	National and/or local political/public opposition results in delays and extra costs.	3/3/M	3/3/M	2/3/M	2/3/M	2/3/M	2/3/M
C-3	National and/or local political /public opposition results in project cancellation.	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M	5/1/M
C-4	Sufficient line item funds are not available (either in individual fiscal years or in total), resulting in a delay to completion of construction and startup.	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H	2/2/H
C-5	Intra-agency and/or inter-agency disputes delay project and introduce extra costs or unwanted restrictions on the project.	5/4/L	5/4/L	3/3/M	3/3/M	3/3/M	3/3/M
C-6	Program requirements change (e.g., weapon types or numbers).	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M	2/3/M
C-7	Functional performance requirements change (e.g., requirement introduced for computerized tomography).	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M	4/2/M
C-8	More stringent interpretations of safety requirements during design and construction require significant facility structural or service system upgrades.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
C-9	Additional security provisions (e.g., clearances, escorts, fences, changes in the design basis threat) beyond planned are imposed.	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H	1/3/H or 2/2/H
C-10	Construction or repair and modifications impact ongoing site or facility operations, or ongoing site or facility activities impact construction or repair and modifications.	1/3/H or 1/2/H	5/5/L	5/5/L	5/5/L	5/5/L	5/5/L
C-11	Existing facilities require more work than planned to meet applicable codes and standards (i.e., latent conditions may unexpectedly come into play). Equivalently, unforeseen conditions in existing facilities during repair or upgrades result in more work than planned.	3/3/M	N/A	4/3/L	N/A	2/3/M	N/A
C-12	Material characterization (MC) capability is insufficient to support the schedule for the nonrecurring testing and analysis required to develop and qualify the manufacturing parameters for the W87 production process.	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L	4/3/L
C-13	Unexpected underground site conditions are encountered (e.g., geotechnical, buried pipelines, or buried waste).	4/3/L	4/3/L	5/5/L	4/3/L	5/5/L	4/3/L
C-14	Project design issues occur during work (construction/modifications/repairs).	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M	3/3/M
C-15	There are issues with process qualification and/or design agency approval.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-16	There are issues with worker training and hiring of qualified workers.	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L	3/4/L
C-17	A seismic event occurs during construction, damaging site infrastructure.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)
C-18	A seismic event occurs, causing damage to facility under construction.	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)	5/1/M (C)