Pacific Northwest National Laboratory Regional Populations – 2020 Census

Richland Campus and Sequim Campus

February 2023

SA Rose
JD Tagestad
SF Snyder

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, **makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights**. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Pacific Northwest National Laboratory Regional Populations – 2020 Census

Richland Campus and Sequim Campus

February 2023

SA Rose
JD Tagestad
SF Snyder

Pacific Northwest National Laboratory
Richland, Washington 99354

Summary

The U.S. Department of Energy conducts radiological operations in south-central (Richland) and northwestern (Sequim) Washington State. Collective dose estimates to regional populations must be performed to provide a measure of the impact from site radiological releases. Results of the U.S. 2020 Census and, for the Sequim location only, the Canada 2021 Census, were used to determine counts and distributions for the residential population located within 50 miles (80 kilometers) of the Pacific Northwest National Laboratory Richland Campus and the Sequim Campus. Since the 2010 Census, total regional populations increased 25–40 percent. This revision updates and expands the data presented in the prior report by the addition of PNNL-Richland Campus population distribution information.

Acronyms and Abbreviations

API	Application Programming Interface
DOE	U.S. Department of Energy
GIS	Geographic Information Systems
km	kilometer(s); 1 km = 0.621 mi
mi	mile(s); 1 mi = 1.609 km
PNNL	Pacific Northwest National Laboratory
PSF	Physical Sciences Facilities

Contents

Figures

Tables

Contents

1.0 Introduction

The 2020 U.S. Census data (Census 2021a, 2021b) were used to estimate the 50-mile (80-km) residential population data relative to the U.S. Department of Energy, Office of Science, Pacific Northwest National Laboratory (PNNL) Richland Campus and Sequim Campus (Figure 1.1) in Washington State. The 50-mile population data are developed specifically for determining collective dose from radioactive material emissions to air. Only the PNNL Richland and Sequim locations are permitted for such radioactive material emissions in air effluent.

The PNNL-Richland Campus collective dose assessments previously used Hanford Site 300 Area centroid population data (e.g., Hamilton and Snyder 2011) because of its close proximity, adjacent to the north. The PNNL-Sequim Campus collective dose assessments previously used Zuljevic et al. (2016) population data. The Canadian border is 20 mi (32 km) from the PNNL-Sequim Campus. Both 2020 US Census (Census 2021a, 2021b) and 2021 Canada Census (Statistics Canada. 2021a, 2021b) data were used to determine the 50-mile distributions from the PNNL-Sequim Campus.

As in prior population assessments, for this 2020 Census report, the population within 50-miles is provided for a radial grid of 160 segments centered on a location central to Campus radiological operations. Figure 1.2 indicates the Richland Campus location and county borders with the 50-mile grid centered on the Physical Sciences Facilities (PSF) where the major emission units are located. Morrow and Umatilla Counties are in Oregon. All other counties are in Washington. Figure 1.3 indicates the Sequim Campus location and county/country borders with the grid centered on laboratory operations.

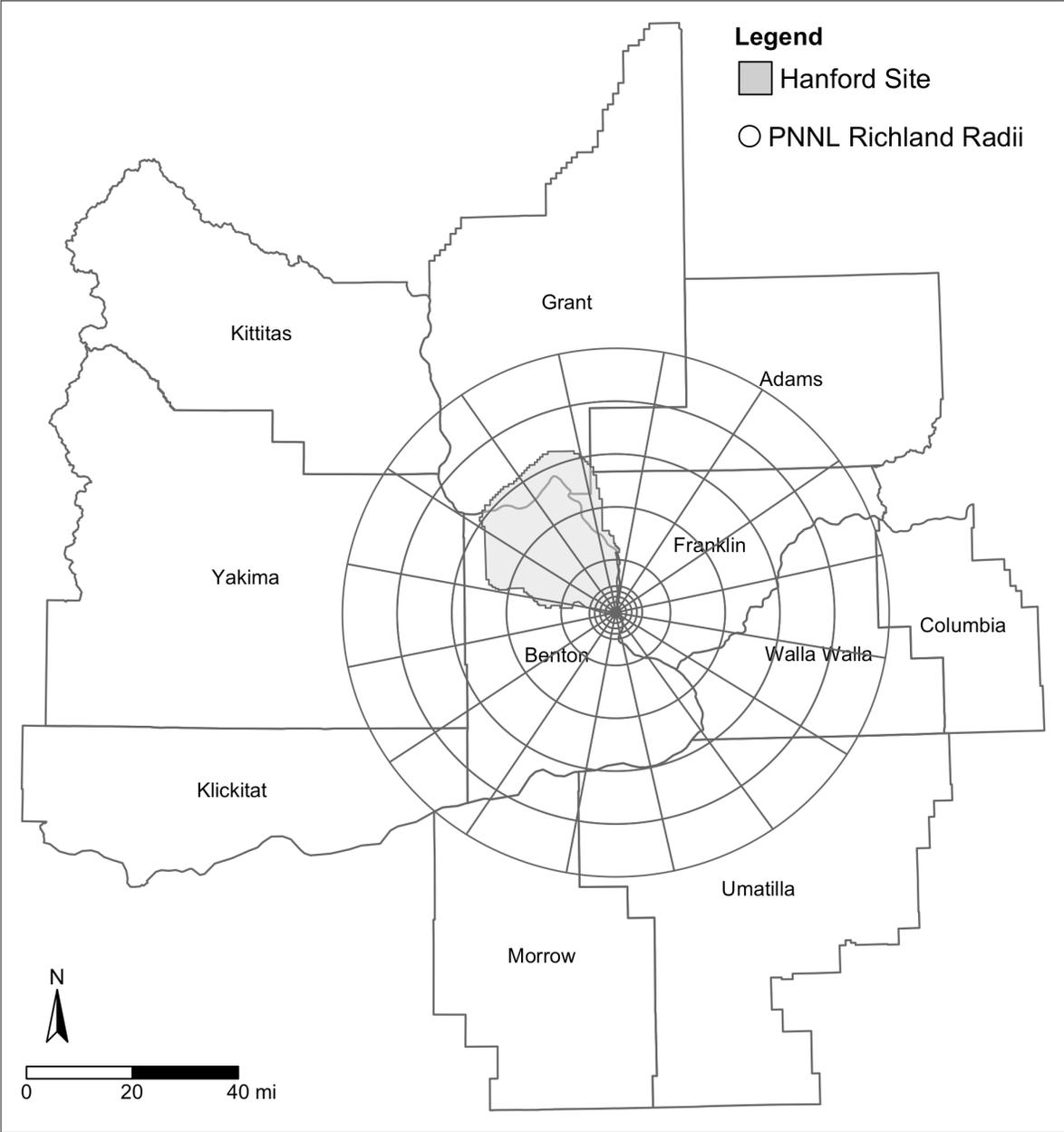Figure 1.1. PNNL Locations in Washington State Region.

Figure 1.2. PNNL-Richland Campus 50-mile Region and County Overlay.
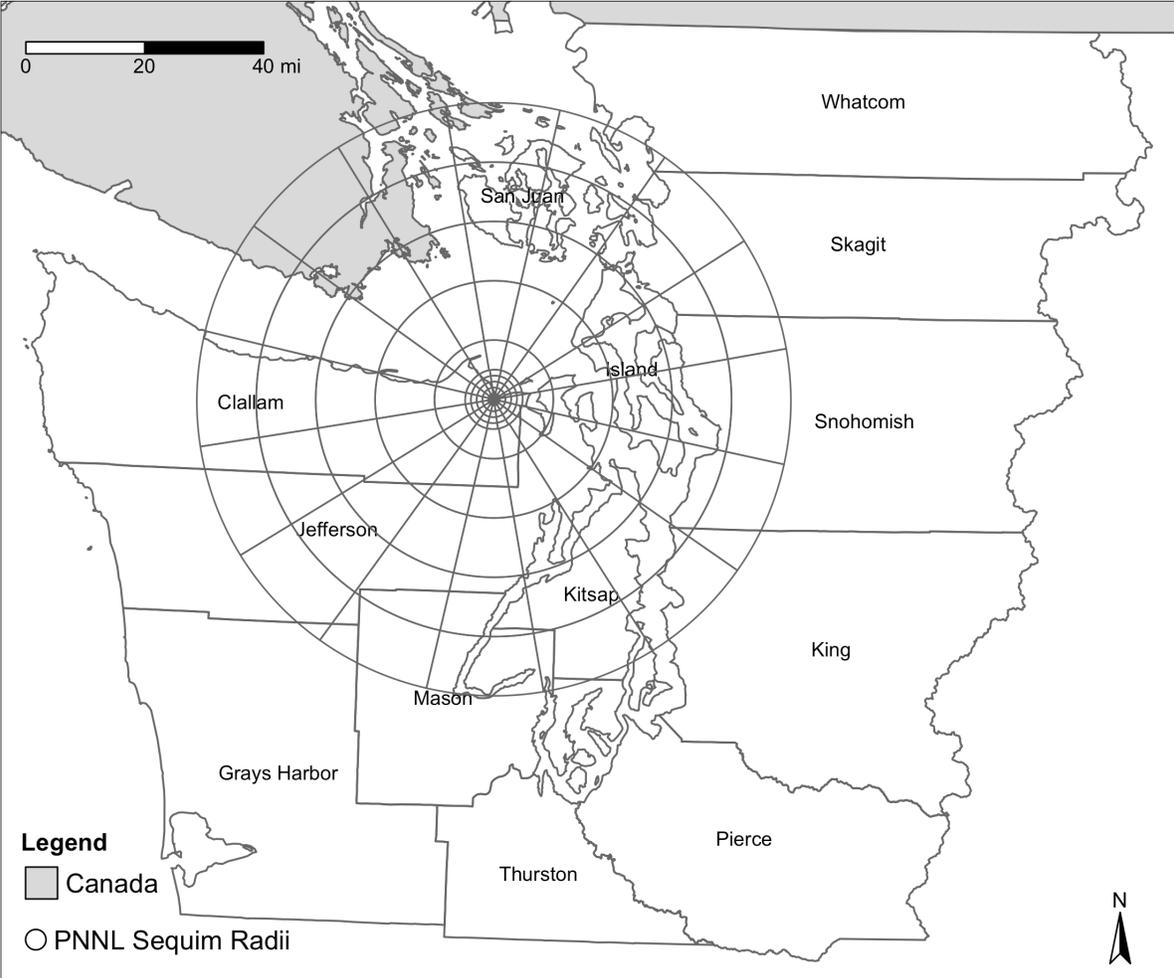
Figure 1.3. PNNL-Sequim Campus 50-mile Region and County Overlay.

2.0 Data Evaluation

Statistical software, R (R Core Team 2022), with Geographic Information Systems (GIS) packages, sf (Pebesma 2018), tigris (Walker 2022), tmap (Tennekes 2018), ggplot2 (Wickham 2016), and tidycensus (Walker and Herman 2022), were used to create direction- and distance-specific circular grids centered at PSF on the PNNL-Richland Campus and at a central emission location at the PNNL-Sequim Campus. The grids contained concentric circles with radii of 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 miles, expanding from the central point.

The 16 directional sectors of the grid were created using the four cardinal directions (N, E, S, W), the four ordinal directions (NE, SE, SW, NW), and the eight half-wind directions (NNE, ENE, ESE, SSE, SSW, WSW, WNW, NNW). The 10 concentric distance circles were then combined with the 16 directional sectors to create a circular grid with 160 sections (See Figure 1.2 and Figure 1.3).

Table 2.1 Locations of Radial Grid Center

PNNL Campus	Longitude	Latitude	State Plane X (meters)	State Plane Y (meters)
Richland	-119.27713	46.352244	594113.4	113980.9
Sequim	-123.04665	48.078368	335113.4	122266.6

In order to determine the population totals for each circular grid section, Census 2020 Tiger/Line block-level shapefiles containing Census 2020 Redistricting population totals (Census 2021a, 2021b) were brought into R via Census application programming interface (API) accessing packages tidycensus and tigris (Walker 2022, Walker and Herman 2022). Canadian Census population totals and geographic attribute files were loaded in manually to RStudio downloaded from the Statistics Canada website (Statistics Canada, 2021a, 2021b). Canada Census population totals were bound to U.S. Census totals and arranged by unique geographic identifier code. The area was calculated for each block and the population was assumed to be evenly distributed within that area. Then the block-level boundaries were intersected with the circular grids. The area was again calculated for the newly intersected blocks. To calculate a new population for each of the 160 grid segments, the areas for the block portions within a grid were multiplied by their respective original average census block population densities, then summed and rounded to the nearest whole number. For example, if a circular grid section contained 40% of the original area of a block, then it was assumed that the section also contained 40% of the block's original population. This procedure was repeated for grids centered at each location of interest to create the 50-mile (80-km) population distribution based on the census data used. See Sections 3.1 and 4.1 for census block overlays with the 50-mile radial grid. All circular grids, census blocks, and site centroids were projected to NAD83 Washington State Plane South (EPSG:32149) prior to analysis.

3.0 PNNL-Richland Campus

The PNNL-Richland Campus grid and census block overlay is presented, as well as data analysis results in grid and tabular forms. The 2020 U.S. Census data were used for locations within 50-miles of the Campus. The user can then format the population distributions, as needed, for a particular application. The centroid location for the PNNL-Richland Campus 50-mile grid is indicated in Figure 3.1. The remainder of this section presents various figures and tables associated with the geographic context and population distribution results.
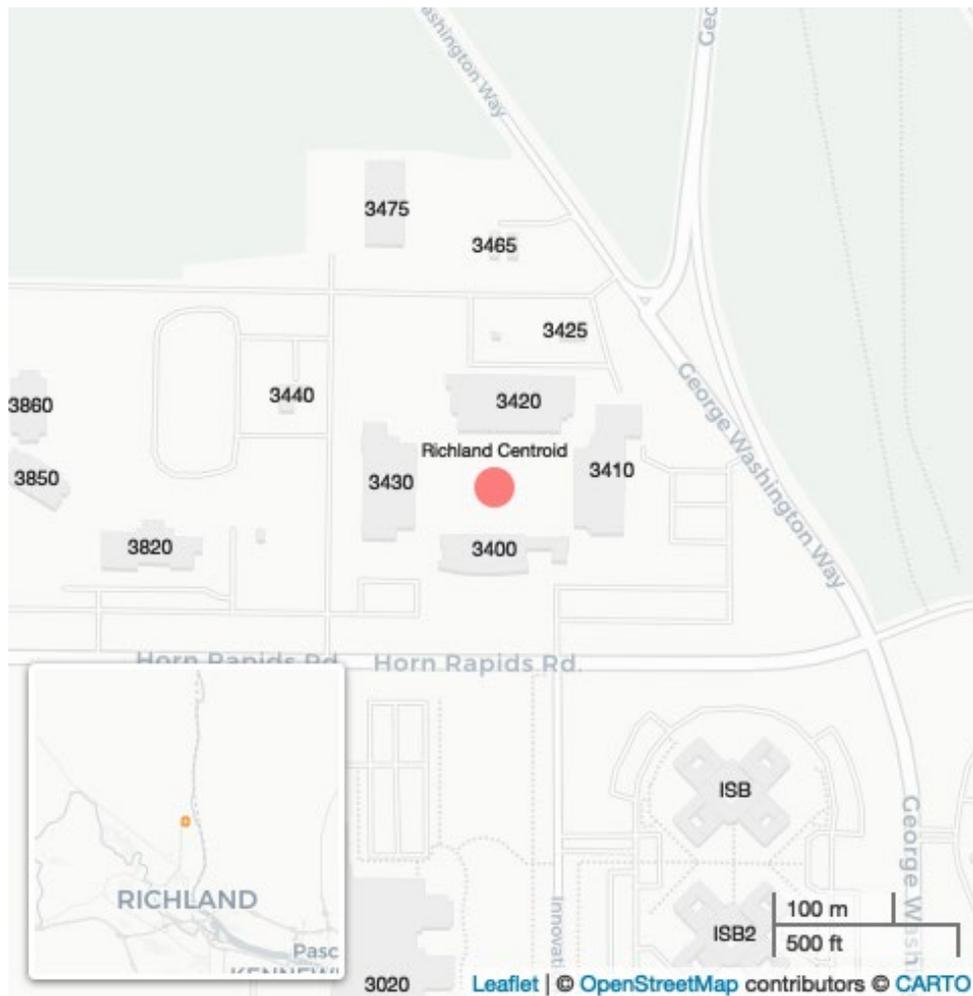
Figure 3.1. Centroid location for the PNNL-Richland Campus.

3.1 PNNL-Richland Campus Centroid Overlay
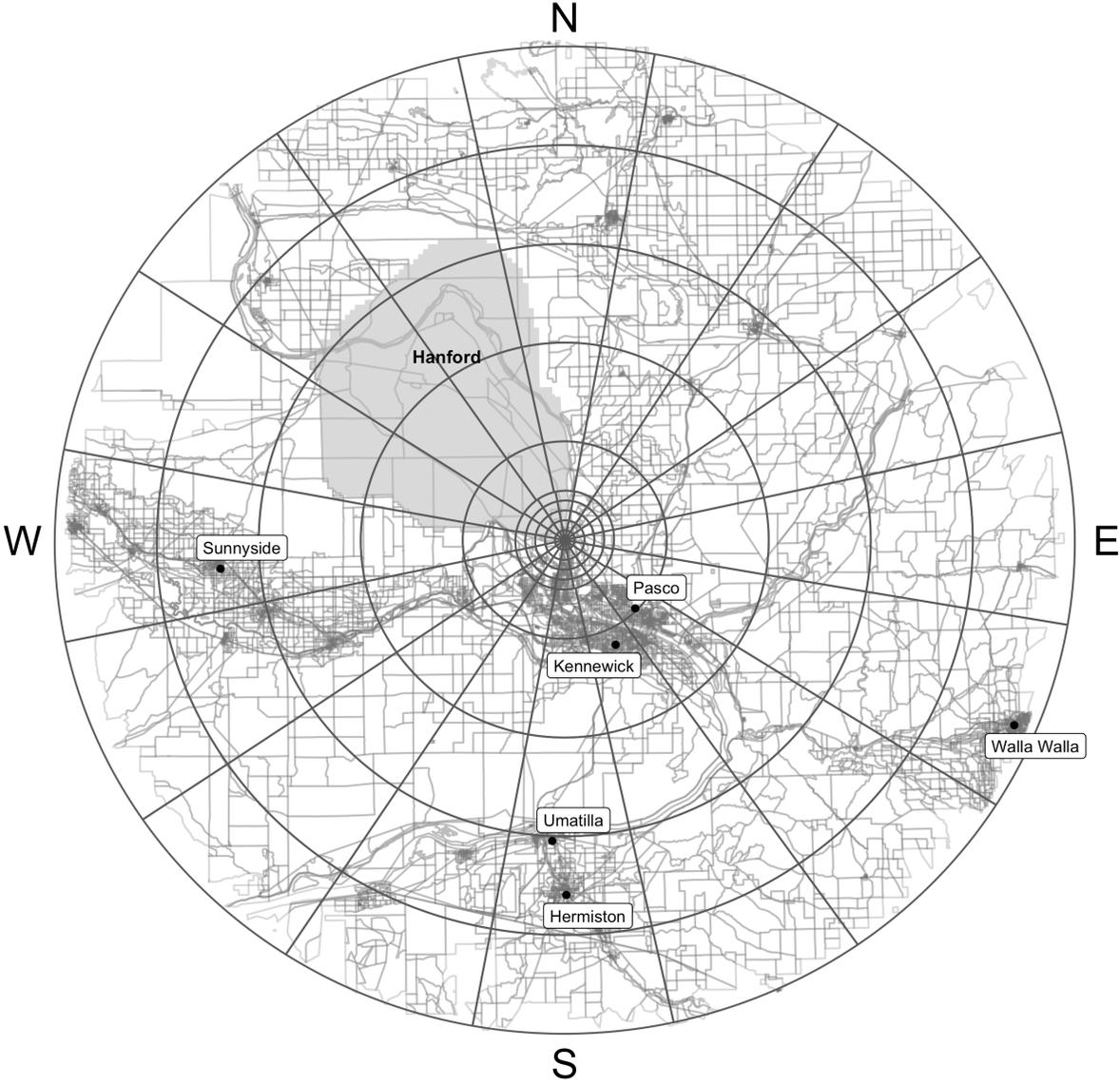
Figure 3.2. PNNL-Richland Campus 50-mile Grid and Census Block Overlay

3.2 PNNL-Richland Campus Data Grids and Tables
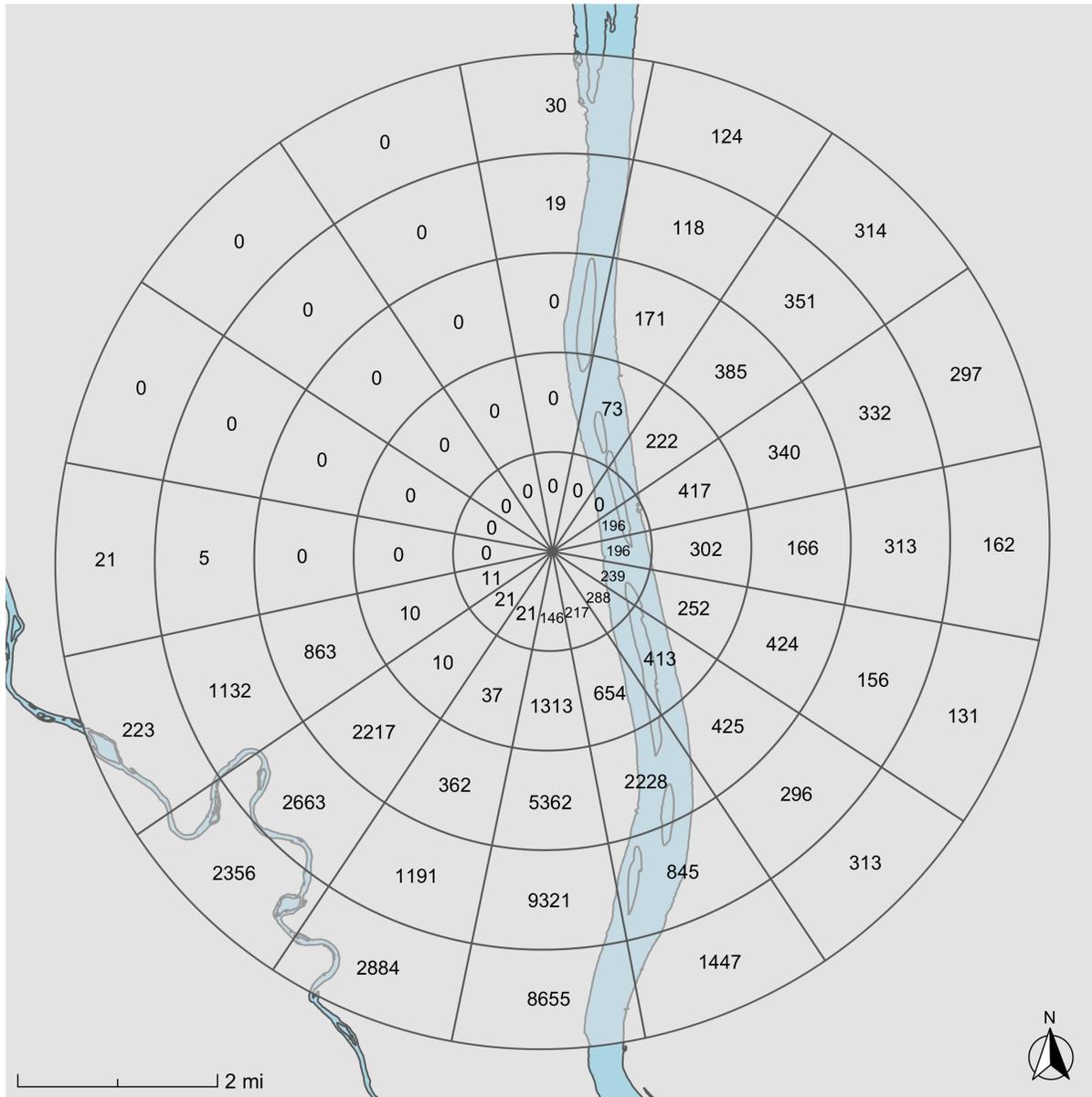
Figure 3.3. PNNL-Richland Campus 1-mile Grid 0–5-mile Population Distribution
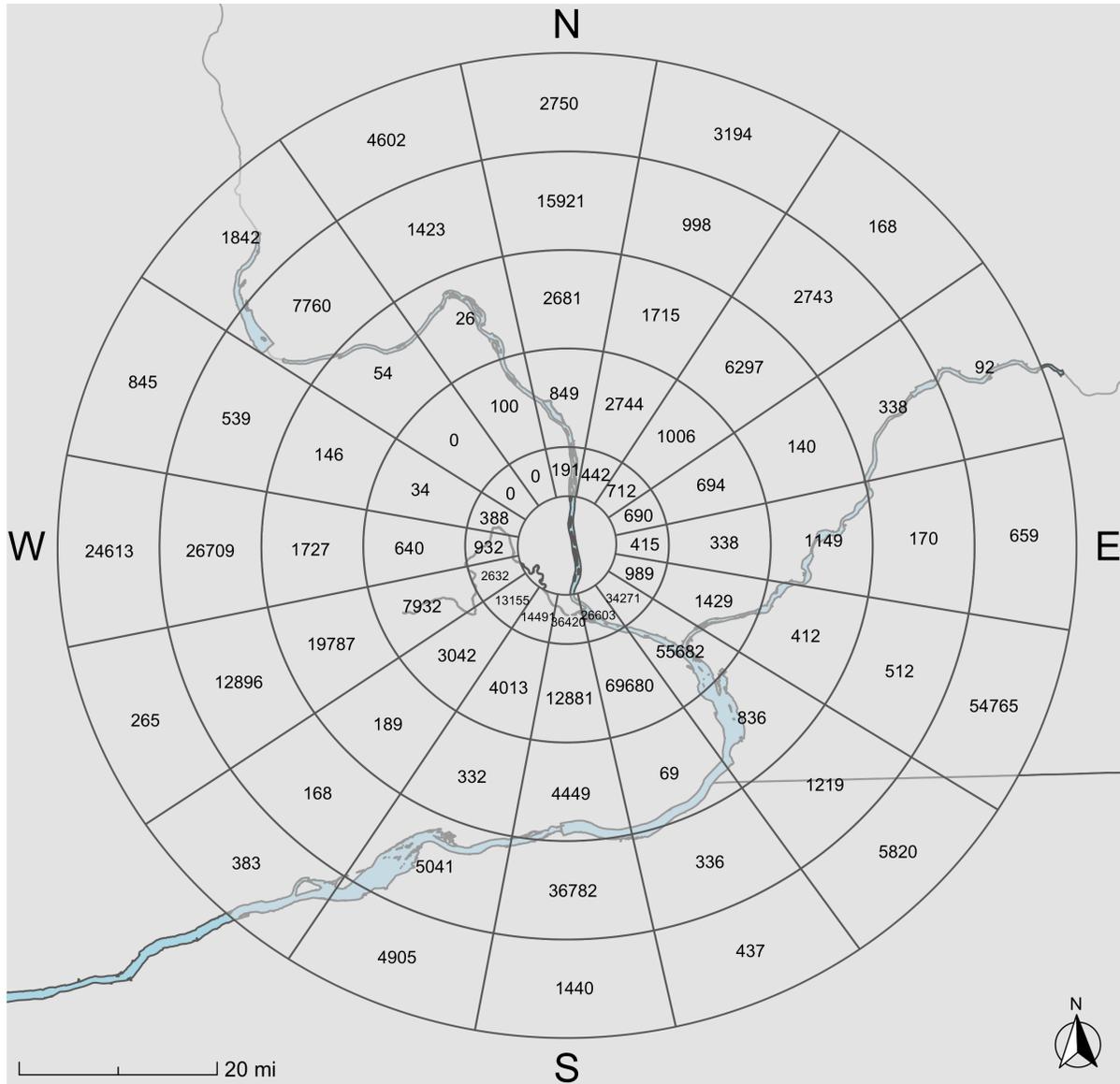
Figure 3.4. PNNL-Richland Campus 5-mile (5–10) and 10-mile (10–50) Population Distribution

Table 3.1 PNNL-Richland Campus 50-mile Population Distribution

Distance (mi)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
															Direction		
0-1	0	0	0	196	196	239	288	217	146	21	21	11	0	0	0	0	1335
1-2	0	73	222	417	302	252	413	654	1313	37	10	10	0	0	0	0	3703
2-3	0	171	385	340	166	424	425	2228	5362	362	2217	863	0	0	0	0	12943
3-4	19	118	351	332	313	156	296	845	9321	1191	2663	1132	5	0	0	0	16742
4-5	30	124	314	297	162	131	313	1447	8655	2884	2356	223	21	0	0	0	16957
5-10	191	442	712	690	415	989	34271	26603	36420	14491	13155	2632	932	388	0	0	132331
10-20	849	2744	1006	694	338	1429	55682	69680	12881	4013	3042	7932	640	34	0	100	161064
20-30	2681	1715	6297	140	1149	412	836	69	4449	332	189	19787	1727	146	54	26	40009
30-40	15921	998	2743	338	170	512	1219	336	36782	5041	168	12896	26709	539	7760	1423	113555
40-50	2750	3194	168	92	659	54765	5820	437	1440	4905	383	265	24613	845	1842	4602	106780
Total	22441	9579	12198	3536	3870	59309	99563	102516	116769	33277	24204	45751	54647	1952	9656	6151	**605419**

Table 3.2 PNNL-Richland Campus Representative Cities in Sectors

| mi | Direction | | | | | | | | | | | | | | | | Total |
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
0-1	H	H												H	H	H	H	1335
1-2	H													H	H	H	H	3703
2-3	H									Richland				H	H	H	H	12943
3-4	H								Richland						H	H	H	16742
4-5	H								Richland						H	H	H	16957
5-10	H							Pasco, West Pasco	Kennewick	Richland			West Richland	H	H	H		132331
10-20	H							Pasco, Finley	Kennewick				Benton City	H	H	H		161064
20-30			Connell										Prosser	H	H	H		40009
30-40	Othello								Umatilla, Hermiston			Sunnyside	Grandview					113555
40-50						Walla Walla, College Place					Boardman		Granger					106780
Total	22441	9579	12198	3536	3870	59309	99563	102516	116769	33277	24204	45751	54647	1952	9656	6151	**605419**

H = Includes sizable areas of the Hanford Site.

4.0 PNNL-Sequim Campus

The PNNL-Sequim Campus grid and census block overlay is presented, as well as data analysis results in grid and tabular forms. The 2020 U.S. Census data and the 2021 Canada Census data were used for appropriate locations within 50-miles of the Campus. The user can then format the population distributions, as needed, for a particular application. The centroid location for the PNNL-Sequim Campus 50-mile grid is indicated in Figure 4.1. The remainder of this section presents various figures and tables associated with the geographic context and population distribution results.

Figure 4.1. Centroid location for the PNNL-Sequim Campus.

4.1   PNNL-Sequim Campus Centroid Overlay

Figure 4.2. PNNL-Sequim Campus 50-mile Grid and Census Block Overlay

4.2   PNNL-Sequim Campus Data Grids and Tables

The geographic base map used in Figures 4.3 and 4.4 differs from the census shapefiles in the vicinity of the coastline. This is particularly the case for the Sequim Bay, which is the water body east-to-south-southeast of the Campus, which is not reflected in the shapefiles at all. Populations estimated within the 0-1 mi sectors, clockwise, NNE through E of the centroid have been removed to reflect the populations in actual, occupied land areas.

Figure 4.3. PNNL-Sequim Campus 1-mile Grid 0–5-mile Population Distribution
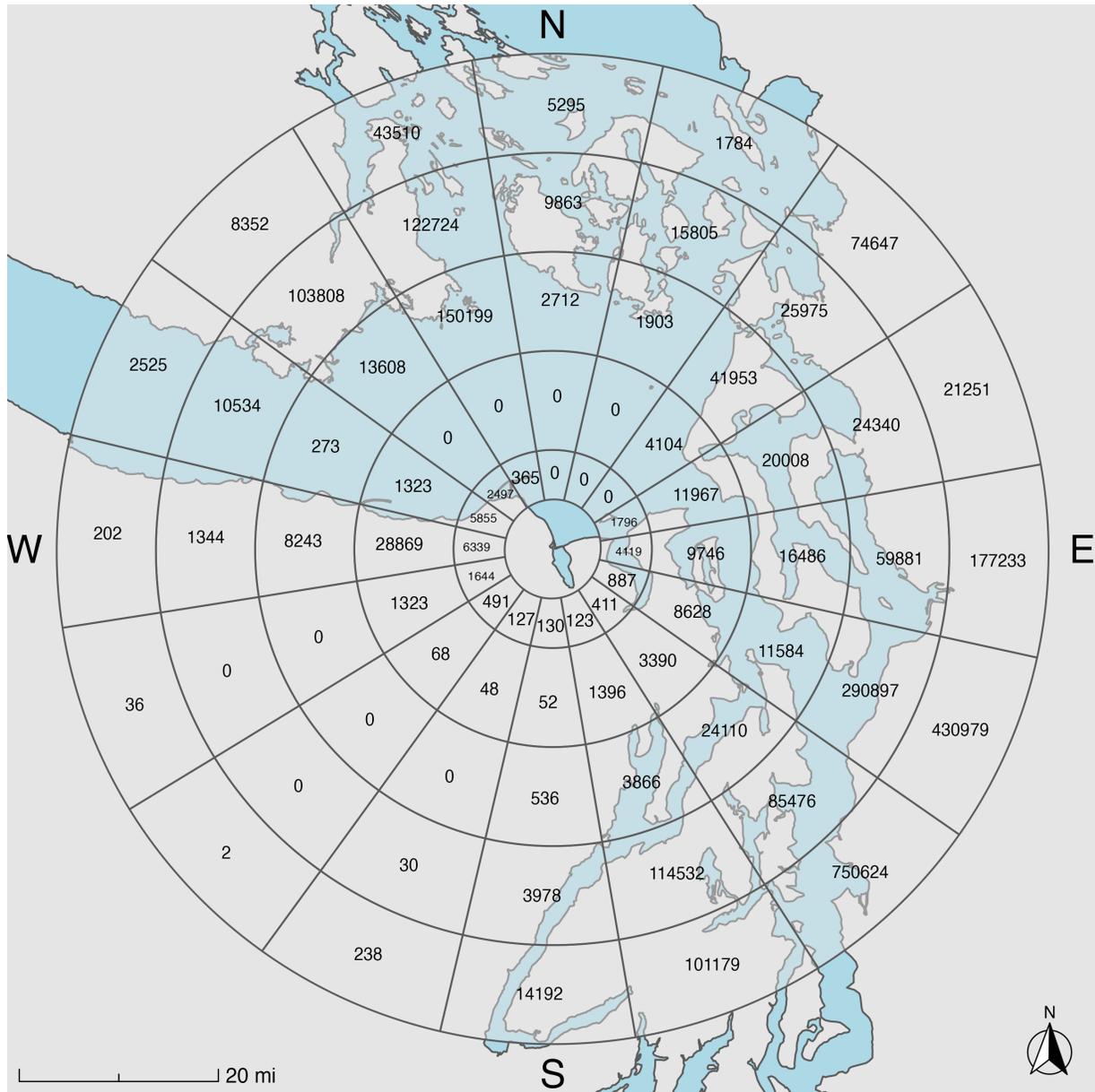
Figure 4.4. PNNL-Sequim Campus 5-mile (5–10) and 10-mile (10–50) Population Distribution

Table 4.1 PNNL-Sequim Campus 50-mile Population Distribution

Distance (mi)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
														Direction			
0-1	18	0(*)	0(*	0(*)	0(*)	0(*)	0(*)	2(*)	193	214	659	728	548	311	113	18	2804
1-2	18	-	-	253	235	235	-	136	410	590	629	1357	1481	358	146	123	5971
2-3	-	-	-	253	465	465	465	390	382	494	805	1692	3328	908	1068	18	10733
3-4	-	-	-	235	465	362	624	171	367	288	713	1515	4465	2834	2495	394	14928
4-5	-	-	-	428	667	445	722	203	205	125	306	1433	1998	1629	989	179	9329
5-10	-	-	0(*)	1796	4119	887	411	123	130	127	491	1644	6339	5855	2497	365	24784
10-20	-	0(*)	4104	11967	9746	8628	3390	1396	52	48	68	1323	28869	1323	-	-	70914
20-30	2712	1903	41953	20008	16486	11584	24110	3866	536	0	0	0	8243	**273**(a)	**13608**	**150199**	**295481**
30-40	9863	15805	25975	24340	59881	290897	85476	114532	3978	30	0	0	1344	**10534**(b)	**103808**	**122724**(c)	**869187**
40-50	**5295**(d)	1784	74647	21251	177233	430979	750624	101179	14192	238	2	36	202	**2525**	**8352**	**43510**(e)	**1632049**
Total	**17906**	19492	146679	80531	269297	744482	865822	221998	20445	2154	3673	9728	56817	**26550**	**133076**	**317530**	**2936180**

Bold values include Canadian populations.

"-" = sea locations in the Strait of Juan de Fuca

(*) Predominantly a sea location but also contains some land.

(a) This WNW sector includes both Canadian and American populations. Fewer Canadians (55) and more Americans (218) are attributed to this sector.

(b) This WNW sector includes both Canadian and American populations. Fewer Americans (4) and more Canadians (10530) are attributed to this sector.

(c) This NNW sector includes both Canadian and American populations. Fewer Americans (15) and more Canadians (122709) are attributed to this sector.

(d) This N sector includes both Canadian and American populations. Fewer Canadians (1150) and more Americans (4145) are attributed to this sector.

(e) This NNW sector includes both Canadian and American populations. Fewer Americans (31) and more Canadians (43479) are attributed to this sector.

Table 4.2 PNNL-Sequim Campus Representative Cities in Sectors

mi	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0-1			Sea	Sea	Sea	Sea	Sea	Sea									2804
1-2		Sea	Sea			Sea	Sea										5971
2-3	Sea	Sea	Sea				Sea						Sequim				10733
3-4	Sea	Sea	Sea										Sequim				14928
4-5	Sea	Sea	Sea														9329
5-10	Sea	Sea	Sea														24784
10-20	Sea	Sea		Port Townsend							ONP/NF		Port Angeles	Sea	Sea		70914
20-30		Anacortes	Oak Harbor				Poulsbo			ONP/NF	ONP/NF	ONP/NF		Victoria		Victoria	295481
30-40	Friday Harbor	Anacortes	Anacortes	Stanwood		Edmonds, Lynwood, Mukilteo	Shoreline	Bremerton			ONP/NF	ONP/NF		Victoria		Victoria	869187
40-50		Mt. Vernon, Burlington		Arlington, Marysville		Bothell, Everett	Seattle, Kirkland	Bremerton			ONP/NF	ONP/NF				Mill Bay	1632049
Total	17906	19492	146679	80531	269297	744482	865822	221998	20445	2154	3673	9728	56817	26550	133076	317530	2936180

ONP/NF = Contains sizable areas of Olympic National Park or Olympic National Forest.
Bold names are Canadian (British Columbia) cities.
"Sea" indicates sectors that are predominantly or all marine environments (i.e., some sectors may have small land masses such as an island in them).
Orange sectors contain portions of Canada.

5.0   Notes on Data Use

The data presented in this report strictly follow the evaluation procedure described, with only the adjustments indicated in Section 4.2 performed. The process of averaging populations over the census block area may indicate the presence of a residential individual where none exists, or no individuals where one does exist. In addition, census data may not be complete for some census blocks due to collection issues within the U.S. or Canada Census. These are important factors to consider, especially for dose calculations at distances in closer proximity to an emission source. Furthermore, census counts were collected at two different points in time, 2020 for the U.S. and 2021 for Canadian Census. Thus, while both sources represent the most recent comprehensive counts, they offer two different point-in-time counts.

6.0 Summary of Population Data

6.1 PNNL-Richland Campus

The PNNL-Richland Campus Physical Sciences Facility 50-mile centroid had a 2020 Census population of 605,419. This count is similar to the 2020 Census population from the Hanford Site, 300 Area 50-mile centroid of 609,715 (Rose et al. 2022).

Table 6.1   Trends for PNNL-Richland Campus 50-mile Population

Centroid	2010 Census	2020 Census	Year 2010 to 2020 Change	
Hanford Site, 300 Area[a]	432,117	609,715	41%	increase
PNNL-Richland Campus, PSF	432,117[b]	605,419	40%	increase

(a) Hanford Site: 2010 data from Hamilton and Snyder (2011); 2020 data from Rose et al. 2022.
(b) Hanford Site, 300 Area data used in lieu of non-specific data.
PSF = Physical Sciences Facilities

6.2 PNNL-Sequim Campus

The 50-mile PNNL-Sequim Campus centroid for the 2020[1] Census resulted in a population of 2,936,686. This is a 25% increase from Zuljevic et al. (2016) 2010 Census population of 2,349,091.

Table 6.2   Trends for PNNL-Sequim Campus 50-mile Population

Centroid	2010 Census[a]	2020 Census	Year 2010 to 2020 Change	
PNNL-Sequim Campus	2,349,091	2,936,180	25%	increase

(a) Zuljevic et al. 2016

---

[1] While 2020 Census is indicated, the data includes 2021 Canadian Census information.

7.0　References

Census–U.S. Census Bureau. 2021a. "Census 2020 Block Tiger/Line Shapefiles." (Website: https://www.census.gov/cgi-bin/geo/shapefiles/index.php). U.S. Census Bureau, Washington, D.C. Accessed October 13, 2022.

Census–U.S. Census Bureau. 2021b. "Census 2020 Redistricting Data (P.L. 94-171) Summary File – Washington. (Website: https://www.census.gov/programs-surveys/decennial-census/about/rdo/summary-files.html). U.S. Census Bureau, Washington, D.C. Accessed October 13, 2022.

Hamilton EL, and SF Snyder. 2011. *Hanford Site Regional Population – 2010 Census*. PNNL-20631, Pacific Northwest National Laboratory, Richland, Washington.

Pebesma E. 2018. "Simple Features for R: Standardized Support for Spatial Vector Data." *The R Journal* 10(1), 439-446. https://doi.org/10.32614/RJ-2018-009.

R Core Team. 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rose, SA, JD Tagestad, and SF Snyder. 2022. *Hanford Site Regional Population – 2020 Census*. PNNL-33718, Pacific Northwest National Laboratory, Richland, Washington.

Statistics Canada. 2021a. *2021 Census of Population products by type: Population and dwelling counts*. Canadian Government. Retrieved January 11, 2023, from https://www12.statcan.gc.ca/census-recensement/2021/rt-td/population-eng.cfm

Statistics Canada. 2021b. *2021 Census - Boundary Files*. Geographic Attribute Files. Canadian Government. Retrieved January 11, 2023, from https://www12.statcan.gc.ca/census-recensement/2021/geo/sip-pis/boundary-limites/index2021-eng.cfm?year=21

Tennekes M. 2018. "tmap: Thematic Maps in R." *Journal of Statistical Software*, 84(6), 1-39. https://doi.org/10.18637/jss.v084.i06.

Walker K. 2022. *tigris: Load Census TIGER/Line Shapefiles*. R package version 1.6.1, https://CRAN.R-project.org/package=tigris.

Walker K and M. Herman. 2022. *tidycensus: Load US Census Boundary and Attribute Data as 'tidyverse' and 'sf'-Ready Data Frames*. R package version 1.2.3.9000, https://walker-data.com/tidycensus/.

Washington State Department of Ecology. 2019. *WA Hydrography - NHDWaterbody*. Washington Geospatial Open Data Portal. Retrieved January 23, 2023, from https://geo.wa.gov/datasets/7cdd7c3de6524e4c83d71c5077ddae30_26/explore

Wickham, H. 2016. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag, New York.

Zuljevic, N, TE Seiple, and SF Snyder. 2016. *Battelle Land-Sequim Regional Population*. PNNL-25305, Pacific Northwest National Laboratory, Richland, Washington.

Pacific Northwest
National Laboratory

902 Battelle Boulevard
P.O. Box 999
Richland, WA 99354

1-888-375-PNNL (7665)

www.pnnl.gov