2.4 WINTER STORMS (WEATHER)

For the purpose of this plan, *Winter Storms* is a risk assessment that is encompasses multiple hazards: *Blizzards, Extreme Cold and Windchill*, *Frost and Freeze*, *Heavy Snow, Ice Storms, Winter Storms, and Winter Weather* events as reported and defined by the National Weather Service Instruction 10-1605.

Winter Storms are winter weather events that has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet and ice) and meets or exceeds locally/regionally defined 12- and/or 24-hour warning criteria for at least one of the precipitation elements. Normally, a Winter Storm would pose a threat to life or property.

Blizzard conditions occur when the following conditions last three hours or longer:
- 35 mph or greater wind speeds,
- Considerable snowfall and blowing snow bringing visibility below ¼ mile.
- Severe blizzards have wind speeds exceeding 45 mph, visibility near zero, and temperatures of 10º F or lower.

Extreme Cold and Wind Chill events are defined as A period of extremely low temperatures or wind chill temperatures reaching or exceeds locally/regionally defined warning criteria. Normally these conditions should cause significant human and/or economic impact. The NWS issues windchill alerts for:
- Advisories when windchills are expected to be 10°F to -25°F for at least 3 hours,
- Warnings when -25°F or colder with wind speeds 5 mph or greater for at least 3 hours.
- These criteria are, for the most part, uniformed across all Ohio NWS office, with the exception of Northern Indiana where their windchill advisories are issued at -15° F to -29° F.

Canadian and Arctic cold fronts that push cold temperatures, ice, and snow into the State generally cause winter storms, blizzards, and ice storms. Severe winter weather in Ohio consists of freezing temperatures and heavy precipitation, usually in the form of snow, freezing rain, or sleet. Severe winter weather affects all parts of the State.

Snow and strong easterly wind conditions ahead of a warm front usually cause ice storms. The snow, however, changes temporarily to sleet and then to rain that freezes when it hits the ground, covering exposed surfaces with a layer of ice. Local accumulations of ice may be heavy if the storm halts over a region for extended periods of time. Ice storms lasting more than 12 hours usually produce ice accumulations several inches thick and affect an area that may range from a few square miles to areas covering several states. The typical ice storm swath is 30 miles wide and 300 miles long.

While Ohio residents and governments are accustomed to handling winter storm events, occasional extreme events can make conditions dangerous and disruptive. Heavy snow volume makes snow removal difficult. Trees, cars, roads, and other surfaces develop a coating of ice, making even small accumulations of ice extremely hazardous to motorists and pedestrians. The most prevalent impacts of heavy accumulations of ice are slippery roads and walkways that lead to vehicle and pedestrian accidents; collapsed roofs from fallen trees and limbs from heavy ice and snow loads; and felled trees, telephone poles and lines, electrical wires, and communication towers. As a result of severe ice storms, telecommunications and power can be disrupted for days.

The northeastern portion of Ohio near the Great Lakes experiences what is known as "lake-effect snow" As cold air passes over the relatively warm waters of the large lakes, the weather system absorbs moisture and heat, and releases this in the form of snow. Lake effect snowfall intensity is affected by:

- The contrast between the lake and air temperatures,
- The distance air has traveled over water, known as the fetch, and
- The regional weather conditions-- a snow storm's maximum penetration inland will generally be greatest during late autumn/early winter and shortest during the late winter.

Lake-effect snowstorms have been known to cause continuous snowfall for as long as 48 hours over a sharply defined region. One single, intense local storm cell can yield as much as 48 inches of light-density snow in 24 hours or less. Consequently, snowfalls can vary greatly, with areas of deep snowfall adjacent to areas with relatively little snow.

Figure 2.4.a
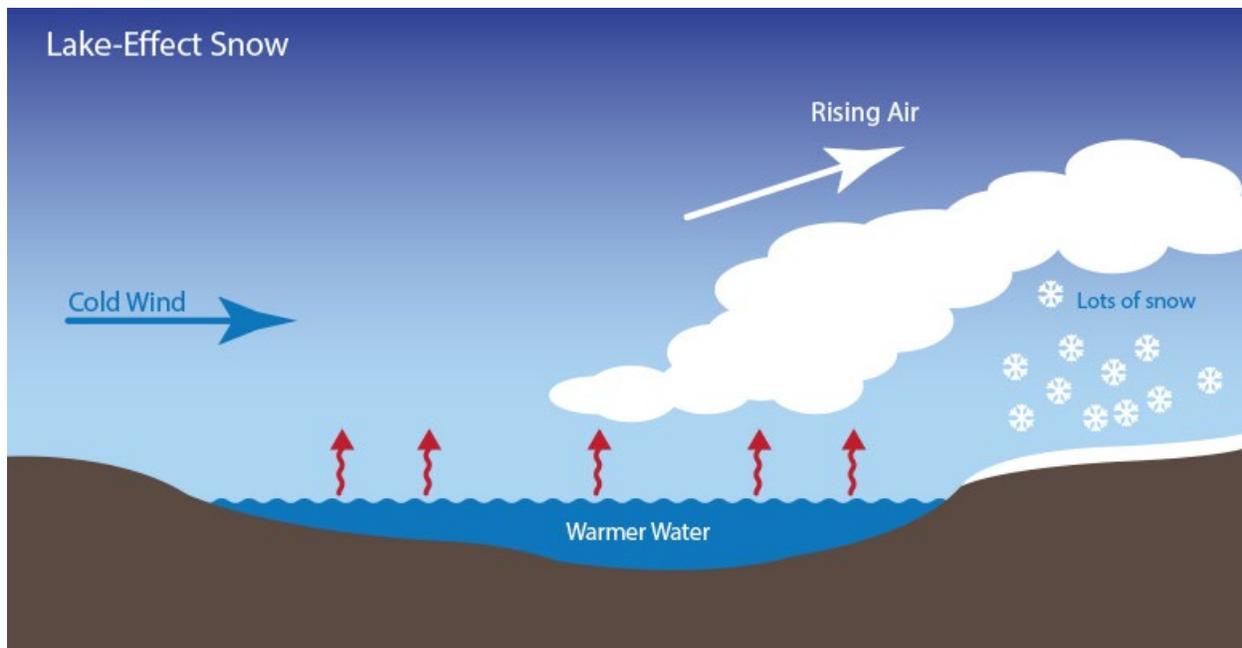
Figure 2.4.a: Generation of Lake Effect Snow
Source: NOAA SciJinks

LOCATION

Winter Storms events are not spatially-specific hazards but affects all parts of the State; therefore, it is difficult to determine the actual location of the damage that may result from a winter storm event. In an effort to address this limitation, the mean annual snow depth from 2017 to 2022 was mapped.

Figure 2.4b: State of Ohio Annual Mean Snowfall, 2017-2022
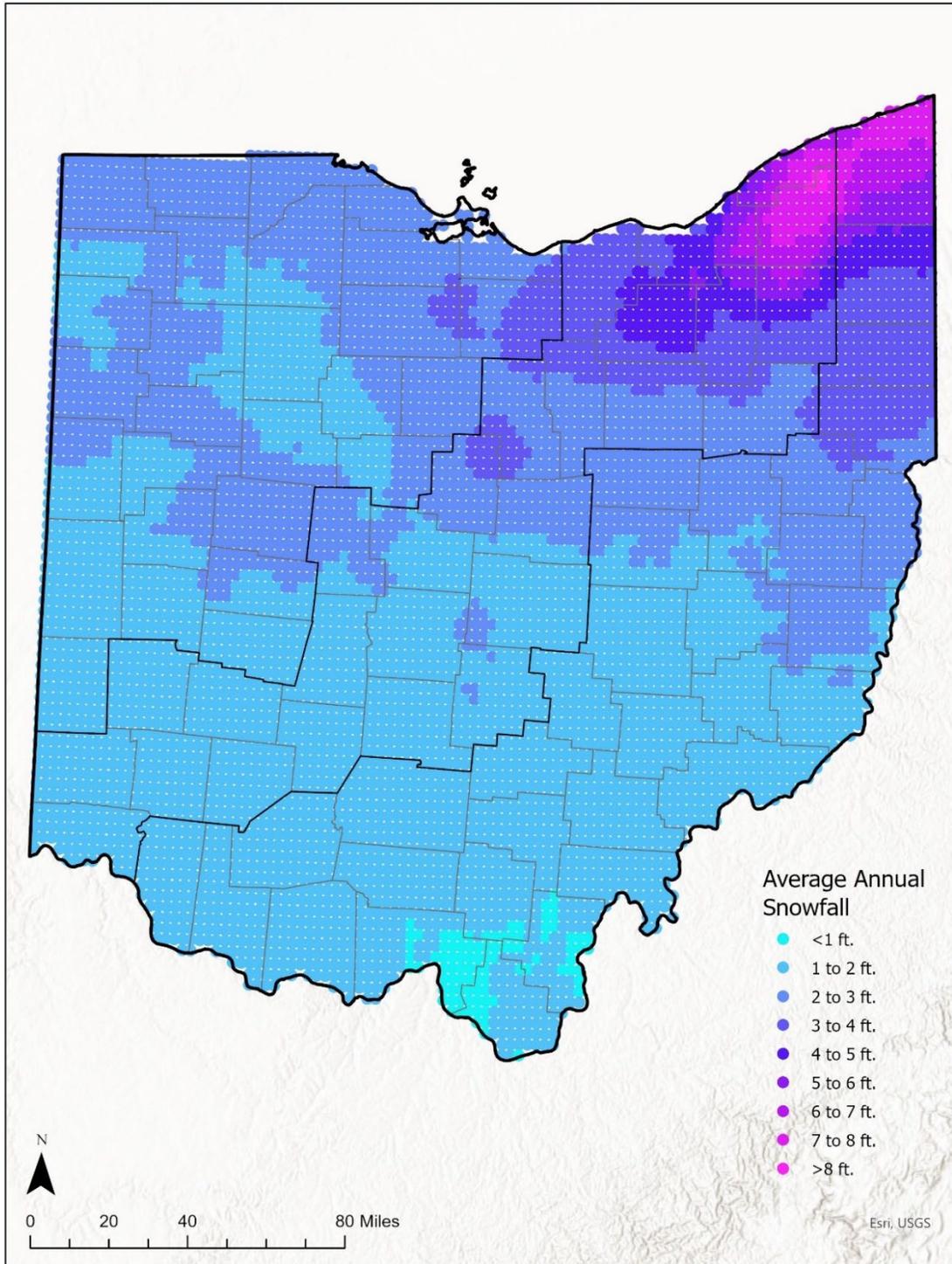
Source: Annual data compiled from the NOAA National Gridded Snowfall Analysis; https://www.nohrsc.noaa.gov/snowfall/

PAST OCCURANCES AND PROBABILITY OF FUTURE EVENTS

According to the NCDC Storm Database, there has been 367 Winter Storms events from January 1, 2003 to January 1, 2023 statewide. From these events, about $737,247,674 (Inflation-adjusted value 2023) in property and crop damages have been reported and have resulted in 27 deaths and 99 injuries. Table 2.4.a depicts the reported events by county, as well as the estimated annual probability based on reported data. Past occurrences are reported based as *Days with Event*. When a county reports multiple hazard events on the same day, it is calculated as a single event for that day. When multiple counties report one or more *Winter storm* event(s) on the same day, it's reported as a single event in the statewide count.

Based on these figures, Ohio with has a 100% chance events of occurring in any given year. However, the probability and severity of snowfall vary greatly by location. The higher snowfall totals and probability for the northeastern portion of Ohio can be attributed to the lake effect snows caused by the area's proximity to Lake Erie. Lake, Geauga, and Ashtabula counties can see greater than eight feet of snowfall in a given year. This trend tapers off as the level of snowfall generally decreases as you move closer to the south and southwestern counties where average snow depths are one to two feet. Global climate change may have an impact on the probability of future events; however, it is unclear as to the extent of this impact. Several storms were notable and since 1964, two involved federal declarations.

Table 2.4.a

Severe Winter Storms Past Occurrences and Probability Assessment by County													
Region 1				Region 2				Region 3					
County	Total Deaths	Total Injuries	Days with Event [1,2]	Est. Annual Probability [3]	County	Total Deaths	Total Injuries	Days with Event [1,2]	Est. Annual Probability [3]	County	Total Deaths	Total Injuries	Days with Event [1,2]	Est. Annual Probability [3]
Allen	0	0	65	3.1	Ashland	0	0	41	1.9	Adams	0	0	102	4.8
Auglaize	0	0	103	4.9	Butler	3	0	113	5.3	Ashtabula	0	0	104	4.9
Champaign	0	0	101	4.8	Clinton	0	0	122	5.8	Athens	2	0	52	2.5
Clark	0	0	108	5.1	Cuyahoga	3	0	81	3.8	Belmont	0	0	38	1.8
Crawford	0	0	26	1.3	Delaware	0	4	104	4.9	Brown	0	0	103	4.9
Darke	0	0	112	5.3	Fairfield	0	0	102	4.8	Carroll	0	0	43	2.0
Defiance	0	0	68	3.2	Fayette	0	0	95	4.5	Clermont	1	1	105	5.0
Erie	0	0	33	1.6	Franklin	0	4	127	6.0	Columbiana	3	0	59	2.8
Fulton	1	0	60	2.9	Geauga	0	0	108	5.1	Coshocton	0	0	36	1.7
Hancock	0	0	26	1.2	Greene	1	0	107	5.1	Gallia	0	0	41	1.9
Hardin	0	0	76	3.6	Hamilton	2	32	114	5.4	Guernsey	0	0	35	1.7
Henry	0	0	64	3.0	Knox	0	0	25	1.2	Harrison	0	0	33	1.6
Huron	0	0	32	1.7	Lake	0	4	73	3.5	Highland	0	0	93	4.4
Logan	0	0	116	5.5	Licking	0	0	100	4.8	Hocking	0	0	86	4.1
Lucas	0	0	34	1.6	Lorain	1	0	45	2.1	Holmes	0	0	30	1.4
Marion	0	0	22	1.1	Madison	1	0	87	4.1	Jackson	1	0	45	2.1
Mercer	0	0	93	4.4	Medina	1	0	49	2.3	Jefferson	0	0	45	2.1
Miami	1	0	103	4.9	Montgomery	2	0	132	6.3	Lawrence	0	0	38	1.8
Ottawa	0	0	29	1.4	Morrow	0	0	23	1.1	Mahoning	0	3	36	1.7
Paulding	1	0	74	3.5	Pickaway	0	0	97	4.6	Meigs	0	0	47	2.2
Preble	0	0	110	5.2	Portage	0	0	51	2.5	Monroe	0	0	29	1.4
Putnam	0	0	70	3.3	Richland	0	0	39	1.9	Morgan	0	0	50	2.4
Sandusky	0	0	29	1.4	Stark	0	0	30	1.4	Muskingum	0	0	41	1.9
Seneca	0	0	24	1.1	Summit	1	40	54	2.6	Noble	0	0	25	1.2
Shelby	0	0	102	4.8	Union	0	1	98	4.6	Perry	0	0	54	2.6
Van Wert	2	0	71	3.4	Warren	0	10	114	5.4	Pike	0	0	82	3.9
Williams	0	0	60	2.9	Wayne	0	0	32	1.6	Ross	0	0	95	4.5
Wood	0	0	32	1.5						Scioto	0	0	96	4.5
Wyandot	0	0	21	1.0						Trumbull	0	0	52	2.6
										Tuscarawas	0	0	50	2.4
										Vinton	0	0	48	2.3
										Washington	0	0	50	2.4

1- Count includes blizzards, extreme cold and windchill, frost/freeze, heavy snow, ice storms, winter storms, and winter weather events as reported by the National Weather Service.

2- Events are counted as days with events, where multiple events per day is counted as one event.

3- Due to the reason above, estimated annual probability is the probability of an event day occurring in a given year.

The Great Blizzard of 1978, January 1978 (EM-3055): Homes and businesses were closed for one week and caused the deaths of 51 people. Wind gusts reached 70 mph and caused blowing and drifting snow. The worst winter storm in Ohio history struck before dawn on Thursday, January 26th, 1978. The Blizzard of '78 continued through Thursday and into Friday. Transportation, business, industry, and schools were closed statewide for two days with the normal pace of society not returning to the state for five days. Atmospheric pressure fell to 28.28 inches at Cleveland, the lowest ever recorded in Ohio, as the center of the blizzard crossed Ohio. This rapidly intensifying storm pulled bitterly cold air across Ohio on winds of 50 to 70 mph. These conditions, combined with heavy snow and blowing of deep snow already on the ground, caused extreme blizzard conditions all across Ohio. Enormous snowdrifts covered cars and houses, blocked highways and railways, and closed all airports for two days. More than 5,000 members of the Ohio National Guard were called to duty and were pressed into long hours of work with heavy equipment clearing roads, assisting electric utility crews, rescuing stranded persons, and transporting doctors and nurses to hospitals. Forty-five National Guard helicopters flew 2,700 missions across Ohio rescuing thousands of stranded persons, many in dire medical emergencies. Thousands of volunteers with snowmobiles and four-wheel drive vehicles responded to pleas from police statewide to deliver medicine and transport doctors and nurses to hospitals. The death toll of 51 made this one of the deadliest winter storms in Ohio history. As a result of this event, Ohio counties received a total of $3,546,669 in public assistance funds.

Severe Winter Storm, February 2003 (DR-1453): Prior to this event, a several series of low-pressure systems tracked through the Ohio River valley, producing up to four inches of snow across west central Ohio all through the month of January. The main event happened when a warm front ahead of low-pressure passing through the Tennessee Valley brought abundant moisture to the Ohio Valley on east-southeast winds. Cold air was already in place on the surface and conditions were right for snow accumulation of 6 to 8 inches to occur over much of the region north of the Ohio River. Counties closest to the Ohio River saw some ice accumulations to a quarter or a half inch, but the majority of the weather associated with this system was heavy snow along the I-70 corridor. Fayette, Franklin, Greene, Guernsey, Monroe, and Muskingum counties received record snowfall from this event. Adams, Gallia, Lawrence, Meigs, and Scioto Counties had severe ice accumulation in addition to snow that downed trees and power lines. Loss of power to water treatment and sewage systems resulted in the loss of water pressure to customers. For those who had some water, boil alerts were issued. In Gallia County, most of the water customers lost service and needed generators to restore service. Booster station in the affected areas did not have full power until a week after the storm hit the region. At one time more than an estimated 12,000 customers were without water. As a result of this event, thirty Ohio counties received a total of $15,761,979.42 in public assistance funds.

Severe Winter Storms, Flooding and Mudslides, December 2004 – January 2005 (DR-1580): A low-pressure system moved into the northeast across the Ohio Valley. Cold west to northwest winds behind the low caused lake effect snow showers to develop in Northeast Ohio. This activity began during the predawn hours of the 16th and continued through midday on the 17th. The heaviest fell during the late afternoon and evening hours of the 16th when visibilities at times were near zero. Accumulations ranged from 6 to 8 inches in Geauga, southern Ashtabula, and eastern Cuyahoga Counties. This storm system affected four additional counties to the previous storm and caused an approximate $106,901,000 in property damage. As a result of this event, Ohio counties received a total of $7,948,685.48 in public assistance funds.

Snow Event, January - February 2005 ([EM-3198](#)): An Alberta Clipper passed to the north of Lake Erie during the evening hours of November 23rd. An arctic cold front trailing this low swept east across Ohio by the early morning hours of the 24th. Cold northwest winds behind this front caused lake effect snow showers to develop just before daybreak on the 24th. These bands quickly intensified and by mid-morning, visibilities in some areas were less than one-quarter mile. Northwest winds gusting in excess of 30 mph accompanied the snow and caused considerable blowing and drifting. The snow showers tapered to flurries during the early evening hours. Snowfall totals of 6 to 9 inches were reported in both Geauga and inland Ashtabula Counties by sunset on the 24th. Then, after midnight on the 25th, an upper-level disturbance rotated through the region. This caused a new round of lake effect snow showers to develop. This activity diminished during the afternoon of the 25th after another 6 to 9 inches of snow had fallen. Two-day totals for this event exceed a foot of snow in many locations.

A peak of 15.6 inches was measured in Hambden Township (Geauga County) with 14 inches at Hartsgrove (Ashtabula County). This storm system affected four additional counties to the previous storm and caused an approximate $5,475,000 in property damage. As a result of this event, Ohio counties received a total of $1,447,217.85 in public assistance funds.

Blizzard Event, March 2008 ([EM-3286](#)): On the morning of March 7th, snow spread into the region during the morning and afternoon hours, then tapered off during the evening and overnight into the 8th. Snow intensified across the area as low-pressure moved north into the Carolinas by the morning of the 8th. Snow persisted across much of the area but did mix with sleet and freezing rain at times across far eastern Ohio. By the evening hours of the 8th, snow began tapering off from west to east. Any areas of mixed precipitation across far eastern Ohio changed back to snow before ending. The low-pressure continued intensifying as it moved into New England by the morning hours of the 9th. Some light snow and flurries persisted overnight, mainly from around Cleveland and points east, but by midday on the 9th the snow tapered off across the entire area. Throughout this event, locations across northwest Ohio picked up between 5 and 10 inches. Those locations experienced a rather steep gradient for snowfall totals. In eastern Ohio, snowfall amounts were slightly lower as sleet and freezing rain mixed in at times causing reduced snowfall amounts. Locations across northeast and north-central Ohio saw the greatest snowfall amounts with 21.5 inches in Broadview Heights in Cuyahoga County, and 21.0 inches in Galion located in Crawford County. As a result of this event, Ohio counties received a total of $1,709,668.49 in public assistance funds.

LHMP DATA

Cuyahoga County: The Countywide All Natural Hazards Mitigation Plan of 2022 states that severe winter storm hazards most often impact driving conditions, electric infrastructure, and community or business functions. Losses may be as small as lost productivity and wages when workers are unable to travel or as large as sustained roof damage or building collapse. According to the National Climatic Data Center website, between January 1996 and March 2021, Cuyahoga County has been impacted by 87 severe winter weather events that have accounted for $34,685,000 in damages and 10 casualties.

Lake County: The Lake County Hazard Mitigation Plan of 2022 indicates there have been 114 severe winter storms from 1950 to 2021 causing $30,587,000 in damages with an average of $268,307 per event. These types of storms are known to cause utility, infrastructure, structural damage. They can also cause severe transportation problems and exposure threats for residents. This hazard is noted as a high frequency event with a total of 47 injuries and business disruptions ranging from days to weeks for the county.

Ashtabula County: The HIRA of the Ashtabula County Countywide All Natural Hazards Mitigation Plan of August 2019 examines subcategories of winter storms: blizzards, ice storms, lake effect snow on the southeastern Lake Erie Snow Belt, and extreme cold. From 1993 to 2019, there was a total of $33,281,00 of damages with an average event causing $180,875 of damage, and the worst single event causing $5,000,000.

MIP LHMP HIRA ASSESSMENT

Winter storms ranked third in cumulative scoring when scored amongst all local hazard mitigation plans. It has fallen for second place in the 2019 SOHMP.

WINTER STORMS MIP LHMP HIRA ASSESSMENT								
Ranking	2	6	9	1	6	5	4	3
Criteria Score	4.65	3.84	2.43	3.17	1.53	1.70	1.83	19.14
	Hazard Frequency	Response Time	Onset Time	Magnitude	Impact on Business	Impact on Humans	Impact on Property	Cumulative Score

VULNERABILITY ANALYSIS & LOSS ESTIMATION

METHODOLOGY

To determine the estimated annual damage at the county level, a historical analysis was done first for each county. The 20-year (January 2003 to January 2023) reported damages of was adjusted to 2023 dollars and summed up to for each respective county. This was then divided by 20 for the number of years assessed. The resulted in the average annual damage for each county.

In order to offset under-reporting in the state, the sum of the twenty-year reported damages across the state was divided by 20 to determine the average estimated annual loss. This figure was then divided by the State-wide Taxable Value of Real Estate to determine the Statewide percentage of annual damage relative to real estate, 0.0121%. A corresponding calculation was also done for each county within the state. These percentages were used to determine the counties that reported less than average damages relative to their value of taxable real property; whichever county that falls below the Statewide percentage of damage relative to real estate threshold, their respective countywide percentage of damage relative to real estate gets replaced with the statewide value. Annual estimated losses for each of these counties would then be calculated by multiplying their respective Countywide Taxable Value of Real Estate.

RESULTS- Table 2.4.b

In Region 1, it is estimated that Hancock County has the highest county-wide damage per year at $1,569,680. However, the county with the highest per-capita cost is Wyandot at $33.58 dollars per person. Region 1 has a higher estimated annual damage at $13,040,719, which is much more than Region 3 but also much less than Region 2.

In Region 2, it is estimated that Franklin County will have the highest county-wide damage per year at $4,364,277. Close behind is Cuyahoga County at $4,056,703. The county with the highest per-capita cost is Ashland County at $28.62 dollars per person.

In Region 3, it is estimated that Ashtabula County will have the highest county-wide damage per year by far at $2,168,190. The second highest is Holmes County at $1,001,468. Holmes County had the highest at $22.65 per person and Ashtabula County had the second highest per-capita cost at $22.22 dollars per person.

Table 2.4.b

Estimate of Potential Losses to Severe Winter Storms by Region										
Region 1			**Region 2**			**Region 3**				
County	Population Census 2020	Est. Damage Per Year	Annual Damage per Capita	County	Population Census 2020	Est. Damage Per Year	Annual Damage per Capita	County	Population Census 2020	Est. Damage Per Year	Annual Damage per Capita

County	Population Census 2020	Est. Damage Per Year	Annual Damage per Capita	County	Population Census 2020	Est. Damage Per Year	Annual Damage per Capita	County	Population Census 2020	Est. Damage Per Year	Annual Damage per Capita
Allen	102,206	$ 265,779	$ 2.60	Ashland	52,447	$ 1,500,915	$ 28.62	Adams	27,477	$ 59,842	$ 2.18
Auglaize	46,422	$ 143,078	$ 3.08	Butler	390,357	$ 1,136,382	$ 2.91	Ashtabula	97,574	$ 2,168,190	$ 22.22
Champaign	38,714	$ 133,267	$ 3.44	Clinton	42,018	$ 124,564	$ 2.96	Athens	62,431	$ 132,882	$ 2.13
Clark	136,001	$ 360,490	$ 2.65	Cuyahoga	1,264,817	$ 4,056,703	$ 3.21	Belmont	66,497	$ 213,481	$ 3.21
Crawford	42,025	$ 1,265,145	$ 30.10	Delaware	214,124	$ 1,143,814	$ 5.34	Brown	43,676	$ 113,837	$ 2.61
Darke	51,881	$ 154,731	$ 2.98	Fairfield	158,921	$ 649,020	$ 4.08	Carroll	26,721	$ 99,924	$ 3.74
Defiance	38,286	$ 102,666	$ 2.68	Fayette	28,951	$ 86,812	$ 3.00	Clermont	208,601	$ 608,159	$ 2.92
Erie	75,622	$ 600,375	$ 7.94	Franklin	1,323,807	$ 4,364,277	$ 3.30	Columbiana	101,877	$ 261,942	$ 2.57
Fulton	42,713	$ 123,918	$ 2.90	Geauga	95,397	$ 1,467,368	$ 15.38	Coshocton	36,612	$ 88,651	$ 2.42
Hancock	74,920	$ 1,569,680	$ 20.95	Greene	167,966	$ 569,857	$ 3.39	Gallia	29,220	$ 178,150	$ 6.10
Hardin	30,696	$ 71,611	$ 2.33	Hamilton	830,639	$ 2,562,039	$ 3.08	Guernsey	38,438	$ 113,795	$ 2.96
Henry	27,662	$ 84,761	$ 3.06	Knox	62,721	$ 1,221,042	$ 19.47	Harrison	14,483	$ 61,939	$ 4.28
Huron	58,565	$ 989,600	$ 16.90	Lake	232,603	$ 2,312,930	$ 9.94	Highland	43,317	$ 107,551	$ 2.48
Logan	46,150	$ 201,326	$ 4.36	Licking	178,519	$ 631,019	$ 3.53	Hocking	28,050	$ 106,011	$ 3.78
Lucas	431,279	$ 1,037,610	$ 2.41	Lorain	312,964	$ 1,305,725	$ 4.17	Holmes	44,223	$ 1,001,468	$ 22.65
Marion	65,359	$ 1,131,335	$ 17.31	Madison	43,824	$ 147,753	$ 3.37	Jackson	32,653	$ 70,590	$ 2.16
Mercer	42,528	$ 142,590	$ 3.35	Medina	182,470	$ 1,226,788	$ 6.72	Jefferson	65,249	$ 161,779	$ 2.48
Miami	108,774	$ 374,275	$ 3.44	Montgomery	537,309	$ 1,271,752	$ 2.37	Lawrence	58,240	$ 140,103	$ 2.41
Ottawa	40,364	$ 434,858	$ 10.77	Morrow	34,950	$ 853,300	$ 24.41	Mahoning	228,614	$ 814,465	$ 3.56
Paulding	18,806	$ 60,555	$ 3.22	Pickaway	58,539	$ 171,580	$ 2.93	Meigs	22,210	$ 217,588	$ 9.80
Preble	40,999	$ 111,938	$ 2.73	Portage	161,791	$ 599,053	$ 3.70	Monroe	13,385	$ 69,328	$ 5.18
Putnam	34,451	$ 109,466	$ 3.18	Richland	124,936	$ 2,742,270	$ 21.95	Morgan	13,802	$ 33,587	$ 2.43
Sandusky	58,896	$ 496,795	$ 8.44	Stark	374,853	$ 1,425,660	$ 3.80	Muskingum	86,410	$ 228,751	$ 2.65
Seneca	55,069	$ 980,565	$ 17.81	Summit	540,428	$ 1,695,957	$ 3.14	Noble	14,115	$ 38,439	$ 2.72
Shelby	48,230	$ 148,816	$ 3.09	Union	62,784	$ 311,442	$ 4.96	Perry	35,408	$ 77,111	$ 2.18
Van Wert	28,931	$ 76,547	$ 2.65	Warren	242,337	$ 1,106,844	$ 4.57	Pike	27,088	$ 53,885	$ 1.99
Williams	37,102	$ 101,015	$ 2.72	Wayne	116,894	$ 1,121,883	$ 9.60	Ross	77,093	$ 197,686	$ 2.56
Wood	132,248	$ 1,032,570	$ 7.81	Total	7,837,366	$ 35,806,747	$ 4.57	Scioto	74,008	$ 143,463	$ 1.94
Wyandot	21,900	$ 735,358	$ 33.58					Trumbull	201,977	$ 832,520	$ 4.12
Total	1,976,799	$ 13,040,719	$ 6.60					Tuscarawas	93,263	$ 284,517	$ 3.05
								Vinton	12,800	$ 26,684	$ 2.08
								Washington	59,771	$ 186,875	$ 3.13
								Total	1,985,283	$ 8,893,193	$ 4.48

Statewide			
County	Population	Est. Damage Per Year	Annual Damage per Capita
All 88	11,799,448	$ 57,740,658	$ 4.89

FEMA National Risk Index

In the National Risk Index, a cold wave, ice storm, and winter weather hazard risk index score/rating represent a community's relative risk for those hazards when compared to the rest of the United States. Generally, the exposure value represents a community's agriculture and building values (in dollars), and population (in both people and population equivalence) exposed to cold waves, ice storms, and winter weather. The Expected Annual Loss (EAL) represents the relative level of agriculture, building, and population loss each year. For more information on current methodology and data, refer to Sections 8 (Cold Wave), 14 (Ice Storms), and 23 (Winter Weather) of the National Risk Index Technical Manual.

Table 2.4.c

FEMA National Risk Index Ice Storm Analysis by Region								
Region 1			**Region 2**			**Region 3**		
County	EAL (Buildings)	EAL (Pop Equiv.)	County	EAL (Buildings)	EAL (Pop Equiv.)	County	EAL (Buildings)	EAL (Pop Equiv.)
Allen	$ 11,882	$ 530	Ashland	$ 386,989	$ 176	Adams	$ 80,582	$ 10,805
Auglaize	$ 5,043	$ 18,410	Butler	$ 56,922	$ 497,190	Ashtabula	$ 49,098	$ 90,385
Champaign	$ 301,960	$ 15,956	Clinton	$ 623,232	$ 25,962	Athens	$ 404,845	$ 22,398
Clark	$ 1,415,468	$ 75,878	Cuyahoga	$ 103,461	$ 9,842	Belmont	$ 379,239	$ 24,174
Crawford	$ 115,098	$ 90	Delaware	$ 1,595,821	$ 64,116	Brown	$ 111,970	$ 19,495
Darke	$ 8,576	$ 54,837	Fairfield	$ 1,279,104	$ 70,659	Carroll	$ 177	$ 6,295
Defiance	$ 2,799	$ 1,470	Fayette	$ 412,016	$ 17,267	Clermont	$ 23,663	$ 167,050
Erie	$ 366,839	$ 300	Franklin	$ 208,386	$ 6,578	Columbiana	$ 319	$ 37,795
Fulton	$ 6,395	$ 1,651	Geauga	$ 46,521	$ 605	Coshocton	$ 228	$ 7,078
Hancock	$ 867,639	$ 593	Greene	$ 1,907,019	$ 100,512	Gallia	$ 53,964	$ 6,607
Hardin	$ 86,042	$ 96	Hamilton	$ 190,932	$ 5,737	Guernsey	$ 160,717	$ 7,413
Henry	$ 10,856	$ 252	Knox	$ 325,413	$ 149	Harrison	$ 1,939	$ 2,817
Huron	$ 358,972	$ 237	Lake	$ 48,940	$ 1,422	Highland	$ 173,693	$ 24,875
Logan	$ 487,801	$ 17,616	Licking	$ 878,455	$ 42,923	Hocking	$ 292,278	$ 12,534
Lucas	$ 226,692	$ 3,758	Lorain	$ 514,670	$ 1,753	Holmes	$ 242,619	$ 116
Marion	$ 213,675	$ 117	Madison	$ 415,268	$ 21,756	Jackson	$ 96,568	$ 10,554
Mercer	$ 6,857	$ 36,753	Medina	$ 590,976	$ 793	Jefferson	$ 21,578	$ 25,575
Miami	$ 16,732	$ 58,643	Montgomery	$ 77,890	$ 325,321	Lawrence	$ 92,280	$ 16,964
Ottawa	$ 92,783	$ 277	Morrow	$ 109,739	$ 71	Mahoning	$ 161,054	$ 106,181
Paulding	$ 5,030	$ 711	Pickaway	$ 529,431	$ 25,804	Meigs	$ 149,207	$ 7,258
Preble	$ 5,797	$ 48,141	Portage	$ 93,422	$ 896	Monroe	$ 96,205	$ 4,172
Putnam	$ 4,453	$ 269	Richland	$ 429,969	$ 284	Morgan	$ 110,347	$ 5,745
Sandusky	$ 144,002	$ 428	Stark	$ 134,469	$ 1,220	Muskingum	$ 714	$ 18,103
Seneca	$ 538,525	$ 360	Summit	$ 152,691	$ 2,250	Noble	$ 123,025	$ 6,101
Shelby	$ 7,055	$ 18,647	Union	$ 498,315	$ 22,942	Perry	$ 579	$ 15,456
Van Wert	$ 3,214	$ 658	Warren	$ 39,665	$ 149,896	Pike	$ 65,055	$ 9,497
Williams	$ 49,370	$ 1,563	Wayne	$ 664,909	$ 390	Ross	$ 587,031	$ 34,127
Wood	$ 234,223	$ 1,142	Total	$ 12,314,624	$ 1,396,511	Scioto	$ 92,742	$ 19,948
Wyandot	$ 117,781	$ 80				Trumbull	$ 129,113	$ 128,536
Total	$ 5,711,561	$ 359,463				Tuscarawas	$ 19,677	$ 239
						Vinton	$ 96,450	$ 5,628
						Washington	$ 266,802	$ 14,722
						Total	$ 4,083,757	$ 868,645

Statewide		
County	EAL (Buildings)	EAL (Pop Equiv.)
All 88	$ 22,109,942	$ 2,624,619

Table 2.4.d

| FEMA National Risk Index Coldwave Analysis by Region | | | | | | | | | | | |
| Region 1 | | | | Region 2 | | | | Region 3 | | | |
County	EAL (Buildings)	EAL (Pop Equiv.)	EAL (Agriculture)	County	EAL (Buildings)	EAL (Pop Equiv.)	EAL (Agriculture)	County	EAL (Buildings)	EAL (Pop Equiv.)	EAL (Agriculture)
Allen	$ 4,393	$ 17,725	$ 1,022	Ashland	$ 4,338	$ 6,822	$ 623	Adams	$ 811	$ 1,807	$ 11,781
Auglaize	$ 2,469	$ 6,615	$ 32,330	Butler	$ 3,532	$ 493,689	$ 29,741	Ashtabula	$ 2,293	$ 1,669,590	$ 12,357
Champaign	$ 2,204	$ 5,513	$ 32,631	Clinton	$ 2,310	$ 2,761	$ 35,116	Athens	$ 480	$ 1,353	$ 972
Clark	$ 2,332	$ 19,386	$ 29,807	Cuyahoga	$ 15,774	$ 3,634,092	$ 28	Belmont	$ 1,100	$ 139,121	$ 2,706
Crawford	$ 2,077	$ 18,686	$ 1,175	Delaware	$ 3,358	$ 28,058	$ 32,918	Brown	$ 996	$ 1,915	$ 15,921
Darke	$ 4,098	$ 49,530	$ 45,221	Fairfield	$ 2,284	$ 12,196	$ 27,948	Carroll	$ 718	$ 97,812	$ 9,081
Defiance	$ 1,369	$ 139,926	$ 40,061	Fayette	$ 1,761	$ 2,540	$ 32,467	Clermont	$ 1,278	$ 9,147	$ 9,684
Erie	$ 5,490	$ 33,234	$ 473	Franklin	$ 17,400	$ 2,411,494	$ 41,783	Columbiana	$ 2,858	$ 373,181	$ 19,921
Fulton	$ 1,601	$ 156,338	$ 64,654	Geauga	$ 5,973	$ 34,315	$ 148	Coshocton	$ 954	$ 2,379	$ 25,286
Hancock	$ 3,898	$ 32,921	$ 682	Greene	$ 2,570	$ 38,822	$ 33,805	Gallia	$ 123	$ 316	$ 807
Hardin	$ 1,833	$ 4,375	$ 2,650	Hamilton	$ 7,980	$ 860,405	$ 14,387	Guernsey	$ 704	$ 1,664	$ 4,555
Henry	$ 1,129	$ 15,477	$ 852	Knox	$ 3,291	$ 8,250	$ 740	Harrison	$ 219	$ 30,300	$ 1,988
Huron	$ 3,813	$ 28,399	$ 1,095	Lake	$ 6,878	$ 156,829	$ 304	Highland	$ 1,599	$ 1,899	$ 23,536
Logan	$ 3,799	$ 6,459	$ 40,281	Licking	$ 2,783	$ 17,606	$ 31,711	Hocking	$ 693	$ 1,538	$ 1,534
Lucas	$ 13,270	$ 191,788	$ 254	Lorain	$ 18,031	$ 221,314	$ 672	Holmes	$ 3,145	$ 5,331	$ 914
Marion	$ 3,915	$ 7,883	$ 683	Madison	$ 2,181	$ 5,282	$ 30,464	Jackson	$ 143	$ 354	$ 469
Mercer	$ 3,292	$ 40,605	$ 28,722	Medina	$ 11,434	$ 81,113	$ 259	Jefferson	$ 1,211	$ 136,454	$ 981
Miami	$ 2,838	$ 15,507	$ 32,626	Montgomery	$ 14,712	$ 64,803	$ 42,564	Lawrence	$ 134	$ 28,215	$ 327
Ottawa	$ 4,406	$ 17,943	$ 297	Morrow	$ 1,992	$ 4,215	$ 423	Mahoning	$ 10,840	$ 1,210,152	$ 18,304
Paulding	$ 1,008	$ 78,600	$ 74,048	Pickaway	$ 2,598	$ 4,493	$ 33,997	Meigs	$ 97	$ 240	$ 706
Preble	$ 2,010	$ 33,115	$ 31,114	Portage	$ 8,599	$ 65,411	$ 157	Monroe	$ 348	$ 28,006	$ 1,490
Putnam	$ 1,210	$ 20,648	$ 1,469	Richland	$ 7,368	$ 16,248	$ 740	Morgan	$ 168	$ 448	$ 2,298
Sandusky	$ 2,978	$ 26,157	$ 507	Stark	$ 13,074	$ 151,544	$ 437	Muskingum	$ 2,230	$ 5,618	$ 17,877
Seneca	$ 3,349	$ 24,489	$ 707	Summit	$ 28,238	$ 218,468	$ 58	Noble	$ 336	$ 29,530	$ 778
Shelby	$ 3,653	$ 6,795	$ 35,944	Union	$ 3,707	$ 8,775	$ 40,179	Perry	$ 575	$ 1,915	$ 7,193
Van Wert	$ 1,088	$ 33,608	$ 220,466	Warren	$ 4,554	$ 15,941	$ 26,470	Pike	$ 748	$ 1,779	$ 14,320
Williams	$ 1,552	$ 135,786	$ 45,864	Wayne	$ 4,032	$ 51,968	$ 1,646	Ross	$ 1,649	$ 4,508	$ 21,725
Wood	$ 6,094	$ 58,788	$ 799	Total	$ 200,751	$ 8,617,455	$ 459,788	Scioto	$ 1,437	$ 2,432	$ 2,275
Wyandot	$ 1,427	$ 9,625	$ 790					Trumbull	$ 5,158	$ 1,832,997	$ 14,961
Total	$ 92,594	$ 1,235,923	$ 767,223					Tuscarawas	$ 2,233	$ 6,064	$ 343
								Vinton	$ 93	$ 277	$ 484
								Washington	$ 623	$ 1,310	$ 3,575
								Total	$ 45,993	$ 5,627,652	$ 249,151

| Statewide | | | |
County	EAL (Buildings)	EAL (Pop Equiv.)	EAL (Agriculture)
All 88	$ 339,338	$ 15,481,031	$ 1,476,162

Table 2.4.e

FEMA National Risk Index Winter Weather Analysis by Region											
Region 1				**Region 2**				**Region 3**			
County	EAL (Buildings)	EAL (Pop Equiv.)	EAL (Agriculture)	County	EAL (Buildings)	EAL (Pop Equiv.)	EAL (Agriculture)	County	EAL (Buildings)	EAL (Pop Equiv.)	EAL (Agriculture)
Allen	$ 3,781	$ 77,982	$ 506	Ashland	$ 1,027,427	$ 52,608	$ 402	Adams	$ 81,010	$ 22,546	$ 152
Auglaize	$ 32,807	$ 36,436	$ 748	Butler	$ 61,003	$ 599,086	$ 253	Ashtabula	$ 278,896	$ 31,070	$ 940
Champaign	$ 54,093	$ 31,749	$ 452	Clinton	$ 70,994	$ 41,184	$ 528	Athens	$ 12,033	$ 11,242	$ 1
Clark	$ 52,402	$ 111,636	$ 478	Cuyahoga	$ 1,106,533	$ 70,116	$ 68	Belmont	$ 872	$ 5,684	$ 1
Crawford	$ 483,733	$ 38,677	$ 712	Delaware	$ 68,463	$ 167,427	$ 314	Brown	$ 65,054	$ 39,732	$ 301
Darke	$ 52,234	$ 73,938	$ 2,206	Fairfield	$ 56,341	$ 153,119	$ 443	Carroll	$ 800	$ 3,007	$ 3
Defiance	$ 8,558	$ 19,379	$ 370	Fayette	$ 84,198	$ 28,935	$ 586	Clermont	$ 54,836	$ 59,487	$ 136
Erie	$ 522,396	$ 65,735	$ 302	Franklin	$ 98,699	$ 184,551	$ 176	Columbiana	$ 881	$ 12,166	$ 307
Fulton	$ 11,676	$ 25,260	$ 697	Geauga	$ 597,818	$ 71,995	$ 534	Coshocton	$ 997	$ 19,586	$ 244
Hancock	$ 458,283	$ 61,645	$ 402	Greene	$ 53,341	$ 131,879	$ 351	Gallia	$ 5,262	$ 15,623	$ 47
Hardin	$ 3,296	$ 23,419	$ 806	Hamilton	$ 126,089	$ 452,759	$ 102	Guernsey	$ 823	$ 3,534	$ 1
Henry	$ 6,891	$ 19,670	$ 450	Knox	$ 414,859	$ 56,011	$ 411	Harrison	$ 814	$ 1,531	$ 1
Huron	$ 712,439	$ 53,923	$ 625	Lake	$ 462,684	$ 19,189	$ 982	Highland	$ 106,433	$ 40,168	$ 525
Logan	$ 4,635	$ 35,993	$ 440	Licking	$ 59,785	$ 130,528	$ 625	Hocking	$ 76,137	$ 26,523	$ 22
Lucas	$ 288,091	$ 84,621	$ 158	Lorain	$ 820,976	$ 94,383	$ 594	Holmes	$ 1,043,234	$ 42,056	$ 569
Marion	$ 718,026	$ 58,078	$ 425	Madison	$ 61,068	$ 46,589	$ 563	Jackson	$ 7,046	$ 18,644	$ 29
Mercer	$ 45,230	$ 51,290	$ 2,284	Medina	$ 927,135	$ 102,308	$ 263	Jefferson	$ 972	$ 7,118	$ 0
Miami	$ 60,203	$ 226,526	$ 412	Montgomery	$ 49,778	$ 415,222	$ 304	Lawrence	$ 6,844	$ 84,497	$ 10
Ottawa	$ 388,153	$ 37,629	$ 185	Morrow	$ 563,698	$ 30,403	$ 242	Mahoning	$ 426,000	$ 67,516	$ 259
Paulding	$ 5,016	$ 9,978	$ 627	Pickaway	$ 72,253	$ 58,494	$ 749	Meigs	$ 7,757	$ 2,116	$ 1
Preble	$ 29,644	$ 52,805	$ 565	Portage	$ 411,761	$ 66,300	$ 210	Monroe	$ 1,437	$ 968	$ 1
Putnam	$ 3,768	$ 25,089	$ 741	Richland	$ 1,206,934	$ 81,471	$ 433	Morgan	$ 1,273	$ 1,497	$ 1
Sandusky	$ 390,618	$ 51,960	$ 307	Stark	$ 570,728	$ 82,200	$ 315	Muskingum	$ 969	$ 8,239	$ 3
Seneca	$ 410,713	$ 48,944	$ 417	Summit	$ 918,721	$ 215,952	$ 74	Noble	$ 1,543	$ 974	$ 0
Shelby	$ 6,809	$ 37,862	$ 645	Union	$ 4,241	$ 52,229	$ 809	Perry	$ 5,642	$ 26,481	$ 117
Van Wert	$ 3,841	$ 15,014	$ 676	Warren	$ 164,436	$ 372,905	$ 223	Pike	$ 66,561	$ 21,232	$ 199
Williams	$ 11,319	$ 21,940	$ 495	Wayne	$ 858,384	$ 83,702	$ 1,024	Ross	$ 56,763	$ 70,151	$ 326
Wood	$ 62,228	$ 82,015	$ 458	Total	$ 10,918,343	$ 3,861,546	$ 11,578	Scioto	$ 128,403	$ 60,679	$ 67
Wyandot	$ 313,037	$ 18,369	$ 466					Trumbull	$ 203,784	$ 26,541	$ 397
Total	$ 5,143,918	$ 1,497,560	$ 18,056					Tuscarawas	$ 904	$ 10,180	$ 7
								Vinton	$ 6,407	$ 7,747	$ 16
								Washington	$ 6,318	$ 6,680	$ 2
								Total	$ 2,656,705	$ 755,214	$ 4,684

Statewide			
County	EAL (Buildings)	EAL (Pop Equiv.)	EAL (Agriculture)
All 88	$ 18,718,966	$ 6,114,320	$ 34,318

STATE-OWNED AND STATE-LEASED CRITICAL FACILITIES VULNERABILITY ANALYSIS & LOSS ESTIMATION

METHODOLOGY

The methodology for analyzing vulnerabilities of state-owned and state-leased critical facilities to Winter Storms is extended from the methodology of countywide vulnerabilities in the previous pages. The adjusted Countywide Percentages of Damage Relative to Real Estate are multiplied with their respective county's value of state-owned and state-leased critical facilities to determine an estimated annual damage to state-owned and state-leased critical facilities for that county. Table 2.4.c depicts the estimated annual damage to State-owned and State-leased critical facilities by county.

RESULTS

Within Region 1, Lucas County has the highest value of State-owned and State-leased critical facilities. However, because they reported zero dollars in property damages to the various hazards under *Winter Storms* from 2003 to 2023, it's only estimated annual damage to critical facilities are $33,253 - the fourth highest in region 1. Marion County with almost the number and value of critical facilities compared to Lucas County, had the highest estimated damage at $195,704 dollars per year. Overall, Region 1 has second highest total estimated damage amongst the three regions at $428,365 per year.

In Region 2, Franklin County by far had the highest number and value of critical facilities, and but only had the second highest estimated annual damage to State-owned and State-leased critical facilities at $283,103. Richland County had the highest estimated damage at $307,358 to 77 critical facilities. This may be due to two recorded events that together estimated over $50 million in damages, which is higher than other counties relative to their typical taxable value of real estate. With the most number and value of critical facilities of all the regions, Region 2 has the highest total estimated damage at $1,181,599 per year.

In Region 3, there is a total estimated annual damage of $297,370 regionwide- the lowest amongst the three regions. Ross County has the highest estimated annual damage per capita at $61,879. Scioto County had the second highest estimated damage at $57,958 per year.

Table 2.4.c

Estimated Annual Damage to State-owned and State-leased Critical Facilities- Winter Storms											
Region 1				Region 2				Region 3			
County	Number of Crit. Fac.	Value of Crit. Fac.	Est. Damage Per Year	County	Number of Crit. Fac.	Value of Crit. Fac.	Est. Damage Per Year	County	Number of Crit. Fac.	Value of Crit. Fac.	Est. Damage Per Year
Allen	99	$ 148,535,104	$ 17,994	Ashland	145	$ 103,491,091	$ 12,537	Adams	30	$ 12,672,306	$ 1,535
Auglaize	18	$ 6,542,813	$ 793	Butler	29	$ 17,200,278	$ 2,084	Ashtabula	72	$ 25,195,275	$ 3,052
Champaign	21	$ 9,246,093	$ 1,120	Clinton	31	$ 13,450,515	$ 1,629	Athens	35	$ 53,251,615	$ 6,451
Clark	27	$ 9,650,921	$ 1,169	Cuyahoga	106	$ 389,621,908	$ 47,199	Belmont	70	$ 153,564,291	$ 18,603
Crawford	12	$ 11,520,704	$ 1,396	Delaware	33	$ 61,002,573	$ 7,390	Brown	31	$ 35,387,446	$ 4,287
Darke	27	$ 17,992,950	$ 2,180	Fairfield	67	$ 94,557,543	$ 11,455	Carroll	18	$ 5,220,360	$ 632
Defiance	15	$ 12,622,416	$ 1,529	Fayette	23	$ 11,052,410	$ 1,339	Clermont	51	$ 32,967,768	$ 3,994
Erie	55	$ 150,149,608	$ 18,189	Franklin	190	$ 2,336,963,045	$ 283,103	Columbiana	36	$ 14,981,756	$ 1,926
Fulton	12	$ 9,821,964	$ 1,190	Geauga	27	$ 12,064,728	$ 1,462	Coshocton	21	$ 16,813,037	$ 2,037
Hancock	20	$ 12,221,847	$ 1,481	Greene	21	$ 17,560,307	$ 2,127	Gallia	61	$ 49,786,218	$ 6,031
Hardin	18	$ 6,825,758	$ 827	Hamilton	41	$ 113,316,790	$ 13,727	Guernsey	50	$ 58,733,741	$ 7,115
Henry	16	$ 4,250,244	$ 515	Knox	41	$ 76,691,482	$ 9,291	Harrison	24	$ 9,202,403	$ 1,115
Huron	22	$ 10,837,347	$ 1,313	Lake	21	$ 12,988,101	$ 1,792	Highland	11	$ 6,701,555	$ 812
Logan	21	$ 9,389,923	$ 1,138	Licking	67	$ 186,741,453	$ 28,821	Hocking	27	$ 7,590,231	$ 919
Lucas	52	$ 274,497,738	$ 33,253	Lorain	83	$ 212,390,581	$ 25,729	Holmes	29	$ 9,188,433	$ 1,113
Marion	59	$ 237,054,145	$ 28,717	Madison	104	$ 398,511,572	$ 61,584	Jackson	21	$ 10,211,085	$ 1,237
Mercer	27	$ 9,141,077	$ 1,107	Medina	17	$ 16,239,797	$ 1,967	Jefferson	34	$ 14,685,898	$ 1,779
Miami	30	$ 20,994,660	$ 2,543	Montgomery	72	$ 187,896,794	$ 22,762	Lawrence	26	$ 9,167,439	$ 1,111
Ottawa	52	$ 42,237,937	$ 5,117	Morrow	19	$ 12,996,574	$ 1,574	Mahoning	58	$ 109,678,167	$ 13,287
Paulding	11	$ 8,375,637	$ 2,514	Pickaway	137	$ 346,622,641	$ 58,764	Meigs	24	$ 9,369,001	$ 2,838
Preble	28	$ 7,555,862	$ 1,937	Portage	25	$ 17,793,583	$ 7,096	Monroe	12	$ 3,933,796	$ 477
Putnam	19	$ 4,857,269	$ 1,822	Richland	77	$ 236,998,425	$ 78,276	Morgan	15	$ 7,945,305	$ 963
Sandusky	14	$ 8,633,501	$ 1,693	Stark	57	$ 148,641,582	$ 62,245	Muskingum	36	$ 14,169,870	$ 1,717
Seneca	47	$ 47,263,740	$ 38,357	Summit	65	$ 197,956,468	$ 156,751	Noble	32	$ 65,273,141	$ 35,271
Shelby	35	$ 32,329,713	$ 26,690	Union	55	$ 169,438,472	$ 219,741	Perry	9	$ 7,167,121	$ 868
Van Wert	16	$ 7,772,807	$ 7,174	Warren	109	$ 323,719,448	$ 312,011	Pike	12	$ 8,643,712	$ 1,047
Williams	17	$ 7,837,080	$ 5,221	Wayne	22	$ 12,202,802	$ 16,081	Ross	129	$ 510,798,521	$ 61,879
Wood	40	$ 68,292,566	$ 116,921	Total	1,684	$ 5,728,110,964	$ 1,448,538	Scioto	66	$ 478,434,987	$ 57,958
Wyandot	22	$ 6,729,705	$ 8,186					Trumbull	69	$ 97,032,569	$ 17,872
Total	852	$ 1,203,181,127	$ 332,084					Tuscarawas	54	$ 50,576,265	$ 12,042
								Vinton	19	$ 14,102,427	$ 9,690
								Washington	50	$ 36,699,000	$ 42,232
Statewide								Total	1,232	$ 1,939,144,738	$ 321,889
County	Number of Crit. Fac.	Value of Crit. Fac.	Est. Damage Per Year								
All 88	3,768	$ 8,870,436,830	$ 2,102,512								