STATE OF OHIO HAZARD MITIGATION PLAN

EXECUTIVE SUMMARY

The turn of the millennia witnessed a dramatic change in how our Nation prepares for and responds to disasters. The passage of the Disaster Mitigation Act of 2000 (DMA2K) reoriented the focus of the Federal Emergency Management Agency (FEMA) programs to promote projects and plans which reduce the exposure of Americans and their property to natural hazards. In 2002 Congress further defined how to implement DMA2K by publishing rules in the Federal Register containing criteria for state mitigation plan content. Ohio must have a FEMA-approved hazard mitigation plan to remain eligible for Federal Mitigation and Public Assistance funds associated with a Presidential disaster declaration.

The development of the state plan began in 2002, and it involved the participation of numerous state and federal agencies, adjacent state EMA representatives, and various subject-matter experts. The plan was approved by FEMA in 2005, and updated and re-approved in 2008 and 2011, and 2012. The 2014 revision of the plan analyzes Ohio's highest priority hazards: riverine flood, tornado, winter storm, landslide, dam/levee failure, wildfire, seiche/coastal flooding, earthquake, coastal erosion, drought, severe summer storm, invasive species and land subsidence. The states vulnerability to those hazards is analyzed utilizing data from multiple sources to evaluate risk, including: HAZUS software, historical damage data, input from subject-matter experts, and information from local natural hazard mitigation plans. The state hazard mitigation plan describes the unique vulnerabilities associated with the highest priority hazards in Ohio.

The plan also includes a statewide blueprint of actions that will mitigate the risk to the identified hazards. The State Mitigation Strategy includes: goals, objectives, and action items that will help reduce risk, an evaluation of state capability to accomplish this task, and identification of available funding sources. The State Mitigation Strategy is outlined in broad terms by the following goals described in this plan update:

- Reduce loss of life and injury from hazard events;
- Minimize damage to property and societal disruptions from hazard events;
- Integrate hazard mitigation policies and programs;
- Eliminate vulnerable repetitive loss flood-prone structures;
- Promote research, education, and outreach activities to create a culture of mitigation in Ohio; and
- Provide leadership in hazard mitigation in Ohio.

Each of these goals has associated objectives and actions aimed at getting the state closer to realizing community resiliency. For example, the Ohio EMA developed the Ohio Safe Room Rebate Program. This program provides funding to homeowners for the construction/installation of a safe room that is capable of providing near absolute protection from a tornado with 250 mph wind speeds.

The statewide blueprint for hazard reduction is only part of the solution. To effectively reduce hazard exposure the state plan must reflect the goals, objectives and actions identified in local mitigation planning efforts. While the state has a goal of eliminating structures that are repetitively flooded, it is local planning that leads to the projects that will mitigate those properties. The state plan contains information from various local hazard mitigation plans, ranging from hazard identification and vulnerability analysis to specific, community mitigation objectives and actions.

Ohio's mitigation plan addresses each required element for "standard" plan approval in 44 CFR 201.4 and "enhanced" plan approval in 44 CRF 201.5. Ohio is one of only seven states that currently meet enhanced plan criteria. The enhanced plan status designation is a recognition of Ohio's comprehensive mitigation program, and qualifies the state for additional Federal mitigation funds following future disasters.

SECTION 1: INTRODUCTION

1.1 STATE PROFILE

INTRODUCTION

Ohio was the 17th territory to become part of the United State of America with its induction on March 1, 1803. Ohio is an Iroquoian word (Senecan dialect) meaning, 'beautiful river.' Located in the north central region of the United States, Ohio was home to eight of the forty-three people whom have held the office President of the nation including William Henry Harrison, Ulysses Simpson Grant, Rutherford Birchard Hayes, James Abram Garfield, Benjamin Harrison, William McKinley, William Howard Taft and Warren Gamaliel Harding

GEOGRAPHY

The state is divided into two broad geographic regions loosely following a diagonal line running from the south-western corner to the north-eastern corner. The portion of the state above the line was repeatedly inundated by glaciers. The result is a generally flat or gently rolling topography with layers of glacial sediments conducive to agriculture and large population centers. One notable exception is a region in west central Ohio where an outcropping of large hills exists. The portion south of the line consists of the foothills to the Appalachian Mountains, a weathering range located south and east of Ohio.

Water distribution across the state is also regional. The glaciers which altered the land also impacted Ohio's water system. Lake Erie, which encompasses the majority of Ohio's northern border, was created by and subsequently filled with water from glaciers. Rivers systems in approximately the northern third of Ohio flow north into Lake Erie. Major rivers from west to east include the Maumee, Middle Branch, Sandusky, Huron, Black, Cuyahoga and Grand. The remainder of the waterways in the state flow south into the Ohio River. Significant rivers include the Great & Little Miami, Scioto, Hocking and Muskingum along with the Ohio itself.

Ohio borders the states of Pennsylvania, Kentucky, West Virginia, Indiana and Michigan while sharing an international border with the Canadian province of Ontario. A large portion of the state's border is associated with bodies of water including West Virginia and Kentucky along the Ohio River and Ontario near the center of Lake Erie.

Ohio covers 40,952 square miles of land. Land use percentages range from a high of 43.53 for cropland to a low of 1.30 for wetlands (See Table 1.1.a)

Table 1.1.a

Land Use/Land Cover	
Type	**Percentage**
Urban	9.17
Cropland	43.53
Pasture	7..81
Forest	37.12
Open Water	0.92
Wetlands	1.30
Bare/Mines	0.16

From the perspective of taxable land value, the distribution varies significantly from land use. Ohio has over 161 billion dollars of residential inventory and agriculture has nearly 9 billion (See Table 1.1.b)

Table 1.1.b

Taxable Value Inventory	
Type	**Value (in Billions)**
Residential	161.27
Agriculture	8.80
Industrial	9.46
Commercial	38.96
Mineral	0.13

DEMOGRAPHY

The last decennial US census placed Ohio's population at 11,536,504 with a projected population in 2030 of 12,317,610. The Ohio Development Services Agency, Office of Strategic Research has developed fact sheets for the state and each of Ohio's 88 counties. Based on statewide data, the largest racial group in Ohio is White followed by African-American (See Table 1.1.c)

Table 1.1.c

Population		
Race	**Count**	**Percentage**
White	9,669,759	84.0
African-American	1,349,893	11.7
Native American	21,960	0.2
Asian	173,463	1.5
Pacific Islander	2,870	0.0
Other	100,807	0.9
Two or More Races	193,106	1.7
Hispanic (any race)	301,340	2.6

There are a total of 2,143,439 persons falling into minority categories making up 18.6 percent of the population. The median age of Ohioans is 37.9 years.

Map 1.1 A

Source: http://development.ohio.gov/files/research/P3002.pdf

Ohio is home to three large metropolitan statistical areas (MSAs) located around the cities of Cleveland (2,077,240), Columbus (1,836,536) and Cincinnati (2,130,151) based on the 2010 census and information from the Ohio Development Services Agency 2010 State of Ohio Profile. There are an additional four notable moderate sized MSAs located around the cities of Akron (703,200), Dayton (841,502), Toledo (651,429) and Youngstown (565,773), see Map 1.1.a. Combined, these MSAs account for 9,120,655 people or 76.3 percent of the state's population. The central counties for these MSAs account for 1,102,290 African-Americans or 9.55 percent of the state population. Individual county populations range from a low of 13,435 in Vinton County located in south-east Ohio to a high of 2,077,240 in Cuyahoga County which is the center of the Cleveland MSA.

Ohio contains a federally and state recognized demographic region knows as Appalachia. In 1965, the U.S. Congress identified counties in thirteen states along the Appalachian Mountain Range as part of the Appalachian Regional Commission. The Governor's Office of Appalachia represents the interests of the 29 counties comprising East Central, Southeast and Southern Ohio (See Map 1.1.b).

Map 1.1.b

Source: http://www.odod.state.oh.us/research/files/s0/appalachia.pdf

Appalachia's population in 2010 was 2,042,040 of which 93.1 percent is white. In recent history, Appalachia has faced significant economic and developmental challenges.

TRANSPORTATION

Ohio has been dubbed the crossroads connecting the northeastern US with the Midwest (See Map 1.1.c). The map only represents federal highways and interstates. Three major east-west interstates (I-70, I-80 and I-90) traverse the state. Three north-south interstates (I-75, I-71 and I-77) run the full length of the state.

Map 1.1.c

Source: http://geology.com/state-map/ohio.shtml

LAND USE

REGIONAL LEVEL ANALYSIS

Ohio has elected to address hazard mitigation planning on three regions which have similar geographic, socio-economic and land-use characteristics. Still, there are a few anomalies, which do not reflect these general trends for the host region. For example, the region as a whole may be experiencing population growth, but some of the counties within that region may be experiencing significant population decline due to out-migration. Analyses of these types of differences are a necessary process in the development of the risk and vulnerability assessments for each hazard as well as for the development of the hazard mitigation strategies.

REGION 1

Region 1 is characterized by largely rural, agricultural counties with flat to gently rolling topography. It is the northwest portion of the state.

General Population

Region 1 experienced modest population increases between 1980 and 2010, but the average population increase between these two dates (1.18%) was less than half that of the state as a whole (6.84%). Regional growth is expected to continue at a rate of about 0.85% (see Table 1.1.d).

All communities did not share same increase in growth even though the region as a whole has experienced an increase in population (see Table 1.1.e). Half of the ten largest communities experienced population decreases between 1990 and 2010 with Lima (Allen County) having the largest decrease at –14.88%. The final four largest communities saw an increase. The most significant, with an increase of 28.65%, was in Troy (Miami County).

Table 1.1.d

Region 1 Population Trends 1980-2030		
YEAR	**POPULATION**	**% CHANGE 1980-2030**
1980	2,108,373	
1990	2,109,289	(+) 0.04%
2000	2,159,494	(+) 2.32%
2010	2,147,186	(-) 0.57 %
2020 (projected)	2,204,560	(+) 2.67 %
2030 (projected)	2,214,330	(+) 0.44%

Source: Ohio Development Services Agency

Table 1.1.e

Region 1: Percent Growth in Large Cities				
LARGEST AREAS	**1990**	**2000**	**2010**	**% CHANGE**
Toledo	332,943	313,619	287,208	(-) 8.42%
Springfield	70,487	65,358	60,608	(-) 7.26%
Lima	45,549	40,081	38,771	(-) 3.27%
Findlay	35,703	38,967	41,202	(+) 5.74%
Marion	34,075	35,318	36,837	(+) 4.30%
Bowling Green	28,176	29,636	30,028	(+) 1.32%
Sandusky	29,764	27,844	25,793	(-) 7.37%
Troy	19,478	21,999	25,058	(+) 13.90
Sidney	18,710	18,135	21,229	(+) 17.06
Tiffin	18,604	18,135	17,963	(-) 0.94%
Source: Ohio Development Services Agency				

Special Populations

The number of people within the special population category generally increases with the size of the county or community. These special population groups include: infant children, elderly, non-English speaking populations, convalescing populations, assisted living populations, as well as inmates. The number of people with disabilities in the region's two largest counties, Lucas and Clark, is higher than most counties in the region.

Convalescing and Assisted Living Populations

There are a number of facilities in Region 1 that house special or disabled populations. They include 219 nursing homes and 54 hospitals with a total of 26,705 beds. There are also two psychiatric hospitals within the region. Although these facilities have their own contingency plans, they coordinate with state, county and city hazard mitigation planning efforts.

Inmate Populations

There are eight correctional facilities in Region 1 including 2 prisons in Allen County, 1 in Lucas County, 2 in Madison County, 2 in Marion County, and 1 in Union County. As of the second quarter of 2011, the combined inmate population in these facilities totals 15,127.

Ethnic / Poverty Level Considerations

Ethnicity, poverty levels, and the ability to comprehend the English language vary throughout the region. Caucasians comprise over 90% of the region's ethnic mix compared to the state's average of 84%. The region's largest minority (African-American) groups are concentrated in more urbanized areas such as Lucas (17.8%), Allen (11.3%), Clark (8.6%) and Erie (8.4%) counties. African-Americans across the region as a whole comprise about 6.28% of the population (see Table 1.1.f).

Table 1.1.f

REGION 1 ETHNIC PROFILE		
POPULATION BY RACE	**NUMBER**	**PERCENT**
Total Population	**2,147,186**	**100**
Total Minority	**295,586**	**13.77**
Caucasian	1,941,529	**90.42**
African-American	134,783	**6.28**
Hispanic	73,083	**3.40**
Native American	5,358	**0.25**
Asian	10,797	**0.50**
Pacific Islander	660	**0.06**
Other	25,535	**1.19**
Two or More Races	38,512	**1.79**
Source: Ohio Development Services Agency		

The Hispanic population encompasses the region's third largest ethnic group at 3.4% of the population. The main cores of Hispanic inhabitants are located in more rural northwestern Ohio counties such as Defiance (8.2), Sandusky (8.0), Fulton (6.8), Henry (6.8), Putnam (5.5), and Huron (5.4) counties, which also have large numbers of foreign language speakers. Other ethnic groups in the region total less than 1% of the population. Poverty rates between 2005 and 2009 doubled in most instances across the region from 6.3% to 13.6%. Among the highest were Williams (15.7%), Huron (15.4%), Wyandot (13.9%), Fulton (13.4%), and Henry (13.3%) counties. Three of these counties (Huron, Henry and Fulton) also have the largest ethnic minority populations.

Age Profiles

The median age group in Region 1 is 39.6. The age population categories, which require the most care after a disaster event are the "under 5 years of age" and over "65 years of age" and are distributed consistently throughout the region. The percentage of children under the age of 5 is about the same throughout Region 1 counties but ranges from a high of 18.2% of the population in Allen County to a low of 5.4% in Ottawa County. The percentage of people 65 years of age and older is also consistent with percentages ranging from a low of 11.7% in Wood County to a high of 17.1% in Erie and Ottawa counties (see Table 1.1.g). The highest median age for any of Ohio's counties occurs in Region 1 (44.4 in Ottawa County).

Regional Economy

The economy in Region 1 is firmly based in trade, transportation and utilities both in terms of work force and wages. Other economic sectors ranked in terms of workforce and wages include (2) professional and business services, (3) leisure and hospitality, (4) education and health services, and (5) construction. In early 2008, the Financial Crisis took a significant toll on the automotive industry and related supply/parts manufacturing firms in the region, resulting in massive

layoffs, unemployment and foreclosures. Statistics show there was a loss of 3,300 assembly and 2,400 parts manufacturing jobs from 10 years ago. At the same time, fuel prices increased to record levels impacting the many transportation firms located in the central part of the region and farm vehicles in the agriculture sector. The effects of the financial crisis remain to the present with little to no improvement. While currently there is no change in the aerospace and defense sectors, the projections for the next several years are not as favorable as the changes experienced from 2000 to 2007. (See Table 1.1.h).

Regional unemployment rates rose dramatically from 6.38% in 2005 to 13.6% in 2009. The highest median incomes were in Putnam ($55,630), Ottawa ($53,277), Madison ($53,041), and Wood ($52,818) counties. Several other counties were slightly lower (see Table 1.1.i).

Table 1.1.g

REGION 1 POPULATION BY AGE								
COUNTY	**Population 2010**	**Under 5 Years**	**5-17 years**	**18-24 years**	**25-44 years**	**45-64 years**	**65 years & over**	**Median Age**
Allen	106,331	7,025	19,166	10,501	25,498	27,632	15,174	37.9
Auglaize	45,949	3,032	8,782	3,966	11,228	12,517	7,095	39.4
Champaign	40,097	2,499	7,510	3,332	9,832	10,955	5,421	39.3
Clark	138,333	8,994	24,494	12,240	34,545	38,158	21,988	39.8
Clinton	42,040	2,916	7,815	4,169	11,295	11,242	5,383	37.4
Crawford	43,784	2,645	7,754	3,330	10,810	12,246	7,396	40.9
Defiance	39,037	2,647	6,745	3,550	9,365	10,582	5,627	39.0
Darke	52,959	3,353	9,841	4,216	12,672	14,078	8,396	40.1
Erie	77,079	4,375	13,076	6,131	17,516	23,099	13,203	42.6
Fayette	29,030	1,950	5,003	2,318	7,297	7,532	4,105	38.4
Fulton	42,698	2,743	8,277	3,447	10,419	11,875	5,721	39.2
Hancock	74,782	4,678	12,982	7,291	19,493	19,388	10,226	37.5
Hardin	32,058	1,949	5,149	4,696	8,333	7,513	4,099	34.2
Henry	28,215	1,878	5,399	2,547	7,014	7,953	4,185	38.5
Huron	59,626	4,345	11,806	4,942	15,240	15,771	7,893	37.2
Logan	45,858	3,128	8,570	3,684	11,796	12,545	6,707	39.1
Lucas	441,815	31,204	82,297	45,334	127,414	119,424	59,283	63.2
Madison	43,435	2,373	7,112	3,759	12,399	11,007	4,979	38.1
Marion	66,501	3,856	11,137	5,827	18,186	17,509	9,078	38.4
Morrow	34,827	2,193	6,575	2,684	9,232	9,563	4,188	38.2
Mercer	40,814	2,857	8,128	3,612	9,223	10,954	5,987	38.1
Miami	102,506	6,155	18,111	7,983	25,327	28,594	14,812	39.8
Ottawa	41,428	2,207	6,617	2,978	9,097	13,198	7,035	44.4
Paulding	19,614	1,218	3,485	1,525	4,749	5,528	2,681	40.1
Preble	42,270	2,576	7,380	3,282	10,501	11,842	6,108	40.6
Putnam	34,499	2,481	6,993	3,192	8,084	8,947	4,832	37.9
Sandusky	60,944	4,000	10,981	4,953	14,750	16,972	9,003	39.7
Seneca	56,745	3,633	9,895	5,905	13,860	15,400	8,018	38.7
Shelby	49,423	3,593	9,745	4,017	12,495	12,836	6,026	37.1
Van Wert	28,744	1,859	5,153	2,431	7,055	7,934	4,414	39.2
Williams	37,642	2,315	6,666	3,232	9,637	10,583	5,771	39.7
Wood	125,488	6,958	20,202	24,802	26,685	31,697	14,631	34.4
Wyandot	22,615	1,351	4,062	1,752	5,703	5,988	3,643	40.2
Region Median								**39.6**

Source: OSU Extension Data Center

The median annual income for Region 1 households is $47,295, which slightly exceeds that of the State of Ohio ($47,144). The regional median income is greater, but 15 of its 33 counties are below the state mean (see Table 1.1.j). There are approximately 7.5% of the people residing in Region 1 that live below the Ohio poverty level, which is not a high percentage, considering that the state average is about 8.3%. The Region 1 counties that have comparatively high numbers of people living below the poverty level include: Hardin (12.3%), Lucas (10.7%), Marion (9.0%), Fayette (8.5%), and Allen (8.3%). These counties may warrant special consideration in pre- and post- disaster planning.

Table 1.1.h

REGION 1 EMPLOYMENT AND WAGES BY SECTOR						
	2008			2009		
Industrial Sector	# of Establishments	Avg Employment	Total Wages	# of Establishments	Avg Employment	Total Wages
Private Sector	45,636	23,667	$27,921,610,875	44,851	21,614	$25,268,002,893
Goods Producing	8,895	7,308	$11,840,325,495	8,585	6,219	$9,898,099,741
Natural Resources & Mining	583	148	$145,381,336	588	213	$211,608,755
Construction	4,924	766	$1,174,757,084	4,701	898	$1,335,566,497
Manufacturing	3,395	5,974	$9,894,158,845	3,306	5,029	8,138,722,981
Services-Providing	36,747	16,359	$16,081,285,380	36,264	15,395	$15,369,903,152
Trade, Transportation & Utilities	11,647	5,586	$5,803,079,881	11,409	5,111	$5,337,637,819
Information	649	292	$386,651,915	653	269	$353,668,812
Financial Services	4,584	937	$1,210,277,192	4,503	904	$1,182,110,486
Professional & Business Services	5,609	2,160	$2,486,839,856	5,558	1,861	$2,243,780,155
Education & Health Services	4,950	3,883	$4,530,022,105	4,931	3,879	$4,653,607,031
Leisure & Hospitality	5,111	2,628	$1,070,435,439	5,079	2,542	$1,038,792,618
Other Services	4,163	870	$592,046,466	4,080	821	$554,150,173
Federal Government	573	200	$344,117,935	570	200	$347,260,737
State Government	512	609	$976,286,801	461	581	$990,664,577
Local Government	3,081	3,139	$3,831,950,596	3,066	3,112	$3,892,378,047
Source: Ohio Development Services Agency						

Table 1.1.i

Region 1 Unemployment Rate					
Labor Force	2005	2006	2007	2008	2009
Employed	1,056,600	1,072,700	1,032,100	1,044,600	986,300
Unemployed	67,400	62,700	65,700	80,600	134,100
Unemployment Rate	6.38	5.85	6.37	7.72	13.60
Source: Ohio Development Services Agency					

Housing

2010 Census statistics indicate that there are approximately 1,792,112 housing units in Region 1, of which 96,867 (5.4%) are vacant (see Table 1.1.k). Ottawa and Logan counties have a surprisingly high number of vacant units. Ottawa County has a total of about 27,148 housing units, of which 9,287 units (34.21%) are vacant. Logan County has a total of about 23,096 housing units, of which

about 4,633 units (20.06%) are vacant. The reasons for such high vacancy rates may be real estate used as seasonal and vacation property (categorized as a second home) rather than structures used to house the permanent population.

More than half of the houses in Region 1 were constructed before the implementation of the National Flood Insurance Program was implemented, which has important mitigation implications. It is likely that a majority of homes built in the region's floodplains do not provide adequate flood protection.

Table 1.1.j

REGION 1 HOUSEHOLD INCOME IN 2010		
	Number	**Percent**
Total Households	**847,539**	**100**
Less than $10,000	63,283	7.47
$10,000 - $19,999	100,966	11.91
$20,000 - $29,999	103,468	12.21
$30,000 - $39,999	97,559	11.51
$40,000 - $49,999	89,579	10.57
$50,000 - $59,999	80,275	9.47
$60,000 - $74,999	97,526	11.51
$75,000 - $99,999	104,911	12.38
$100,000 - $149,999	79,344	9.36
$150,000 - $199,999	17,664	2.08
$200,000 or more	12,964	1.53
Source: Ohio Development Services Agency		

Table 1.1.k

Region 1 Housing by Type		
Housing Units	**Number**	**Percent**
Total Units	**1,792,112**	**100**
Occupied Units	847,633	47.30
Owner Occupied	616,454	34.40
Renter Occupied	231,158	12.90
Vacant Housing Units	96,867	5.41
Source: Ohio Development Services Agency		

Transportation

Region 1 has a well-developed transportation system, despite the fact that 14 of its 33 counties do not have interstate highways. State and US Highway systems coupled with extensive rail networks meets ground transportation needs for

residents in Region 1. Every county in Region 1 has at least 1 commercial airport. Four lake-oriented counties have ports (see Table 1.1.l).

Table 1.1.l

REGION 1 TRANSPORTATION SYSTEMS						
Counties	**Interstate Highways**	**US Highways**	**Rail Line (Number)**	**Principal Airport (Number)**	**Local Airport (Number)**	**Lakeports (Number)**
Allen	X	X	4		1	
Auglaize	X	X	6		1	
Champaign	X	X	3		2	
Clark	X	X	4		2	
Clinton	X	X	2		3	
Crawford	0	X	4		1	
Darke	0	X	2		1	
Defiance	0	X	2		1	
Erie	X	X	2		2	3
Fayette	X	X	4		1	
Fulton	X	X	2	1	1	
Hancock	X	X	3		2	
Hardin	0	X	4		2	
Henry	0	X	3		1	
Huron	0	X	4		2	
Logan	0	X	3		1	
Lucas	X	X	7	1		1
Madison	X	X	2		1	
Marion	0	X	4		1	
Mercer	0	X	1		1	
Miami	X	X	1		2	
Morrow	X	X	2		1	
Ottawa	X	X	2		6	
Paulding	0	X	2			
Preble	X	X	1			
Putnam	0	X	3		3	
Sandusky	X	X	3		2	
Seneca	0	X	5		4	
Shelby	X	0	3		1	
Van Wert	0	X	3		1	
Williams	X	X	3		1	
Wood	X	X	4		4	
Wyandot	0	X	3		1	

Source: Ohio Development Services Agency

REGION 2

Region 2 is defined by the I-71 corridor and contains all of Ohio's largest cities: Cleveland, Columbus, and Cincinnati. Geographically, it is also, in many respects, the boundary between the previously glaciated portion of the state, and the unglaciated Appalachian foothills.

General Population

The population in Region 2, according to the Ohio Development Services Agency, was 7,845,610 in 2010. The Region has experienced modest, but steady, population growth since 1980. The regional growth rate between 1980 and 2010 was about 6.99%, which is similar to the State of Ohio's rate of 6.84% for the same period. Regional growth rates are expected to increase approximately by 4% into 2020 and 3% into 2030.

The counties in Region 2 do not share regional growth trends as eight of the region's 10 largest communities registered a population decline in 2000 and 2010. The minus (-) 18.4% decline in Youngstown (Mahoning Co.) contrasts with that of Columbus (Franklin Co.), which gained 9.68% during the same period (see Table 1.4.4.1.b). Rapid population gains or declines can have an effect on hazard mitigation strategies, but due to the relatively recent history of mitigation projects and the impact of Region 2 population changes, the effect it has on mitigation activities is unknown.

Special Populations

Region 2 shares the same special population concerns as Regions 1 and 3. The large number of people warranting special consideration coincides with the region's most populous areas. Nine of Ohio's ten most-populated counties are in Region 2.

Emergency managers and mitigation planners must pay particular attention to counties having large numbers of disabled people (e.g., Cuyahoga, Hamilton, and Montgomery counties), large numbers of people living below the state's poverty level (e.g., Cuyahoga, Mahoning, Hamilton, and Montgomery counties), and those with limited English capabilities (e.g., Cuyahoga, Geauga, and Wayne counties). The age of the population is also an important factor. Each county is unique and must be treated accordingly.

Convalescing and Assisted Living Populations

There are a large number of hospitals (139) and nursing homes (558) in Region 2. They account for 93,804 beds. The average availability of these beds is yet to be determined, but they figure prominently in pre- and post- disaster considerations. There also are eleven psychiatric hospitals within the region. Although these facilities have their own contingency plans, they must be coordinated with state, county and city hazard mitigation planning efforts.

Table 1.1.m

Region 2 Population Trends 1980-2030		
YEAR	POPULATION	% CHANGE 1980-2030
1980	7,283,925	
1990	7,332,975	(+) 0.04%
2000	7,697,425	(+) 2.32%
2010	7,845,610	(+) 1.95 %
2020 (projected)	8,165,410	(+) 4.08%
2030 (projected)	8,407,580	(+) 2.97%
Source: Ohio Development Services Agency		

Table 1.1.n

Region 2: Percent Growth in Large Cities				
LARGEST AREAS	1990	2000	2010	% CHANGE
Columbus	632,270	702,132	770,122	(+) 9.68
Cleveland	505,616	478,403	396,815	(-) 17.05
Cincinnati	364,040	331,285	296,943	(-) 10.37
Akron	223,019	217,019	199,110	(-) 8.25
Montgomery	182,044	166,179	141,527	(-) 14.83
Youngstown	95,706	82,076	66,971	(-) 18.40
Canton	84,161	80,806	73,007	(-) 9.65
Lorain	71,245	68,652	64,097	(-) 6.63
Hamilton	61,368	60,960	62,477	(+) 2.49
Mentor	47,358	50,278	47,159	(-) 6.20
Source: Ohio Development Services Agency				

Inmate Populations

There are 17 prisons within Region 2 with a total inmate population of about 10,604. Each prison has a contingency plan that addresses a variety of circumstances. The challenge then is coordination with prison officials. The large inmate population and associated special considerations cannot be ignored.

Ethnic / Poverty Level Considerations

The minority population in Region 2 is almost 22.5% of the regional total (7,845,610) (Table 1.1.o). African-Americans are the largest minority (15.08%) followed by Hispanics (2.74%), Asians (0.17%) and Native Americans (0.14%). Their concentrations within the largest communities may be linked to the availability of jobs in the area. The greatest concentration of people with limited English skills is in those counties with the greatest Hispanic populations (Lorain, Cuyahoga, and Franklin). There also appears to be a correlation with counties

having the greatest number of people living below the state's poverty level and those counties having the greatest minority populations.

Table 1.1.o

REGION 2 ETHNIC PROFILE		
POPULATION BY RACE	**NUMBER**	**PERCENT**
Total Population	**7,845,610**	**100**
Total Minority	**1,764,725**	**22.49**
Caucasian	6,156,229	78.47
African-American	1,183,185	15.08
Hispanic	214,835	2.74
Native American	13,344	0.17
Asian	10,797	0.14
Pacific Islander	1,750	0.16
Other	70,943	0.90
Two or More Races	132,036	1.68

Source: Ohio Development Services Agency

Age Profiles

The median age group in Region 2 is 38.5. The age population categories, which require the most care after a disaster event are the "under 5 years of age" and over "65 years of age" and are distributed consistently throughout the region. The percentage of children under the age of 5 is about the same throughout Region 2 counties with percentages ranging from a low of 5.3% in Portage County to a high of 7.5% in Franklin County and 7.9% in Delaware County. The percentage of people 65 years of age and older is also consistent with percentages ranging from a low of 8.4% in Delaware County to a high of 17.4% in Mahoning County (see Table 1.1.g).

Table 1.1.p

REGION 2 POPULATION BY AGE								
COUNTY	**Population 2010**	**Under 5 Years**	**5-17 years**	**18-24 years**	**25-44 years**	**45-64 years**	**65 years & over**	**Median Age**
Ashland	53,139	3,495	9,709	5,949	13,193	14,287	7,989	38.1
Ashtabula	101,497	6,188	18,194	7,915	25,350	28,697	15,049	40.3
Butler	368,130	24,822	64,201	35,983	102,815	89,410	39,647	35.4
Cuyahoga	1,280,122	80,846	225,273	111,438	335,462	346,775	196,493	39.2
Delaware	174,214	12,658	32,176	11,434	49,909	40,213	13,478	36.2
Fairfield	146,156	9,071	27,487	11,442	39,625	36,906	16,311	37.1
Franklin	1,163,414	84,685	187,994	112,089	371,618	257,413	110,274	33.1
Geauga	93,389	5,742	19,833	8,028	19,701	30,401	14,438	41.9
Greene	161,573	9,179	25,962	27,124	34,168	42,155	19,801	36.7
Hamilton	802,374	56,878	147,643	83,503	231,856	217,924	114,513	36.8
Knox	60,921	3,846	10,257	7,097	13,764	15,490	8,417	38.2
Lake	230,041	13,218	39,830	18,617	59,423	68,275	35,217	41.4
Licking	166,492	10,440	28,340	14,098	40,467	43,027	20,042	38.5
Lorain	301,356	18,830	55,132	26,008	79,491	83,172	40,178	38.8
Mahoning	238,823	13,219	40,450	20,183	56,911	68,479	41,829	42.0
Medina	172,332	10,676	32,977	12,832	45,213	47,769	20,479	39.2
Montgomery	535,153	34,716	90,418	50,946	142,628	140,480	79,111	38.2
Pickaway	55,698	3,335	9,179	4,898	15,468	14,266	6,718	37.9
Portage	161,419	8,310	25,351	25,959	36,123	41,600	18,658	37.0
Richland	124,475	7,658	21,424	10,705	31,848	34,491	19,665	39.8
Stark	375,586	22,522	65,982	33,160	92,869	104,664	59,361	40.3
Summit	541,781	32,875	94,534	45,867	145,463	149,062	76,420	39.1
Trumbull	210,312	11,947	36,047	17,073	51,218	61,535	35,530	41.8
Warren	212,693	14,456	40,152	14,908	61,143	52,298	20,172	36.8
Wayne	114,520	8,090	21,206	11,040	26,004	29,988	15,500	37.6
Region Median								**38.5**

Source: Ohio Development Services Agency

Regional Economy

Trade, transportation and utilities are the region's principal economic sector. Other sectors, in order of economic importance, include (2) Education & Health Services, (3) Professional Business Services (4) Manufacturing, and (5) Leisure & Hospitality (see Table 1.1.q). The region contains the Columbus-Dayton corridor which is home for many types of trucking firms and rail. Interstate 71 bisects the region from southwest to northeast and links to other freeways leading to both the Midwestern states as well as the east coast. The region contains the majority of the state's rail lines with several intermodal sites. Region 2 also is home to many colleges and universities, which are located in the larger metropolitan statistical areas. This accounts for the slight job increase in the education and health sector as some of the hospitals are also teaching facilities.

Region 2 is home to aerospace and defense industries such as General Electric Aircraft Engines in Cincinnati, Joint Systems Manufacturing in Lima, and Wright-Patterson Air Force Base in Dayton. Cincinnati is also home to a significant

concentration of corporations engaged in the communications systems and software industries. In manufacturing, Cincinnati is ranked #6, Cleveland #10 and Columbus #19 in the nation. However, it has been reported that the state, once third in nation in manufacturing GDP in 2008, has lost 106,629 manufacturing jobs and over 1,000 manufacturers since 2007.

Region 2 unemployment rates increased dramatically between a low of 5.57% in 2006 to a high of 10.62 % in 2009 (see Table 1.1.r). There is a correlation between unemployment rates and the fortunes of the manufacturing sector. Government and health care services have generated a large number of jobs in Region 2, after the manufacturing sector. The median household income in Region 2 is between $60,000 and $74,999 a year (see Table 1.1.s).

Table 1.1.q

REGION 2 EMPLOYMENT AND WAGES BY SECTOR						
	2008			2009		
Industrial Sector	**# of Establishments**	**Average Employment**	**Total Wages**	**# of Establishments**	**Average Employment**	**Total Wages**
Private Sector	193,047	130,149	$135,563,420,107	189,317	122,300	$126,990,859,658
Goods Producing	30,385	24,782	$31,913,662,367	29,117	21,186	$27,124,757,770
Natural Resources & Mining	827	205	$182,536,117	836	195	$173,517,129
Construction	17,646	2,213	$2,371,537,412	16,704	1,897	$2,061,656,358
Manufacturing	11,921	18,470	$24,651,971,377	11,581	15,791	20,839,227,259
Services-Providing	162,661	105,367	$103,649,757,740	160,201	101,114	$99,866,101,888
Trade, Transportation & Utilities	45,743	29,059	$26,302,578,042	44,775	27,151	$24,386,911,855
Information	2,936	2,775	$3,995,116,074	2,774	2,578	$3,726,603,263
Financial Services	21,051	9,085	$12,669,859,186	20,440	8,763	$12,322,483,782
Professional & Business Services	35,270	21,793	$28,741,956,552	34,841	20,272	$26,889,591,061
Education & Health Services	21,132	23,653	$23,153,726,498	21,349	24,063	$24,018,803,571
Leisure & Hospitality	18,751	14,342	$5,711,245,295	18,509	13,856	$5,589,737,088
Other Services	17,232	4,630	$3,005,681,907	16,819	4,383	$2,899,557,648
Federal Government	925	2,612	$4,322,205,969	924	2,652	$4,445,913,039
State Government	774	3,558	$4,371,998,308	682	3,563	$4,449,762,415
Local Government	6,125	13,961	$14,810,069,772	6,084	13,815	$14,994,490,492

Source: Ohio Development Services Agency

Table 1.1.r

Region 2 Unemployment Rate					
Labor Force	**2005**	**2006**	**2007**	**2008**	**2009**
Employed	3,807,600	3,859,200	3,882,400	3,863,600	3,713,400
Unemployed	228,500	215,100	219,400	260,500	394,200
Unemployment Rate	6.00	5.57	5.65	6.74	10.62
Source: Ohio Development Services Agency					

Table 1.1.s

REGION 2 HOUSEHOLD INCOME IN 2010		
	Number	**Percent**
Total Households	**3,099,436**	**100**
Less than $10,000	257,241	8.30
$10,000 - $19,999	347,736	11.22
$20,000 - $29,999	345,147	11.14
$30,000 - $39,999	335,324	10.82
$40,000 - $49,999	301,924	9.74
$50,000 - $59,999	261,408	8.43
$60,000 - $74,999	329,952	10.65
$75,000 - $99,999	378,021	12.20
$100,000 - $149,999	344,276	11.11
$150,000 - $199,999	109,410	3.53
$200,000 or more	88,997	2.87
Source: Ohio Development Services Agency		

Housing

About one half of Region 2's housing stock was constructed prior to 1969, when the National Flood Insurance Program was created. This implies that a large number of houses constructed in the region's floodplains do not have adequate flood protection. Most of the homes in Region 2 are owner occupied (60.56%), as opposed to those occupied by renters (28.84%). The number of vacant homes is relatively low (10.54%), but livability of these vacant homes is unknown.

Table 1.1.t

Region 2 Housing by Type		
Housing Units	**Number**	**Percent**
Total Units	**3,466,755**	**100**
Occupied Units	3,109,452	89.69
Owner Occupied	2,099,623	60.56
Renter Occupied	999,829	28.84
Vacant Housing Units	367,276	10.59
Source: Ohio Development Services Agency		

Transportation

Region 2 has a well-developed transportation system, which includes 6 principal airports and 65 local airports. Geauga and Knox Counties are the only Region 2 counties that do not have interstate highways. All are served by the US Highway system and a variety of rail lines. The region possesses both lake and river port facilities (see Table 1.1.u).

Table 1.1.u

REGION 2 TRANSPORTATION SYSTEMS						
County	**Interstate Highways (X)**	**US Hwys (X)**	**Rail Lines (number)**	**Principal Airport (number)**	**Local Airport (number)**	**Lake/River Ports (number)**
Ashland	X	X	3	0	1	0
Ashtabula	X	X	4	0	3	2
Butler	X	X	6	0	3	0
Cuyahoga	X	X	6	1	2	1
Delaware	X	X	3	0	1	0
Fairfield	X	X	0	0	2	0
Franklin	X	X	4	1	5	0
Geauga	0	X	1	0	2	0
Green	X	X	1	0	2	0
Hamilton	X	X	7	1	3	2
Knox	0	X	1	0	2	0
Lake	X	X	2	0	2	1
Licking	X	X	3	0	1	0
Lorain	X	X	4	0	5	1
Mahoning	X	X	4	0	4	0
Medina	X	X	4	0	3	0
Montgomery	X	X	3	1	5	0
Pickaway	X	X	3	0	2	0
Portage	X	X	6	0	5	0
Richland	X	X	3	0	3	0
Stark	X	X	5	1	1	0
Summit	X	X	6	0	3	0
Trumbull	X	X	4	1	2	0
Warren	X	X	1	0	2	0
Wayne	X	X	5	0	1	0
Sources: Ohio Department of Transporation - Ohio Development Services Agency						

REGION 3

Region 3 is defined largely as the Appalachian region of Ohio. This region consists largely of the Appalachian foothills, and also is the area of the state that has the most exposure to the Ohio River, a significant flooding source in the state.

General Population

The population in Region 3 of 1,491,408, according to the Ohio Development Services Agency, demonstrated an increase of 36,095 people over a 10-year period (2000-2010). The 2.48% growth rate is below the state's growth of 4% for the same period. Since 1950 the regional growth has increased steadily (see Table 1.1.v).

The region as a whole has seen an increase in population, but four of the region's areas have experienced losses in population between 2000 and 2010 (see Table 1.1.w). These areas include Portsmouth (Scioto County), Marietta (Washington County), Steubenville (Jefferson County) and Zanesville (Muskingum County).

Table 1.1.v

Region 3 Population Trends 1980-2030		
YEAR	**POPULATION**	**% CHANGE 1980-2030**
1980	1,376,130	
1990	1,372,893	(-) 0.23%
2000	1,455,313	(+) 6.00%
2010	1,491,408	(+) 2.48%
2020 (projected)	1,571,210	(+) 5.35%
2030 (projected)	1,610,340	(+) 2.49%

Source: Ohio Development Services Agency

Table 1.1.w

Region 3: Percent Growth in Large Cities				
LARGEST AREAS	**1990**	**2000**	**2010**	**% CHANGE**
Union Twp., Clermont County	33,368	42,332	46,416	(+) 9.65%
Miami Twp., Clermont County	28,199	36,632	40,161	(+) 9.63%
Zanesville, Muskingum County	26,778	25,586	25,487	(-) 0.39%
Chillicothe, Ross County	21,923	21,796	21,901	(+) 0.48%
Athens, Athens County	21,265	21,342	23,832	(+) 11.67%
Portsmouth, Scioto County	22,676	20,909	20,226	(-) 3.27%
Steubenville, Jefferson County	22,125	19,015	18,659	(-) 1.87%
New Philadelphia, Tuscarawas County	15,698	15,039	17,288	(+) 14.95%
Batavia Twp., Clermont County	11,254	15,039	23,280	(+) 54.80
Marietta, Washington County	15,026	14,515	14,085	(-) 2.96%

Source: Ohio Development Services Agency

Special Populations

There is a significant part of the population in Region 3 that could require higher levels of assistance before and after a disaster occurs. These special population groups include: infant children, elderly, non-English speaking populations, convalescing populations, assisted living populations, as well as inmates.

Convalescing and Assisted Living Populations

The convalescing and assisted living populations include hospitals, nursing homes, and mental institutions. There are 146 nursing homes and 32 hospitals in Region 3 with a total of 16,764 beds. There also are three psychiatric hospitals in the region. Although these facilities have their own contingency plans, they coordinate with state, county and city hazard mitigation planning efforts.

Inmate Populations

Region 3 also contains six prisons, which are divided among Belmont, Hocking, Noble, Ross, and Scioto counties. The inmate population at this point in time is 12,215. Most notably is Ross County, which contains two of the six prisons but approximately 42.44% of the population.

Ethnic / Poverty Level Considerations

Approximately 81.39% of the region's 1,491,408 people are Caucasian. This leaves a total minority population of 79,321; many who may not be fluent in the English language (see Tables 1.1.x). Athens and Coshocton counties have significantly large populations that speak languages other than English in the home (5.4 and 6.7% respectively). By comparison, the average for the State of Ohio is about 6.1 %.

Table 1.1.x

REGION 3 ETHNIC PROFILE		
POPULATION BY RACE	**NUMBER**	**PERCENT**
Total Population	**1,491,408**	**100**
Total Minority	**79,321**	**5.32**
Caucasian	1,213,804	81.39
African-American	30,674	2.06
Hispanic	12,848	0.86
Native American	3,141	0.21
Asian	10,797	0.72
Pacific Islander	460	0.04
Other	4,048	0.27
Two or More Races	21,578	1.45

Source: Ohio Development Services Agency

The African-American (2.02%) and Hispanic (0.75%) populations in Region 3 are comparatively small. The largest percentages of African Americans reside in Noble (7.4%), Jefferson (5.2%) and Ross (5.1%) counties. The majority of Hispanics reside in Jackson (1.4%), Athens (1.3%), Clermont (1.3%) and Columbiana (1.3%) counties.

Approximately 8.3% of Ohio's populations live below the poverty level. Twenty-three counties within the region are above the state average. Athens County (16.5%) has the highest poverty level in the state. In comparison, six of the Region 3 counties have poverty levels less than that of the state average: Clermont: 7.1%, Coshocton: 9.1%, and Tuscarawas: 9.4%. Counties listed as below poverty level face potentially severe implications of ensuring mitigation actions are implemented and often must depend on outside resources.

Age Profiles

The median age in Region 3 is 38.9 years, which does not vary significantly from that in Region 1 (39.6) or Region 2 (38.5).

The two populations, which often require special attention during disaster times, are children under 5 and those over 65. At present, approximately 6.11% of the region's population is less than 5 years of age (91,183) and 14.09% of the population is 65 or more (210,191). Within the region, Columbiana and Clermont counties contain the largest population above 65 years of age. Additionally, Clermont County also contains the highest number of minor population under the age of 5.

Table 1.1.y

Region 3 Population by Age						
COUNTY	Population	Under 5	21 yrs. +	65 yrs. +	85 yrs. +	Median
Adams	27,330	1,756	19,067	3,643	412	36
Athens	62,223	2,972	40,721	5,793	702	26
Belmont	70,226	3,531	52,526	12,758	1,503	41
Brown	42,285	2,979	29,024	4,914	540	35
Carroll	28,836	1,731	20,578	1,809	398	39
Columbiana	112,075	6,618	80,752	16,843	1,755	38
Clermont	177,977	13,550	121,525	16,747	1,692	35
Coshocton	36,655	2,351	25,608	5,375	579	38
Gallia	31,069	1,963	21,811	4,211	493	37
Guernsey	40,792	2,748	28,569	5,896	678	38
Harrison	15,856	914	11,713	2,804	383	41
Highland	40,875	2,906	28,241	5,649	666	36
Holmes	38,943	4,003	23,233	4,092	546	28
Hocking	28,241	1,879	20,023	3,708	410	38
Jackson	32,641	2,139	22,867	4,439	520	36
Jefferson	73,894	3,860	55,001	13,752	1,516	42
Lawerence	62,319	3,839	44,559	8,966	891	38
Meigs	23,072	1,312	16,625	3,406	386	39
Monroe	15,108	804	11,060	2,467	290	41
Morgan	14,897	903	10,548	2,327	256	39
Muskingham	84,585	5,637	58,767	12,092	1,536	36
Noble	14,058	703	10,229	1,836	227	36
Perry	34,078	2,505	23,095	4,093	434	35
Pike	27,695	1,905	19,054	3,756	467	35
Ross	73,345	4,544	53,040	8,928	984	37
Scioto	79,195	5,025	56,391	11,826	1,409	37
Tuscarawas	90,914	6,002	64,447	13,599	1,686	38
Vinton	12,806	921	8,807	1,551	148	36
Washington	63,251	3,691	45,586	3,925	1,094	39
Region Median						35.7

Source: Ohio Development Services Agency

Regional Economy

Region 3 is Ohio's most forested region containing 5,284,888 acres of woodland. The remaining acreage, 9,197,677 acres are committed to urban development. The economic base of Region 3 is deeply rooted in its land use.

Natural resources and mining was the primary source of regional income in 2008 and 2009, followed by (2) Construction, (3) Health Care, and (4) Local Government, and (5) Federal Government. The natural resources and mining sector increase can be attributed to the Great Shale Gas Rush whereby natural gas deposits located in the Utica and Marcellus Shale can be extracted through hydraulic fracturing techniques. The current status and future impacts of hydraulic fracturing is discussed in greater detail in later sections. A probable correlation can be drawn as the second notable increase in jobs is the construction sector followed by the health care sector. This is good news as the region is well-known for the iron and steel industry. As the state produces between 14% and 17% of the nation's raw steel, employment rates have declined, generally attributed to the weakening national economy. The Ohio

Development Services Agency predicts decreases will continue in the coming years.

Regional unemployment rates fluctuated between 2005 and 2008, but the rates differed only by a percentage point or less. In 2009, unemployment rates reached an incredible high of 12.43% leaving 78,920 workers in Region 3 without jobs (see Table 1.1.aa).

The state median income for the year was $48,370 and for the U.S., $47,640 (see Table 1.1.bb). In 2009, the median household income in Region 3 was $41,180 that is considerably lower than the state and national median income.

Table 1.1.z

REGION 3 EMPLOYMENT AND WAGES BY SECTOR								
	2008				2009			
Industrial Sector	# of Establishments	Average Employment	Total Wages	Average Weekly Wage	# of Establishments	Average Employment	Total Wages	Average Weekly Wage
Private Sector	27,773	12,741	$11,837,939,400	$592	27,360	11,992	$11,106,032,659	$594
Goods Producing	5,797	3,396	$4,260,307,519	$820	5,580	2,909	$3,635,556,550	$832
Natural Resources & Mining	566	122	$141,033,186	$389	567	221	$314,968,187	$685
Construction	3,349	488	$638,672,117	$483	3,177	627	$782,022,778	$741
Manufacturing	1,887	2,348	$2,907,141,846	$770	1,841	1,995	2,448,627,574	$772
Services-Providing	21,981	9,345	$7,577,631,881	$493	21,784	9,083	$7,470,476,109	$503
Trade, Transportation & Utilities	7,226	3,229	$2,752,499,415	$528	7,101	3,090	$2,667,005,543	$538
Information	364	193	$248,543,671	$634	356	185	$229,363,410	$630
Financial Services	2,609	609	$678,668,687	$603	2,514	575	$641,388,176	$612
Professional & Business Services	3,232	892	$851,162,517	$548	3,192	812	$785,345,078	$578
Education & Health Services	3,029	2,462	$2,273,523,613	$549	3,071	2,494	$2,376,328,944	$566
Leisure & Hospitality	2,914	1,525	$516,264,548	$210	2,896	1,501	$519,151,662	$218
Other Services	2,600	425	$248,454,146	$335	2,626	417	$245,253,728	$348
Federal Government	503	186	$298,644,366	$884	505	186	$299,156,563	$887
State Government	410	470	$647,802,519	$847	376	459	$668,307,739	$875
Local Government	2,412	2,278	$2,187,684,844	$612	2,386	2,290	$2,257,785,936	$629
Source: Ohio Development Services Agency								

Table 1.1.aa

Region 3 Unemployment Rate					
Labor Force	2005	2006	2007	2008	2009
Employed	657,300	664,400	666,300	658,600	635,100
Unemployed	48,200	43,300	44,300	50,300	78,920
Unemployment Rate	7.33	6.52	6.65	7.64	12.43
Source: Ohio Development Services Agency					

Table 1.1.bb

REGION 3 HOUSEHOLD INCOME IN 2010		
	Number	Percent
Total Households	**561,773**	**100**
Less than $10,000	52,847	9.41
$10,000 - $19,999	82,029	14.60
$20,000 - $29,999	74,604	13.28
$30,000 - $39,999	68,293	12.16
$40,000 - $49,999	57,765	10.28
$50,000 - $59,999	49,803	8.87
$60,000 - $74,999	58,630	10.44
$75,000 - $99,999	58,583	10.43
$100,000 - $149,999	42,323	7.53
$150,000 - $199,999	9,695	1.73
$200,000 or more	7,201	1.28
Source: Ohio Development Services Agency		

Housing

There were 634,000 housing units in Region 3 (see Table 1.1.cc). The majority of the homes (88.45%) are owner-occupied and about 23% are rentals. There were 11% of the region's stocks that were vacant.

According to the Ohio Development Services Agency, approximately 71% of the region's housing stock was built before 1970, which indicates most construction, occurred prior to the National Floodplain Insurance Program (NFIP) floodplain mapping initiative. Communities participating in the NFIP are routinely visited to ensure compliance with building and floodplain management standards, which ensures reduction in the vulnerability to flood related damage.

Table 1.1.cc

Region 3 Housing by Type		
Housing Units	Number	Percent
Total Units	**634,594**	**100**
Occupied Units	561,323	88.45
Owner Occupied	415,436	65.46
Renter Occupied	146,337	23.06
Vacant Housing Units	72,821	11.48
Source: Ohio Development Services Agency		

Transportation

Table 1.1.dd provides a general overview of Region 3 transportation systems, which include interstate highways, US highways, rail lines, local airports, and river ports. There are no large (i.e., principal) airports in the Region.

Only six of twenty-nine counties are served by the interstate system, but most counties have at least one US highway. A major rail line serves all counties except Noble and eight counties have ports along the Ohio River. Knowledge of transportation systems provides a basis for regional hazard mitigation and emergency response strategies.

Table 1.1.dd

REGION 3 TRANSPORTATION SYSTEMS						
County	**Interstate Highways**	**US Hwys**	**Rail Line (Number)**	**Principal Airport (Number)**	**Local Airport (Number)**	**Riverports (Number)**
Adams		X	1		1	
Athens		X	1		1	
Belmont	I -70	X	1		2	3
Brown		X	1		1	
Carroll		0	2		3	
Columbiana		X	2		2	2
Clermont		X	2		1	
Coshocton		X	1		2	
Gallia		X	2		1	2
Guernsey	I -70; I-77	X	1		1	
Harrison		X	2		1	
Highland		X	1		1	
Holmes		X	1		1	
Hocking		X	1		0	
Jackson		X	1		1	
Jefferson		X	3		2	3
Lawerence		X	2		1	2
Meigs		X	1		0	
Monroe		0	2		1	2
Morgan		0	1		1	
Muskingum	I - 70	X	4		2	
Noble	I - 70	0	0		1	
Perry		X	2		2	
Pike		X	2		1	
Ross		X	3		1	
Scioto		X	2		1	3
Tuscarawas	I - 77	X	3		1	
Vinton		X	1		1	
Washington	I - 77	X	1		0	2
Source: Ohio Development Services Agency						

1.2 PLANNING PROCESS

According to 44CRF 201.4(c)(1) Ohio's SHMP must provide a, 'Description of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how other agencies participated.'

STATE MITIGATION PLANNING ADVISORY TEAMS

State Hazard Mitigation Team (SHMT)

Prior to DMA 2000, Ohio had created a mitigation team, the SHMT, which served two primary functions: To provide input / score applications for FEMA mitigation programs and to provide general input on the State of Ohio's hazard mitigation policies. Today the SHMT continues to exist and is the lead advisory group involving mitigation project scoring and mitigation policy – which includes mitigation planning issues.

Currently, the SHMT includes the following entities:

State Hazard Mitigation Team (March 2014)	
Agency	**Name**
Ohio EMA - Recovery Branch	Brigitte Bouska
Ohio DNR - Division of Soil and Water	Christopher Thoms
Ohio DNR - Division of Soil and Water	Matt Knittel
Ohio DNR - Division of Soil and Water	Matt Lesher
Ohio Department of Development	Karen Fabiano
Ohio PWC	Kim Killian
MWCD	Boris Slogar
US Army Corps of Engineers-Buffalo	Laura Ortiz
US Army Corps of Engineers-Huntington	Dan Bailey
US Army Corps of Engineers-Louisville	Brandon Brummett
FEMA (NFIP and Mitigation Branches)	Jenn Redmond
Emergency Mgmt. Association of Ohio	Sean Miller, Delaware Co. EMA
US Geological Survey	Scott Jackson
Ohio EMA - Mitigation Branch (non-voting)	Steve Ferryman
Ohio EMA - Mitigation Branch (non-voting)	Jacob Hoover
Ohio EMA - Mitigation Branch (non-voting)	Rachael Evans
Ohio EMA - Mitigation Branch (non-voting)	Dan Clevidence
Ohio EMA - Mitigation Branch (non-voting)	Sharon Rolf
Ohio EMA - Mitigation Branch (non-voting)	Jessica Nelson
Ohio EMA - Mitigation Branch (non-voting)	Dean Ervin

Ohio Mitigation Plan Advisory Team (OMPAT)

For the initial creation of the SHMP, a larger advisory group called the OMPAT was created. This was to ensure that the initial development of the plan was comprehensive and inclusive. After the initial plan was completed, the OMPAT became defunct. From that point on, the SHMT, coordinating with various entities involved in different aspects of the SHMP will provide overall plan guidance.

INITIAL STATE MITIGATION PLAN DEVELOPMENT & ADOPTION PROCESS (2005)

In early 2004, the SHMT outlined a draft of the plan and determined additional input from members of OMPAT was necessary to enhance the plan. The SHMT scheduled an initial meeting with potential members of the OMPAT in May 2004. The selection of state agencies invited was determined by the DAS comprehensive agency listing. Key criteria for receiving a POC request included agencies already involved with mitigation, agencies dealing with financial issues, and any agency that could be impacted during project development and implementation. Fifty-three State agencies received request for points of contact from Ohio EMA. Of those, 46 responded favorably and agreed to participate as needed in the State's mitigation planning process and provided points of contact for Ohio EMA (see Table 1.2.a). Eight of the 46 agencies attended the kick-off meeting and agreed to become members of the active OMPAT (see Table 1.2.d).

Invitations were also forwarded to the FEMA Region V Regional Director and Director of the Mitigation and Flood Insurance Directorate, the emergency management agencies of the five states contiguous to Ohio and the directors of the seven Ohio regional planning commissions (see Table 1.2.c). The only representatives from this category that were able to attend the meeting were from the West Virginia Office of Emergency Management and Pennsylvania Emergency Management Agency.

The meeting included a general introduction by the Ohio EMA Executive Director, which provided attendees with an overview of emergency management and natural hazard mitigation. The SHMO outlined the significance of and benefits received from mitigation planning and showed the state has received over $35M in mitigation funding from federal programs. The state mitigation planner discussed the detailed requirements of the two types of state plans (Standard and Enhanced) and a question and answer session provided an opportunity for attendees to query anyone present regarding the subject at hand. The attendees were then encouraged to become a part of the OMPAT. All attendees agreed to assist with the planning initiative by:

- Developing the narrative and conducting analyses;
- Reviewing and commenting on draft planning documents;
- Identifying new and existing goals and actions;
- Reviewing and commenting on final planning documents; and/or
- Promoting participation from fellow colleagues.

Table 1.2.a

Agencies That Have Received Invitations to Participate in the Planning Process			
Agency	**First Name**	**Last Name**	**Title**
Auditor of State	Betty	Montgomery	Auditor of State
Air Quality Development Authority	Mark R.	Shanahan	Executive Director
Ambulance Licensing Board	Robert F.	Featheringham	Executive Director
Architects & Landscape Board	William N.	Wilcox	Executive Director
Arts & Sports Facilities Commission	Kathleen M.	Fox	Executive Director
Attorney General	Jim	Petro	Attorney General
Board of Engineers & Surveyors	Mark T.	Jones	Executive Secretary
Board of Regents	Roderick	Chu	Chancellor
Board of Tax Appeals	Julia	Snow	Executive Director
Civil Rights Commission	G. Michael	Payon	Executive Director
Commission on Minority Health	Cheryl A.	Boyce	Executive Director
Counselor & Social Worker Board	Beth	Farnsworth	Executive Director
Dept. of Administrative Services	C. Scott	Johnson	Director
Dept. of Aging	Joan	Lawrence	Director
Dept. of Agriculture	Fred L.	Dailey	Director
Dept. of Commerce	Jeanette	Bradley	Lt. Governor/Director
Dept. of Development	Bruce E.	Johnson	Director
Dept. of Education	Susan T.	Zelman	Sup. of Public Instruction
Dept. of Health	James	Baird Jr.	Director
Dept. of Insurance	Ann Womer	Benjamin	Director
Dept. of Job & Family Services	Tom	Hayes	Director
Dept. of Mental Health	Michael F.	Hogan	Director
Dept. of Mental Retardation	Kenneth W.	Ritchey	Director
Dept. of Taxation	Pat	McAndrew	Interim Tax Comm.
Dept. of Transportation	Gordon	Proctor	Director
Dept. of Youth Services	Geno	Natalucci-Persichetti	Director
Dept. of Natural Resources	Samuel W.	Speck	Director
Dept. of Rehabilitation and Correction	Reginald A.	Wilkinson	Director
Employment Relations Board	Carol Nolan	Drake	Chairman
Environmental Protection Agency	Christopher	Jones	Director
Ethics Commission	David E.	Freel	Executive Director
Industrial Commission	William E.	Thompson	Chairman
Legal Rights Service	Carolyn S.	Knight	Executive Director
Legislative Information Services	George	Yeager	Director
Office of Budget and Management	R. Thomas W.	Johnson	Director
Office of the Adjutant General	Major General John H.	Smith	Adjutant General
Ohio Arts Council	Wayne P.	Lawson	Executive Director
Ohio Historical Society	Gary C.	Ness	Director
Ohio Library Board	Michael	Lucas	State Librarian
Public Utilities Commission	Alan R.	Schriber	Chairman
Public Works Commission	W. Laurance	Bicking	Director
Rail Development Commission	James E.	Seney	Executive Director
School Facilities Commission	Mary Lynn	Readey	Executive Director
Secretary of State	J. Kenneth	Blackwell	Secretary of State
Treasurer of State	Joseph	Deters	Treasurer of State
Veterinary Medical Board	Heather	Hissom	Executive Director

Table 1.2.b

Regional Planning Agency Invitation List			
Name	**Title**	**Department**	**City**
Theken	Section Director	Medina County Planning Department	Magadore
Efland	Section Director	Senior City, Planner City of Cincinnati	Cincinnati
Reddy	Section Director	City of Cleveland Heights Planning and Development	Cleveland
Gad	Section Director	ODOT Office of Urban and Corridor Planning	Columbus
Anderson	Section Director	City Planner, City of Kettering	Kettering
Etchie	Section Director	Transportation Planner, Mannik & Smith Group	Maumee

Table 1.2.c

List of Initial Kick off Meeting Attendees	
Name	**Agency**
Sharon Gbur	Ohio Environmental Protection Agency
Shawn Smith	Public Utilities Commission
Ron Grout	Ohio Department of Transportation
Scott Roberts	Ohio Department of Administrative Services
Chuck Kirschner	Ohio Department of Agriculture
Carol Shkolnik	Ohio Department of Aging
Karen Ernes	Ohio Department of Job and Family Services
Deborah LoSchiano	Board of Tax Appeals

Drafting the Plan

The development of the 2005 SHMP required the participation of many state and federal agencies. Their cooperation and assistance in the development of the mitigation plan made the completion of the plan possible.

The Ohio EMA Mitigation Branch initially worked with ODNR – Division of Water in the fall of 2003 to develop the flood and dam/levee failure sections of the HIRA. A FEMA DAE assisted the state in its planning efforts as it was handling multiple disasters at the time. The enhanced section of the original plan (formerly Section 7) was initially developed by the SHMO.

The development of the risk and vulnerability assessment portion of the State plan was partially completed through a contract FEMA assigned to URS; however, only portions of it were used for tornadoes, landslides, and winter storms. Other data was not used for a variety of reasons.

The initial SHMP provided a comprehensive inventory of local and state capabilities. The local capability assessments information was also identified in local plans. Ohio EMA Mitigation staff reviewed the plans, collected the information and created a database utilizing the 17 state certified local plans. The database included information on the types of plans for each jurisdiction and any future-planning activities. The information from the database was used to develop a narrative discussing the capabilities identified and the need for additional information.

The Ohio EMA Mitigation Branch sent surveys via e-mail to the participating state agencies to identify their capabilities. The survey requested the title of the agency, a contact name and telephone information. However, information on any agency policies, procedures, funding sources or programs that could impact mitigation activities was the main focus of the survey. The agencies were asked to determine if the program would support, hinder or facilitate mitigation actions. Ohio EMA received 21 responses to the surveys after follow-up phone calls and meetings with several agencies to explain the significance of the survey process. The information received was incorporated in the Section 4.2 State Capability Assessment.

The state mitigation planner reviewed the existing goals, objectives and action items in the latest 409 SHMP. Any goal, objective or action item, which supports the current mitigation strategy and remained applicable to the hazards affecting Ohio for tornado, landslide, and severe winter storms were incorporated into the new mitigation plan.

The existing hazard mitigation goals and actions were evaluated and additional information was requested from various agencies. Each agency was asked to review, comment and identify any additional existing goals, related objectives and pending action items not currently documented. The state mitigation planners reviewed each response and incorporated any newly identified mitigation goals, related objectives or pending action items into the appropriate sections of the mitigation plan. The state mitigation planner reviewed the current hazard analysis and loss estimate to develop new mitigation goals, objectives and actions for the tornado, dam failure and severe winter storm sections. The newly identified mitigation goals, related objectives or pending action items were incorporated into the appropriate section of the mitigation plan. Plan update procedures were drafted by the Ohio EMA Mitigation Branch.

Reviewing the Plan

An electronic copy of a draft of the mitigation plan was posted on the Ohio EMA web page, hard copies were supplied to the state library of Ohio for distribution to the public, and notification was made through the Alert Newsletter to all county directors. A public survey regarding the draft plan was available on the Ohio EMA web page and included in all hard copies of the draft plan.

All surveys returned to the Ohio EMA were forwarded to the members of the OMPAT and SHMT for their review. The results of the surveys were discussed at regularly scheduled meetings of the OMPAT and SHMT. Recommendations made by the OMPAT and SHMT, from their assessment of the information from the public surveys, were incorporated into the mitigation plan.

Approving the Plan

Members of the OMPAT worked cooperatively in the mitigation planning effort. The agencies developed narratives, conducted analyses, reviewed draft-planning documents and provided comments. All the information received from their plan development efforts were incorporated into the final plan.

The document was submitted to FEMA Region V for a courtesy compliance review of the plan with the CFR. Once FEMA completed the courtesy review and states the plan meets the requirements of the 44 CFR 201.4 the plan was returned to the state for promulgation by the Governor.

The final step after the approval of the plan by the OMPAT, SHMT, and FEMA (preliminary approval), was the Governor's Authorized Representative signature of the plan and promulgation by the Governor on January 24, 2005. FEMA gave Standard Plan approval on January 26, 2005. Some additional revisions were made to the plan, including a FEMA review of the state's management performance over the previous four quarters and FEMA gave Enhanced Plan approval on May 17, 2005.

After the plan received FEMA approval, copies were made available to the public on the Ohio EMA webpage.

STATE OF OHIO

Executive Department

OFFICE OF THE GOVERNOR

Columbus

STATE OF OHIO MITIGATION PLAN PROMULGATION

The primary role of the government is to provide for the welfare of its citizens. The welfare of Ohio citizens is never more threatened than during disasters. The goal of emergency management is to provide for mitigation, preparedness, response and recovery actions that ensure public welfare is restored and preserved. The State of Ohio Mitigation Plan is an integral element of that emergency management effort.

The State of Ohio Mitigation Plan provides a comprehensive framework for statewide disaster mitigation. It identifies the risks and vulnerabilities of the state to multiple hazards and identifies goals and strategies to address those risks and vulnerabilities.

State agencies cooperated with the Ohio Emergency Management Agency in the planning process to provide an effective framework for the implementation of the identified mitigation strategies. State departments have demonstrated repeatedly that they can work together to achieve the common goal of disaster mitigation in an effort to reduce the risks and vulnerabilities Ohio faces to natural disasters.

The State of Ohio Mitigation Plan ensures consistency with current policy guidance and describes the interrelationship with other levels of government. The plan will continue to evolve, reflecting lessons learned from actual experiences in disasters and ongoing state planning. I am confident that it will serve as a basis for improving coordination and strengthening relationships among all of our emergency management partners on the state, federal and local levels of government as well as the private sector.

Therefore, in recognition of the responsibility of state government to provide for the general welfare and the authority vested in me as the Chief Executive Officer of the State of Ohio, I do hereby promulgate the State of Ohio Standard Mitigation Plan.

Bob Taft

Governor of the State of Ohio

January 24, 2005

Date

2008 PLAN UPDATE AND ADOPTION PROCESS

Conceptually, it was realized that the 2008 Mitigation Plan Update would be much different than the original plan creation. As discussed earlier the overall coordination / advisory body for the update would be the SHMT. Also, other agencies would need to be identified who could provide technical data for the HIRA development/review. The steps involved in updating the 2008 plan are identified below.

Step 1: Review the Existing State Mitigation Plan, Other Plans, Agency Goals and Objectives, Trends, Etc.

The initial 2005 SHMP identified several mitigation actions that were related to the update of the SHMP. Specifically, those were:

- Develop risk assessments and vulnerability analyses for remaining hazards of which Ohio was vulnerable.
- Update the SHMP with new information provided in approved local mitigation plans.
- Update the inventory of state assets worth more than $1 million.
- Update goals, objectives, action.

The Ohio EMA Mitigation Branch also reviewed the following plans:

- State Emergency Operations Plan, State Preparedness Plan, Homeland Security Strategic Plan, Ohio EMA and Mitigation Branch Strategic Plans, Ohio Water Resource Council Strategic Plan
- Mitigation Strategies and Administrative Plan updates after Federal disaster declarations and National level plans for specific hazards.

Step 2: Coordinate with SHMT – Obtain Input on Overall Plan Update Method

The SHMT meets several times per year (2-4) and discusses and is briefed on the SHMP update. SHMT members have been solicited for input, and several team members have contributed to the update.

Step 3: Apply for PDM Funding for Plan Update Project

In 2006, the Ohio EMA Mitigation Branch began to prepare its framework for updating the SHMP. One project idea was developed that would assist with the enhanced plan update criteria, the creation of a portal / information management system that would 1) Store, catalog, and provide easy access to local mitigation plans, supported by a database which would capture key local plan data; 2) Provide planning and other mitigation program data in an easily accessible public web portal that could be updated by local mitigation plan “keepers” and Ohio EMA Mitigation Branch and 3) Identify and catalog mitigation successes and cataloging/tracking acquired properties.

Step 4: Draft the HIRA

Agencies with either the assigned statutory authority related to a particular hazard or those with expertise in dealing with the hazard were contacted and information was requested. For some hazards, such as tornado and winter storm, the Ohio EMA Mitigation Branch was the primary author.

In the 2008 update, HAZUS was used for three different hazards: flood, seiche/coastal flood, and earthquake. HAZUS work on the seiche/coastal flood and earthquake portion of the HIRA was performed in-house by the Mitigation Branch. HAZUS work on the flood portion of the HIRA was accomplished through two avenues – as a work activity identified in the Mitigation Strategy developed for DR-1720-OH, and as a deliverable under a Planning Assistance to States (PAS) cooperative agreement between Ohio EMA, Ohio DNR, and the USACE. The PAS project resulted in Level 1 HAZUS runs for 41 of 88 Ohio counties for the 25-year and 100-year scenario floods.

Step 5: Draft/Update State Mitigation Strategy, Goals, Objectives, and Action Items

Since 2005, the goals, objectives and action items have been reviewed on an annual basis. The 2008 update contains a significant reformatting of this section, and identifies progress made, or not made on the 2005 goals. Also, input from the SHMT, local mitigation plans, and other state plans were reviewed.

One element that was updated included the creation of a Severe Repetitive Loss (SRL) Addendum. The SRL Addendum was created to identify specific state mitigation goals and actions to address severe repetitive loss properties. This addendum was approved by FEMA on April 22, 2008.

Step 6: Draft other Elements of the Plan

The 2008 update reflects a restructuring of the plan from the 2005 version, including the incorporation of the enhanced plan criteria into the state plan. The enhanced plan elements will not be updated until the plan is being submitted for enhanced plan approval.

Step 7: Review Draft

The 2008 update had several levels of review. First, elements of the HIRA where another agency was identified as the lead were review by Ohio EMA. Second, the draft plan was reviewed by the SHMT, and the Ohio EMA executive group. Finally, an action item in the State Mitigation Strategy of this plan is to have a comment form on the website for the public to provide input at any time.

Step 8: Approve Plan

The 2008 update was approved by the Ohio EMA Executive Director and later approved by FEMA Region V. After meeting all of the State Standard Mitigation Plan requirements, and formal adoption by the State of Ohio, the State Standard Mitigation Plan was fully approved by FEMA Region V on May 16, 2008.

Step 9: Implement PDM Plan Update Project

Because the 2008 update is being performed in two steps – standard plan approval in May and enhanced plan approval later. This enhanced approval is projected to be completed in 2011.

Step 10: Draft Enhanced Plan Element Updates

These elements were drafted after the standard plan review and approval in May 2008 and prior to the projected completion date of 2011.

Step 11: Review Draft Enhanced Plan Element Updates

The enhanced plan review follows a similar procedure that was used in the standard plan review.

Step 12: Approve Enhanced Plan Element Updates

The enhanced plan review follows a similar procedure that was used in the standard plan review.

2011 PLAN UPDATE AND ADOPTION PROCESS

The 2011 plan update process was similar to the 2008 process and the steps involved in the 2011 update process are outlined below. Various state and federal agencies participated in the 2011 plan update either through the SHMT, silver jackets team, and/or as subject-matter experts. The SHMT helped to develop the mitigation strategy and reviewed draft sections of the plan.

Step 1: Review the existing state mitigation plan, other plans, agency goals and objectives, trends, etc.

Several of the 2011 SHMP update tasks were identified in the 2008 SHMP update including:

- To enhance the current Ohio EMA Mitigation Branch webpage(s) to provide much more information than currently exists. This action item was addressed through the development of the State Hazard Analysis Resource and Planning Portal (SHARPP).
- To complete HAZUS analyses for all Ohio counties for the 100-year and 25-year scenario floods.
- To review and update scoring/ranking criteria for mitigation projects to ensure projects that propose mitigating repetitive loss structures are prioritized.
- Update the HIRA to include an analysis of levees in the state.
- Update the SHMP with new information provided in local mitigation plans.
- Update goals, objectives, and action items.

- Update the SHMP to include information on the straight-line wind event (DR-1805) and the two tornado events that occurred in Ohio since the last plan update.

In addition to reviewing the SHMP, Mitigation Branch staff also reviewed the following plans to ensure coordination:

- State Emergency Operations Plan, State Preparedness Plan, Homeland Security Strategic Plan, Ohio EMA and Mitigation Branch Strategic Plans, Ohio Water Resource Council Strategic Plan
- Mitigation Strategies and Administrative Plan updates after Federal disaster declarations and National level plans for specific hazards.

Step 2: Coordinate with SHMT – Obtain Input on Overall Plan Update

The SHMT meets several times per year, which provided opportunities to discuss the SHMP update and implementation progress. SHMT provided input to the plan HIRA and mitigation strategy, and reviewed draft sections of the plan. The Ohio Silver Jackets Team was also consulted during the mitigation plan update process.

Step 3: Initiate and Complete the SHARPP Project

SHARPP (see Appendix J) was funded through a PDM grant utilizing state dollars as non-federal match. SHARPP has been designed, built, and is in the final stages of testing. The completion of SHARPP is a critical component of the state's strategy for coordinating local mitigation programs, and will help the state plan to meet federal mitigation planning criteria.

Step 4: Complete HAZUS Analyses

For the 2008 update, Ohio EMA and ODNR cooperated with the US Army Corps of Engineers (USACE) to undertake a HAZUS analysis project under the USACE's Planning Assistance to States program. In this project, the ODNR-FPM and USACE combined to complete Level 1 flood analyses for 49 counties. During 2009 and 2010, Ohio EMA analyzed the remainder of the state using HAZUS-MH MR-4, with versions 1 and 2. All county analyses included runs for the 100-year and 25-year events, while analyzing watersheds at the 4-square-mile drainage area. Results of HAZUS analyses were shared with counties and jurisdictions to assist in updating local mitigation plans.

Step 5: Update the SHMP HIRA to Include a Levee Analysis

Mitigation Branch staff members coordinated with the ODNR-Dam Safety Program, FEMA, and the USACE to gather data for the levee analysis portion of the HIRA update.

Step 6: Draft/Update the State Mitigation Strategy, Goals, Objectives and Action Items

The Mitigation Branch is the author of this section, and has the responsibility to review and update the goals, objectives and action items on an annual basis. Input from the SHMT, local mitigation plans, and the various other plans reviewed by the Mitigation Branch were considered during the development the current mitigation strategy.

Step 7: Develop a Draft Plan Document

Major revisions to the plan are documented in the Guide to Revisions. Portions of the HIRA were also updated to include two tornado events and one straight-line wind event that have occurred since the last plan update.

Step 8: Review the Draft Plan

The draft plan was reviewed by the SHMT and the Ohio EMA Executive Branch. The public was provided the opportunity to comment on the draft plan through the Ohio EMA website. Comments and suggestions were incorporated into the plan where appropriate.

Step 9: Standard Plan Review and Comment

The plan will be submitted to FEMA Region V for review and comment. The Mitigation Branch will incorporate any required changes to the plan document before resubmitting for approval.

Step 10: Standard Plan Adoption

Once the plan has been approved as meeting standard plan criteria, the plan will be formally adopted by the State of Ohio.

Step 11: Enhanced Plan Review and Submittal

Once the standard plan has been formally adopted by the State of Ohio, the Mitigation Branch will resubmit the plan to FEMA for Enhanced Plan review.

2014 PLAN UPDATE AND ADOPTION PROCESS

The 201 plan update process was similar to the 2011 process and the steps are listed below. Various state and federal agencies participated in the 2014 plan update either through the SHMT, silver jackets team, and/or as subject-matter experts. The SHMT helped to develop the mitigation strategy and reviewed draft sections of the plan.

Step 1: Review the existing state mitigation plan, other plans, agency goals and objectives, trends, etc.

Several of the 2014 SHMP update tasks were identified in the 2012 SHMP update including:

- Update the HIRA to incorporate information from SHARPP

- Update the SHMP with new information provided in local mitigation plans.
- Update goals, objectives, and action items and address all recommendations identified by FEMA in the 2012 plan crosswalk
- Update the SHMP to include information from DR-4002(Spring Flooding), DR-4077 (Derecho), and DR-4098 (Super Storm Sandy).

In addition to reviewing the SHMP, Mitigation Branch staff also reviewed the following plans to ensure coordination:

- State Emergency Operations Plan, State Preparedness Plan, Homeland Security Strategic Plan, Ohio EMA and Mitigation Branch Strategic Plans, Ohio Water Resource Council Strategic Plan
- Mitigation Strategies and Administrative Plan updates after Federal disaster declarations and National level plans for specific hazards.

Step 2: Coordinate with SHMT – Obtain Input on Overall Plan Update

The SHMT meets several times per year, which provided opportunities to discuss the SHMP update and implementation progress. SHMT provided input to the plan HIRA and mitigation strategy, and reviewed draft sections of the plan. The Ohio Silver Jackets Team was also consulted during the mitigation plan update process.

Step 3: Update the HIRA to incorporate information from SHARPP and address the Ohio Balanced Growth Initiative, hydraulic fracturing and the impacts of climate change.

The Ohio EMA mitigation branch will integrate available information entered in SHARPP as part of the local hazard mitigation plans into the HIRA. The HIRA will also include information addressing the Ohio Balanced Growth Initiative, Hydraulic Fracturing and the impacts of climate change on the State.

Step 4: Update the SHMP to include the necessary language to allow for an increase of 5% projects to 10% in wind specific presidentially declared disasters.

FEMA allows increasing the 5 percent Initiative amount up to 10 percent for a Presidential major disaster declaration for tornadoes and high winds. The increased initiative funding can be used for activities that address the unique hazards posed by tornadoes. The SHMP will address the warning of citizens (ensuring 90 percent coverage), further the concept of safe room construction or rehabilitation for residences or commercial structures, and address sheltering in mobile home parks. The SHMP will also explain how the state will implement an ongoing public education program so that citizens are aware of warning systems and their meaning and the availability of in-home shelter designs.

Step 5: Update the SHMP to include a Rural Electric Cooperative Addendum.

The Ohio EMA mitigation branch has partnered with Ohio Rural Electric Cooperative to develop this addendum. The addendum is needed for many reasons, first Rural Electric Cooperatives (RECs) are allowed to apply for FEMA's PDM and HMGP grant programs as sub-applicants with an approved Rural Electric Cooperative Addendum to the SHMP. Second, by establishing a formal hazard mitigation planning process for rural electric cooperatives, an emphasis is made on reducing the impacts of natural disasters. Third, the development of a hazard mitigation plan annex allow for RECs to develop a plan, even though the cooperative may be in a county that does not have a plan or is in the process of developing a local hazard mitigation plan.

Step 6: Draft/Update the State Mitigation Strategy, Goals, Objectives and Action Items

The Mitigation Branch is the author of this section, and has the responsibility to review and update the goals, objectives and action items on an annual basis. Input from the SHMT, local mitigation plans, and the various other plans reviewed by the Mitigation Branch were considered during the development the current mitigation strategy.

Step 7: Develop a Draft Plan Document

Major revisions to the plan are documented in the Guide to Revisions. Portions of the HIRA were also updated to include the three presidential declared disasters (DR-4022, DR-4077, and DR-4098) that have occurred since the last plan update.

Step 8: Review the Draft Plan

The draft plan was reviewed by the SHMT and the Ohio EMA Executive Branch. The public was provided the opportunity to comment on the draft plan through the Ohio EMA website. Comments and suggestions were incorporated into the plan where appropriate.

Step 9: Enhanced Plan Review and Comment

The plan will be submitted to FEMA Region V for review and comment. The Mitigation Branch will incorporate any required changes to the plan document before resubmitting for approval.

Step 10: Enhanced Plan Adoption

Once the plan has been approved as meeting enhanced plan criteria, the plan will be formally adopted by the State of Ohio.

1.3 PLANNING PROCESS COORDINATION AMONG AGENCIES & ENTITIES

44 CFR 201.4 (b) recommends coordinating with other state agencies, appropriate federal agencies, and other interested entities to participate in the development of the SHMP.

INITIAL STATE HAZARD MITIGATION PLAN (2005)

The Ohio EMA Mitigation Branch developed and distributed a participation letter to all state agencies. The letter explained the federal requirements for development of the SHMP and the importance of the plan for all State agencies. The agencies were encouraged to participate and the letter requested they identify a liaison to represent their agency in the development of the SHMP. In January of 2004, the participation letter was sent directly from the Director of the Department of Public Safety to all other cabinet level Directors.

In May of 2004 the Ohio EMA Mitigation Branch hosted a SHMP kick-off meeting and invited the forty-seven state agencies that received and responded to the participation letter. The State requested the agencies support the planning process as a member of the OMPAT, which guided the mitigations plan's development and future implementation. Membership in the OMPAT requires: review and comments of the draft plan, adoption of the final plan, attendance at an annual meeting to review and direct plan update and revision, and assistance in soliciting additional state agencies for OMPAT membership. The activities required of the OMPAT are minimal compared to those of the SHMT.

The FEMA Region V Regional Administrator and Region V Chief of the Mitigation and Flood Insurance DM received participation letters and an invitation to the mitigation plan kick-off meeting, but were unable to attend. However, FEMA R-V and R-IV staffs were active participants in the mitigation planning process.

There were other Federal agencies that actively participated in the development of the plan. These agencies included NWS, USACE, USFW, HUD, Census Bureau.

The plan development also incorporated non-governmental groups. Ohio's Regional Planning Commissions and the Ohio VOAD contributed information for several sections of the plan. VOAD represents all the non-profit groups with interests in assisting disaster victims and is responsible for coordination of all volunteer activities associated with disaster events in Ohio. The Regional Planning and Development Organizations, established as not-for-profit corporations, receive financial support from a combination of federal and state grants and local service contracts. The Regional Commissions help counties plan and secure funding for development with projects such as construction, repair of upgrade of roads, bridges and water and sewer lines, industrial park development as well as projects related to community services, education and workforce development.

Ohio EMA Mitigation staff solicited assistance from The Ohio State University Department of Geology who works in cooperation with the ODNR Division of Geological Survey to study Ohio's earthquake risk. The OSU departments involved in geo-coding, long-term weather forecasting, hydrological analysis and urban development were also consulted during plan development. Potential updates for the plan could include information from The University of Akron's Emergency Management Program, which provides a network to other academic institutions including: the Ohio University Geology Department, OSU Agricultural Extension Office and University of Cincinnati Law Enforcement Program.

Pennsylvania and West Virginia State EMA's, which are contiguous to Ohio and have similar risks and vulnerabilities and were able to provide insight, which assisted Ohio in its state mitigation planning efforts.

2008 UPDATE

As was indicated in Section 1.2, several agencies who either had the statutory programmatic responsibility for various hazards or those that had data/expertise in those hazards were coordinated with closely (*see table 1.2.d*). Also, the Ohio Department of Administrative Services and Ohio Department of Insurance were consulted. Additionally, the agencies / entities that are members of the SHMT were consulted, often leading to extensive coordination (*see Section 1.2*) on the plan update.

2011 UPDATE

Agency coordination for the 2011 SHMP update was conducted very similarly to the 2008 plan update. Agencies with statutory programmatic responsibility or that are subject matter experts in particular areas were consulted on an as-needed basis. The State Hazard Mitigation Team also participated in the development and review of the 2011 plan update.

2014 UPDATE

Agency coordination for the 2014 SHMP update was conducted very similarly to the 2011 plan update. Agencies with statutory programmatic responsibility or that are subject matter experts in particular areas were consulted on an as-needed basis. The State Hazard Mitigation Team also participated in the development and review of the 2014 plan update.

1.4 PLAN INTEGRATION WITH OTHER INITIATIVES

The 44 CFR 201.4(b)(1) indicates the state's mitigation plan must be integrated to the extent possible with 1) ongoing state and/or regional planning efforts, 2) FEMA mitigation programs, and 3) other initiatives that provide guidance to state and regional agencies. This is optional for a standard SHMP and is required in an enhanced SHMP. The list below identifies the many ways the State of Ohio's mitigation plan and programs are integrated.

PROJECT / PROGRAM / AGENCY	INTEGRATED HOW?
STATE / REGIONAL / LOCAL PLANNING EFFORTS	
Local Hazard Mitigation Planning	Local entities are encouraged to review SHMP; state mitigation planner reviews all local plans for consistency with state plan and federal planning requirements. Local plan data reviewed and integrated into state plan. Ongoing.
Silver Jackets / USACE	Utilizing USACE Planning Assistance to States program, Silver Jackets pilot program began in Ohio in 2006 and the program is now active in multiple states around the country. Silver Jackets is a strategic and collaborative initiative of federal and state agencies to advance natural hazard risk reduction activities that align with state priorities. The initiative seeks to leverage resources available through all levels of government, the private sector, and NGO's to identify and implement local solutions to risk vulnerability. Various members of the SHMT also participate in this effort. 2006-ongoing.
Local Flood Plain Management Plans / USACE	Local FPM plan required whenever a community requests a USACE Feasibility Study for a flood control project. State and local mitigation officials work to ensure state and local plan goals are followed. Also, state and local mitigation plan is good source for data. Ongoing
Southern Ohio Watershed Study / Appalachian Regional Commission (ARC)	ARC is doing a study to provide coordination assistance to five Appalachian counties and develop watershed plans to address a variety of challenges such as flooding, storm water, ecosystem degradation, etc. Ohio EMA Mitigation Branch and Ohio DNR – Floodplain Management Program providing local and state data including data from LHMP and SHMP. 2007-ongoing.
Strategic Plan Update / Ohio Water Resource Council	Ohio EMA Mitigation Branch participated in strategic plan update in 2006-07. Plan includes water hazards section that is consistent with SHMP, goals, and objectives. See website: http://www.dnr.state.oh.us/owrc/hazards/tabid/15359/Default.aspx. Complete.
Strategic Plan Update / Ohio Water Science Center	The USGS's Ohio Water Science Center has requested Ohio EMA Mitigation Branch to participate in the update of its strategic plan to ensure consistency with SHMP goals. Beginning May 2008.
Strategic Plan Update / Ohio Homeland Security	Ohio EMA Mitigation Branch participated in the initial development of Ohio Homeland Security strategic plan by ensuring that the plan was consistent with State of Ohio Hazard Mitigation Plan. The Mitigation Branch currently participates on the OHS Strategic Plan Infrastructure and Structural Recovery Advisory Committee and continues to participate in the development of this plan. Ongoing.

PROJECT / PROGRAM / AGENCY	INTEGRATED HOW?
Strategic Plan Update / Ohio EMA	The Ohio EMA updates its strategic plan on an annual basis. Different branches, including the Mitigation Branch, formulate branch strategic goals and objectives. The Ohio EMA Mitigation Branch strategic plan is partially based on actions in SHMP.
SHARPP / Ohio EMA	SHARPP is a web portal that encompasses mitigation planning efforts, project-related information, record and data assessment calculations that can share data and information with all levels of government. The general public is able to access selected components for review and comment on plans, programs and activity information.
STATE / FEDERAL MITIGATION PROGRAMS	
CDBG & HUD Supplemental Funds / ODOD	The Ohio Development Services Agency ODSA works both independently and with Ohio's mitigation programs to provide funding for non-structural mitigation projects in communities with populations of low and moderate income individuals. Such funds may match FEMA mitigation programs or may be independent of them. Program staff are members of the SHMT.
NFIP & State Floodplain Management Program / ODNR–DOW Floodplain Management Program	State coordinating entity for the National Flood Insurance Program as well as state floodplain management office. Coordinates closely with Ohio EMA Mitigation Branch, and participates on the SHMT. Participates extensively on SHMP updates. Works with Ohio EMA during events and post-flood issues – coordinates education and outreach for community floodplain administrators. Staff from ODNR and OHIO EMA collaborated to create the Ohio Natural Hazard Mitigation Planning Guidebook. This document was developed to provide mitigation planning guidance to communities participating in the Appalachian Flood Risk Reduction Initiative (AFRRI) – which preceded large scale mitigation planning projects available through FEMA. As a result of AFRRI, 41 jurisdictions are covered by natural hazard mitigation plans. Information from the plans was utilized in the SHMP and will continually be updated as more plans are approved. Staff from ODNR and OHIO EMA also collaborated on facilitating Risk MAP in the state. Risk Mapping, Assessment, and Planning (Risk MAP) is the Federal Emergency Management Agency (FEMA) Program that provides communities with flood information and tools they can use to enhance their mitigation plans and take action to better protect their citizens. Through more precise flood mapping products, risk assessment tools, and planning and outreach support, Risk MAP strengthens local ability to make informed decisions about reducing risk.
Ohio Dam Safety Program / ODNR–DOW, Dam Safety Program	The Dam Safety Program has statutory authority for permitting/monitoring dams and levees in Ohio. The DSP provides data for the state plan HIRA.
Ohio Building Code / ODC, OBOA	The Ohio Department of Commerce – Board of Building Standards and the Ohio Building Officials Association work on state building codes and issues related to hazards in Ohio. The Ohio Residential Code of Ohio includes provisions for flood

PROJECT / PROGRAM / AGENCY	INTEGRATED HOW?
	hazards and the ODNR – Floodplain Management Program coordinates closely with them to ensure the Ohio RCO meets federal requirements. The state has utilized information provided in the "Flood Resistant Construction" section of the OBBC to outline expectations of the local jurisdictions, post-disaster, to help them achieve the flood reduction goals. The Board of Building Standards has also adopted code specific to the construction and/or installation of FEMA tornado safe rooms.
Ohio Mine Subsidence Insurance / OMSIUA	Underground mines, some of which have been abandoned for years, can be found in many parts of the state, particularly eastern Ohio. When buildings are constructed above mines, major damage to walls and foundations can occur if the mine collapses. The Ohio Legislature authorized the establishment of the Ohio Mine Subsidence Insurance Underwriting Association (OMSIUA), the Mine Subsidence Governing Board and the Mine Subsidence Insurance Fund in 1985. Ohio Mine Subsidence Insurance is a regional mitigation tool.
Firewise / ODNR – Div. of Forestry	The ODNR – Division of Forestry administers the Firewise program which is a multi-organizational initiative designed to include not only fire safety professionals, but also homeowners, community leaders, planners, developers, and others in localized efforts to lessen the risk of interface wildfires. The ultimate goal of this program is to reduce the susceptibility of homes, communities, and structures to wildfire through cooperative education and mitigation techniques. The Division of Forestry contributed to the wildfire portion of the HIRA.
Unified Hazard Mitigation Programs (HMGP, FMA, PDM) / FEMA	FEMA's hazard mitigation program closely coordinated with and consistent with SHMP. FEMA sits on the SHMT. Ohio EMA utilizes FEMA repetitive loss lists to identify projects for funding under the FMA, and PDM programs. The Ohio EMA Mitigation Branch manages these three programs. These programs provide a significant portion of the mitigation funding resources to implement mitigation activities. Funding from the PDM and HMGP programs are used as funds to assist the State of Ohio and local governments in developing and updating their hazard mitigation plans.
Disaster Resistant University / FEMA	The University of Akron was one of the few recipients of the DRU grant provided by FEMA. The DRU project was coordinated by Ohio EMA.
Structural Flood Control and Non-Structural Authorities / USACE	USACE sits on the SHMT which is the primary vehicle for program/plan coordination. Also, USACE participates in state plan update and FEMA's competitive PDM review panels.
Flood Gauging & Warning / USGS	The USGS's Ohio Water Science Center assists local entities by entering into cooperative agreements for stream gauging and warning system development. These mitigation activities are identified in numerous local mitigation plans and factor into the state mitigation strategy. The USGS also attends the SHMT meetings and assist the Ohio EMA Mitigation Branch with data development for benefit cost analyses. Finally the USGS also produces reports on significant flood events in cooperation with Ohio DNR and Ohio EMA.

PROJECT / PROGRAM / AGENCY	INTEGRATED HOW?

OTHER INITIATIVES

EMAP Accreditation	Emergency Management Accreditation Program (EMAP) is a standard-based voluntary assessment and accreditation process for state and local government. In June 2008, Ohio EMA received EMAP Accreditation for requirements pertaining to a state mitigation program. Ohio EMA received EMAP Re-Accreditation in 2014.

1.5 PLAN MAINTENANCE

Section 201.4(c) requires that the state plan to be reviewed, revised, and submitted for approval to the Regional Director of the FEMA every three years. The regulations require a plan maintenance process that includes an established method and schedule for monitoring, evaluating and updating the plan; a system for monitoring implementation of mitigation measures and project closeouts; and a system for reviewing goal and objective progress. The Ohio EMA Mitigation Branch staff is the primary group responsible for the plan maintenance but will utilize other entities review and comments as part of the maintenance process.

The State of Ohio Hazard Mitigation Plan is a living document and will be reviewed, and potentially updated constantly. The plan will be revised if conditions, under which the plan was developed, change such as new or revised Ohio policies, a major disaster, or availability of funding. This section describes how the plan will be monitored, evaluated and updated.

INITIAL STATE HAZARD MITIGATION PLAN MAINTENANCE, MONITORING, AND EVALUATION PROCESS (2003)

The initial SHMP described a process whereby the state would:

- Review the SHMP by SHMO and OMPAT every 12 months to include a review summary
- Review the SHMP after every disaster event
- Update the plan, primarily focusing on the HIRA and updating progress on goals/objectives/actions
- Monitor mitigation projects funded under FEMA's mitigation programs

Since the 2005 plan approval, these items were largely followed; however, the annual review was cursory and a review summary was not prepared due to the ongoing disaster workload. The state plan was reviewed after every disaster event, primarily to ensure that the required Mitigation Strategy was consistent with the state plan and to implement any recommended actions. The HIRA was updated and mitigation projects are subject to an extensive monitoring program. Updates to the state plan action items are discussed in Section 3 of this plan.

2008 STATE MITIGATION PLAN MONITORING, EVALUATION & UPDATE

The Ohio EMA Mitigation Branch will ensure that the SOHMP is monitored and make any adjustments necessary after Presidential disaster declarations. Also, the Mitigation Branch will monitor the plan on the annual basis with a written report to the SHMT and FEMA by the quarterly reporting deadline after the first of the year (April 30th).

Three types of evaluations will occur, annual evaluation of progress on the mitigation actions identified in Section 3, an interim update to achieve "enhanced plan" status, and a comprehensive evaluation in November 2009 which is approximately 1.5 years from the next update. This extensive evaluation will

result in the framework for the comprehensive plan update. The evaluation of mitigation actions will be included in the annual written report.

2012 STATE MITIGATION PLAN MONITORING, EVALUATION & UPDATE

Before the next comprehensive update that will be required, there will be an update of the SOHMP so an enhanced plan status can be achieved. The enhanced plan update will occur after the full implementation and integration of SHARRP, allows for better organization, integration and tracking of local plans. As part of the next enhanced plan update, hazard information will be updated as necessary and if any disasters are declared prior to that time, information will be incorporated as well. In fact, the entire plan will be reviewed and updated to include current information where necessary.

The method for updating will include consulting with the SHMT, posting the update process on the website and inviting general public feedback on the plan and the update by the Ohio EMA Mitigation Branch to be completed three months before the updated plan is due to FEMA.

2014 STATE MITIGATION PLAN MONITORING, EVALUATION & UPDATE

The SOHMP achieved enhanced plan status as part of the 2012 update and the state plans on continuing this status for the 2014 SOHMP. As part of the next enhanced plan, hazard information will be updated as necessary and if any disasters are declared prior to that time, information will be incorporated as well. This process will be made less cumbersome by using SHARRP, which was implemented after the 2012 update. In fact, the entire plan will be reviewed and updated to include current information where necessary.

The method for updating will be similar to the 2012 update and will include consulting with the SHMT, posting the update process on the website and inviting general public feedback on the plan and the update by the Ohio EMA Mitigation Branch.

MONITORING PROJECT IMPLEMENTATION

Section 201.4(c) requires that the standard state plan maintenance process must include a system for monitoring implementation of mitigation measures and project closeouts. The Ohio EMA Mitigation Branch is responsible for monitoring implementation of FEMA funded mitigation projects under HMGP, PDM, and FMA. Review of implementation progress occurs quarterly with the submission of quarterly reports. These reports are verified by monitoring visits. Details of the extensive monitoring program can be found in the Administrative Plan attached in Appendix H. Ohio EMA Mitigation Branch will also coordinate the monitoring of the actions identified in Section 4 of this plan.

Likewise, project closeout procedures can be found in the Administrative Plan. Because project closeouts are a priority for FEMA Region V, they have been included as a strategic goal for the Ohio EMA Mitigation Branch.

1.6 COMPLIANCE WITH FEDERAL LAWS AND REGULATIONS

The 44 CFR 201.4(c)(7) indicates that the SHMP must include assurances that the state will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with CFR 13.11(c). The state will amend its plan whenever necessary to reflect change in state or Federal laws and statutes as required in CFR 13.11(d).

Through the development and enforcement of this plan, the State of Ohio will comply with all provisions in 44 Code of Federal Regulations, Part 13, as well as Subchapter B-Insurance and Mitigation, Subchapter D- Disaster Assistance and Subchapter F-Preparedness. Additionally, the assurances listed below are provided as documentation that the state or any subsequent sub-grantee (recipients) that receive federal grant funds will comply with all applicable Federal statutes and regulations. The state will amend the plan whenever necessary to reflect changes in federal statutes and regulations or material changes in state law, organization, policy or state agency operations.

To the extent the following provisions apply to the award of assistance:

a) Recipient possesses legal authority to enter into agreements and to execute the proposed programs;

b) Recipient's governing body has duly adopted or passed as an official act a resolution, motion or similar action authorizing the execution of hazard mitigation agreements, including all understandings and assurances contained therein, and directing and authorizing the Recipient's chief administrative officer or designee to act in connection with any application and to provide such additional information as may be required;

c) No member of or delegate to the Congress of the United States, and no Resident Commissioner, shall be admitted to any share or part of any agreement or to any benefit to arise from the same. No member, officer, or employee of the Recipient or its designees or agents, no member of the governing body of the locality in which the program is situated, and no other public official of such locality or localities who exercises any functions or responsibilities with respect to the program during his tenure or for one year thereafter, shall have any interest direct or indirect, in any contract or subcontract, or the proceeds thereof, for work to be performed in connection with the program assisted under this plan. The Recipient shall incorporate or cause to be incorporated, in all such contracts or subcontracts, a provision prohibiting such interest pursuant to the purpose state above;

d) All Recipient contracts for which the State Legislature is in any part a funding source, shall contain language to provide for termination with reasonable costs to be paid by the Recipient for eligible contract work completed prior to the date the notice of suspension of funding was received by the Recipient. Any cost incurred after the Recipient receives a notice of suspension or termination may not be funded with funds

provided under a grant agreement unless previously approved in writing by the Department. All Recipient contracts shall contain provisions for termination for cause or convenience and shall provide for the method of payment in such event;

e) Recipient will comply with:

1) Contract Work Hours and Safety Standards Act of 1962, 40 U.S.C. 327 et seq., requiring that mechanics and laborers (including watchmen and guards) employed on federally assisted contracts be paid wages of not less than one and one-half times their basic wage rates for all hours worked in excess of forty hours in a work week; and

2) Federal Fair Labor Standards Act, 29 U.S.C. Section 201 et seq., requiring that covered employees be paid at least the minimum prescribed wage, and also that they be paid one and one-half times their basic wage rates for all hours worked in excess of the prescribed work-week.

f) Recipient will comply with:

1) Title VI of the Civil Rights Act of 1964 (P.L. 88-352), and the regulations issued pursuant thereto, which provides that no person in the United States shall on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Recipient receives Federal financial assistance and will immediately take any measures necessary to effectuate this assurance. If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Recipient, this assurance shall obligate the Recipient, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended, or for another purpose involving the provision of similar services or benefits;

2) Any prohibition against discrimination on the basis of age under the Age Discrimination Act of 1975, as amended (42 U.S.C.: 6101-6107), which prohibits discrimination on the basis of age or with respect to otherwise qualified handicapped individuals as provided in Section 504 of the Rehabilitation Act of 1973;

3) Executive Order 11246 as amended by Executive Orders 11375 and 12086, and the regulations issued pursuant thereto, which provide that no person shall be discriminated against on the basis of race, color, religion, sex or national origin in all phases of employment during the performance of federal or federally assisted construction contracts; affirmative action to insure fair treatment in employment, upgrading, demotion, or transfer; recruitment or recruitment advertising;

layoff/termination, rates of pay or other forms of compensation; and election for training and apprenticeship;

g) The Recipient agrees to comply with the Americans With Disabilities Act (Public Law 101-336, 42 U.S.C. Section 12101 et seq.), where applicable, which prohibits discrimination by public and private entities on the basis of disability in the areas of employment, public accommodations, transportation, state and local government services, and in telecommunications;

h) Recipient will comply with Title IX of the Education Amendments of 1972, as amended (20 U.S.C.: 1681-1683 and 1685 - 1686), which prohibits discrimination on the basis of sex;

i) Recipient will comply with the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970, (42 U.S.C. 4521-45-94) relating to nondiscrimination on the basis of alcohol abuse or alcoholism;

j) Recipient will comply with 523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. 290 dd-3 and 290 ee-3), as amended, relating to confidentiality of alcohol and drug abuse patient records;

k) Recipient will comply with Title VIII of the Civil Rights Act of 1968, 42 U.S.C. 2000c and 42 3601-3619, as amended, relating to non-discrimination in the sale, rental, or financing of housing, and Title VI of the Civil Rights Act of 1964 (P.L. 88-352), which prohibits discrimination on the basis of race, color or nation origin;

l) Recipient will comply with the Intergovernmental Personnel Act of 1970, 42 U.S.C. 4728-4763;

m) Recipient will comply with the Rehabilitation Act of 1973, Section 504, 29 U.S.C. 794, regarding non-discrimination;

n) Recipient will establish safeguards to prohibit employees from using positions for a purpose that is, or gives the appearance of, being motivated by a desire for private gain for themselves or others, particularly those with whom they have family, business, or other ties pursuant to Section 112.313 and Section 112.3135, FS;

o) Recipient will comply with the Anti-Kickback Act of 1986, 41 U.S.C. Section 51 which outlaws and prescribes penalties for "kickbacks" of wages in federally financed or assisted construction activities;

p) Recipient will comply with the Hatch Act (18 USC 594, 598, 600-605), which limits the political activities of employees;

q) Recipient will comply with the flood insurance purchase and other requirements of the Flood Disaster Protection Act of 1973 as amended, 42 USC 4002-4107, including requirements regarding the purchase of flood insurance in communities where such insurance is available as a condition for the receipt of any Federal financial assistance for construction or

acquisition purposes for use in any area having special flood hazards. The phrase "Federal financial assistance" includes any form of loan, grant, guaranty, insurance payment, rebate, subsidy, disaster assistance loan or grant, or any other form of direct or indirect Federal assistance;

r) Recipient will require every building or facility (other than a privately owned residential structure) designed, constructed, or altered with funds provided under a grant agreement to comply with the "Uniform Federal Accessibility Standards," (AS) which is Appendix A to 41 CFR Section 101-19.6 for general type buildings and Appendix A to 24 CFR Part 40 for residential structures. The Recipient will be responsible for conducting inspections to ensure compliance with these specifications by the contractor;

s) Recipient will, in connection with its performance of environmental assessments under the National Environmental Policy Act of 1969, comply with Section 106 of the National Historic Preservation Act of 1966 (U.S.C. 470), Executive Order 11593, 24 CFR Part 800, and the Preservation of Archaeological and Historical Data Act of 1966 (16 U.S.C. 469a-1, et seq.) by:

1) Consulting with SHPO to identify properties listed in or eligible for inclusion in the National Register of Historic Places that are subject to adverse effects (see 36 CFR Section 800.8) by the proposed activity; and

2) Complying with all requirements established by the State to avoid or mitigate adverse effects upon such properties.

3) Notifying FEMA and the state if any project may affect a historic property. When any of Recipient's projects funded under a grant agreement may affect a historic property, as defined in 36 CFR 800. (2)(e), FEMA may require Recipient to review the eligible scope of work in consultation with SHPO and suggest methods of repair or construction that will conform with the recommended approaches set out in the Secretary of Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings 1992 (Standards), the Secretary of the Interior's Guidelines for Archeological Documentation (Guidelines) (48 Federal Register 44734-37), or any other applicable Secretary of Interior standards. If FEMA determines that the eligible scope of work will not conform with the Standards, Recipient agrees to participate in consultations to develop, and, after execution by all parties, to abide by, a written agreement that establishes mitigation and recondition measures, including but not limited to, impacts to archeological sites, and the salvage, storage, and reuse of any significant architectural features that may otherwise be demolished.

4) Notifying FEMA and the state if any project funded under a grant agreement will involve ground disturbing activities, including, but not limited to: subsurface disturbance; removal of trees; excavation for

footings and foundations; and installation of utilities (such as water, sewer, storm drains, electrical, gas, leach lines and septic tanks) except where these activities are restricted solely to areas previously disturbed by the installation, replacement or maintenance of such utilities. FEMA will request the SHPO's opinion on the potential that archeological properties may be present and be affected by such activities. The SHPO will advise Recipient on any feasible steps to be accomplished to avoid any National Register eligible archeological property or will make recommendations for the development of a treatment plan for the recovery of archeological data from the property.

If Recipient is unable to avoid the archeological property, it will develop, in consultation with the SHPO, a treatment plan consistent with the Guidelines and take into account the Advisory Council on Historic Preservation (Council) publication "Treatment of Archeological Properties". Recipient shall forward information regarding the treatment plan to FEMA, the SHPO and the Council for review. If the SHPO and the Council do not object within 15 calendar days of receipt of the treatment plan, FEMA may direct Recipient to implement the treatment plan. If either the Council or the SHPO object, Recipient shall not proceed with the project until the objection is resolved.

5) Notifying the state and FEMA as soon as practicable: (a) of any changes in the approved scope of work for a National Register eligible or listed property; (b) of all changes to a project that may result in a supplemental DSR or modify an HMGP project for a National Register eligible or listed property; (c) if it appears that a project funded under a grant agreement will affect a previously unidentified property that may be eligible for inclusion in the National Register or affect a known historic property in an unanticipated manner. Recipient acknowledges that FEMA may require Recipient to stop construction in the vicinity of the discovery of a previously unidentified property that may be eligible for inclusion in the National Register or upon learning that construction may affect a known historic property in an unanticipated manner. Recipient further acknowledges that FEMA may require Recipient to take all reasonable measures to avoid or minimize harm to such property until FEMA concludes consultation with the SHPO. Recipient also acknowledges that FEMA will require, and Recipient shall comply with, modifications to the project scope of work necessary to implement recommendations to address the project and the property.

6) Acknowledging that, unless FEMA specifically stipulates otherwise, it shall not receive funding for projects when, with intent to avoid the requirements of the PA or the NHPA, Recipient intentionally and significantly adversely affects a historic property, or having the legal power to prevent it, allowed such significant adverse affect to occur.

t) Recipient will assist the awarding agency in assuring compliance with the National Historic Preservation Act of 1966, as amended, 16 U.S.C. 270;

u) Recipient will assist the awarding agency in assuring compliance with the Preservation of Archeological and Historical Preservation Act of 1966, 16 U.S.C. 469a, et seq;

v) Recipient will comply with the requirements of Titles II and III of the Uniform Relocation Assistance and Property Acquisition Policies Act of 1970, 42 U.S.C. 4621-4638, which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally assisted programs;

w) Recipient will assure project consistency with the approved State program developed under the Coastal Zone Management Act of 1972, 16 U.S.C. 1451-1464; and

x) With respect to demolition activities, recipient will:

1) Create and make available documentation sufficient to demonstrate that the Recipient and its demolition contractor have sufficient manpower and equipment to comply with the obligations as outlined in a grant agreement.

2) Return the property to its natural state as though no improvements had ever been contained thereon.

3) Furnish documentation of all qualified personnel, licenses and all equipment necessary to inspect buildings located in Recipient's jurisdiction to detect the presence of asbestos and lead in accordance with requirements of the U.S. Environmental Protection Agency, the Ohio Department of Environmental Protection and the County Health Department.

4) Provide documentation of the inspection results for each structure to indicate:

- Safety Hazards Present
- Health Hazards Present
- Hazardous Materials Present

5) Provide supervision over contractors or employees employed by Recipient to remove asbestos and lead from demolished or otherwise applicable structures.

6) Leave the demolished site clean, level and free of debris.

7) Notify the department promptly of any unusual existing condition which hampers the contractors work.

8) Obtain all required permits.

9) Provide addresses and marked maps for each site where water wells and septic tanks are to be closed, along with the number of wells and septic tanks located on each site. Provide documentation of closures.

10) Comply with mandatory standards and policies relating to energy efficiency that are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (Public Law 94-163).

11) Comply with all applicable standards, orders, or requirements issued under Section 112 and 306 of the Clean Air Act (42 U.S.C. 1857 (h), Section 508 of the Clean Water Act (33 U.S. 1368), Executive Order 11738, and the U.S. Environmental Protection Agency regulations (40 CFR Part 15 and 61). This clause shall be added to any subcontracts.

12) Provide documentation of public notices for demolition activities.

y) Recipient will comply with Lead-Based Paint Poison Prevention Act (42 U.S.C.: 4821 et seq.), which prohibits the use of lead based paint in construction of rehabilitation or residential structures;

z) Recipient will comply with the Energy Policy and Conservation Act (P.L. 94-163; 42 U.S.C. 6201-6422), and the provisions of the state Energy Conservation Plan adopted pursuant thereto;

aa) Recipient will comply with the Laboratory Animal Welfare Act of 1966, 7 U.S.C. 2131-2159, pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by an award of assistance under this agreement;

bb) Recipient will comply with the Clean Air Act of 1955, as amended, 42 U.S.C. 7401-7642;

cc) Recipient will comply with the Clean Water Act of 1977, as amended, 42 U.S.C. 7419-7626;

dd) Recipient will comply with the Endangered Species Act of 1973, 16 U.S.C. 1531-1544;

ee) Recipient will comply with environmental standards which may be prescribed pursuant to the National Environmental Policy Act of 1969, 42 U.S.C. 4321-4347;

ff) Recipient will comply with the environmental standards that may be prescribed pursuant to the Safe Drinking Water Act of 1974, 42 U.S.C. 300f-300j, regarding the protection of underground water sources;

gg) Recipient will comply with the Wild and Scenic Rivers Act of 1968, 16 U.S.C. 1271-1287, related to protecting components or potential components of the national wild and scenic rivers system;

hh) Recipient will comply with the following Executive Orders: EO 11514 (NEPA); EO 11738 (violating facilities); EO 11988 (Floodplain Management); EO 11990 (Wetlands); and EO 12898 (Environmental Justice);

ii) Recipient will comply with the Coastal Barrier Resources Act of 1977, 16 U.S.C. 3510;

jj) Recipient will comply with the Fish and Wildlife Coordination Act of 1958; 16 U.S.C. 661-666.

1.7 ASSURANCES / PROMULGATION

The State of Ohio Hazard Mitigation Plan meets the standard requirements of Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, 42 United States Code Sections 5121 and following (commonly referred to as the Stafford Act - Public Law 93-288). Additionally, this plan meets the SRL planning requirements of 44 Code of Federal Regulations, Part 79.4 (SRL and FMA beginning in 2009).

It is intended that this plan also meet the requirements of the Section 322 of the Stafford Act which requires that States, as a condition of receiving federal disaster mitigation funds, have a mitigation plan in place that describes the planning process for identifying hazards, risk and vulnerabilities, identifies and prioritizes mitigation actions, encourages the development of local mitigation and provides technical support for these efforts. In addition, the Act requires local and tribal governments to also have mitigation plans as a condition of receiving disaster mitigation funds.

The development and implementation of this strategy is authorized and/or required by the following state statutes:

- Chapter 5502, Ohio Revised Code (specifically Section 5502.22 establishes the Ohio Emergency Management Agency and requires plan development).
- Chapter 5502, Ohio Revised Code (specifically Sections 5502.26, 5502.27, and 5502.271 require the establishment of county emergency management agencies and plan development).

The adoption and promulgation of the 2008, 2011 and 2014 update is being done by the Executive Director of the Ohio EMA in her capacity as the Governor's Authorized Representative (GAR). The original SHMP was promulgated by Governor Taft in 2005.

State of Ohio Hazard Mitigation Plan

STATEMENT OF ADOPTION

The State of Ohio Hazard Mitigation Plan (SOHMP) is a comprehensive description of the State's commitment to reduce or eliminate the impacts of natural and human-caused hazards. The Disaster Mitigation Act of 2000 requires that states have a natural hazard mitigation plan to maintain eligibility for federal disaster assistance and mitigation funds. The SOHMP is coordinated and maintained by the Ohio Emergency Management Agency, however, the plan is the culmination of input and recommendations from numerous stakeholders from local, state and federal government agencies, private sector organizations, and residents of Ohio.

The SOHMP was initially approved by FEMA on January 17, 2005 and has been updated every three years. The previous plan was updated and approved by FEMA as meeting the "enhanced" plan requirements on June 12, 2012. The 2014 plan update will again meet the "enhanced" plan criteria. This "enhanced" plan status is a testament to the Ohio Emergency Management Agency's commitment to mitigation and will allow the state to continue to qualify for additional funds following future disaster declarations.

In adopting the 2014 update of the SOHMP, the State of Ohio agrees to comply with all applicable state and federal statutes and regulations, as stipulated in previously documented assurances, and will update the plan at least every five years. The SOHMP has been amended to reflect emerging hazard conditions and risks as well as new or revised state and federal statutes and regulations. Future amendments will also reflect changes to State organization or policy as appropriate.

As the Executive Director of the Ohio Emergency Management Agency, I the undersigned do hereby formally adopt the State of Ohio Hazard Mitigation Plan 2014 update.

Date: 5/8/14

Nancy J. Dragani, Executive Director
Ohio Emergency Management Agency

SECTION 3:
STATE MITIGATION STRATEGY

3.1 STATE HAZARD MITIGATION GOALS, OBJECTIVES, & ACTIONS

OVERVIEW

Due to the abundance of natural hazards / disasters, Ohio has been active in the hazard mitigation arena for several years. In some ways, Ohio has been a national leader in hazard mitigation for a very long time. Consider the following:

- After the devastating 1913 flood, widely noted as being the largest statewide flood to occur in recorded history, the Ohio Conservancy Act was passed. The law permitted citizens of an area with flood concern to work together to plan, finance and manage a flood control project. As a result, two conservancy districts were created – the Miami Conservancy District in 1915 and Muskingum Watershed Conservancy District in 1933. Both have extensive systems of flood control measures and have resulted in millions of dollars in flood loss reduction.

  The Miami Conservancy District (MCD) is perhaps one of the most comprehensive flood management authorities in the nation. Using a combination of planning, structural and non-structural flood mitigation measures, the MCD has helped reduce flood losses for over 1,500 events. MCD Flood control structures are designed to contain runoff that is 40% more than the 1913 flood, which is well over a 1,000 year flood level. Arthur Morgan, the engineer who designed and built the MCD projects went on to be the first Director of the Tennessee Valley Authority in the 1930s.

- In 1971, a report entitled *The Development of Floodplain Management in Ohio* by Battelle Columbus Laboratories, suggested several unique and innovative non-structural approaches to floodplain management. State officials followed-up this report with the first edition of *Ohio Floodplain Regulation Criteria*, which recommended several standards to promote effective floodplain management through land-use codes.

- The State of Ohio has nearly always provided some amount of matching funds for the Hazard Mitigation Grant Program – sometimes matching Federal funds dollar for dollar. State matching contributions to HMGP to date exceed $34 million dollars.

- The State of Ohio produced an all hazards mitigation planning guide that was the one of the first in the nation in 2002 and preceded FEMA planning guidance by more than one year.

- The State of Ohio was the only recipient in FEMA Region V of 2007 Repetitive Flood Claims funds for two projects.

- Ohio has one of the highest rates of compliance with FEMA's local mitigation planning requirements in the nation.

- Ohio has achieved a 97% NFIP participation rate among Ohio communities with identified flood hazard areas and prioritized compliance with flood protection criteria following disasters.

According to 44 CFR 201.4(c)(3) a SHMP must contain a mitigation strategy that is the state's blueprint for reducing losses identified in the risk assessment. The state's mitigation strategy is described below, and has been updated as part of the 2014 revision. During the update of hazard mitigation goals, objectives, and actions, the Ohio EMA Mitigation Branch:

- Identified applicable mitigation goals, objectives, and actions of the stakeholders that participated in the updating of the plan. This includes direct feedback from the SHMT and other participating entities.
- Identified and reviewed the goals, objectives and actions of the all hazard county mitigation plans that have been developed and approved by FEMA, the handful of community specific mitigation plans that have been developed and approved and any FMA plans that have not been incorporated into local DMA2K plans. These local goals, objectives and action items were compared to those found in the state plan and gave the Ohio EMA Mitigation Branch a clearer vision of what the locals felt was important.
- Identified and reviewed the goals, objectives, and actions of the currently existing State of Ohio Hazard Mitigation Plan.
- Reviewed the state's priority hazards, which include: flooding, tornado/wind, severe summer storms and severe winter storms.

The State of Ohio mitigation strategy in this section of the plan utilizes the following terminology based on FEMA's *State and Local Mitigation Planning How-To Guide*:

- *Goals* – General guidelines that explain what is desired to be achieved. They are usually broad policy-type statements, long term, and represent global visions.
- *Objectives* – Strategies or implementation steps to attain identified goals. Unlike goals, objectives are specific and measurable.
- *Mitigation Actions* – Specific actions to achieve goals and objectives. The mitigation actions are described below and listed in the Mitigation Action Plan Table found in Section 3.2. This table prioritizes mitigation actions, identifies a lead agency for implementation, and is used to track implementation status.

PROGRESS ON 2011 GOALS/OBJECTIVES/ACTIONS; CHANGES IN 2014 UPDATE

The format used to report the goals, objectives, and mitigation actions in the 2014 plan update is consistent with previous state mitigation plan updates. For example, the 2008 plan identified goals by hazard and sometimes by agency.

This update generally identifies goals that are all hazard in nature, with specific objectives related to one or more hazards (with the exception of the goal of mitigating repetitive flood loss structures). A 2012 Mitigation Action Plan Update Summary Table is in the appendices (Appendix E); which provides commentary on the status of the action items identified in the 2012 Enhanced plan update. Finally, the goals/objectives/actions items in this update incorporate priority goals and actions identified in local plans that have been submitted and approved by Ohio EMA and FEMA; incorporate any changes/updates in the strategic plans of agencies that have a role in hazard mitigation; and reflect current trends, issues and priorities. The 2014 mitigation strategy update outlined below was developed with input from the Ohio EMA Executive Staff, the State Hazard Mitigation Team, the Silver Jackets team, and various federal, state, and local entities.

Goal #1: Reduce Loss of Life and Injury from Hazard Events.

Goal Discussion. Ohio is a populous state with over 11 million people. Furthermore, population centers in Ohio are often concentrated in hazard areas – especially floodplains. This is due to their natural progression from communities whose economies were largely water dependent (steel mills needed water for cooling, water was needed for transportation). Events that historically caused loss of life were epidemiological – specifically outbreaks of cholera and influenza killed thousands of Ohioans in the 19th and early 20th centuries. More recently, hazards that have resulted in significant losses of life include: flooding (467 in Great 1913 flood, 26 in 1990 Shadyside flash flood); fires (322 in 1950 Columbus Penitentiary, 95 in 1963 Marietta nursing home); blizzards/winter storms (51 in 1978 blizzard); and tornadoes (35 in 1974 Xenia tornado).

Less known, but more widespread are injuries from hazard events. In addition to minor or major physical injuries, mental injury (trauma, etc.) is an issue after any type of major hazard event. In addition, both injuries and loss of life are possible not only for direct victims of a hazard event, but also for those responding to / assisting those victims.

If the flood of 1913 occurred today, it is doubtful that there would be as many casualties. This is due to *building and other safety codes*. For example, over 700 communities in Ohio have adopted flood loss reduction regulations to participate in the National Flood Insurance Program. The regulations make buildings more resilient in flood events, which results in improved safety for building occupants. Similarly, building codes today contain standards for wind and fire resistance, and dam/levee construction and rehabilitation standards help prevent catastrophic failures of these structures.

Monitoring and warning systems today are far more sophisticated and effective than their predecessors. The Ohio STORMS (State of Ohio Rain/Snow Monitoring System) effectively monitors precipitation during hazardous weather events. Integrated warning systems (not just a siren on a pole) are effective in flash flood and tornado prone areas; which can also be very effective in reducing potential loss of life and injury.

New or continuation? This goal is a continuation from the 2008 update.

Objective 1: Continue to map hazard areas, refine existing hazard mapping data, and develop/refine loss estimation and vulnerability analysis data.

Action: Build on the success of the Risk MAP Areas of Mitigation Interest (AOMI) pilot project by continuing to utilize SHARPP to map areas of mitigation interest.

Action: Conduct HAZUS Level 2 flood analyses for all Counties in Region 2 using Ohio Statewide Imagery Program data and corresponding Digital Flood Insurance Rate Map data.

Action: Continue to update and improve the vulnerability analysis for state-owned buildings and critical facilities.

Objective 2: Promote the use of effective early alert / warning systems.

Action: Work with USGS, NOAA, and other partners to promote flood warning systems and the importance of stream and rain gauges.

Objective 3: Prioritize acquisition of properties, including those in high risk areas (floodways) or those in imminent danger (e.g., landslide) for available funds from FEMA mitigation programs.

Action: Reduce the number of pre-FIRM, flood prone properties each year by assisting such owners with successful funding of mitigation projects through FEMA mitigation programs.

Objective 4: Ensure the continuation of an effective dam/levee safety program.

Action: Inspect all high hazard dams once every 5 years.

Action: Take enforcement actions on violations of state dam/levee safety laws for severely deficient and/or structurally unsound high hazard dams.

Action: Increase the number of Emergency Action Plans through compliance and education efforts.

Objective 5: Promote wind mitigation techniques and programs.

Action: Continue to implement and improve the Ohio Safe Room Rebate Program.

Action: Develop wind mitigation educational materials and outreach programs for vulnerable populations.

Goal #2: Minimize Damage to Property and Societal Disruptions from Hazard Events.

Goal Discussion. Property damage from hazard events is significant in Ohio. Between 1978 and October, 2014, there has been over $284,647,444.62 in paid claims from the NFIP in Ohio. Although this data is a good indicator – it does not account for all of the property losses due to flood. Only about 30% of flood prone structures have flood insurance, the data doesn't include flood claims available through private insurers (for large facilities like factories – private insurance through a secondary insurer is significant), and the data doesn't include crop losses due to flooding.

Similarly, tornadoes and straight-line winds have high loss potential. The 1974 Xenia tornado event resulted in over $1 billion in damages in a multi-state region (including Ohio). According to the Insurance Information Institute, New Jersey tops the list of states with the highest average expected losses from tornadoes, followed by Connecticut, Massachusetts, Ohio and Rhode Island, based on A.M. Best's analysis of Risk Management Solutions modeling data. The September 2008 straight-line wind event in Ohio resulted in over $553.1 million in insured losses, which set a record for the highest amount of insured losses as a result of a single event in Ohio. This event also resulted in over $52,643,099 in public assistance to communities for infrastructure repair and debris removal. In addition to property losses, societal disruptions occur after a hazard event. Consider the following impacts:

- Infrastructure disruption can result in the cutoff of evacuation routes, pollution due to sanitary facilities not working, lack of clean drinking water, and isolation of populated areas (such as in a road or bridge collapse). Loss of medical facilities, and or public safety facilities, can result in vulnerable populations should a subsequent disaster event occur.
- Direct loss of facilities used by employers, or indirect loss due to infrastructure disruption, can lead to lost wages and lost tax revenues for all levels of government.
- Research has shown that mental health problems, divorce rates, and physical/emotional abuse increase after a significant hazard event.
- Local "gathering places" that are destroyed in a hazard event result in disruption of the social fabric of a community.

Strengthening of laws, regulations, and ordinances for new and existing facilities is not only critical to the protection of property and life but, also, the reduction of massive physical, social, and economic disruption that accompanies disasters. Regulations and ordinances help communities design and construct new facilities or alter existing facilities in a manner that resists the forces of nature and ensures safety. Local land use laws can support this effort by keeping buildings and development out of the most hazardous areas through local land use planning. It is essential that mitigation planning be incorporated into all land use planning activities at the local and state levels.

New or continuation? This goal is a continuation from the 2005 plan.

Objective 1: Evaluate and improve safety & loss reduction codes/standards for hazards that affect Ohio.

Action: Promote the adoption of standards beyond NFIP minimums for flood loss reduction.

Objective 2: Develop mitigation resource information for the business community.

Action: Continue to participate in the public/private partnership effort between Ohio EMA and the business community.

Objective 3: Identify funding sources and obtain funds from a variety of Federal, state, regional and local entities to implement mitigation activities.

Objective 4: Promote sustainable communities and hazard resilient development.

Goal #3: Integrate Hazard Mitigation Policies and Programs.

Goal Discussion. Hazard mitigation, which includes loss reduction, has historically occurred in piecemeal fashion – where a need existed or an opportunity made available, mitigation happened. However, with the requirements to do mitigation planning at the state and local level, mitigation programs have the potential to be more robust and have a need to be integrated. Policies and programs at all levels of government tend to be stove-piped, and it is often up to communities to understand how the programs fit together – many times with little help.

As indicated in the previous goal, incorporating actions identified in local mitigation plans such as suggested code and/or land use changes by actually updating local codes and land use plans is one significant way hazard mitigation policies and programs can be integrated. Another is to promote interagency coordination at the state and national level.

New or continuation? This goal is a continuation from the 2008 plan update.

Objective 1: Expand the SHMT to include other federal, state and local entities.

Action: Invite at least two additional entities each year to participate on the SHMT.

Objective 2: Ohio EMA Mitigation Branch will work with non-traditional partners to better align programs and policies.

Action: Continue inter-agency participation on the USACE Silver Jackets Initiative.

Action: Develop and implement strong state incentives for maintaining local mitigation plans.

Action: Participate in FEMAs Risk MAP outreach initiatives by facilitating local discussions on hazard mitigation.

Objective 3: Ensure better coordination of state and local mitigation planning activities.

Action: Provide training to local county EMA Directors and mitigation plan keepers on entering local plan data into the State Hazard Analysis, Resource, and Planning Portal (SHARPP).

Goal #4: Eliminate Vulnerable Repetitive Loss Flood-Prone Structures in the State of Ohio.

Goal Discussion. Ohio ranks in the top twenty states in the nation in the number of FEMA identified repetitive loss flood prone structures. Furthermore, flooding is Ohio's most costly natural hazard. Although there are various definitions of repetitive loss, these structures represent the most vulnerable and flood prone building stock in Ohio. For such structures, the best and preferred mitigation option is acquisition/demolition. However, it may be possible to use other mitigation techniques (i.e., flood proofing) especially when the structure use is non-residential.

The Ohio EMA Mitigation Branch and ODNR–Soil and Water Resources, Floodplain Management Program continues to be active in this area. The Mitigation and Recovery Branch utilizes repetitive loss lists published by FEMA to identify repetitive loss structures and target them for outreach regarding FEMA mitigation grant programs that may be available. The ODNR Floodplain Management Program addresses repetitive loss properties through education and training of local floodplain administrators. The Floodplain Management Program's efforts ensure that the local floodplain administrators are aware of the requirements to conduct "substantial damage" determinations, which require compliance with local flood damage reduction regulations to ensure that vulnerable structures are mitigated during the repair/renovation process. Structures that are substantially damaged/improved, and have flood insurance, may also have access to additional funds available through the property owner's flood insurance policy to make such changes. During the year, substantial damage training is provided in workshops statewide. After significant flood events, the Floodplain Management Program conducts NFIP briefings that focus on a community's responsibility to conduct substantial damage determinations. Finally, the Floodplain Management Program works with the Ohio Building Official's Association to train a volunteer cadre of building officials to conduct substantial damage determination field inspections.

New or continuation? This goal is a continuation from the 2008 plan update.

Objective 1: Continue to educate Ohio Floodplain Administrators and volunteer cadres such as the Ohio Building Officials Association on the post-event "substantial damage" process.

Action: Conduct training and/or post-disaster briefings for appropriate audiences on substantial damage assessments.

Objective 2: Educate owners of repetitive loss properties on mitigation techniques and programs that are available.

Action: Develop and implement an outreach strategy targeting repetitive loss property owners on mitigation techniques and funding programs.

Objective 3: Prioritize repetitive loss properties for available funds from FEMA mitigation programs.

Action: Reduce the number of severe repetitive loss properties by 5% each year by assisting such owners with successful funding of mitigation projects through FEMA mitigation programs.

Goal #5: Promote Research, Education, and Outreach Activities to Create a Culture of Mitigation in Ohio.

Goal Discussion. To take effective mitigation actions, individuals, communities, and the state must have data upon which to make decisions. This data must be based on the best and latest scientific research (ranging from data on the hazard itself to the mitigation actions taken) and must be disseminated effectively.

New or continuation? This goal is a continuation from the 2008 plan update.

Objective 1: Develop publications and information on all hazards that could potentially impact Ohio.

Action: Develop success stories in wind resistant construction codes and mitigation techniques.

Action: Work with stakeholders interested in expanding knowledge of earthquake risk.

Action: Ohio EMA will continue to actively participate on the Ohio Committee for Severe Weather Awareness.

Objective 2: Utilize the State Hazard Analysis, Resource, and Planning Portal to promote hazard mitigation.

Action: Continue to maintain, populate, and enhance the State Hazard Analysis Resource and Planning Portal.

Action: Add a range of mitigation focused web-based training courses to the SHARPP.

Objective 3: Seek opportunities to partner with academic institutions to promote mitigation and resilience principles.

Action: Develop a Mitigation and Recovery Branch internship program.

Goal #6: Provide leadership in hazard mitigation.

Goal Discussion. Mitigation and Recovery Branch staff strive to integrate hazard mitigation principles in a variety of ways to make Ohio communities more sustainable and citizens more resilient in the face of future disaster events. The Branch is the leading voice for mitigation in the State of Ohio.

The Branch Chief leads and coordinates activities for the State Hazard Mitigation Team (SHMT). The role of the SHMT is twofold: to facilitate a collaborative discussion of mitigation policies, programs, and procedures in Ohio, and to have a mechanism for efficiently and objectively reviewing project applications for many of FEMA's hazard mitigation programs. Additionally, the Branch is the state entity responsible for implementing FEMA's Hazard Mitigation Assistance programs, and assists Ohio communities in their mitigation planning efforts. State and local governments rely on Mitigation and Recovery Branch staff technical

assistance to develop mitigation plans and projects both before and after a disaster.

The Branch is very active in state and federal associations and workgroups in order to provide hazard mitigation guidance that is aligned with the Branch vision and mission. Such groups include (but are not limited to) the External Stakeholder Workgroup, FEMA's Cooperating Technical Partnership, the Association of State Floodplain Managers, and the Ohio Floodplain Management Association.

New or Continuation? This goal is a continuation from the 2011 update.

Objective: Continue to be a leading voice in mitigation nationwide through increased involvement in national and state initiatives, dialogues and workgroups.

Action: Continue to support efforts to comply with the Emergency Management Accreditation Program (EMAP).

Action: Continue participation on emergency management and floodplain association workgroups.

3.2 STATE MITIGATION ACTION PLAN

OVERVIEW

According to the planning requirements of DMA 2000, a SHMP will contain mitigation actions that are cost-effective, environmentally sound, and technologically feasible. Additionally, such actions are to be prioritized. The mitigation action plan below attempts to provide a concise table of the mitigation actions identified in the previous section, with an assigned priority. Additionally, a lead agency is identified for each action. The “status” and “complete” fields are left blank, as this is a new plan. The mitigation action plan will be reviewed, the table updated, and sent to the SHMT and FEMA annually.

Borrowing a prioritization technique from the State of Kentucky, the mitigation actions have been prioritized in the following way:

Table 3.2.a

Priority	Description
A	Projects or activities that permanently eliminate damages or deaths and injuries across the state from any hazard
B	Projects or activities that reduce the probability of damages, deaths, and injuries across the state from any hazard
C	Projects or activities that educate the public on the subjects of hazard mitigation, hazard research, and disaster preparedness
D	Projects or activities that warn the public to approaching natural hazard threats

2014 MITIGATION ACTION PLAN TABLE

Table 3.2.b

Action	Goal / Objective Reference	Hazard	Lead Agency	Priority	Status	% Complete
1. Build on the success of the Risk MAP Areas of Mitigation Interest (AOMI) pilot project by continuing to utilize SHARPP to map areas of mitigation interest.	Goal 1, Obj 1	Flood	Ohio EMA Mitigation Branch	C	The Ohio EMA will utilize the AOMI tool in SHARPP to capture AOMI data during upcoming Risk MAP Resilience meetings.	Ongoing
2. Conduct HAZUS Level 2 flood analyses for all Counties in Region 2 using Ohio Statewide Imagery Program data and corresponding Digital Flood Insurance Rate Map data.	Goal 1, Obj 1	Multi	Ohio EMA Mitigation Branch	C	The state applied for funding to complete this task through the Silver Jackets program.	5%
3. Continue to update and improve the vulnerability analysis for state-owned buildings and critical facilities.	Goal 1, Obj 1	Multi	Ohio EMA Mitigation Branch	C	Obtained state-owned and state-leased facility information from DAS; obtained supplemental data (HSIP Gold) from FEMA; developed vulnerability analysis methodologies for each hazard; analyzed all spatial hazards; generated maps/tables depicting results of analyses	Ongoing
4. Work with USGS, NOAA, and other partners to promote flood warning systems	Goal 1, Obj 2	Flood	Ohio EMA Mitigation	C	Mitigation staff developed an HMGP application that is specific to 5% projects that includes guidance on warning	100%

Action	Goal / Objective Reference	Hazard	Lead Agency	Priority	Status	% Complete
and stream/rain gauges.			Branch		systems.	
5. Reduce the number of pre-FIRM, flood prone properties each year by assisting such owners with successful funding of mitigation projects through FEMA mitigation programs.	Goal 1, Obj 3	Flood	Ohio EMA Mitigation Branch	A	Ongoing effort through the administration and implementation of FEMA HMA programs and other mitigation funding sources. According to SHARPP, 1281 properties have been mitigated in Ohio using HMA programs.	Ongoing
6. Inspect all Class I-III dams once every 5 years.	Goal 1, Obj 4	Dam Failure	ODNR-DDS	B	The Dam Safety Program has recently expanded the number of dams that will be inspected every 5 years to include Class II-III dams.	Ongoing
7. Take enforcement actions on violations of state dam/levee safety laws for severely deficient and/or structurally unsound high hazard dams.	Goal 1, Obj 4	Dam Failure	ODNR-DDS	B	Notices of Violation are issued for deficiencies identified during inspections. The Dam Safety Program provides technical assistance to remedy deficiencies.	Ongoing
8. Increase the number of Emergency Action Plans through compliance and education efforts.	Goal 1, Obj 4	Dam Failure	ODNR-DDS	B	New mitigation action.	Ongoing
9. Continue to implement and improve the Ohio Safe Room Rebate Program.	Goal 1 Obj 5	Wind	Ohio EMA Mitigation Branch	B	Ohio EMA recently applied for a PDM grant to fund construction of 39 residential safe rooms.	Ongoing
10. Develop wind mitigation educational	Goal 1 Obj 6	Wind	Ohio EMA	C	Ohio EMA was recently awarded an	15%

Action	Goal / Objective Reference	Hazard	Lead Agency	Priority	Status	% Complete
materials and outreach programs for vulnerable populations.			Mitigation Branch		HMGP grant for wind education and outreach. The project will begin in May, 2014.	
11. Promote the adoption of standards beyond NFIP minimums for flood loss reduction.	Goal 2, Obj 1	Flood	ODNR-DOW, FPM	B	The majority of these initiatives include flood plain regulation, map modification & higher standards workshops.	Ongoing
12. Continue to participate in the public/private partnership effort between Ohio EMA and the business community.	Goal 2, Obj 2	Multi	Ohio EMA Mitigation Branch	C	New action item.	0%
13. Invite at least two additional entities each year to participate on the SHMT.	Goal 3, Obj 1	Multi	SHMT	C		Ongoing
14. Continue inter-agency participation on the USACE Silver Jackets Initiative.	Goal 3, Obj 2	Flood	SHMT	C	The Ohio Silver Jackets Team developed a flood awareness campaign focused on the anniversary of the 1913 flood.	Ongoing
15. Develop and implement strong state incentives for maintaining local mitigation plans.	Goal 3, Obj 2	Multi	Ohio EMA	C	New action item.	0%
16. Participate in FEMA's Risk MAP Outreach initiatives by facilitating local discussions on hazard mitigation	Goal 3, Obj 2	Multi	Ohio EMA Mitigation Branch	C	Ohio EMA continues to partner with ODNR on FEMA Risk MAP initiatives.	Ongoing
17. Provide training to local county EMA	Goal 3, Obj 3	Multi	Ohio EMA	C		Ongoing

Action	Goal / Objective Reference	Hazard	Lead Agency	Priority	Status	% Complete
Directors and mitigation plan keepers on entering local plan data into the State Hazard Analysis, Resource, and Planning Portal (SHARPP).			Mitigation Branch			
18. Conduct training and/or post-disaster briefings for appropriate audiences on substantial damage assessments	Goal 4, Obj 1	Flood	ODNR-DOW, FPM	A	Workshops are conducted as needed or requested. Post-event briefings are ready for deployment.	Ongoing
19. Develop and implement an outreach strategy targeting repetitive loss property owners on mitigation techniques and funding programs	Goal 4, Obj 2	Flood	Ohio EMA Mitigation Branch	C		Ongoing
20. Reduce the number of severe repetitive loss properties by 5% each year by assisting such owners with successful funding of mitigation projects through FEMA mitigation programs	Goal 4, Obj 3	Flood	Ohio EMA Mitigation Branch	A		Ongoing
21. Develop success stories in wind resistant construction codes and mitigation techniques.	Goal 5, Obj 1	Tornado	Ohio EMA Mitigation Branch	C		50%
22. Work with stakeholders interested in expanding knowledge of earthquake risk.	Goal 5, Obj 1	Earthquake	Ohio EMA Mitigation Branch	C		0%
23. Ohio EMA will continue to actively	Goal 5, Obj 1	Multi-	Ohio EMA	C	Ongoing	Ongoing

Action	Goal / Objective Reference	Hazard	Lead Agency	Priority	Status	% Complete
participate on the Ohio Committee for Severe Weather Awareness.		hazard	Mitigation Branch			
24. Continue to maintain, populate, and enhance the State Hazard Analysis Resource and Planning Portal.	Goal 5, Obj 2	Multi	Ohio EMA Mitigation Branch	C		80%
25. Add a range of mitigation focused web-based training courses to the State Hazard Analysis Resource and Planning Portal (SHARPP).	Goal 5, Obj 2	Multi	Ohio EMA Mitigation Branch	C		0%
26. Develop a Mitigation and Recovery Branch internship program.	Goal 5, Obj 3	Multi	Ohio EMA	C	New action item.	0%
27. Continue to support efforts to comply with the Emergency Management Accreditation Program (EMAP).	Goal 6, Obj 1	Multi	Ohio EMA Mitigation Branch	C		Ongoing
28. Continue participation on emergency management and floodplain association workgroups.	Goal 6, Obj 1	Multi	Ohio EMA Mitigation Branch	C	Mitigation Branch staff participate in multiple associations and work groups.	Ongoing

3.3 STATE CAPABILITY ASSESSMENT

The 44 CFR 201.4(c)(3)(ii) states the mitigation strategy shall include a description of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including an evaluation of the State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas.

This section outlines these items. This section includes a discussion of the state's primary laws, regulations, programs, and policies related to hazard mitigation strategy. State agency programs were evaluated via a self-assessment. A brief evaluation of the state's overall approach to development in hazard-prone areas and mitigation funding capability is also included.

Overall, the state's capability to manage hazards and implement hazard mitigation has remained steady.

LAWS AND REGULATIONS

Ohio Constitution

Section 3 of Article XVIII of the Ohio Constitution designates Ohio as a "home rule" state. Home Rule gives municipal jurisdictions the power to govern themselves in local municipal matters independent of state laws. Section 7 of Article XVIII requires that municipalities need to adopt or amend a charter for its government to enact laws. Municipal corporations that do not adopt a charter must follow the procedures provided in state law.

Ohio Revised Code (ORC) and Ohio Administrative Code (OAC)

All statutes of a permanent and general nature of the State of Ohio are organized and published in the Ohio Revised Code (ORC). These are the laws passed by the Ohio General Assembly. The Ohio Administrative Code (OAC) is a codification of the rules of the administrative agencies of the state. These rules must be reviewed by the Joint Committee on Agency Rule Review (JCARR). The committee consists of five State Representatives and five State Senators.

The primary function of JCARR is to review proposed new, amended, and rescinded rules. JCARR ensures that: the rules do not exceed the scope of the rule-making agency's statutory authority, the rules do not conflict with a rule of that agency or another rule-making agency, the rules do not conflict with the intent of the legislature in enacting the statute under which the rule is proposed, and the rule-making agency has prepared a complete and accurate rule summary and fiscal analysis of the proposed rule, amendment, or rescission.

A discussion of the primary laws, regulations, and policies that have an impact on mitigation programs within the State of Ohio follows.

Planning, Zoning, and Subdivision Authorities

Under the Ohio Constitution, the power to plan, zone, subdivide or regulate land use belongs to the General Assembly. Most state authority to plan and regulate land use has been delegated to local government. In recent years some of the delegated power has been taken back to address state wide concerns, especially in the environmental arena (for example the authority to regulate drilling for oil and gas wells used to rest with home rule municipalities but now rests with the ODNR–Division of Mineral Resource Management).

Planning, zoning, and subdivision regulations are not the same. Each is described below.

A plan is a guideline for future growth, usually portraying a long-term period (usually 20-30 years). Planning aides a community in determining where it is, where it wants to be and how to get there. A plan is a guide to reach one or more objectives. In some states, i.e., Florida and New Jersey, plans are enhanced by laws or judicial rulings giving the plans substantial authority.

Comprehensive planning and zoning evolved from the Standard State Zoning Enabling Act (SZEA) of 1922. However, the Act is criticized because it does not define 'comprehensive plan'. Neither municipal zoning enabling authority nor county/township zoning enabling authority in the ORC, Chapter 303 and 519 defines what constitutes a comprehensive or master plan. Ohio statutes do not require a comprehensive planning process prior to the enactment of a zoning ordinance or resolution, although county and township enabling statutes specify the Board of County Commissioners or the Board of Township Trustees may regulate "...in accordance with a comprehensive plan..." If a plan exists, it may support zoning regulations provided it is compiled following significant public participation and is current. In Ohio, state statutes enabling planning are permissive and not mandatory. Failure to plan does not necessarily invalidate zoning regulations.

The elements of a comprehensive plan can vary from community to community. In most cases though, the plan consists of a study of existing conditions and a discussion of future trends, goals, and objectives. Land-use patterns, housing conditions, population, roadways, and other infrastructure are usually the principle elements that are studied. In some cases, educational facilities along with recreation and other government facilities are reviewed. Social service facilities can also be discussed. Comprehensive plans also deal with the land-use related issues relevant to each of these topics.

The relationship between wise land use planning and the reduction of a community's exposure, risk, and vulnerability to hazards is clear. Experience has shown that those communities that carefully plan the location, type, and structural requirements of development to avoid (to the extent possible) hazard areas and vulnerable structures suffer much less disaster-related damage and impact than do communities that don't carefully plan for development. The benefits of wise land use and development planning, from a hazard mitigation standpoint, include:

- less disruption to a community's economic, social, and physical structure;
- less impact on the community's tax base;
- less impact on the provision of essential services; and
- less financial impact in terms of local participation in disaster program cost sharing.

In addition, communities that are more prone to disaster damage may be looked upon less favorably by potential business enterprises as a safe, secure place in which to conduct business. Wise land use planning has very practical benefits for all communities. Two ways to incorporate hazard mitigation planning into comprehensive planning is to: 1) have a hazard mitigation element in the comprehensive plan, or 2) incorporate hazard mitigation concepts, strategies, and policies into existing elements of the comprehensive plan.

Ohio zoning processes are based on the SZEA. The purposes of zoning are to regulate land use, prevent land-use conflict, and allow growth to occur in a rational manner. More specifically, zoning aims to:

- Use land for its most suitable purpose
- Protect or maintain property values
- Promote public health and safety
- Protect the environment
- Manage traffic
- Manage density
- Encourage housing for a variety of lifestyles and economic levels
- Manage aesthetics
- Provide for more orderly development
- Help attract business and industry

Zoning is a regulatory way to implement a community's comprehensive plan. From a hazard mitigation perspective, zoning can be used to regulate land use and development in hazardous areas. For example, many Ohio communities have adopted zoning standards for floodplains and steep slope/landslide prone areas.

The authority to subdivide land is found in ORC Chapter 711. Subdivision regulations are generally adopted to provide for:

- The proper arrangement of streets or highways in relation to existing or planned streets or highways, or to the Official Land Use Plan and Official Thoroughfare Plan,
- The orderly and efficient layout and the appropriate use of the land,

- A common ground of understanding and a sound working relationship between the county and the developer and to safeguard the interests of the homeowner, the subdivider and the county and its citizens,
- The accurate surveying of land, preparing and recording of plats and the equitable handling of all subdivision plats by approving authority and subdividers,
- Technically feasible and economically reasonable standards which achieve a level of subdivision design & construction to minimize damage to property, degradation of natural resources, and to promote and maintain the health, safety and general well-being.

Subdivision regulation can incorporate hazard mitigation principles. For example, subdivision regulations could require flood studies be completed for drainage ways, streams, etc. where no data exists and stormwater management measures for a subdivision could be required to be designed to a 100-year flood event vs. a higher frequency event (such as a 10-year event). Similarly, standards for infrastructure could specify protection against any potential significant hazard.

Chapter 5502.22 et seq., ORC – State / Local Emergency Management Agencies

The Chapter provides for a State EMA (which includes the Mitigation Branch), and authorizes countywide (5502.26), regional (5502.27), or local emergency management authorities (5502.271), requiring an emergency management director or coordinator and an Emergency Operations Plan for each county. The law also establishes the legal protection and authority of the EMA to work in times of a disaster. The Ohio EMA is the central point of coordination within the state for response and recovery to disasters.

The Mitigation Branch of the Ohio EMA is responsible for management of FEMA mitigation program activities for the state (except for the ODNR–DOW, which is the state coordinating entity for the NFIP – see below). The Ohio EMA Mitigation Branch administers pre- and post-disaster HMGP, FMA, PDM, SRL and RFC grant programs, including project ranking, implementation, technical assistance, and monitoring. The Mitigation Branch staff coordinates with State agencies to incorporate mitigation techniques into their everyday functions and to provide assistance with project development.

Title XXXVII Health-Safety-Morals, ORC -Ohio Basic Building Code (OBBC)

The Board of Building Standards is comprised of 10 members appointed by the Governor, with the advice and consent of the Senate. The board provides uniform standards and requirements for construction and materials to make buildings safe and sanitary for their intended use and occupancy. This refers to any building that may be used as a place of resort, assembly, education, entertainment, lodging, dwelling, trade, manufacture, repair, storage, traffic or occupancy by the public, and all other buildings or parts and appurtenances thereof erected within the state. The Ohio Department of Commerce, Division of

Industrial Compliance ensures compliance with and enforcement of OBBC for industrial facilities.

The Board emphasizes the importance of mitigation techniques. In 1995, the International Basic Building Code was implemented and that date is used as a marker for NFIP determinations. Homes built pre-1995 were not required to meet the same standards as those after the code's inception, and are more hazard-prone. The code includes provisions for several mitigation initiatives, such as flood damage reduction, compliance with established building standards and protection of existing buildings from future hazard events.

Chapter 1301, ORC - Ohio Fire Code

The Ohio Fire Code was enacted with the purpose of prescribing rules to safeguard life and property from the hazards of fire and explosion. ORC 3781.03 requires the fire marshal or fire chief of municipal corporations having fire departments or the fire chief of townships having fire departments to enforce all provisions of Chapter 3781, and 3791, of the ORC relating to fire prevention. ORC 1301:7-7-07 consists of issues relating to emergency planning and preparedness. The Fire Code effectively reduces the wildfire hazard through the comprehensive scope of the code, which ranges from training and conducting exit drills, to the development of emergency plans.

Chapter 1506, ORC - Ohio Coastal Management Act, Ohio Coastal Erosion Management Program

The ODNR-DOW is the designated lead agency for the development and implementation of the Federal Coastal Zone Management Program. The Coastal Erosion Management Program identifies the coastal erosion areas, enforces rules and regulations for new structures and issues permits for coastal erosion control structures. Coastal erosion is a major concern for cities that border Lake Erie. The permitting and enforcement of the rules and regulation by the ODNR-DOW has been effective in reducing coastal erosion in hazard-prone areas.

Chapter 1521, ORC - Ohio Dam Safety Program

The ODNR-DOW is the agency that does inspections and the permitting programs for dams and levees. Legislation outlines the standards for dam and levee construction and ODNR-DOW enforces the dam safety laws. The consequence, if the Dams are not regulated, is flood inundation and potential loss of life. The ODNR-DOW's active enforcement of the laws prevents damage, which is the primary goal of mitigation. The program has been effective; there have not been any significant dam failures since the creation of the program.

Chapter 1521.13-14; 18 ORC - Ohio Floodplain Management Program

The ODNR–DOW, Floodplain Management Program coordinates all floodplain management activities for the State of Ohio. The Floodplain Management Program administers the NFIP established in the National Flood Insurance Act of 1968, "82 Stat. 572, 42 U.S.C.A. 4001, as amended and ensures a participating community's compliance with all requirements.

The Floodplain Management Program in Ohio has been the most effective method of flood reduction and prevention. Regulation of development within the floodplains and compliance after natural disasters lessens the extent of flood damages. The Floodplain Management Program and the Mitigation Branch work closely together to ensure mitigation techniques are being considered.

Chapter 3733.02, Revised Code - Rules for manufactured home parks, recreational vehicle parks, recreation camps; temporary park-camps

The public health council of the ODH has the exclusive power to adopt, rules of uniform application throughout the state governing the review of plans, issuance of flood plain management permits, and issuance of licenses for manufactured home parks. This includes the location, layout, density, construction, drainage, sanitation, safety, and operation of those parks; blocking and tie downs of mobile and manufactured homes in those parks; and notices of flood events concerning, and flood protection at, those parks. The rules pertaining to floodplain management are consistent with the floodplain management criteria of the NFIP adopted under the "National Flood Insurance Act of 1968," 82 Stat. 572, 42 U.S.C.A. 4001, as amended. The actions of the ODH have a major role in the reduction of damage from flood and tornado hazards in manufactured home parks.

Chapter 6101, ORC - Ohio Conservancy District

The Chapter outlines the responsibilities for the organization of conservancy districts. The ODNR-DOW has been successful with the conservancy districts, which work to prevent floods, modify stream channels, regulate stream flow and prevent erosion along the Lake Erie Ohio shoreline. Funding for mitigation occurs when a conservancy district assesses property owners.

Chapter 6131, ORC - Ohio Petition Ditch Enabling Authority

The provisions in this chapter allow counties to dispose or remove surplus water for controlled drainage, irrigation, the storing of water to regulate stream flow or to prevent the overflow of any land the county and for water conservation. The ODNR-DOW assists counties to enact actions associated with the Ditch Enabling Authority, which effectively reduces flood damage. Funding occurs through assessment of property owners benefiting from specific project.

STATE AGENCY PROGRAMS & POLICIES

The State of Ohio emphasizes reduction of adverse effects from hazard events and promotes programs to achieve this objective. The State identified the SHMT to assist with mitigation activities in the pre- and post-disaster phases. Staff from the Mitigation Section of the Ohio EMA works with the SHMT and state agencies to guide mitigation activities based on the specific event, establish goals, objectives and strategies for the development and implementation of a comprehensive state mitigation program and to evaluate policies and state-funded or administered programs that benefit mitigation activities. This section provides a better understanding of the resources available through State Agencies Pre- and Post-Disaster as related to hazard mitigation.

Ohio EMA utilized a revised form from FEMA 386-3 (part of the mitigations planning series) to assist in the determination of specific mitigation capabilities of Ohio's Departments and Agencies. The assessment surveys were sent to all participating State agencies in 2005. Minor changes have taken place since that time, and the 2008 update has updated data where appropriate. In addition, there is a format change to eliminate a named POC.

The following section incorporates the information for each agency into charts. The matrix allowed the agencies to identify the most significant state funded or state administered programs, policies, regulations or practices relating to hazard mitigation or loss reduction. The agencies were then evaluated to determine if their programs supported, facilitated or hindered mitigation objectives, which is listed in the Comments column of each agency's mitigation summary. None of the agencies responded with programs, policies or regulations that would hinder the mitigation process**.**

Definitions:

- Support loss reduction – Programs, plans, policies, regulations, funding or practices that help implement mitigation measures.
- Facilitate loss reduction – Programs, plans, policies, etc. that make implementing mitigation measures easier.
- Hinder loss reduction – Programs, plans, policies, etc., that pose obstacles to implementing mitigation measures.

Several state agencies promote programs that encompass pre- and post-disaster mitigation activities. Hazards are unpredictable, but there are programs that present an opportunity to mitigate the hazard's destruction before an event occurs. Utilization of mitigation programs prior to a disaster could prevent the damage from occurring or work to lessen the recovery time and expenditures caused by the natural hazard. Post-disaster the State relies on its agencies to assist with the recovery process. A State requests a Presidential Declaration when the scope of recovery from an event is beyond the State's capability. A Presidential Declaration provides numerous resources, which are incorporated into the State agency functions, for assistance in the response and recovery from a disaster.

Office of Budget and Management (OBM)

The Ohio OBM is a cabinet-level agency within the executive branch of the Ohio State government. The director of OBM sits on the Governor's cabinet as the Governor's chief financial officer. The primary mission of OBM is to provide fiscal accounting and budgeting services to state government. These services include the coordination, development, and monitoring of agency operating and capital budgets and the review, processing, and reporting of financial transactions made by state agencies. OBM also assists the Governor and other state agencies by providing policy and management support relative to the state's fiscal activities.

Table 3.3.a

Office of Budget and Management Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
Allocation of Project Funds (Pre- and Post-Disaster)	X			The Controlling Board of the OMB supports mitigation activities by allocating the funds to complete the State's cost share match for the grant programs. Ohio EMA worked diligently during the 1997 flood event, with the State Controlling Board to identify a 100% match to the federal HMGP, and PDM allocations. The State's ability to match dollar for dollar continued through disaster declarations of March 2003. More recently, the State's fiscal stability has prevented the State from providing a 100% match to federal funds.

Ohio Department of Administrative Services Office of Risk Management (ORM)

The ORM is responsible for the placement of property and casualty insurance for state agencies, the state's bonding program and administration of the self-insured vehicle liability program. The ORM facilitates the mitigation process by providing information and services that are useful tools for planning initiatives.

Table 3.3.b

Ohio Department of Administrative Services – Office of Risk Management Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
Statewide Catastrophic Property Insurance Program (Pre-Disaster)		X		All state-owned buildings are insured under one single policy. The policy is underwritten on an all risk basis. Loss control and safety inspections identify specific hazards and allow the state agency the opportunity to correct and mitigate hazards prior to loss.
Comprehensive Risk Management Plan (Pre-Disaster)		X		Protects the state's assets as well as streamlines current insurance policies, procedures and claims services. The plan facilitates the mitigation process by providing information, which is a useful planning tool for local planning initiatives.
Ohio Administrative Knowledge System (OAKS), Enterprise Resource Planning (Pre-Disaster)		X		DAS is a sponsoring Agency of the OAKS enterprise computer project. As part of the asset management system, all state-owned buildings and land will be listed in the database, which will provide important planning information to the State and local jurisdictions.
Property Insurance Building Inventory (Pre-Disaster)	X			DAS maintains a building inventory of all state-owned buildings insured under this program, which assists the State in locating specific assets and identifying potential hazards and prevention.

Ohio Department of Commerce (ODC)

The ODC regulates and provides services to Ohio industries. Its mission is to protect the safety and welfare of Ohio's citizens while fostering a business friendly environment. The ODC regulates much of the construction industry and is involved in many industrial compliance issues in the state. It charters banks, credit unions and savings and loans/savings banks and licenses real estate brokers, auctioneers and security guards. The seven divisions of the ODC include Financial Institutions, Consumer Finance, Industrial Compliance, Real Estate, Securities, State Fire Marshal, and Unclaimed Funds.

Table 3.3c

Ohio Department of Commerce Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
Ohio Basic Building Code Flood Regulations (Pre- and Post-Disaster)	X			The Industrial Compliance, Board of Building Standards administers the OBBC, which incorporates provisions of the BOCA. BOCA is a model code governing building regulations for the protection of public health, safety and welfare. The Code includes mitigation methods for hazard reduction. Flood hazard mitigation is accounted for in Section 2102.0 "Flood Resistant Construction" of the OBBC. If local authorities determine a building or structure requires flood resistant construction, they must comply with the OBBC.
Site, Building and Community Profiles (Pre- and Post-Disaster)		X		Provides a catalog of businesses and industrial sites in Ohio, and assists the State and local jurisdictions with identification of hazardous material locations as part of the planning process.
Education and Outreach (Pre- and Post-Disaster)		X		The office of the State Fire Marshal provides information on Fire Prevention as well as Severe Weather Awareness

Ohio Department of Development (ODOD)

The Mission of the ODOD is to attract, retain and create business in Ohio. The ODOD has created 12 regional economic development offices to enhance the overall business climate by providing outreach assistance to local governments, business, professional economic development agencies and the public. They serve as the focal point for problem solving and as advocates for specific regions of Ohio. The ODOD, Community Development Division, Office of Housing and Community Partnerships are most active in mitigation by assisting local communities with mitigation projects through CDBG and CHIP.

The Department is a cabinet level agency that oversees a full portfolio of programs including: small business growth, technology commercialization, exports promotion, travel promotion, energy efficiency, affordable housing, community infrastructure, downtown revitalization and brownfield clean-up.

Table 3.3.d

Ohio Department of Development Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	**Effect on Loss Reduction (X)**			**Comments**
	Support	**Facilitate**	**Hinder**	
Community Development Block Grants (CDBG) (Pre- and Post-Disaster)		X		The funds can assist with the rebuilding process that occurs after disasters. Local communities utilize CDBG funds as part of the match for HMGP projects. The program is an effective mitigation initiative since it reduces or eliminates flood damage by elevating, acquiring or retrofitting repetitively flooded structures.
Community Housing Improvement Program (CHIP) (Pre- and Post-Disaster)		X		Provides grants to eligible communities interested in undertaking housing-related activities, including necessary infrastructure improvements. The program promotes mitigation objectives as part of the building process and can be used as the match for HMGP projects.

Ohio Department of Health (ODH)

The ODH strives to protect and improve the health of all Ohioans, through partnerships with 143 local health departments and members of the medical health communities, by preventing disease, promoting good health and assuring access to quality health care.

Table 3.3.e

Ohio Department of Health Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
Regulation of Manufactured Home Parks (Pre- and Post-Disaster)	X			ODH has exclusive regulatory authority over plan approval of manufactured home parks and has entered into a Cooperative Agreement with ODNR and Ohio EMA in an effort to further flood hazard reduction. ODH requires individual pad heights to be elevated as much as two feet above the 100-year elevation. Park owners and operators are required to report flood events and conduct substantial damages determinations.
Private Water Supply System Standards	X			ODH does not allow private water supply systems to be located in FEMA identified 100-year floodplain areas.
Protection from Bio-terrorism and Other Disasters (Pre-Disaster)	X			ODH utilizes new technology and scientific and medical discoveries to meet the ever growing, ever changing needs of the communities. In addition to research, ODH teams with public safety and the public health and medical partners to ensure that Ohio is prepared and is protected from bio-terrorism, as well as other disasters. ODH also offers grants relating to a variety of public health programs to organizations in Ohio, including county and local health departments.

Ohio Department of Insurance (ODI)

Agency Mission/Function

The mission of the ODI is to protect the interests of the public through consistent and fair application of Ohio's Insurance Laws and Regulations and to inform and educate the public on insurance issues. The Department encompasses many offices including: the Office of Consumer Advocate; Consumer Services Division; Office of Investigative and Licensing Services; Market Conduct Division; Licensing Division; Office of Legal Services; Office of Property and Casualty Services; Office of Life and Health and Managed Care Services; Managed Care Division; and the Office of Financial Regulation Services.

Table 3.3.f

Ohio Department of Insurance Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
Education and Outreach (Pre- and Post-Disaster)	X			The ODI supports loss reduction through educational outreach provided to Insurance Agencies, pre- and post-disaster. The information includes mitigation options to reduce damage from hazardous events. The agencies are responsible for providing the information to their policyholders, since any pre-disaster mitigation actions or mitigation during the repair process will reduce or eliminate the number of policy claims filed after future hazard events.

Ohio Department of Natural Resources (ODNR)

A department of incredible diversity, ODNR owns and manages more than 590,000 acres of land, including 74 state parks, 20 state forests, 127 state nature preserves, and 120 wildlife areas. The department also has jurisdiction over more than 120,000 acres of inland waters; 7,000 miles of streams; 481 miles of the Ohio River; and 2-1/4 million acres of Lake Erie.

ODNR licenses all hunting, fishing, and watercraft in the state and is responsible for overseeing and permitting all mineral extraction, monitoring dam safety, managing water resources, coordinating the activity of Ohio's 88 county soil and water conservation districts, mapping the state's major geologic structures and mineral resources, and promoting recycling and litter prevention through grant programs in local communities. As an umbrella organization for such diverse interests, the department pulls all these activities into four fundamental mission components:

- Resource management by sustained productivity of Ohio's renewable natural resources, promoting the wise use of non-renewable natural resources, and protecting Ohio's invaluable threatened and endangered natural resources.
- Economic development through job creation/expansion/retention, stimulating local economies, developing industry and tourism opportunities, and supporting the present and future economic health of the state.
- Recreation by providing leisure services and recreation opportunities for the public at all levels.
- Health and safety through fair and consistent law enforcement participating in regulatory matters and identifying and responding to environmental hazards.

Table 3.3.g

Ohio Department of Natural Resources Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
Ohio Floodplain Management Program ORC 1521.13-14;.18 (Pre- and Post-Disaster)	X			ODNR-DOW coordinates with the NFIP; monitors compliance with state and local floodplain management standards; provides assistance in mitigation planning; and identifies flood hazards. Assists Ohio communities with adopting flood loss reduction standards that meet NFIP minimums and assists communities interested in adopting standards beyond NFIP minimums. Coordinates the FEMA Map Modernization Program. This program will modernize the flood mapping program and outline the steps necessary to update and digitally format FEMA's flood maps for the nation and streamline public awareness of the importance of the maps. The updated maps outline flood hazard areas, which helps with the implementation of mitigation actions by easily identifying if structures are within floodplains during eligibility determinations for acquisition projects.
Urban Stormwater Program, Watershed Programs (Pre- and Post Disaster)		X		ODNR, Division of Soil and Water Conservation develops model regulations for urban stormwater management; provides assistance with stream morphology assessments; funds/administers Ohio Watershed Coordinator Program.
Ohio Coastal Management Act, Ohio Coastal Erosion Management Program ORC 1506. (Pre- and Post-Disaster)	X			ODNR, Office of Coastal Management identifies coastal erosion areas, enforces rules regulating new structures in coastal erosion areas, and issues permits for coastal erosion control structures. Provides Coastal Management Assistance Grants and Erosion Control Loans.
Ohio Dam Safety Program ORC 1521 (Pre- and Post-Disaster)	X			ODNR-DOW DS has inspection and permitting permits programs for dam and levees, classifies hazards and develops standards for dams and

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
				levees. They have authority for emergency drawdown of water. Provides funds for the Dam Repair Loan Fund.
Ohio Conservancy District ORC 6101 (Pre-Disaster)		X		ODNR-DOW enables organization of conservancy districts for the purposes of preventing floods, modifying stream channels, and regulating flow of streams and erosion along the shoreline of Lake Erie. Mitigation funding occurs when a conservancy district assesses property owners.
Ohio Petition Ditch enabling authority ORC 6131 (Pre- and Post-Disaster)		X		ODNR-DOW allows counties to dispose or remove surplus water, for controlled drainage of any land, for irrigation, and storage of water to regulate stream flow or to prevent the overflow of any land in the county.
Abandoned Mined Lands Program (Pre-Disaster)	X			ODNR, Division of Mineral Resources Management administers mine lands programs to reclaim those area disturbed by coal mining operations. Types of problems addressed include: mine openings, landslides, highwalls, erosion and subsidence.
Ohio Mine Subsidence Insurance (Pre-Disaster)	X			Ohio Fair Plan, Mine Subsidence Insurance Underwriting Association pays insurance claims as a result of mine subsidence. The insurance is mandatory as part of homeowners insurance in 26 Ohio counties and optional for 11 counties.
Ohio Seismic Network (Pre-Disaster)		X		ODNR, Division of Geological Survey is a cooperative effort consisting of 23 seismic stations coordinated by the Division and managed from the Ohio Earthquake Information Center. The stations provide historical and current information to Ohio.
Firewise Program (Pre-Disaster)		X		ODNR, Division of Forestry heads a multi-organizational initiative designed to include fire safety professionals, homeowners, and community leaders in localizing efforts to lessen the risk of wildfires. The goal is to reduce susceptibility to wildfires through a cooperative effort.

Ohio Department of Transportation (ODOT)

The ODOT's mission is to provide a world-class transportation system that links Ohio to a global economy, while preserving the state's unique character and enhancing its quality of life. The TRAC, created by the Ohio General Assembly in 1997 to bring an open, fair, numbers-driven system to choosing major new transportation projects, is composed of the director of ODOT and eight appointees. The director of ODOT certifies the amount of money available for major, new capacity projects to the TRAC after funds for system preservation are determined. Historically, the TRAC has had about $300 million a year to pay for projects, including design, right of way, and construction. The ODOT considers mitigation objectives as part of their project development.

Table 3.3.h

Department of Transportation Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X)			Comments
	Support	Facilitate	Hinder	
Engineering and Design Practices (Pre- and Post-Disaster)	X			Ensures that land use and re-use laws and regulations are adhered to, which reduces loss from future events.
Disaster Recovery and Repair (Post-Disaster)		X		Clear and repair roadways interrupted by flooding, tornados and landslides. Promotes and utilizes mitigation measures throughout engineering and design process to prevent future damage. Performs small-scale bank stabilization.
Transportation Review Advisory Council (TRAC) (Pre- and Post-Disaster)	X			Established by ORC in 1997 at ODOT's request, the TRAC is a permanent body of predominantly non-ODOT personnel that develops and modifies the Major New Project Selection process and approves major new capacity by adding projects for funding. Mitigation objectives are taken into consideration as part of the process.
Education and Outreach (Pre- and Post-Disaster)	X			The DOT provides information to citizens on safety and prevention techniques and promotes severe weather awareness.

Ohio Emergency Management Agency (Ohio EMA)

Established under Chapter 5502 of the ORC, the Ohio EMA is the central point of coordination within the state for all hazard preparedness, response, recovery and mitigation. Ohio EMA coordinates all situation and damage assessment operations in a disaster area. The agency routinely cooperates with federal, state, and local governments to maintain and develop disaster preparedness, response, recovery, and mitigation plans. Ohio EMA establishes and maintains a state Emergency Operations Center (EOC) to provide coordination and public information during emergencies and disasters. It is the State Coordinating Agency responsible for the administration of federal disaster assistance programs under The Robert T. Stafford Act, Public Law 93-288, which requires mitigation recommendations and implementation as a condition of federal financial assistance.

The primary focus of the agency, when not in a response or recovery mode, is to ensure that the state, and the 11 million citizens residing in it, is prepared to respond to an emergency or disaster and to lead mitigation efforts against the effects of future disasters. It is critical that Ohio EMA's staff interfaces regularly with their local and federal counterparts to ensure preparedness and the capability to respond at all levels.

Table 3.3.i

Ohio Emergency Management Agency Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
Manages the State Hazard Mitigation Program (Pre- and Post-Disaster)	X			The mitigation staff's purpose is to promote mitigation statewide and to manage the FEMA mitigation programs for Ohio.
Hazard Mitigation Grant Program (HMGP) (Post-Disaster)	X			Ohio EMA Mitigation Branch administers this program, which is available after a Presidential Disaster Declaration. HMGP funds hazard mitigation plans and cost-effective projects that reduce or eliminate the effects of hazards and/or vulnerability to future disaster damage. Typically, the state provides a portion of the required non-federal match.
Pre-Disaster Mitigation Grant Program (PDM - Pre-Disaster)	X			Ohio EMA Mitigation Branch administers funds from this annual, nationally competitive program. PDM funds hazard mitigation plans and cost-effective projects that reduce or eliminate the effects of hazards and/or vulnerability to future disaster damage.
Flood Mitigation Assistance Program (FMA – Pre - Disaster)	X			Ohio EMA Mitigation Branch administers this program, which funds flood mitigation plans, provides technical assistance, and funds construction projects that reduce flood risk to insured, repetitive loss properties.
Repetitive Flood Claims Program (RFC – Pre-Disaster)	X			Ohio EMA Mitigation Branch administers this program, which funds construction projects that reduce flood risk to insured, repetitive loss properties.
Severe Repetitive Loss Program (SRL – Pre-Disaster)	X			Ohio EMA Mitigation Branch administers this program, which funds construction projects that reduce flood risk to insured, severe repetitive loss properties.
NFIP good standing requirement for mitigation project funding (Pre- and Post- Disaster)	X			Ohio EMA Mitigation Branch requires good standing in the NFIP and no outstanding CAV issues as a prerequisite to mitigation funding. Ohio EMA coordinates with ODNR (who administer the program) to promote floodplain management and reduction through NFIP participation.
Mitigation Post-Disaster PDA (Post-Disaster)	X			Mitigation Staff accompanies PDA teams to evaluate the disaster in its

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
				early stages and determine which communities could benefit from mitigation actions. It also presents an opportunity to highlight potential success stories.
Education and Outreach (Pre- and Post-Disaster)	X			Mitigation Staff conducts education and outreach activities focused on promoting pre- and post-disaster mitigation techniques, developing effective mitigation projects, benefit-cost analysis, mitigation planning, and other mitigation related topics.
Ongoing Technical Assistance (TA)		X		If a community requests technical assistance at any time, the Mitigation Branch will facilitate the request, if possible.
Hazards United States (HAZUS) (Pre-Disaster)		X		The Mitigation staff encourages and facilitates local and state use of HAZUS to support mitigation planning and development of mitigation strategies for areas at risk to earthquake and flood.
Mitigation Planning Coordination (Pre-and Post-Disaster)		X		Mitigation Planner assists with the update of the SHMP, as well as facilitates and reviews local plans that are developed. Assists communities with integrating local mitigation plans into other plans/functions; assists with plan implementation.
Public Assistance	X			Ohio EMA Disaster Recovery Branch (DRB) administers Stafford Act recovery programs including Public Assistance (PA). The PA program provides mitigation funding for certain public facilities that are damaged in a declared disaster event and PA funds are also available to mitigate these facilities (Section 406 mitigation). The Recovery Branch is responsible for this program and Mitigation Branch assists when needed.

Ohio Environmental Protection Agency (OEPA)

The OEPA is a trusted leader and environmental steward using innovation, quality service, and public involvement to ensure a safe and healthy environment for all Ohioans. Their mission is to protect the environment and public health by ensuring compliance with environmental laws and demonstrating leadership in environmental stewardship. OEPA has played a prominent role in many of the state's environmental success stories. They have a nationally acclaimed water monitoring program, one of the country's most extensive air monitoring networks, a groundbreaking agreement with the federal government to oversee clean-ups at federal sites and an innovative funding program to protect and restore water resources.

Table 3.3.j

Ohio Environmental Protection Agency Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X)			Comments
	Support	Facilitate	Hinder	
Regulation of Waste Streams (Pre- and Post-Disaster)	X			Defines regulated waste streams; outlines requirements for proper management and disposal. Includes flood reduction criteria.
Public Outreach Materials (Pre- and Post-Disaster)	X			Provide clarification of regulatory requirements, including flood reduction criteria.
Debris Management Course (Pre- and Post-Disaster)		X		Co-presented with Ohio EMA; provides guidance/training for anyone involved in disaster preparedness and response/recovery activities. Provides an opportunity to outline mitigation goals and objectives for flood reduction.
Technical Assistance (Pre- and Post-Disaster)		X		Provide guidance to local officials regarding regulatory requirements for managing and disposing of various waste streams without making them hazard-prone.
Project Development (Pre-Disaster)	X			Provide clearance for any mitigation project actions that would alter the natural environment as part of the development process.
Water Pollution Control Loan Fund (WPCLF)		X		Provides funding for wastewater treatment facility improvements. Funded WWTPs must ensure that upgrades and facility are protected to 500-year flood or 2 feet above 100-year flood.

Ohio Historic Society (OHS)

The Mission of the OHS is to preserve and encourage the study of our heritage and to inspire the efforts of others to that end. They provide leadership in preserving and interpreting evidence of the past and work to further knowledge, understanding and appreciation of all aspects of history related to Ohio and its cultural and natural environment. The OHPO, an office under OHS, is the most active in mitigation as it ensures compliance with the National Historic Preservation Act of 1968, as amended.

Table 3.3.k

Ohio Historic Preservation Office Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X)			Comments
	Support	Facilitate	Hinder	
National Historic Preservation Act (Pre- and Post-Disaster)	X			OHPO, ensures all historic and archeological laws and statutes are addressed and adhered to.
Project Application Review Process (Pre-Disaster)	X			OHPO, ensures the archeological integrity of lands and structures are addressed and reviewed for environmental applicability during project ranking process.
Provide Technical Assistance and Training (Pre-Disaster)		X		If the structure is protected under the National Historic Preservation Act, the OHS works with the homeowner and State to provide a mitigation solution for preservation without compromising the integrity of the structure.

Ohio Public Works Commission (OPWC)

The OPWC was created to assist in financing local public infrastructure improvements. These programs provide financial assistance to local communities for the improvement of their basic infrastructure systems. The SCIP, created in 1987, by an amendment to the Ohio Constitution creating Section 2K, Article VIII of the Ohio Constitution, which allows the state to use its general revenues as debt support and issues up to $120 million in bonds each year. State bond proceeds are distributed to each of the commission's nineteen District Public Works Integrating Committees. Aid is limited to roads, bridges, water and sanitary sewer projects concerning storm water and solid waste. This program was re-authorized in 1995 by the addition of Section 2M, Article VIII of the Ohio Constitution.

Table 3.3.l

Ohio Public Works Commission Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X)			Comments
	Support	Facilitate	Hinder	
Infrastructure Financing (Pre- and Post-Disaster)	X			Provides funding to assist Ohio jurisdictions in repairing/replacing public infrastructure, including emergency projects. Mitigation objectives are incorporated into project development.
Clean Ohio Fund (Pre-Disaster)	X			Approved in 2001, the $400 million dollar bond program that provides funds to preserve natural areas and farmland, protect streams, creates outdoor recreational opportunities, and revitalizes urban areas by returning contaminated properties to productive use. At this time (May 2008), the fund has expended all appropriations; Governor Strickland has proposed an additional $400 million as part of a larger jobs package.

Ohio Manufactured Homes Commission (OMHC)

The State of Ohio has adopted laws and rules that regulate the installation of manufactured homes and the installation of foundations (base support systems) for manufactured homes. The OMHC has exclusive authority over the installation of manufactured homes not located in licensed manufactured home parks. The Ohio Manufactured Homes Commission (Commission) is charged with enforcing these laws pursuant to ORC Chapter 4781

Table 3.3.m

Ohio Manufactured Homes Commission Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	Effect on Loss Reduction (X) Support	Facilitate	Hinder	Comments
Site / Plan Review		X		Requires flood hazard data and lowest floor data for proposed home installations in special flood hazard areas.
Inspections		X		Requires inspection of all manufactured home installations, including those in special flood hazard areas.

Public Utilities Commission of Ohio (PUCO)

The PUCO was created to assure Ohioans adequate, safe and reliable public utility services at a fair price. Monitoring and enforcing PUCO rules and state laws against unfair, inadequate and unsafe public utility and transportation services achieve this. More recently, the PUCO gained responsibility for facilitating competitive utility choices for Ohio consumers. The PUCO regulates providers of multiple utility services including electric and natural gas companies, local and long distance telephone companies, water and wastewater companies, and rail and trucking companies.

Table 3.3.n

Public Utilities Commission Mitigation Summary

Programs, Plans, Policies, Regulations, Funding or Practices	**Effect on Loss Reduction (X)**			**Comments**
	Support	**Facilitate**	**Hinder**	
Technical Assistance for Program Development (Pre-Disaster)	**X**			The PUCO supports mitigation measures and provides imperative information to Ohio EMA, during project development, regarding the safety of property before demolition of homes, including the locations of buried power lines.
Identify Projects Post-Disaster (Post-Disaster)	**X**			Work with utility companies post-disaster to identify projects and utilize 406 mitigation funds through the PA program, if possible.

STATE DEVELOPMENT POLICIES FOR HAZARD-PRONE AREAS

State development policies for hazard areas are generally manifested through the programs identified in the previous section. As a home rule state, Ohio does not have comprehensive or overarching standards for development in hazard-prone areas. At the same time, Ohio communities have significant freedom to adopt and enforce policies for these areas. For example, any Ohio community could adopt zoning standards that apply to hazard-prone areas because such standards have a direct tie to public health and safety. As was stated earlier, Ohio does not have a requirement for comprehensive planning nor hazards planning other than the requirements found in the Disaster Mitigation Act of 2000.

Most Ohio policies are targeted and limited to the hazard of flooding or coastal erosion. A few examples follow:

- Under Section 1521 of the Ohio Revised Code (ORC), development in 100-year floodplains that is funded by state and state-administered federal monies must comply with the minimum National Flood Insurance Program (NFIP) criteria.
- Infectious waste treatment facilities permitted under Section 3734 of the ORC are prohibited in all special flood hazard areas.
- The Ohio Basic Building Code and the Ohio Fire Code are now based on the International Code Council codes. The OBBC contains minimum standards for flood resistant construction.

The Ohio EMA has prioritized hazard mitigation planning and the use of acquisition of hazard-prone structures as a mitigation action for many years and such a priority will continue.

STATE FUNDING CAPABILITY FOR HAZARD MITIGATION

As of this update, Ohio, like many states, is feeling the results of a difficult economic climate. Tax revenues are down and there are increasing demands on both state and local resources. Still, Ohio has been aggressive in pursuing hazard mitigation projects available through FEMA programs. Appendix F: FEMA Mitigation Programs Funding Summary shows that since 1990, the date of the first Federal disaster declaration, which resulted in mitigation funding, over $23.7 million of state funds have been spent on FEMA's hazard mitigation programs (this does not include state match assistance for 406 mitigation accomplished through the Public Assistance program). Typically, the State of Ohio provides a cost share for the HMGP that varies from disaster to disaster. Despite the difficult economy, the State of Ohio will provide 12.5% of the mitigation project cost for the most recent disaster declared in July 2011 (DR-4002). Ohio has provided anywhere from matching Federal mitigation funds dollar-for-dollar, to providing a portion of the non-Federal matching funds required to only providing funds to match the state management costs of the program. It has generally been a policy of the state, even when Federal mitigation funds were matched dollar-for-dollar, that there be some amount of

local match contributed so a community would have some vested interest in the project.

However, Ohio is not only committed to hazard mitigation through providing funds for FEMA mitigation programs, Ohio also has committed to building / maintaining state staffing to provide a good measure of technical assistance to Ohio communities and citizens in both the state Floodplain Management Program, Dam Safety Program and Mitigation Branch. However, these programs as well as others in state government are not immune to budgetary challenges.

Clearly, the State of Ohio is committed to hazard mitigation.

3.4 FEMA MITIGATION PROGRAM IMPLEMENTATION CAPABILITY ASSESSMENT

Since hazard mitigation is a Federal-state-local partnership, states have a responsibility for maintaining competency in the ability to manage and implement a robust state hazard mitigation program. Effective state mitigation programs not only administer FEMA mitigation programs, but assist in the administration or promotion of other entities mitigation programs. For example, many local mitigation plans identify structural flood control as a possible mitigation measure. A competent state mitigation program is aware of possible USACE programs that could be utilized, and could facilitate project initiation.

Overall, Ohio has been a leader in implementing FEMA mitigation programs for many years. In addition to participating in every FEMA mitigation initiative that has ever been proposed, Ohio achieved the *managing state* status, which provided Ohio more autonomy over the management of these programs. Unfortunately, this status has been discontinued by FEMA because of new statutory language in DMA 2000 for which FEMA has not yet written implementation rules. This new statutory language would allow FEMA mitigation programs to be delegated to the state.

State mitigation planning criteria under the Stafford Act focuses on competency delivering FEMA mitigation programs. The following sections describe the Ohio EMA Mitigation Branch's capability in this regard. This section does not currently include evaluation of the state's other hazard mitigation programs that are at least partially supported by FEMA – the Floodplain Management Program and Dam Safety Program.

PROJECT IMPLEMENTATION CAPABILITY

The 44 CFR 201.5(b)(2) (i) and (ii) states that an enhanced SHMP must document the state's project implementation capability, identifying and demonstrating the ability to implement the plan, including:

- Established eligibility criteria for multi-hazard mitigation measures;
- a system to determine the cost effectiveness of mitigation measures, consistent with OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs; and
- a system to rank the measures according to the state's eligibility criteria (*Evaluation criteria)*.

For the purposes of this section, *eligibility criteria* are those that either allow or disallow a mitigation project to be considered further. *Evaluation criteria* are those that allow for a comparison of different mitigation projects.

Eligibility Criteria for Hazard Mitigation Measures

Generally, the State of Ohio does not establish eligibility criteria for hazard mitigation measures that exceed those found in the CFR or specific program

guidance. The main exception to this is under HMGP. In fact, Ohio in many instances, advocates for inclusion of measures where guidance is vague.

HMGP

The CFR identifies several eligibility requirements for projects under HMGP (these criteria, with usually only slight modifications are applicable to the other four FEMA mitigation programs as well):

1. Applicants can only be state and local governments or certain non-profit entities (Ohio does not have any federally recognized Indian tribes).
2. Projects must be in conformance with the state and local mitigation plans approved under 44 CFR 201.
3. Projects must have a beneficial impact on the disaster area.
4. Projects must be in conformance with Federal environmental regulations, including 44 CFR Part 9, Floodplain Management and Protection of Wetlands and 44 CFR Part 10, Environmental Considerations.
5. Projects must solve a problem independently or constitute a functional portion of a solution, where there is assurance that the project as a whole will be completed.
6. Projects must be cost-effective and substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster (*see Cost-Effectiveness of Mitigation Measures section below*).
7. Project must be an eligible activity. Under HMGP, an eligible activity could be one that is an eligible project type – a mitigation planning project, a 5% special initiative project, or a routine “sticks and bricks” mitigation project (acquisition, elevation, retrofitting, safe room, etc.).
8. Applicant must commit to required non-Federal cost share.

In Ohio, competition for HMGP funds is tremendous. On average, project applications will exceed available funding by 3-10 times. As a result, both eligibility criteria and evaluation criteria have been developed to fairly distribute these post-disaster funds. These criteria, and modifications needed if necessary, are found in the Administrative Plan (see Appendix H) and Mitigation Strategy for the event.

PDM, FMA, RFC, SRL

The statute, CFR, and specific program guidance identifies eligibility criteria for these programs that are different from the ones described for HMGP. Ohio follows these eligibility criteria.

Determining Cost-Effectiveness of Mitigation Measures

A key criterion for mitigation projects to be eligible for funding is that they must be cost-effective according to OMB Circular A-94, Guidelines and Discount Rates

for Benefit-Cost analysis of Federal Programs. If the project benefits are higher than the project costs, then the project is cost-effective.

In order to ensure a consistent approach in determining the cost-effectiveness of all mitigation projects, the state uses the FEMA benefit-cost analysis (BCA) software. Since this is also the method used by FEMA to determine the cost-effectiveness of a project, it is only reasonable that the state use the same method. The BCA is an assessment of the mitigation project to determine whether the cost of investing federal/state/local funds in a hazard mitigation project is justified by the prevented or reduced damages from future disasters.

It is understood that a positive benefit cost ratio (BCR > 1) does not necessarily guarantee that a hazard mitigation project will be approved – but it does ensure that it meets the cost-effectiveness eligibility requirement. By applying project specific information to the benefit cost analysis module, we can get a good initial look at the mitigation potentials associated with that project. The results of this analysis can also help communities evaluate current and future mitigation projects and adjust their overall mitigation strategy accordingly.

For HMGP, the Ohio EMA Mitigation Branch develops data for projects that do not require extensive engineering as part of the project design and analysis (e.g. stormwater projects). For flood projects, this usually includes the development of four different elevations/frequencies of flood events and obtaining the finished floor elevation of structures in the project. This data is developed in partnership with the USGS Ohio Water Science Center. For other hazard types, the data is developed as needed. The Mitigation Branch strives to complete a full data analysis whenever possible – this is a task accomplished by trained Mitigation Branch staff. The Ohio HMGP project application requires the necessary data needed for BCA analysis, depending on the mitigation option being pursued.

For the non-disaster HMA programs (PDM, FMA, SRL, RFC) the applicant is generally responsible for completing the BCA. In most instances local BCA development requires intense technical assistance from the Ohio EMA Mitigation Branch.

The Mitigation Branch coordinates with FEMA Region V to provide BCA training in late June every year. This training coincides with the release of the HMA Guidance and start of the non-disaster application cycle. Mitigation Branch staff also periodically conduct BCA training workshops. Information on BCA training and instructions for downloading the most current version of the BCA tool can be found on the Mitigation Branch website. **System to Rank Mitigation Measures According to the State's Eligibility Criteria (Evaluation criteria**)

For HMGP projects, evaluation and ranking is a two-step process. First, pre-applications are submitted to Ohio EMA, usually within 10 weeks of the disaster declaration. Based on the pre-applications, the SHMT will evaluate the projects using the scoring forms (see example in Appendix G) provided by Ohio EMA Mitigation Branch. These forms combine basic criteria found in the CFR, criteria for the nationally competitive mitigation programs, and criteria based on Ohio priorities. After the pre-applications are reviewed and scored, the Floodplain

Management Program will conduct an assessment of NFIP compliance, if a recent assessment has not been done. This is done for flood mitigation projects because NFIP compliance is a way to measure a community's day-to-day commitment to flood hazard mitigation.

The second step in HMGP project evaluation is for the SHMT to meet, after the Ohio EMA Mitigation Branch has fully processed the full project applications (conducted environmental review and benefit-cost analysis), to review and discuss all eligible projects. The SHMT again scores the projects using the same criteria that were used in scoring the pre-applications (obviously without needing to make as many assumptions). The scores are then used to determine which projects are funded under the program. In cases where a good, eligible project does not receive funding, Mitigation Branch staff work with the applicant to submit the application for funding under other FEMA mitigation programs, if applicable.

The SHMT also reviews project applications for PDM. The evaluation criteria are similar to those used in the national competition (*see Appendix G)*. The SHMT evaluates these projects based on the full project applications rather the pre-applications and only reviews them once.

PROGRAM MANAGEMENT CAPABILITY

A comprehensive state mitigation program should have effective program management capability. In 1998, Ohio was selected as one of the three "pilot" states to test the Managing State concept, which was to provide the state with more responsibility and autonomy in managing the FEMA mitigation programs. Selection was based on program management ability, well-documented fiscal controls and a strong, well-developed SHMT. In 2006, FEMA terminated the managing state program, not only for Ohio but for all states in the nation. The stated reason was that the DMA 2000 law established a mechanism for a "delegated state" program, and it was FEMA's opinion that such legislation superseded the managing state concept.

The benefits associated with Managing State status included: quicker project approval, ability to review, rank and select projects, pre-approval of environmental reviews and pre-certification of local hazard mitigation plans. An approved project had to include a completion of a benefit cost analysis and environmental clearances from ODNR Division of Natural Areas and Preserves, US Department of Interior Fish and Wildlife Services, and Ohio Historical Preservation Office. Managing States performed the benefit cost analysis and approved the environmental review for each project prior to submitting the selected applications for FEMA's approval. The certified applications enabled FEMA to process the applications quickly.

Environmental Reviews are conducted at the State level in conjunction with all applicable state and federal agencies. The State ensures that the local applicants are aware of the environmental review process and encourages them to provide as much information as possible before the review and contact of

applicable agencies begins. The state then reviews each applicant's project for environmental information, prepares letters of review request to each applicable agency, prepares the REC, and forwards it to FEMA for concurrence and signature. A more detailed explanation of the process is located in the current HMGP Administrative Plan.

A detailed breakdown of the benefit cost capabilities of the State Mitigation staff is located earlier in this section. Benefit cost runs and copies of each type of analysis is kept with each approved project.

The State of Ohio has a good record of providing timely, complete and accurate quarterly progress reports and financial reports. In each grant agreement, regardless of the program, applicants are required to submit quarterly progress reports within 15 days of the end of the quarter. The Mitigation Branch compiles a comprehensive narrative and financial quarterly report to the Region V Office within 30 days of the end of the quarter. A more detailed explanation of the quarterly report is located in the HMGP Administrative Plan. All HMA grant program projects are required to adhere to the same quarterly reporting process.

HMA project closeout and financial reconciliation are also described in detail in Administrative Plan and closeouts have been a Mitigation Branch strategic priority for several years. Mitigation staff conduct explicit reviews of the project or program close-out. The terms of the grant agreements and quarterly reports provided by the project applicant give a detailed summary of the project or program. On-site visits are conducted prior to the projects closeout and fiscal reconciliation.

Ohio EMA actively supports ongoing mitigation planning throughout the state. The Mitigation Branch has one staff position dedicated to mitigation planning. The Mitigation Branch staff and Ohio EMA field liaisons provide educational visits, technical assistance visits and planning presentations to facilitate the planning process in Ohio. The Mitigation Branches SHARPP website (see Appendix J) is very heavily focused on promoting mitigation planning activities. The Mitigation Branch in cooperation with the ODNR-DOW, Floodplain Management Program developed the Ohio Mitigation Planning Guidebook, a FEMA Region V approved planning tool, for local jurisdictions to use in the development of all-natural hazard mitigation plans.

The final aspect of a comprehensive state mitigation program is to develop and present mitigation educational materials and conduct outreach relative to mitigation. Ohio EMA mitigation branch staff conducts mitigation planning courses, natural hazard planning workshops, technical assistance visits, program and project development meetings, and participates in public meetings. As changes occur in FEMA and Ohio EMA mitigation programs, the mitigation branch develops new presentations and courses to provide educational opportunities to the emergency management community in Ohio.

EFFECTIVE USE OF AVAILABLE MITIGATION FUNDING

Appendix F shows that the State of Ohio has been very effective, and aggressive in pursuing available mitigation funding. Ohio is the only state in FEMA Region V that has successfully obtained funding in all of FEMA's mitigation programs. The Mitigation Branch has also developed mechanisms to ensure that funds are effectively used:

- Under HMGP, full project applications are developed based on 200% of the available funding. This ensures that there will be enough complete, eligible project applications to submit for funding before the application deadline has passed. If an application is developed and eligible, but not funded, Mitigation Branch staff will work to find another program under which it can be funded.
- The Mitigation Branch will keep HMA projects that are eligible but not funded as "shelf" projects to be submitted under another program or subsequent HMA funding cycles.
- Mitigation Branch and SHMT leverages other (non-FEMA) sources to fund mitigation projects. USACE's Planning Assistance to States, Floodplain Management Services, and HUD Disaster Supplemental funds have been used for mitigation planning and projects.
- "Zero-Funded Projects" are those actions that are currently prepared for implementation once funding becomes available. These projects have complete information and are prioritized.
- As documented in Appendix F, the State of Ohio consistently and effectively utilizes all HMA programs to help meet the goals and objectives outlined in this plan.

3.5 COMMITMENT TO A COMPREHENSIVE STATE MITIGATION PROGRAM

The State of Ohio has had a long-standing commitment to a comprehensive mitigation program. Certainly, the action items in Section 3.2 reflect this commitment. This commitment has been exhibited through past, existing and future initiatives. This section provides a thorough discussion of different dimensions of the states commitment, how each aspect has been implemented in the past and the states plan to continue said implementation.

Local Mitigation Planning Support

Local mitigation planning has been and will continue to be supported significantly. As stated earlier in the plan, all 88 counties in Ohio either have approved FEMA mitigation plans or are developing them. Ongoing training on developing/updating a local mitigation plan is provided by the Mitigation Branch through the training program at Ohio EMA, and future activities will be to determine the best approach to fund/assist with local plan updates. In addition, a web portal project is planned that would make local plans better integrated with the state plan, information would be made widely available, and make information easier to update.

During February and March 2009, under FEMA DR-1805-OH, Ohio EMA and ODNR conducted the OH-319 Hazard Mitigation Plan Update Workshop in six locations throughout the state, based on the Emergency Management Agency Association (EMAO) sectors. Local EMA Directors, County Planning Commission representatives and other Planners were invited to each workshop that provided the most recent planning guidance, cross reference checklists and examples how the new criteria should be addressed. Over 75 people participated with requests by Licking, Sandusky and Ross Counties to address their Hazard Mitigation Planning Core Groups in preparation for updating their Plans.

Under DR-4002, Ohio EMA and FEMA conducted courses for updating local hazard mitigation plans and the Hazard Mitigation Assistance Application Development course. Thirty-nine people from counties all over the state participated in these two training sessions.

Ohio EMA also participated alongside ODNR in Flood Risk Information Open House meetings for Ross and Tuscarawas Counties as part of the Map Modernization Process. These meetings were held in conjunction with the preliminary map release. Ohio EMA intends to maintain this supporting this effort as the program continues.

SHMT Improvement

The collaborative power of the SHMT is understood. Invitations were sent to additional organizations with the intent to expand the SHMT to allow for better program integration/utility.

Providing Non-Federal Match

As mentioned before, Ohio has almost always accepted its responsibility to be an active partner in funding mitigation activities - $23.7 million over 18 years is a clear demonstration of this.

Use and Promotion of National Building Codes

Since 1998, Ohio has been utilizing the I-Codes as a basis for the Ohio Basic Building Code. The code is mandatory statewide for over 4-family, commercial, and industrial structures and is optional for residential structures up to 4 families in size. The building codes include provisions to meet flood and wind requirements, and simultaneously allow communities to adopt and enforce higher standards for floodplain management should they choose to do so.

Integration of Mitigation in Post Disaster Recovery Operations

Ohio is a true partner with FEMA during disaster events. Ohio EMA is a presence at the Joint Field Office and the Mitigation Branch is fully staffed and functional at these facilities. There is comprehensive Mitigation Strategy that is prepared after every event, and all Ohio agencies involved in mitigation activities are involved.

During FEMA DR-1805-OH, the Mitigation Branch was collocated in the JFO Mitigation Section with federal counterparts. As a result, this joint team crafted the Mitigation Action Plan for 1805 (ref: Appendix H, this Plan) that included objectives and priorities under HMGP, promotion of local mitigation planning and outreach/best practices as well as NFIP coordination with FEMA and ODNR.

FEMA DR-4002-OH was an extended flood event in southern and eastern Ohio. The greatest impact from this event was to infrastructure, specifically roads and bridges. The Joint Hazard Mitigation Strategy for this event included deployment of a 406 specialist to the Joint Field Office that worked with state and local staff to maximize mitigation opportunities for public assistance projects.

FEMA DR-4077-OH included Severe Storms and Straight-line Winds which impacted many parts of Ohio. The Joint Field Office helped develop the Hazard Mitigation Strategy. The Hazard Mitigation Strategy will identify the different activities that are to be conducted as a result of the disaster declaration.

FEMA DR-4098-OH was declared because of the impacts of super storm Sandy and the impacts were felt primarily in Northeast Ohio. The Joint Field Office again helped develop the Hazard Mitigation Strategy. The Hazard Mitigation Strategy will identify the different activities that are to be conducted as a result of the disaster declaration.

SECTION 4:
LOCAL MITIGATION PROGRAM COORDINATION

4.1 LOCAL CAPABILITY ASSESSMENT

OVERVIEW

The preparation of Local Hazard Mitigation Plans (LHMPs) is a precondition for receipt of Hazard Mitigation Assistance grant project funds under the Disaster Mitigation Act of 2000 (DMA 2000) which also requires that states examine LHMPs as part of their SHMP process. FEMA has established mitigation planning requirements for local jurisdictions to meet, among other things, to demonstrate that proposed mitigation actions are based on a sound planning process that accounts for the inherent risk and capabilities of the individual communities.

The Ohio EMA Mitigation Branch administers the LHMP Program for the state. The Mitigation Branch supports and assists local governments in the development and update of LHMPs. In 2002 and 2003, significant amounts of federal and state PDM funds were provided to develop LHMPs. For the time period spanning from the 2005 plan to the 2008 update, the main planning emphasis of the Mitigation Branch has been to get LHMPs reviewed, adopted, and FEMA approved. From 2008 to 2011, the emphasis shifted to tracking LHMP progress and effectiveness in a quantitative way, and integrating plan information more significantly into the state plan. The focus during 2011-2014 will be populating the State Hazard Analysis, Resource and Planning Portal (SHARPP, see Appendix J) with local plan information that will enhance mitigation planning efforts statewide.

Currently, Ohio has a very good LHMP participation rate. A county-by-county plan status report is included in Appendix D. As of December 2010, every county in the state of Ohio had developed a baseline mitigation plan that had been approved by FEMA. Based on an October 2010 report from FEMA Region V:

- **87.4%** of the population of Ohio was situated in a community with a locally adopted, FEMA approved plan.
- There are 885 jurisdictions in Ohio that participated in the development of a LHMP.
- 669 of the 885 jurisdictions have provided plan adoption documentation to FEMA, through Ohio EMA.

There are 41 county plans that are current and have final Federal approval. An additional four county plans (Delaware, Montgomery, Pickaway, and Summit) are federally approved pending adoption. Twenty-three counties are updating their plans under a federal grant, while 14 counties are developing their plans without a grant. Six counties (Fayette, Hardin, Highland, Paulding, Pike and Wyandot) have expired plans.

The Mitigation Branch has engaged in multiple outreach efforts to counties with expiring LHMPs to emphasize the importance of updating the plan, offer technical assistance, and identify possible funding sources for local mitigation plan updates. Twenty-eight LHMP updates were funded in 2010 with HMGP

funds as a result of DR-1805, twelve updates were funded in 2012 as a result of DR-4002. Seven LHMP updates were funded in 2013 as a result of DR-4077 and two counties were recently awarded funding under DR-4098. An application for Shelby County is under consideration for DR-4098 funding. The Mitigation Branch will continue local mitigation plan outreach and technical assistance efforts during the next SHMP update cycle.

SHARPP highlights local mitigation planning and project efforts (see Appendix J). Providing greater public access to local mitigation plans will help publicize local strategies for reducing risk, and support requests for investment in mitigation projects.

In addition to the benefits provided by SHARPP, the local mitigation planning capability has been enhanced by the Mitigation Branch's efforts to conduct statewide HAZUS runs for the 25- and 100-year recurrence intervals (see Section 2.2) and earthquakes. These HAZUS runs were made available to local officials for inclusion in LHMP updates. The Ohio EMA Mitigation Branch will continue to utilize HAZUS-MH and promote the use of the tool throughout the state.

Local authority to implement a comprehensive hazard mitigation program is ample. Ultimately, it is up to each local jurisdiction to determine which mix of authorities, programs, policies, and capabilities it wants to develop. All Ohio communities (cities, villages, and counties) have the power to develop and adopt many different kinds of plans including comprehensive plans, capital improvement plans, economic development plans, emergency operations/response plans, continuity of operations plans, and hazard mitigation plans. Communities have regulatory powers to adopt zoning, subdivision, building and development, floodplain management and health codes. Ohio communities have the power to levy taxes / assessments for special purposes (including petition ditch projects, stormwater utilities) and have the authority to borrow funds (bonding). Finally, communities have the authority to create planning, emergency management, health, public works, economic development and other needed agencies. All of these authorities have, or potentially could have, a bearing on local hazard mitigation.

OHIO
NATURAL HAZARD MITIGATION
PLANNING GUIDEBOOK

A step-by-step guide to help communities prepare natural hazard mitigation plans and minimize future losses

Ohio Department of Natural Resources
Sam Speck, Director

Ohio Emergency Management Agency
Dale W. Shipley, Executive Director

July 12, 2002

INTERIM GUIDANCE

QUALITATIVE ANALYSIS OF LHMPS

Because the Mitigation Branch has reviewed each LHMP, some trends were evident. Again, these trends are based on a qualitative, not quantitative review of the LHMPs.

Overall Plan Quality

Overall, LHMPs involved many local agencies/entities and are of a good quality. It was noted that the quality of the plan is not dependent on its size; rather, it is the format

and quality of information in the plan that is more important. Some of the best LHMPs are small to moderate sized.

Many LHMPs utilized FEMA's planning how-to publications; however, even more utilized the Ohio Natural Hazard Planning Guidebook. The handbook was written to be one volume with the intent to create a basic LHMP. In reality, Mitigation Branch staff advised LHMP plan keepers to use both resources.

Definitions used in the LHMPs were not consistent. The areas where inconsistencies were most evident was in defining critical facilities, identifying what constitutes a mitigation action, and defining hazards to which a community was susceptible.

The way LHMPs conducted risk assessments and ranked hazards to which communities are susceptible was extremely variable. Variability in the risk assessment process and data sources used is not surprising given that communities have significantly different amounts and quality of data. In terms of ranking hazards, some LHMPs ranked the hazards based on a numerical ranking (using a matrix or scoring system), some developed a relative ranking system (one hazard ranked higher than another but no number identified), and some developed a qualitative ranking system (ranking hazards as high, medium or low threat). However, flooding, severe summer storms, high winds/tornadoes, and severe winter storms were consistently ranked high or severe.

Single community LHMPs tended to be much more focused than did multi-jurisdictional mitigation plans. Although the overwhelming majority of mitigation plans in Ohio are multi-jurisdictional (90%+), some jurisdictions felt that a stand-alone plan would be more meaningful. While we do not have data to determine whether this is true, the stand-alone plans were much more focused on specific issues.

Mitigation Policies, Programs & Capabilities

Local mitigation policies and programs can be best understood by reviewing the local mitigation strategies. Those strategies should indicate whether policies or programs exist and need to be modified, or whether they exist at all. A few trends were noted.

It was evident that larger communities and counties have more extensive policies and programs in place vs. smaller communities. Many of the local strategies pertaining to larger local governments tended to be geared towards refining or enhancing existing policies and programs vs. creating them. The reverse was seen with smaller units of government.

A similar trend was seen with local mitigation capability. Participants in the planning process for larger communities tended to be professional staff positions and/or multiple persons, while participants for smaller communities ranged from the mayor to council members, to an appointed citizen.

Mitigation policies/programs/capabilities varied significantly from community to community and county to county. Some communities and counties had very

sophisticated mitigation programs either demonstrated by the sophistication of their mitigation plans/goals/actions or the integration of mitigation programs. In addition, some communities developed their own, stand-alone plans. On the other end of the spectrum were communities that have virtually no involvement in hazard mitigation.

Mitigation Actions

Mitigation actions identified in LHMPs were heavily influenced by whoever was leading the planning effort. For example, a LHMP developed in-house by a county emergency management agency had a tendency to focus on mitigation actions that were emergency management related. Similarly, LHMPs developed by a county planning agency tended to have a focus on land use management measures.

It was evident that there was some confusion as to what constituted a mitigation goal/objective/action. Many actions in LHMPs were either preparedness or response actions. There is one LHMP where nearly no action is related to hazard mitigation.

Education and outreach actions were the most numerous identified in LHMPs. Other actions that were frequently mentioned included flood mitigation projects (acquisitions, stream clearing/dredging), development of emergency action plans downstream of high hazard dams, shelter creation/development, upgrade regulations (building code, floodplain management regulations, zoning), and warning systems (flood/wind).

4.2 LOCAL MITIGATION PLANNING ASSISTANCE

44 CFR 201.4(c)(4)(i) requires the state to include a description of the process to support, through funding and technical assistance, the development of LHMPs.

Hazard mitigation planning is a way, in a non-disaster environment, to understand hazards and prepare strategies and actions to reduce the impact of these hazards. The ever-rising recovery costs of disasters plaguing Ohio made it apparent that a pre-disaster planning and project focus with ongoing risk analysis could reduce these costs. The State of Ohio utilizes any available federal program funds for mitigation projects, and has documented success stories proving the necessity and effectiveness of the programs. The DMA 2000 stipulates that state and local jurisdictions need to have an approved LHMP to remain eligible for most federal funding for mitigation projects. Ohio has taken a very proactive role in the involvement with local jurisdictions to secure the availability of the funding programs and assist local communities in developing LHMPs in the past twelve years (2002-2014). This effort has resulted in a very large number of communities having developed and adopted LHMPs.

INITIAL STATE EFFORTS

LHMP creation has been a primary goal of the Mitigation Branch for several years. From 2002-2006, Ohio EMA distributed PDM and HMGP funds to any jurisdiction with the ability and willingness to complete a LHMP. The Ohio EMA Mitigation Branch staff is responsible for interaction with counties, cities and villages working on LHMPs. The Mitigation Branch explained the initial planning requirements and recommendations on the usage of planning funds during planning coordination meetings. As the planning process evolved, so did the involvement of the state. The availability of the Mitigation Branch to provide technical assistance throughout the process and a final review of the draft plan provide communities with increased opportunities to produce an approvable plan.

When the plan requirements were initially distributed, local jurisdictions were unsure about the creation and significance of the plan. Communities applied for state funds to assist with the planning process. The State of Ohio committed to the effort of LHMP creation by matching 2002 and 2003 PDM planning funds dollar for dollar. Ohio EMA Mitigation staff met individually with all recipients of PDM 2002 funds for planning. All recipients of PDM 2003 funds were invited to one of four regional meetings for assistance with their plans. Any jurisdictions requesting funds for planning, after all of the PDM funds were allocated, were funded through HMGP. The state offered guidance for those recipients at a meeting in the state office.

The meetings provided an opportunity for Ohio EMA staff to verbalize their expectations for the communities to create an approvable plan. Ohio, as a Managing State, was able to pre-approve the plans before they were sent to FEMA. All the plans had to meet the standard planning requirements, but the pre-approval allowed Ohio flexibility. Ohio EMA was aware of the resources available to communities and expected more from urban areas versus limited less developed jurisdictions. Each jurisdiction received several technical assistance tools at the planning briefing to assist with the process. The Mitigation Branch staff who conducted the meeting distributed and explained the relevance of each document.

The informational packet included:

- A copy of the Law listing the requirements for the LHMP
- An outline of Ohio EMA expectations and additional planning resources
- FEMA publications 386-1 thru 386-4, part of the Getting Started Series
- FEMA's DMA 2000 Mitigation Plan Guidance
- Ohio's Mitigation Planning Guidance
- An extensive list of contractors who have assisted other communities with Plans
- A copy of the crosswalk that outlines the requirements and method for assessment of the plan

Ohio utilized and distributed FEMA documents to assist communities with their LHMPs. In addition, communities were provided with a copy of the Ohio Natural Hazard Mitigation Planning Guidebook. The Guidebook outlined requirements relevant to Ohio communities and explained a simple, easy to use, planning process.

From 2002-2006 the Appalachian Flood Risk Reduction Initiative (AFRRI) resulted in the completion of many plans. Of note, the AFRRI was not funded by FEMA; rather, it was jointly funded by the United States Economic Development Administration and the Ohio Department of Natural Resources.

Whether through the initial 2002-03 PDM planning effort, HMGP funding for LHMP planning, or AFRRI, the state staff also provided technical assistance with LHMP development. Staff at the ODNR, Floodplain Management Program and Ohio EMA Mitigation Branch has provided hands-on technical assistance with plan development. State staff provides reviews for LHMPs, facilitate planning meetings, assist with technical data acquisition/development, provide information on mitigation options, and assist in locating funding sources.

CURRENT STATE EFFORTS

LHMPs are now prerequisites to obtaining funds from most FEMA mitigation programs (except RFC). In addition, new requirements published by FEMA on October 31, 2007 require all updated plans to meet FMA planning requirements (additional flood hazard mitigation strategy and strategy for repetitive loss programs). To keep abreast of and implement these changes, the Mitigation Branch will continue to prioritize the planning element of the state mitigation program.

Technical Assistance

Technical assistance that the state can provide communities includes:

- Mitigation planning process assistance including facilitating planning meetings, providing guidance documents for plan creation/update, etc.
- HIRA data development. The Ohio EMA Mitigation Branch and the ODNR, Floodplain Management Program both have competencies in running FEMA's HAZUS-MH program. Staff can provide assistance and training in HAZUS-MH and conduct HAZUS analyses that are available for communities to incorporate into LHMPs. In addition, state staff can provide other data that communities may not have (other flood studies, underground mine maps, etc). State staff, with the assistance of Federal agency partners, often develops data after disasters.
- Information on mitigation actions including manuals, reference documents and other resources on different mitigation actions for all hazards.
- Mitigation action budget information. Since state staff is often involved in implementing mitigation projects statewide, they have a good understanding of the current costs of mitigation actions.

- Reviewing draft LHMPs for compliance with FEMA criteria. A jurisdiction sends their final drafts to Ohio EMA for approval. A reviewer in the Mitigation Branch uses the crosswalk provided by FEMA to evaluate the plan according to the requirements. If the plan meets all the requirements, the crosswalk and draft plan are forwarded to FEMA for approval. If a plan does not meet the requirements, Mitigation Branch staff provides recommendations to the jurisdiction that will address deficiencies. Mitigation Branch staff review the revised draft prior to submittal to FEMA.

Financial Assistance

44 CFR201.4(c)(3)(iv) requires the state to include identification of current and potential sources of federal, state, local or private funding to implement LHMP mitigation actions and to undertake mitigation planning.

It is important not only to provide financial assistance whenever possible, but also to identify sources of funding that can fund hazard mitigation planning and action item implementation (projects). LHMPs, if properly created, should not only identify mitigation actions that can be funded by FEMA, but other agencies as well. Table 4.2.a identifies several potential funding sources for hazard mitigation projects.

The primary source for state and local hazard mitigation projects have been the federally funded cost-share programs. The state has historically matched a portion of FEMA hazard mitigation grant programs (primarily HMGP) through the state's disaster relief fund and has contributed over $21.7 million for hazard mitigation activities since 1990. As a general policy, the state requires local jurisdictions to contribute a portion of the non-federal matching funds. A summary of federal, state, and local contributions to all HMA programs can be found in Appendix F.

The limited funding from local community budgets requires the use of alternate funding sources for the cost-share match. Different state agencies distribute funds that can be used for mitigation activities. This section examines the federal, state, local, and private sources available to provide financial assistance to local communities to implement hazard mitigation projects.

Table 4.2.a

Potential Hazard Mitigation Funding Sources

Program	Administered By?	Federal / State / Local Source?	Purpose / Contact	Used Before?
Hazard Mitigation Grant Program (HMGP)	Ohio EMA Mitigation Branch	Federal - FEMA	Provides funds after Federally declared disaster to implement certain hazard mitigation projects (includes mitigation planning grants). Can be used for any hazard, subject to state Administrative Plan and Mitigation Strategy. Commonly used to acquire/demolish, elevate, retrofit, buildings; construction of tornado/high wind safe rooms, stormwater management system improvements., etc. http://ema.ohio.gov/MitigationBranch.aspx	Yes, extensively. Largest mitigation program used in Ohio – over $100 million Fed/state/local funds since 1990.
Pre-Disaster Mitigation Grant Program (PDM)	Ohio EMA Mitigation Branch	Federal – FEMA	Provides funds annually based on Congressional appropriations to implement certain hazard mitigation projects (includes mitigation planning grants). Can be used for any hazard. Nationally competitive. Commonly used for activities similar to HMGP. http://ema.ohio.gov/MitigationBranch.aspx	Yes, increasingly used. Over $15.9 million Fed/state/local funds since 2002.
Flood Mitigation Assistance Program (FMA)	Ohio EMA Mitigation Branch	Federal – FEMA	Provides funds annually based on Congressional appropriations to implement certain flood hazard mitigation projects (includes flood mitigation planning grants). Each state receives an allocation of funds. Commonly used for flood mitigation activities similar to HMGP. These funds now include the RFC and SRL programs. http://ema.ohio.gov/MitigationBranch.aspx	Yes – FMA funds available since 1988. Ohio receives allocation of between $200,000 and $300,000 per year. Usually funds 1-2 projects from communities.

Program	Administered By?	Federal / State / Local Source?	Purpose / Contact	Used Before?
Repetitive Flood Claims Program (RFC)	Ohio EMA Mitigation Branch	Federal – FEMA	A nationally competitive grant, provides funds annually based on Congressional appropriation to implement certain flood hazard mitigation projects (no planning grants). Commonly used for flood mitigation activities similar to HMGP. This program has been combined with FMA http://ema.ohio.gov/MitigationBranch.aspx	Yes. Program was new in 2007. There have been five grants awarded in Ohio for over $804,000.
Severe Repetitive Loss Program (SRL)	Ohio EMA Mitigation Branch	Federal – FEMA	A nationally competitive grant with an annual funding cycle subject to Congressional appropriation. Funds flood hazard mitigation projects (no planning grants) that will result to the greatest savings to the National Flood Insurance Flood in the shortest period. Commonly used for flood mitigation activities similar to HMGP. This program has been combined with FMA	Yes. Program was new in 2007. There have been two grants awarded in Ohio for over $254,000.
State Match to HMGP and 406 Public Assistance Mitigation	Ohio EMA Mitigation Branch	State – Disaster Relief Fund	Dollars from the State Disaster Relief Fund are used to match federal HMGP project funds and state management cost awards for Hazard Mitigation Assistance grants in Ohio. The State Controlling Board must approve the use of Disaster Relief Funds.	The State of Ohio has contributed over $23.2 million in state funds as match to all of FEMAs HMA grants.
Community Development Block Grant (CDBG)	Ohio Department of Development - Office of Housing Community Partnerships	State	The Community Development Program(s) provides funding to Ohio's non-entitlement counties and cities for housing rehabilitation, economic development and public works improvements that meet federal and state objectives to benefit low- and moderate-income persons and/or eliminate blighted areas. Also includes CHIP funds. http://www.odod.state.oh.us/CDD/OHCP/cdp.htm	Yes, extensively. Has been one of the largest sources of matching funds for FEMA mitigation program projects. Must be used in projects where low to moderate-income households are affected.

Program	Administered By?	Federal / State / Local Source?	Purpose / Contact	Used Before?
HUD Disaster Supplemental Funds	Ohio Department of Development	State or Federal depending on Congress		Yes, used for five previous disasters. When funds are available, can be used to supplement FEMA funds to increase the number and size of mitigation projects.
Home and Business Physical Disaster Loans	Small Business Administration (SBA)	Federal	Any business or non-profit organization that is located in a declared disaster area and has incurred damage during the disaster may apply for a loan to help repair or replace damaged property to its pre-disaster condition. The SBA makes physical disaster loans of up to $1.5 million to qualified businesses. Physical Disaster Loans are for permanent rebuilding and replacement of uninsured or underinsured disaster- damaged privately-owned real and/or personal property. Physical disaster loans are also available to individuals and renters for permanent rebuilding and replacement of uninsured or underinsured disaster- damaged privately-owned real and/or personal property. To help disaster victims fund protective measures, home and business owners may request an increase of up to 20 percent of the total approved SBA loan amount to help pay for mitigation measures. Only available after a Federally declared disaster where there is an SBA declaration. http://www.sba.gov/services/disasterassistance/index.html	Yes – although frequency unknown.

Program	Administered By?	Federal / State / Local Source?	Purpose / Contact	Used Before?
Section 406 Public Assistance Mitigation Funds	Ohio EMA Disaster Recovery Branch	Federal	The Robert T. Stafford Disaster Relief and Emergency Assistance Act provides FEMA the authority to fund the restoration of eligible facilities(public and certain non-profit) that have sustained damage due to a Presidentially declared disaster. Section 406 of the Stafford Act contains a provision for the consideration of funding additional mitigation measures (further described in 44 CFR §206.226) that will enhance a facility's ability to resist similar damage in future events	Frequently used in Ohio. The need and eligibility for 406 mitigation funds are determined on a project-by-project basis, when projects are evaluated by FEMA and the state for normal Public Assistance funding. 406 mitigation can pay to elevate public buildings, upsize damaged culverts, etc.
Clean Ohio Fund	ODNR	State	The Clean Ohio Fund, created by House Bill 3 in November 2000, consists of four competitive funding programs. • The Clean Ohio Green Space Conservation Program helps to fund preservation of open spaces, sensitive ecological areas, and stream corridors. • The Clean Ohio Agricultural Easement Purchase Program supports the permanent preservation of Ohio's most valuable farmland through the purchase of development rights. • The Clean Ohio Trails Fund works to improve outdoor recreational opportunities for Ohioans by funding trails for outdoor pursuits of all kinds. • The Clean Ohio Revitalization Fund supports the cleanup of polluted properties so that they can be restored to productive uses.	Clean Ohio Funds have been used to match several mitigation projects. The 2008 Clean Ohio ballot initiative passed overwhelmingly and the legislature will decide this January on the level of funding for these programs.

Program	Administered By?	Federal / State / Local Source?	Purpose / Contact	Used Before?
Coastal Management Assistance Grant	ODNR – Office of Coastal Management	Federal	Every year, ODNR awards **at least $250,000** in Coastal Management Assistance Grants. Coastal Management Assistance Grants are funds awarded to help preserve, protect and enhance Ohio's Lake Erie coastal resources. Grants are awarded on a competitive basis, with applicants providing a minimum of 50 percent of the project costs.	Since the program began in 1997, 99 projects have been awarded **more than $3.2 million**. For 2010, nine projects totaling $675,000 were awarded Coastal Management Assistance Grants.
Planning Assistance to States (PAS)	USACE	Federal	Section 22 of the Water Resources Development Act (WRDA) of 1974, as amended, provides authority for the Corps of Engineers to assist the states, local governments, and other non-Federal entities in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land. The Planning Assistance to States (PAS) Program is funded annually by Congress. Federal allotments for each State or Tribe from the nation-wide appropriation are limited to $500,000 annually, but typically are much less. These studies are cost shared on a 50 percent Federal-50 percent non-Federal basis.	The PAS was used to conduct a Level 1 HAZUS-MH analysis for the HIRA section of the 2008 SHMP update. The study covered the 25-year and 100-year flood analysis for 49 of the 88 counties in Ohio.
Flood Control (Structural & Non-Structural)	USACE	Federal	USACE, without specific authorization, may study, adopt, and construct small flood control projects, stream clearing and snagging projects, and participate in planning and preparedness. The cost share for Flood Control projects are 65 percent Federal-35 percent non-Federal	

Program	Administered By?	Federal / State / Local Source?	Purpose / Contact	Used Before?
Emergency Streambank and Shore Protection	USACE	Federal	Authorizes USACE to study, adopt, and construct emergency streambank and shoreline protection works to protect highways, bridges, public works, and nonprofit public services. The annual program limit for federal expenditures is $15 million with not more than $1 million expended per site. The cost share for Flood Control projects are 65 percent Federal-35 percent non-Federal	
"Partners in Watershed Management" Project Assistance Program	Muskingum Watershed Conservancy District	Local	The Muskingum Watershed Conservancy District (MWCD), in an effort to support the work of agencies and groups involved in conservation programs, water quality issues, and flood reduction and mitigation projects, has developed the "Partners in Watershed Management" Project Assistance Program (PWM). This competitive grant program provides assistance to local communities, agencies and groups involved in projects and programs that support the conservation and flood control aspects of the MWCD. Political subdivisions of the state, IRS Section 501 groups, and other organizations in the Muskingum River watershed are eligible for potential assistance through this program. Applications are accepted on a year-round basis for assistance with non-federal match to FEMA Hazard Mitigation Assistance programs.	This program was created in 2009 and has been used as non-federal match for two HMA projects in the Muskingum Watershed.

4.3 LOCAL MITIGATION PLAN INTEGRATION INTO STATE PLAN

44 CFR 201.4(c)(4)(ii) requires a description of the state's process and timeframe by which the LHMPs will be reviewed, coordinated, and linked to the State Mitigation Plan.

LHMP REVIEW AND COORDINATION PROCESS

As mentioned in the previous section, the Ohio EMA Mitigation Branch reviews all LHPs; however, FEMA is the final approval authority. The LHMPs are logged into SHARPP upon arrival at the Ohio EMA. The State reviews the draft to ensure compliance with 44 CFR 201.6 local mitigation plan criteria within ~~45~~ 60 days of the arrival. If the plan does not meet FEMA requirements, it is returned to the community with recommendations for revision. If the plan meets all FEMA requirements, it is forwarded to FEMA with a completed Plan Review Tool for approval. The Mitigation Branch communicates the status of the plan review to the community. Once the State has received FEMA plan approval pending local adoption, the State notifies the local jurisdiction in writing and requests copies of the adoption documentation. Upon receipt, the local adoption documentation is forwarded to FEMA for final approval. When the State receives a letter from FEMA indicating final approval, that documentation is forwarded to the jurisdiction with a congratulatory letter that describes the plan update and maintenance requirements.

LHMP TRACKING

Historically, LHMP status was tracked using a spreadsheet (see Appendix D). LHMP status is now tracked through SHARPP. When a local official uploads a draft plan into SHARPP for state review the status of the plan is tracked from the time of submittal to FEMA final approval. Once the plan receives final federal approval, it is posted to SHARPP for view by the public. A report can be generated in SHARPP that summarizes the status of all LHMPs in the state.

SHARPP is a repository for past, present, and future versions of all local natural hazard mitigation plans in Ohio. These documents are stored as *.pdf files and can be searched and retrieved by county and/or community. Providing easier public access to these documents will help inform citizens about local natural hazard risk and the actions that communities have planned to undertake that will reduce risk. As local mitigation plans are updated they will be uploaded into SHARPP by local officials responsible for mitigation plan maintenance in their respective communities.

LINKING LHMPS TO THE SHMP

Because LHMPs are developed based on guidance and must meet specific Federal criteria, there are some similarities in their content. Nonetheless, LHMPs tend to be very different from one another in terms of: the quantity and quality of data presented in the HIRA; the techniques used to complete risk assessments and vulnerability analyses; and the "structure" of goals, objectives and action items. For that reason, the Mitigation Branch has determined that the two most logical areas where the LHMP should link back to the state plan are in the HIRA and the State Mitigation Strategy.

Link to HIRA. The LHMPs were reviewed and used to "ground truth" the data the state used to determine the most serious hazards facing the state. In Section 2, flooding, tornadoes, severed summer storms and winter storms were identified among the most significant risk facing the state. These four were also the highest ranked hazards based on the number of LHMPs reviewed indicating them as serious hazards. Coastal flooding, landslides, and invasive species are ranked high in the state plan; however only some LHMPs identified these hazards as significant. This is likely due to the more limited geographical extent of these hazards. Narrative descriptions and summaries of LHMP data are included throughout the state HIRA.

Analyses in the state plan HIRA are utilized by local officials and may be incorporated into LHMP updates. One of the tasks that the Mitigation Branch completed in early 2011 is to notify local county emergency management agency directors that HAZUS runs were conducted by the Mitigation Branch in all counties for 25- and 100-year recurrence intervals. Local officials were encouraged to incorporate this information into LHMP updates.

Future SHMP updates will analyze local HIRA data input into SHARPP (see Appendix J). When local officials upload a mitigation plan into SHARRP, they are asked to input data that summarize their local hazard analysis and vulnerability assessment. In order to standardize the local data collected, SHARPP utilizes the factors considered in the HIRA methodology used by the State of Ohio. Local officials use information collected in their mitigation plans to complete the hazard analysis summary screen in SHARPP. Collecting the information in a standardized format will allow the state to analyze risk statewide based on local risk assessments.

Many local plans also contain estimates of the potential dollar losses to vulnerable structures. Vulnerability analysis information can be entered into SHARPP as part of the local mitigation plan upload process. Summarizing local HIRA information in a standardized format allows the state to analyze vulnerability and potential loss to structures based on local risk assessments.

Since many of the plans currently in SHARPP were entered by the contractor who developed the application, many communities have not populated their initial HIRA summary. As the Mitigation Branch provides training to local officials on how to use SHARPP, and local mitigation plans are updated and uploaded, a HIRA summary will be completed for each plan in SHARPP.

Link to State Mitigation Strategy. Because the state mitigation strategy is a global view, objectives and actions may be of a different nature than those found in LHMPs. However, the goals in the state mitigation strategy reflect and are complimentary to LHMP goals. LHMP goals/objectives/actions are useful to identify trends, needs, and do have a bearing in the development of state mitigation strategy goals and action items. For example, Goal 2, Objective 2 in the state mitigation strategy, which is to develop web pages and information on mitigation for the business community, is proposed based on the large number of LHMPs that have identified this as an objective / action. Carrying out this action will not only have a positive impact on those counties with this identified in their LHMPs but statewide as well. To determine whether or not a particular local objective / action is reflected in the state plan, it is evaluated to determine whether it has statewide applicability and whether it is a need expressed in a large number of LHMPs.

SHARPP has simplified the task of reviewing mitigation action items in LHMPs. Local officials enter information into SHARPP that summarizes the local mitigation action items identified in their jurisdictions mitigation plan. SHARPP captures basic information about the proposed mitigation action including: project lead, cost, potential funding sources, estimated start and end dates. SHARPP can generate a report that summarizes the locally proposed mitigation action items in each community. Analyzing these data will help the state to identify trends, needs, and assist in project identification and development. Local officials can update the status of proposed mitigation action items as they are implemented to help track progress.

LOCAL RISK ASSESSMENT INTEGRATION

INTRODUCTION.
In the 2011 update of the State Hazard Mitigation Plan, Ohio EMA focused on the integration of local mitigation plans in the counties with the highest number of repetitive loss structures as identified by the National Flood Insurance Program. Due to the amount of completed and approved local mitigation plans in Ohio, it would have been an overwhelming task to review and incorporate all of the local plans throughout the state. The Ohio EMA has been able to better incorporate and analyze data from local mitigation plans with the assistance of SHARPP, once the system was ~~is~~ brought online during the second quarter of 2011.

METHODOLOGY.

The Ohio EMA Mitigation Branch examined repetitive flood loss data for all 88 counties and their affected communities. First, data were compiled and analyzed for the top ten communities with the greatest number of repetitive flood loss structures. Then, data were compiled and analyzed for the top ten Ohio counties with the most repetitive flood loss property. In comparison, seven of the ten counties were confirmed to have both a significant amount of repetitive flood loss property on a community level as well as on a county level. These counties were identified as Erie, Hancock, Hamilton, Lake, Lucas, Ottawa and Washington. The remaining counties that were unique to either category were identified as Athens, Belmont, Cuyahoga, Defiance and Putnam. The Mitigation Branch discussed the significance of both categories, counties and jurisdictions, and decided that the focus should be on the top 12 counties with the highest number of repetitive loss structures. The counties are summarized in Table 4.3.a. The Total Amount of Loss in the right-hand column is the summed building and contents payments from the repetitive loss structures.

Table 4.3.a

RANK	COUNTY	REPETITIVE LOSS STRUCTURES	SEVERE REPETITIVE LOSS STRUCTURES	TOTAL AMOUNT OF LOSS
1	Washington	199	5	$ 11,472,270.92
2	Hancock	196	7	$ 13,249,218.53
3	Ottawa	119	0	$ 2,759,044.98
4	Hamilton	114	3	$ 8,574,924.22
5	Cuyahoga	113	6	$ 17,675,563.14
6	Erie	89	4	$ 2,920,412.73
7	Lake	75	4	$ 3,053,624.25
8	Lucas	67	3	$ 2,216,191.19
9	Belmont	57	1	$ 1,917,278.71
10	Athens	52	0	$ 2,872,596.57
11	Defiance	39	4	$ 1,560,430.50
12	Putnam	40	5	$ 2,668,420.67
	TOTAL	**1,160 Structures**	**42 Structures**	**$ 70,939,976.41**

In regards to Table 4.3.a, repetitive loss structures are defined as NFIP-insured structures that have had at least two paid flood losses of more than $1,000 each in any ten-year period of time since 1978. A severe repetitive loss property is defined as a residential property that is covered under an NFIP flood insurance policy and:

a. That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or

b. For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.

The Hazard Mitigation Plans of each focus county was examined to analyze flood vulnerability, which is summarized in Table 4.3.b. When comparing information on the table below, it should be noted that the methodologies used by the Counties vary due to limited access to specific data and changes in planning guidance provided at the time when the plans were originally written. For better comparison, refer to Section 2.2, of this Plan.

Table 4.3.b

Flood Vulnerability Analysis of Ohio Focus Counties								
Rank	**County**	**Residential Structures**	**Commercial & Industrial Structures**	**Critical Structures**	**Total Structures Vulnerable to Flooding**	**Rank of Flood to Other Hazards**	**Loss Estimation for Flooding**	**Methodology Used for Estimation for Flooding**
1	Hancock	2,683	685	13	3,381	1 of 4	$ 176,784,082	County Auditor GIS - Regis
2	Washington	7,264	301	14	7,579	1 of 15	$ 256,600,560	County GIS
3	Cuyahoga	874	249	49	1,172	2 of 5	$ 563,671,300	County Auditor and ODNR GIMS
4	Hamilton	2,377	750	173	3300	(note 1)	$ 422,296,000	Cincinnati Area GIS (CAGIS) and HAZUS
5	Ottawa	4,362	1,606	64	6,032	1 of 10	$ 1,093,705,663	County Auditor GIS
6	Erie	1,068	939	129	2,136	2 of 7	$ 360,209,700[2]	County Auditor
7	Lucas	3,477	236	56	3,846	4 of 10	$ 459,879,800	GIS
8	Lake	20,567	1,214	0	21,781	6 of 17	$ 1,411,891,110	GIS
9	Belmont	10,469	3,552	839	14,860	1 of 13	$ 1,972,291,000	GIS and HAZUS
10	Athens	511	61	278	850	1 of 5	$ 126,701,840	GIS and HAZUS data
11	Defiance	3,854	1,828	155	5,837	2 of 5	$ 1,033,086,000	GIS
12	Putnam	3,380	191	20	3,591	1 of 5	$ 219,598,000	GIS and HAZUS

Notes:

Note 1: Hamilton County has four jurisdictional-specific plans. Each jurisdictional plan ranked flooding as its number 1 natural hazard. However, the number of hazards analyzed in the local plans ranged from three to six. The Hamilton County assumes a 10% loss would produce $42 million in damages to structures.

Note 2: The Erie County Plan does not give estimates for the total value of critical facilities. It should also be noted that numbers of residential and commercial buildings were estimated and multiplied by their average worth to provide estimate total values.

The Hamilton County entry in Table 4.3.b includes aggregated data from four, separate jurisdictional plans from Colerain Township, Delhi Township, the Village of Fairfax and Hamilton County's remaining jurisdictions. Nineteen local hazard plans were reviewed as part of this analysis.

Even though methodologies may differ in vulnerability assessments throughout the Focus Counties, they all show high numbers of structures at risk, which correspond to high amounts of dollars vulnerable to flooding. This conclusion is in line with the conclusions drawn from the HAZUS data in this state hazard mitigation plan.

It should be noted that local hazard mitigation plan developers utilize different approaches and methodologies to examine risk, calculate the number of affected structures and estimate loss. Some counties examined a few structure types while others may have included several. This is due to local variability in the availability of specific data needed for risk and vulnerability assessment and the flexibility provided by the local mitigation plan criteria. This may explain why smaller counties such as Hancock and Ottawa have greater amounts of monetary value for loss estimation rather than Cuyahoga. Some counties, such as Athens County, conducted a thorough assessment of their structures, but have a unique building stock (i.e., Ohio University is located in Athens, Ohio). Below are approaches and methodologies used in the Focus County plans that address these varying loss estimation methodologies:

Washington County Multi-Jurisdictional Hazard Mitigation Plan, January 2005.
After identifying the areas in which the hazards were most prominent, Washington County profiled and positioned the hazards into a Geographic Information System (GIS)-based map. This map contains several themes with information regarding the individual hazards. Within each of the denoted "hazard risk areas," assets (structures, utilities, etc.) were inventoried and loss estimates were calculated for each of the inventoried assets with respect to that particular hazard.

Hancock County Hazard Mitigation Plan, June 1, 2013.
Projections made for the plan used data obtained from the FIRM (Flood Insurance Rate Maps). The digitized FIRM shape files were utilized when quantifying parcel information. An analysis of the County Auditor's parcel information was performed to determine the numbers and types of property parcels and their respective values. These figures were then compared with those parcels determined to be within the flood hazard area. While expanding analysis for this plan update, structures located within the floodplain, floodway, and within 250 ft. of the floodway were identified. Doing this allowed for more of a tiered analysis of damage estimates.

Ottawa County All-Natural Hazard Mitigation Plan, 2004.
Community profiles and loss estimates were prepared by placing 100-year floodplain boundaries on USGS maps. 2000 Census information and local records helped establish the structure numbers and types. Structure values were determined using property tax records from the Ottawa County Auditor's office. These data were used to tabulate the appraised building values for the townships, villages and the City of Port Clinton.

Hamilton County.
There are three jurisdictional plans as well as a countywide plan in Hamilton County:

Colerain Township All Natural Hazards Mitigation Plan, March 2010.
To determine vulnerability, the potential for damage was measured based on historical events. Information from the National Climatic Data Center was used along with historic flood depth data. Other information was obtained from local libraries. Structure numbers, types and values were determined using information from County Auditor files. All sources combined were used to calculate the impact in terms of damage and loss.

Delhi Township. All Natural Hazard Mitigation Plan, June 2005.
The township plan incorporated at-risk structure data generated by the ODNR Floodplain Structure Inventory project. Structures were broken into use categories by comparing the structure inventory to the township zoning map. There are 32 residential at-risk structures: four located along Muddy Creek; three along Rapid Run; and 25 situated along Wulff Run. The remaining six at-risk structures are industrial and are all located along Rapid Run. The median value of housing of $115,400 was used from the 2000 Census. This figure was multiplied by the 32 structures at-risk structures to determine a potential loss of $3,692,800.

Village of Fairfax Multi-Hazard Mitigation Plan, October 2010.
A level 1 HAZUS analysis was performed to incorporate national GIS datasets and US Census data in order to estimate damages resulting from specified storm events. This analysis was performed for the 10%-, 2%-, 1%- and 0.2%-annual-chance flood events. The analysis did not specifically identify impacted structures and was less accurate than FEMA delineated floodplains available for the area, but provided a good estimate of risk and vulnerability.

Natural Hazard Mitigation Plan, Hamilton County, 2013.
The planning team took GIS data provided by The Polis Center, verified the datasets, using local knowledge, and allowed The Polis Center to use its local GIS data for additional verification. Polis GIS

analysts made these updates and corrections to the HAZUS-MH data tables prior to performing the risk assessment. These changes to the HAZUS-MH inventory reflect an enhanced level 1 analysis. This update process improved the accuracy of the model predictions.

Erie County Natural Hazards Mitigation Plan, January 2005.
The value of the property being damaged was determined based on the average value of a facility within that category. Typical values of the structures were determined using data received from the County's Auditor's Office. The contents value was calculated as a percentage of each structure's value in accordance with FEMA guidance documents. Three levels of physical damage were evaluated for each category of structure. Each level had an associated percentage of damage. According to the local plan, the loss estimates for each level may have been underestimated since the methodology does not consider the cost of downtime associated with closing businesses for extended periods of time.

County-wide All-Natural Hazards Mitigation Plan for Cuyahoga County, December 2011.
For the 2011 update, a more precise methodology was used to identify and obtain information regarding the at-risk structures in the County. The at-risk structure data was generated via analyses of the 2010 FEMA Flood Zones for 100-year risk that contain structure points. The structure points represent all "addressable structures" from the 2006 Location Based Response System (LBRS) for Cuyahoga County. Furthermore, 2010 certified property appraisal data were referenced for median home and commercial/industrial values to account for total loss calculations.

Lucas County, Ohio Countywide All Natural Hazards Plan, March 2013.
County planners utilized GIS to map the 100-year floodplains around major rivers in the county, their tributaries and Lake Erie as a base standard. Flood-prone soils were also included in the data. The Lucas County Auditor's parcel data was used to plot at-risk structures in the floodplain for each jurisdiction. Additional parcel information was used to categorize each at-risk structure's type and value on a table per jurisdiction. The results were tallied and displayed on the Countywide Flood Hazard Area Summary by structure usage, number and value in the 100-year floodplain to determine the loss estimate.

Lake County Multi-Jurisdictional Hazards Mitigation Plan, Updated 2010.
To identify areas in which the hazards were most prominent, the county's GIS Department and the Engineer's Office created maps to identify themed "hazard risk areas." Loss estimation was conducted in accordance with FEMA Publication 386-2. Data were taken from asset inventory information according to the county's GIS Department, Auditor's Office, Development Council and Planning Commission. This information was plotted on the floodplain-themed map and used to determine structure types and values on spreadsheets to

estimate loss. Results were tabulated to show the numbers, types and values of structures in the hazard areas.

Athens County Multi-Jurisdictional Hazard Mitigation Plan (Draft), January 2014
Between 2011 and 2014, Athens County combined several separate plans into one consolidated local hazard mitigation plan. In their revised plan, Athens County compared estimated losses from previous county and jurisdictional plans with estimates generated from HAZUS-MH and GIS systems. The results remained virtually the same with 850 structures valued at a $54,113,915 in the 100-year floodplain. It was noted there was a slight difference in population change in the floodplain areas.

Belmont County Hazard Mitigation Plan, July 2013.
The method used in determining the types and numbers of potential assets exposed to flooding was conducted using the loss estimation model, HAZUS-MH. For the Plan update, a 100-year flood scenario was modeled and the results are presented below. The information that was gathered in the asset inventory stage of the risk assessment was used to determine the estimated losses. A projected loss of 14,860 structures valued at a total of $1,972,291,000 would occur in the 100-year floodplain. I

Natural Hazards Mitigation Plan Defiance County, September 2012.
The Ohio State University Extension utilized HAZUS-MH to identify at-risk structures throughout county. Defiance County has identified 5,837 structures with a value of $1,033,086,000 in the 100-year floodplain.

Putnam County Natural Hazard Plan, 2005.
After identifying the areas in which the hazards were most prominent, local officials utilized GIS to create a multi-themed map identifying these “hazard risk areas.” Within each of the denoted “hazard risk areas,” assets (structures, utilities, etc.) were inventoried and loss estimates were calculated with respect to each hazard.

CONNECTION WITH THE STATE PLAN

In the local risk assessment integration analysis, potential losses were reviewed. It was difficult to compare each of the counties’ potential losses because there is no requirement for a standardized plan template. Therefore, each county had the liberty to use its own methodology and approaches for determining potential loss. As a whole, the local plans list flooding as their number one hazard, which corresponds well with the state’s ranking. There are some dissimilarities, but those may be due to the limited number of significant events those communities had sustained prior to writing or updating their local mitigation plans.

It should be noted that the Focus Counties fill the majority of the top quartile of all counties with repetitive loss structures. Within the twelve counties, six are located

in Region 1, three are located in Region 2 and three are located in Region 3 of the state. These numbers of counties coincide with the NFIP loss data per region found in the state HIRA.

As part of the State mitigation strategy, Goal #4 includes the elimination of repetitive loss flood-prone structures. One of the three objectives under this Goal is to prioritize repetitive loss properties for available funds from FEMA mitigation programs. As opportunities for mitigation funding have developed, Ohio has worked with local jurisdictions, counties and FEMA to address repetitive loss and other issues to reduce loss or disaster impact.

Table 4.3.c

COUNTY	NUMBER OF FLOOD MITIGATION PROJECTS	NUMBER OF MITIGATED STRUCTURES	NUMBER OF RFC	NUMBER OF SRL	NUMBER OF ELEVATED STRUCTURES	NUMBER OF RETROFITTED STRUCTURES	NUMBER OF ACQUIRED STRUCTURES	PROJECT FUNDING TOTAL	NUMBER OF REMAINING PROPERTIES IN OPEN PROJECTS
Washington	3	10	1	0	0	0	10	403,260.00	0
Hancock	4	43	19	1	0	0	43	4,395,042.00	14
Ottawa	3	12	2	0	12	0	0	693,411.00	0
Hamilton	7	80	2	0	0	16	64	5,396,933.00	2
Erie	0	0	0	0	0	0	0	0.00	0
Cuyahoga	5	15	6	1	9	0	6	4,279,100.00	24
Lucas	2	15	1	0	0	0	15	734,595.00	0
Lake	3	42	0	0	0	0	42	7,214,319.00	38
Athens	4	62	6	0	1	6	55	2,927,073.00	0
Belmont	1	36	0	0	0	0	36	1,239,869.00	0
Defiance	0	0	0	0	0	0	0	0.00	0
Putnam	4	39	1	0	0	0	39	1,672,288.00	0
TOTALS:	**36**	**354**	**38**	**2**	**22**	**22**	**310**	**28,955,890.00**	**78**

Assumptions:
Chart reflects structures that have been mitigated as of April 16, 2014.
Project Funding Total column for completed projects = Final Project Cost.
Project Funding Total column for open projects = Total awarded amount with number of remaining properties to be mitigated listed in last column.

Records from closed mitigation projects in Ohio indicate that there have been over 900 structures mitigated in the state. As shown in Table 4.3.c, over 39% of these structures are located in the Focus Counties with an average of about $82,000 invested in mitigation actions per structure. Approximately 88% of the structures in the Focus Counties are acquisition projects and about 12% are identified Repetitive Loss or Severe Repetitive Loss structures. This aligns with the state mitigation strategy of prioritizing acquisitions and concentrating efforts on mitigating repetitive loss structures. Ohio's record of successfully mitigating these structures helps the state reach the goal of minimizing societal disruption and damage to property from hazard events (Goal 2, Objective 3).

Ohio continues to be very active in accomplishing the objectives set forth in the mitigation strategy regarding repetitive loss structures. Still, there are counties where there have been few or no mitigated repetitive loss structures. Ultimately, mitigation occurs at the local level. There are many valid reasons why a particular community has not yet addressed identified repetitive loss structures including: lack of property owner interest, the targeted structure cannot meet benefit-cost analysis requirements, lack of grant match dollars, etc. As demonstrated by the number of successful mitigation projects in the Focus Counties, the Ohio EMA Mitigation Branch is committed to working with Ohio communities to overcome these obstacles and support local mitigation efforts.

The State of Ohio strives to promote sustainable communities and development (Goal #2, Objective 4). The ODNR Floodplain Management Program's effort to promote sound floodplain management statewide is one example of the state's commitment. Ohio EMA's promotion of mitigation planning through SHARPP also demonstrates the state's commitment to promoting community sustainability principles.

The mitigation priorities identified in the State Hazard Mitigation Plan align well with the identified risk in the state. In partnership with the Federal government and local communities, the State of Ohio will continue to develop, implement and administer mitigation grant programs that reduce risk to repetitive loss properties. These mitigation planning and project activities will continue to decrease the burden of repetitively flood damaged structures on the Disaster Relief Fund and the National Flood Insurance Fund.

4.4 PRIORITIZING LOCAL MITIGATION FUNDING ASSISTANCE

44 CFR 201.4(c)(4)(iii) requires states to include criteria in their mitigation plans for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs. The criteria should include consideration for communities with the highest risks, repetitive loss properties, and most intense development pressures. The plan also needs to include a principal criterion for non-planning grants based on the extent to which benefits are maximized according to a benefit-cost review.

Demand for hazard mitigation funds usually exceeds fund availability. In the last four flood-related Presidential Declarations, available Federal mitigation funds have only met 19% of the demand on average. (DR-1805 was not listed due to the hazard was a windstorm event and also, pre-applications were not required.)

Table 4.4.a

EVENT	HMGP FUNDS REQUESTED	HMGP FUNDS AVAILABLE (FED)	DIFFERENCE
DR-1651	$15,191,356	$1,798,019	-$13,393,337 (-88%)
DR-1656	$18,166,108	$3,411,736	-$14,754,372 (-81%)
DR-1720	$44,888,432	$6,630,799	-$38,251,633 (-85%)
DR-4002	$15,287,118	$4,881,818 (Projected)	-$10,405,300 (-68%)
DR-4077	$16,723,428	$3,353,199	-$13,370,229 (-79%)
DR-4098	$14,077,947	$3,704,581	-$10,373,366 (-73%)

Therefore, it is important that the State of Ohio prioritize local mitigation funding assistance. Section 3.4 explains how Ohio has established both eligibility and prioritization criteria. Appendix G includes the worksheets the SHMT uses to rank project and planning applications for funding. **The final project ranking by the SHMT is also the prioritization of eligible projects for funding.** The exceptions to this are under HMGP where 5% and 7% projects are funded outside of the SHMT ranking process. Projects submitted under these categories are funded in accordance with the specific priority outlined in the Administrative Plan and Mitigation Strategy for that particular event.

In the event that there is not enough funding for an eligible, high-ranking mitigation project, Mitigation Branch staff will work with the subapplicant to refine and submit the project for consideration under another grant funding cycle or program.

Although Federal planning guidance indicates criteria for local mitigation funding assistance should include consideration for communities with the highest risks, repetitive loss properties, communities with the most intense development pressures, and maximizing benefits based on a benefit-cost analysis; Ohio only considers repetitive loss and benefit-cost. For the nationally competitive grant

programs, state criteria match the national ranking and evaluation criteria exactly. Doing otherwise would put Ohio projects at a competitive disadvantage as compared to other projects that used the national criteria. For HMGP and FMA, repetitive loss is considered as is benefit-cost; however, communities with the highest risks and high development pressures are not. The reason for this is that it is assumed that almost all Ohio communities have high risk from the most serious hazards and mitigation projects are used to remedy the “already built” environment, not the developing environment, which is much better handled through appropriate codes and land use measures.

Grant applications to update LHMPs are evaluated based on program criteria. The SHMT considers local plan expiration dates and whether or not the jurisdiction has updated information in SHARPP when prioritizing funding.

4.5 ASSESSMENT OF MITIGATION ACTIONS

Mitigation actions identified in both the SHMP and LHMPs are tracked and assessed. For the state plan, tracking and assessment of state goals, objectives, and actions will be done in accordance with the Section 1.5 after each Federal disaster declaration, on an annual basis, and at the next three-year update point.

For mitigation actions in LHMPs, tracking and assessment is done in SHARPP (see Appendix J). Local officials enter information into SHARPP that summarizes the local mitigation action items identified in their jurisdictions mitigation plan. SHARPP captures basic information about the proposed mitigation action including: project lead, cost, potential funding sources, estimated start and end dates. SHARPP can generate a report that summarizes the locally proposed mitigation action items in each community. Action items that can be mapped are displayed in the SHARPP mapping system as an Area of Mitigation Interest.

Local officials can update the status of these action items as they are implemented to help track progress. The status of mitigation action items are recorded in SHARPP as: new, unchanged, deferred, deleted, or completed. These data are analyzed to help establish trends, identify needs, and develop success stories.

SHARPP helps the state demonstrate that mitigation projects are investments that improve community sustainability. The SHARPP home page displays the aggregate losses avoided (benefits) by implementing flood mitigation projects in the state since 2004. SHARPP automatically calculates this figure based on the expected annual benefits (i.e. losses avoided) for each mitigated structure as computed by FEMA benefit-cost analysis software at the time of project application. The expected annual benefits are multiplied by the number of years that the project has been closed (up to the “useful life” of the project) and then totaled for all structures to produce a dollar estimate of the losses avoided to date.

SHARPP will also help to quantify the “actual” costs avoided by implementing flood mitigation projects in the state. In order to calculate the actual costs avoided, a flood must occur in an area where a mitigation project has been implemented. One methodology for quantifying the actual costs avoided is outlined in the FEMA December 2009 publication titled, *Loss Avoidance Study, Riverine Methodology Report*. Using this methodology, actual losses avoided are estimated by comparing damage that would likely have been caused by the same flood events without the mitigation project, with damage that actually occurred with the project completed. In order to estimate the actual losses avoided as the result of implementing a particular mitigation project, data are needed on the pre- and post-conditions of the subject property, in addition to other data collected throughout the project. All of the project-specific data required as input for a loss avoidance study are collected through SHARPP.

Loss avoidance studies will be conducted for past mitigation project implemented in Ohio dependent on:

- A large event occurring in a past mitigation project area that justifies the resources required to conduct a loss avoidance study,
- The availability of the data required to conduct a loss avoidance study in the project area, and
- The availability of 5% HMGP funds, HMA State Management Cost funds, or another funding source to pay for the study.

The Ohio EMA Mitigation Branch contains a page that highlights success stories and best practices (http://www.ema.ohio.gov/Mitigation_BestPractices.aspx). This web page highlights successful mitigation projects in sixteen different communities in the state. The success stories cover a range of mitigation project types that have been implemented across the state to reduce flood risk.

Mitigation Branch staff document losses avoided as the result of previous mitigation measures by implementing the following process:

- Utilize information in SHARPP to determine if a mitigation project has occurred in an area impacted by a hazard event.
- If yes, contact local officials to request information on the effectiveness of the mitigation project and the impact of the event in the project area.
- Meet with local officials to conduct an interview and gather information (photos, high water marks, and historic damage data).
- Develop and publish a success story based on the information collected. Promote the success story statewide to encourage mitigation measures that will reduce future disaster losses.

SECTION 2:
HAZARD IDENTIFICATION & RISK ASSESSMENT

2.1 HIRA OVERVIEW & HAZARD IDENTIFICATION SUMMARY

The State of Ohio is prone to many natural and manmade hazards. Ohio has experienced thousands of hazard events, resulting in millions of dollars in losses and casualties, and 50 Presidential disaster declarations. In 2003 as part of an overall effort to reduce future exposure to damages and meet the planning requirements of the DMA 2000, the State of Ohio began the development of the initial Hazard Identification and Risk Assessment (HIRA). The HIRA has been subsequently reviewed and approved for the 2008, 2011 and 2014 plan updates.

This section will cover six separate requirements of the 44 CFR 201.4 (identifying hazards, profiling hazard events, assessing vulnerability by jurisdiction, estimating potential losses by jurisdiction, assessing vulnerability of state facilities, and estimating potential losses of state facilities). The first four of the six requirements are integrated into each hazard for which is detailed. The last two (state facility vulnerability assessment and loss estimation) are discussed in this section, but specifics are integrated into each hazard. The following will provide a more in-depth explanation of these six elements and describe the steps taken to ensure each element was met.

Identifying Hazards

The 44 CFR 201.4 (c)(2)(i) requires the risk assessment include an overview of the type of all natural hazards that can affect the state. This section of the plan presents a list of potential hazards that may likely impact the state. Due to the states northern geographical setting on Lake Erie, it is vulnerable to a wide array of hazards that threaten its communities, businesses, governments and environment. To determine the hazards that pose the greatest threat to the state, the OMPAT (in conjunction with FEMA) developed a list of potential hazards by conducting a review of several key resources, which include:

- Historical data on events that have occurred in the last 50 years;
- 2003, 2008, 2011 and 2014 plan data;
- Collaboration with various agencies who are known “experts” on different hazards, including the Ohio Departments of Natural Resources, Transportation and Environmental Protection Agency;
- Hazards identified in guidance materials provided by FEMA – Region V; and
- Local hazard mitigation plans. Ohio currently has 41 approved single and multi-jurisdictional plans with 39 in progress and 16 expired plans. Additionally, eight jurisdictions are scheduled to be participants in county plan revision efforts and will no longer have stand-alone plans. The approved plans were used to assess the impacts hazards are having throughout the state.

Risk Assessment

44 CFR 201.4 (c)(2)(i) – "The risk assessment shall include an overview of the location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate."

The risk assessment section for each hazard includes a description of the location of the hazard, past occurrences, and a discussion of probability of future hazard events. The risk assessment relies upon information about past hazard events from published sources such as NOAA, USGS, USACE, Ohio EMA and ODNR, among other agencies.

Vulnerability Analysis by Jurisdiction

44 CFR 201.4 (c)(2)(ii) – The risk assessment shall include "an overview and analysis of the state's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments. The state shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events."

The methodology for the vulnerability section varies by hazard due to available data, and will be more thoroughly discussed prior to the results section for each hazard.

Improved integration of LHMP data into the state HIRA is an ongoing effort. By April 2010, all counties in the state had a mitigation plan. As local plans start to expire and jurisdictions update their plans, they are collecting updated vulnerability information and loss estimation data in the process. Where available, these local hazard data have been evaluated and incorporated into this enhanced plan, as necessary.

The State Hazard Analysis Resource and Planning Portal (SHARPP) was launched "live" in July 2012, and allows Ohio EMA to electronically track and evaluate hazard metrics and impact to residential, commercial and critical building stock, as well as evaluate damage estimates. Following state-provided training seminars and technical assistance, many of the counties uploaded their local HIRA data into SHARPP. Given local resource limitations and local priorities, some counties have yet to upload their data. However, several of the counties in the state have uploaded their hazard data into SHARPP and that information analyzed in this enhanced plan. As mentioned earlier, local hazard mitigation plans are continually being updated around the state. As these plans are updated, they will be uploaded into SHARPP and their corresponding HIRA data will entered as well. More details regarding the local HIRA data evaluated in this plan can be found within each hazard section and in Appendix J.

Estimating Potential Losses by Jurisdiction

44 CFR 201.4 (c)(2)(iii) – The risk assessment shall include "an overview and analysis of potential losses to identified structures, based on estimates provided in local risk assessments."

The methodology for this section varies by hazard due to available data, and will be more thoroughly discussed prior to the results section for each hazard.

Similar to the requirement to utilize vulnerability analysis information from LHMPs, data are incorporated using methods and input as stated in the Vulnerability Analysis section described above. Each jurisdiction's plan utilizes a formal approach to determine losses that can be expected from different hazard scenarios. For purposes of identification, this section of the plan categorizes loss estimates by hazard and provides an example of how an LHMP performed an in-depth analysis. It should be noted that this analysis of LHMPs is a summary of some good practices.

Many counties have uploaded their potential loss data into SHARPP, which are analyzed as appropriate in each hazard section of this plan. Given local resource limitations and local priorities, some counties have yet to upload their data. As mentioned earlier, local hazard mitigation plans are continually being updated around the state. As these plans are updated, they will be uploaded into SHARPP and their corresponding HIRA data will entered as well. More details regarding the local HIRA data evaluated in this plan can be found within each hazard section and in Appendix J. Future updates to the SOHMP will continue to spotlight data entered into SHARPP that depict risk and vulnerabilities from natural hazards.

Assessing Vulnerability of State Facilities

44 CFR 201.4 (c)(2)(ii) – The risk assessment shall include "an overview and analysis of the state's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments. State-owned or operated critical facilities located in the identified hazard areas shall be addressed."

The methodology for this section varies by hazard due to available data and their attributes, and is more thoroughly discussed below.

The State of Ohio Department of Administrative Services (DAS) (Risk Management Section) currently maintains a listing of state-owned and state-leased facilities. Both the state-owned and state-leased facility datasets are attributed and contain a geo-referenced point for each facility. These data include facilities ranging from small salt buildings owned by the Department of Transportation (ODOT) to multi-story office buildings owned by DAS. While the previous state plans only evaluated structures whose values exceeded $1 million, this plan evaluates all state-owned structures as many facilities crucial to response are worth much less than $1 million. Additionally, the state leases nearly 300 facilities around the state, and a significant percentage of those are

critical in nature. Therefore, it was deemed necessary to evaluate all state-owned and state-leased structures, and parse out those that are critical in nature.

A *critical* facility is defined as any facility whose services are necessary to the response and/or recovery operations following a disaster. Such facilities include (but are not limited to) administration office buildings, transportation facilities, highway patrol posts, armories, radio antenna towers etc. Also, numerous facilities exist at correctional institute complexes that are used for sheltering purposes immediately following a disaster, and such facilities include structures appurtenant and necessary to their function.

The state-owned and state-leased datasets are sufficient for vulnerability assessments, as all state-owned data include estimated values for replacement and all state-leased data include annual rent totals. However, assumptions made for vulnerability using these datasets must be fairly general since additional attributed information is not complete. Many of the data include year of construction, construction type, square footage, number of stories, etc. However, not all data include these pieces of information since the data were compiled through multi-agency efforts. As these data are refined and become more complete in the future, updates will be made to the methodologies used here for vulnerability assessments.

An additional dataset was acquired from the National Geospatial-Intelligence Agency in cooperation with FEMA. During DR-4002 recovery efforts, Ohio EMA worked with FEMA to gain access to the Homeland Security Infrastructure Program (HSIP) Gold Dataset 2011. These data are the products of collaborative efforts of various stakeholders in the Defense, Intelligence, and Homeland Security Communities. The data provide national critical infrastructure sectors as defined by Homeland Security. Much of the data are populated in major metropolitan areas, but gaps exist between highly populated areas. Additionally, replacement costs are not provided for various facilities, limiting the discussion on vulnerability in terms of dollars. These data are used to supplement the data obtained from DAS, especially for non-geographic hazards.

Estimating Potential Losses of State Facilities

44 CFR 201.4 (c)(2)(iii) – The risk assessment shall include “an overview and analysis of potential losses to identified structures, based on estimates provided in local risk assessments. The state shall estimate the potential dollar losses to state-owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.”

As mentioned above, the state-owned and state-leased datasets are sufficient for loss estimations, as all state-owned data include estimated values for replacement and all state-leased data include annual rent totals. However, assumptions made for losses using these datasets must be fairly general since additional attributed information is not complete. Many of the data include year of construction, construction type, square footage, number of stories, etc. However, not all data include these pieces of information since the data were

compiled through multi-agency efforts. As these data are refined and become more complete in the future, updates will be made to the methodologies used here for loss estimations.

A summary of the state-owned and state-leased facilities by county and agency is provided in Appendix C. It should be noted that facility specifics (*i.e.*, facility name, location, *etc.*) are not listed in this plan due to increased security. Further information can be obtained from Ohio DAS on said data.

Tables 2.1.a – 2.1.c list state-owned critical and non-critical facility numbers and replacement values within each county. Currently, there are a total of 4,456 state-owned facilities (2,343 critical and 2,113 non-critical) throughout Ohio worth an estimated $4.3 billion. For Region 1 there are 906 critical and 635 non-critical worth approximately $845 million and $354 million, respectively. The county with the largest dollar exposure of state-owned facilities is Marion with $421,369,273, mostly related to a large correctional facility. Marion County also has the highest dollar exposure of critical facilities at $368 million.

Presently, there are a total of 1,709 (900 critical and 809 non-critical) state-owned facilities in Region 2, worth an estimated $2.4 billion. The estimated worth for the critical facilities is over $1.5 billion, and non-critical is over $930 million. As would be expected, Franklin County, which contains the state capital, represents the majority of the dollar value with $994 million in state-owned facilities that include 99 critical in nature, worth approximately $675.5 million.

The lowest total number (1,206) of state-owned facilities is located in Region 3, representing over $633 million. The estimated worth for critical facilities is nearly one-fifth of that in Region 2 ($389 million), and $273 million in non-critical facilities. Ross County accounts for nearly one third of the dollars at risk ($137 million) in the entire Region, which is mainly due to a large correctional facility.

Tables 2.1.d – 2.1.f list state-leased critical and non-critical facility numbers and their respective annual rental costs within each county. Currently, there is a total of 296 state facilities that are leased annually, of which 30 are critical to response and recovery following a disaster. For Region 1, there are three critical and 39 non-critical with approximately $654,528 and $2,851,641 in annual rent, respectively. Region 2 has 24 critical and 168 non-critical leases with annual rental costs of $7,841,431 and $43,721,216, respectively. In Region 3 numbers are similar to those in Region 1 with three state-leased critical facilities ($476,832) and 59 state-leased non-critical facilities ($3,063,305).

UPDATE SUMMARY

The 2003 HIRA identified a comprehensive list of hazards, both manmade and natural, but only included detailed risk assessments and vulnerability analyses for five hazards. Further updates in 2008 and 2011 included risk assessments/vulnerability analyses on all 12 natural hazards, and one technological hazard (dam/levee failure). Developing these data was a collaborative process involving several state and Federal agencies who are deemed to be the “experts” in their particular hazard(s). For the 2012 enhanced

plan, the existing analyses were reviewed for accuracy and data currency. Based on the review it was determined that the following major updates be made:

- Tornado data and loss estimations were updated with 2010 census data and 2011 hazard analyses;
- Hazard identification data from SHARPP were incorporated into the discussion for each hazard
- Vulnerability analyses were completed for all hazards with regard to state-owned and state-leased facilities (critical and non-critical);
- The Dam/Levee Failures section was rewritten to incorporate a state-maintained dam inventory and dam priority list. Also, levee inventories from the State and FEMA were combined and evaluated. Vulnerability analyses were conducted for all inundation mapping received from the USACE.
- 2010 census data and National Urban Change Indicator data were analyzed and incorporated into “Future Growth and Potential Risk Areas” (Section 2.15).
- Section 2.15 has been updated to include information addressing the Ohio Balanced Growth Initiative, hydraulic fracturing and the impacts of climate change.

Table 2.1.a

Region 1 State-Owned Critical and Non-Critical Facilities						
County	**Number of State-Owned Critical Facilities**	**Replacement Value of Critical Facilities**	**Number State-Owned Non-Crit. Facilities**	**Replacement Value of Non-Crit. Facilities**	**Total Number State-Owned Facilities**	**Replacement Value of All State-Owned Facilities**
Allen	87	$129,644,317	51	$17,589,855	138	$147,234,172
Auglaize	22	$4,306,792	11	$3,065,702	33	$7,372,494
Champaign	27	$4,698,459	7	$385,650	34	$5,084,109
Clark	41	$6,604,768	44	$6,594,661	85	$13,199,429
Clinton	9	$4,122,099	16	$1,958,400	25	$6,080,499
Crawford	15	$3,436,499	0	$0	15	$3,436,499
Darke	31	$4,098,855	2	$12,776	33	$4,111,630
Defiance	9	$2,484,068	2	$247,860	11	$2,731,928
Erie	19	$4,126,904	54	$109,901,141	73	$114,028,045
Fayette	14	$2,027,534	6	$402,900	20	$2,430,434
Fulton	14	$1,311,246	1	$51,000	15	$1,362,246
Hancock	18	$7,481,547	8	$1,351,500	26	$8,833,047
Hardin	11	$1,236,823	1	$5,500	12	$1,242,323
Henry	16	$2,139,685	12	$7,251,968	28	$9,391,653
Huron	15	$2,270,434	0	$0	15	$2,270,434
Logan	36	$4,056,192	5	$612,000	41	$4,668,192
Lucas	21	$79,831,356	50	$63,404,099	71	$143,235,456
Madison	73	$70,334,729	81	$20,016,930	154	$90,351,659
Marion	71	$368,616,129	82	$52,753,143	153	$421,369,273
Mercer	27	$3,365,812	1	$366,365	28	$3,732,177
Miami	24	$7,551,858	16	$1,300,222	40	$8,852,080
Morrow	9	$659,529	11	$1,646,280	20	$2,305,809
Ottawa	91	$35,749,476	53	$7,611,680	144	$43,361,155
Paulding	13	$1,446,227	0	$0	13	$1,446,227
Preble	3	$990,179	5	$15,686,860	8	$16,677,039
Putnam	18	$1,379,385	2	$100,000	20	$1,479,385
Sandusky	10	$1,187,463	17	$8,854,154	27	$10,041,617
Seneca	21	$3,786,742	39	$19,210,641	60	$22,997,383
Shelby	24	$10,118,878	2	$306,000	26	$10,424,878
Union	31	$50,301,698	20	$10,374,207	51	$60,675,905
Van Wert	17	$2,177,611	1	$21,165	18	$2,198,776
Williams	14	$2,762,168	13	$1,695,193	27	$4,457,361
Wood	38	$13,105,858	15	$1,412,194	53	$14,518,052
Wyandot	17	$8,118,160	7	$565,386	24	$8,683,546
REGIONAL TOTALS	**906**	**$845,529,480**	**635**	**$354,755,432**	**1,541**	**$1,200,284,912**

Table 2.1.b

Region 2 State-Owned Critical and Non-Critical Facilities						
County	**Number of State-Owned Critical Facilities**	**Replacement Value of Critical Facilities**	**Number State-Owned Non-Crit. Facilities**	**Replacement Value of Non-Crit. Facilities**	**Total Number State-Owned Facilities**	**Replacement Value of All State-Owned Facilities**
Ashland	37	$40,911,576	59	$30,237,420	96	$71,148,996
Ashtabula	68	$36,672,165	23	$4,399,911	91	$41,072,076
Butler	6	$5,677,384	2	$1,400,000	8	$7,077,384
Cuyahoga	51	$19,815,718	39	$57,101,659	90	$76,917,378
Delaware	37	$13,687,947	41	$34,864,515	78	$48,552,463
Fairfield	25	$14,201,092	29	$14,582,043	54	$28,783,134
Franklin	99	$675,509,073	134	$318,826,198	233	$994,335,271
Geauga	15	$3,749,863	43	$6,585,511	58	$10,335,374
Greene	6	$1,647,613	8	$5,291,719	14	$6,939,332
Hamilton	8	$4,955,507	20	$133,397,979	28	$138,353,486
Knox	11	$2,310,567	25	$21,921,501	36	$24,232,068
Lake	15	$3,150,402	4	$503,069	19	$3,653,471
Licking	43	$49,443,301	25	$3,826,107	68	$53,269,408
Lorain	51	$167,396,177	42	$5,956,786	93	$173,352,963
Mahoning	32	$58,580,595	15	$14,175,788	47	$72,756,384
Medina	9	$2,232,067	3	$93,636	12	$2,325,703
Montgomery	59	$32,116,440	38	$49,964,155	97	$82,080,596
Pickaway	61	$146,855,378	90	$46,384,581	151	$193,239,958
Portage	45	$11,207,858	12	$2,089,226	57	$13,297,083
Richland	22	$100,028,878	30	$18,652,194	52	$118,681,072
Stark	18	$8,056,936	9	$51,394,959	27	$59,451,895
Summit	48	$46,370,195	15	$48,131,178	63	$94,501,373
Trumbull	46	$28,726,632	22	$12,032,218	68	$40,758,850
Warren	71	$67,359,537	66	$26,480,686	137	$93,840,222
Wayne	17	$3,033,309	15	$22,317,824	32	$25,351,133
REGIONAL TOTALS	**900**	**$1,543,696,210**	**809**	**$930,610,863**	**1,709**	**$2,474,307,073**

Table 2.1.c

Region 3 State-Owned Critical and Non-Critical Facilities						
County	**Number of State-Owned Critical Facilities**	**Replacement Value of Critical Facilities**	**Number State-Owned Non-Crit. Facilities**	**Replacement Value of Non-Crit. Facilities**	**Total Number State-Owned Facilities**	**Replacement Value of All State-Owned Facilities**
Adams	11	$1,103,231	1	$765	12	$1,103,996
Athens	21	$14,665,205	10	$12,525,127	31	$27,190,332
Belmont	37	$48,194,651	5	$4,675,493	42	$52,870,144
Brown	13	$2,699,466	4	$16,869,649	17	$19,569,114
Carroll	12	$937,951	1	$387,033	13	$1,324,984
Clermont	5	$976,905	21	$10,417,513	26	$11,394,418
Columbiana	27	$3,605,208	5	$2,007,850	32	$5,613,058
Coshocton	15	$2,303,289	4	$478,282	19	$2,781,571
Gallia	7	$2,262,639	43	$21,776,188	50	$24,038,827
Guernsey	20	$5,445,827	98	$69,748,028	118	$75,193,855
Harrison	13	$1,341,875	2	$22,695	15	$1,364,570
Highland	9	$1,287,194	21	$3,145,622	30	$4,432,817
Hocking	12	$10,871,404	66	$8,637,471	78	$19,508,875
Holmes	14	$1,012,866	0	$0	14	$1,012,866
Jackson	9	$3,018,885	4	$275,400	13	$3,294,285
Jefferson	25	$2,991,311	1	$510,000	26	$3,501,311
Lawrence	19	$1,937,552	0	$0	19	$1,937,552
Meigs	15	$2,207,382	2	$145,860	17	$2,353,242
Monroe	9	$1,269,631	0	$0	9	$1,269,631
Morgan	8	$795,407	38	$6,172,377	46	$6,967,784
Muskingum	21	$2,316,961	31	$3,995,784	52	$6,312,746
Noble	22	$45,956,237	5	$6,339,333	27	$52,295,570
Perry	7	$1,075,760	2	$541,930	9	$1,617,691
Pike	8	$882,134	28	$2,012,460	36	$2,894,594
Ross	60	$137,240,093	94	$50,149,531	154	$187,389,623
Scioto	23	$59,447,289	87	$34,673,691	110	$94,120,979
Tuscarawas	54	$24,497,535	53	$6,183,531	107	$30,681,066
Vinton	9	$1,227,839	21	$2,736,660	30	$3,964,499
Washington	32	$8,161,858	22	$9,433,783	54	$17,595,641
REGIONAL TOTALS	**537**	**$389,733,587**	**669**	**$273,862,055**	**1,206**	**$663,595,642**

Table 2.1.d

Region 1 State-Leased Critical and Non-Critical Facilities						
County	**Number of State-Leased Critical Facilities**	**Annual Rent of Critical Facilities**	**Number State-Leased Non-Crit. Facilities**	**Annual Rent of Non-Critical Facilities**	**Total Number State-Leased Facilities**	**Annual Rent of All State-Leased Facilities**
Allen	0	$0	4	$584,976	4	$584,976
Auglaize	0	$0	2	$20,388	2	$20,388
Champaign	0	$0	1	$3,096	1	$3,096
Clark	0	$0	2	$315,744	2	$315,744
Clinton	0	$0	0	$0	0	$0
Crawford	0	$0	0	$0	0	$0
Darke	0	$0	0	$0	0	$0
Defiance	0	$0	3	$124,932	3	$124,932
Erie	0	$0	4	$226,683	4	$226,683
Fayette	0	$0	0	$0	0	$0
Fulton	0	$0	0	$0	0	$0
Hancock	1	$40,788	1	$72,000	2	$112,788
Hardin	0	$0	0	$0	0	$0
Henry	0	$0	0	$0	0	$0
Huron	0	$0	2	$25,536	2	$25,536
Logan	0	$0	0	$0	0	$0
Lucas	1	$23,136	4	$569,010	5	$592,146
Madison	0	$0	2	$60,000	2	$60,000
Marion	0	$0	0	$0	0	$0
Mercer	0	$0	0	$0	0	$0
Miami	0	$0	1	$19,932	1	$19,932
Morrow	0	$0	0	$0	0	$0
Ottawa	0	$0	1	$504	1	$504
Paulding	0	$0	0	$0	0	$0
Preble	0	$0	0	$0	0	$0
Putnam	0	$0	1	$12,384	1	$12,384
Sandusky	0	$0	2	$109,656	2	$109,656
Seneca	0	$0	3	$203,820	3	$203,820
Shelby	0	$0	1	$123,684	1	$123,684
Union	0	$0	1	$14,760	1	$14,760
Van Wert	0	$0	1	$2,292	1	$2,292
Williams	0	$0	0	$0	0	$0
Wood	1	$590,604	3	$362,244	4	$952,848
Wyandot	0	$0	0	$0	0	$0
REGIONAL TOTALS	**3**	**$654,528**	**39**	**$2,851,641**	**42**	**$3,506,169**

Table 2.1.e

Region 2 State-Leased Critical and Non-Critical Facilities						
County	**Number of State-Leased Critical Facilities**	**Annual Rent of Critical Facilities**	**Number State-Leased Non-Crit. Facilities**	**Annual Rent of Non-Critical Facilities**	**Total Number State-Leased Facilities**	**Annual Rent of All State-Leased Facilities**
Ashland	0	$0	0	$0	0	$0
Ashtabula	0	$0	2	$47,232	2	$47,232
Butler	0	$0	4	$618,876	4	$618,876
Cuyahoga	0	$0	12	$1,882,083	12	$1,882,083
Delaware	0	$0	0	$0	0	$0
Fairfield	0	$0	3	$599,661	3	$599,661
Franklin	14	$6,511,974	72	$30,488,803	86	$37,000,777
Geauga	0	$0	1	$11,400	1	$11,400
Greene	0	$0	1	$48,912	1	$48,912
Hamilton	1	$40,224	16	$3,539,370	17	$3,579,594
Knox	0	$0	1	$2,364	1	$2,364
Lake	0	$0	3	$176,676	3	$176,676
Licking	0	$0	0	$0	0	$0
Lorain	0	$0	4	$444,920	4	$444,920
Mahoning	2	$40,519	10	$1,220,285	12	$1,260,804
Medina	0	$0	2	$44,712	2	$44,712
Montgomery	4	$756,042	14	$1,879,239	18	$2,635,281
Pickaway	0	$0	0	$0	0	$0
Portage	0	$0	0	$0	0	$0
Richland	0	$0	5	$827,256	5	$827,256
Stark	0	$0	7	$1,581,603	7	$1,581,603
Summit	2	$481,956	5	$206,022	7	$687,978
Trumbull	1	$10,716	3	$49,152	4	$59,868
Warren	0	$0	2	$28,974	2	$28,974
Wayne	0	$0	1	$23,676	1	$23,676
REGIONAL TOTALS	**24**	**$7,841,431**	**168**	**$43,721,216**	**192**	**$51,562,647**

Table 2.1.f

Region 3 State-Leased Critical and Non-Critical Facilities						
County	**Number of State-Leased Critical Facilities**	**Annual Rent of Critical Facilities**	**Number State-Leased Non-Crit. Facilities**	**Annual Rent of Non-Critical Facilities**	**Total Number State-Leased Facilities**	**Annual Rent of All State-Leased Facilities**
Adams	0	$0	0	$0	0	$0
Athens	0	$0	7	$494,856	7	$494,856
Belmont	0	$0	6	$362,712	6	$362,712
Brown	0	$0	1	$1,308	1	$1,308
Carroll	0	$0	0	$0	0	$0
Clermont	0	$0	0	$0	0	$0
Columbiana	1	$3,600	0	$0	1	$3,600
Coshocton	0	$0	0	$0	0	$0
Gallia	0	$0	0	$0	0	$0
Guernsey	1	$47,856	9	$575,928	10	$623,784
Harrison	0	$0	0	$0	0	$0
Highland	0	$0	2	$43,164	2	$43,164
Hocking	1	$425,376	2	$160,176	3	$585,552
Holmes	0	$0	0	$0	0	$0
Jackson	0	$0	2	$93,048	2	$93,048
Jefferson	0	$0	1	$21,894	1	$21,894
Lawrence	0	$0	3	$89,568	3	$89,568
Meigs	0	$0	0	$0	0	$0
Monroe	0	$0	0	$0	0	$0
Morgan	0	$0	0	$0	0	$0
Muskingum	0	$0	7	$202,932	7	$202,932
Noble	0	$0	0	$0	0	$0
Perry	0	$0	0	$0	0	$0
Pike	0	$0	2	$11,172	2	$11,172
Ross	0	$0	5	$280,656	5	$280,656
Scioto	0	$0	4	$533,843	4	$533,843
Tuscarawas	0	$0	3	$85,968	3	$85,968
Vinton	0	$0	0	$0	0	$0
Washington	0	$0	5	$106,080	5	$106,080
REGIONAL TOTALS	**3**	**$476,832**	**59**	**$3,063,305**	**62**	**$3,540,137**

HAZARD IDENTIFICATION SUMMARY

The hazards initially evaluated in the SOHMP to determine their potential effects on the state include:

1) Coastal Erosion
2) Droughts
3) Earthquakes
4) Floods
5) Storm Surges
6) Landslides
7) Land Subsidence
8) Natural Biohazards (Invasive species)
9) Severe Thunderstorms
10) Windstorms
11) Hailstorms
12) Severe Winter/Ice Storms
13) Tornadoes
14) Wildfire
15) Tropical Cyclones
16) Snow Avalanches
17) Extreme Summer Weather
18) Expansive Soils
19) Tsunami
20) Volcano
21) Dam Failure
22) HAZMAT
23) Terrorism
24) Urban Fire
25) Nuclear Accidents

The list was more closely examined, paying special attention to the likelihood of future occurrence and the interrelated nature of some of the hazards (i.e., landslides can be a result of flooding). Following this evaluation, the list of hazards was reduced from 24 to 15, retaining those most likely to affect the state and most likely to pose serious threats to lives, property, and/or the local economy.

For the purpose of ranking hazards affecting the state, in order of importance for mitigating their effects, a hazard index was assigned (see Table 2.1.g) on a scale of 1-5, with 5 being the highest priority for considering mitigation goals (highest, high, medium, low, and lowest). This index takes into account the anticipated frequency of occurrence (see Table 2.1.h), the specific consequences of impact (see Table 2.1.i) and if there has been a past declaration for that particular hazard. This is not meant to be a scientific process, but will serve as a way to prioritize mitigation goals based on the potential frequency and likely extent of damage from hazards known to affect the state.

It is important to note that HIRAs are developed for different purposes. For the purposes of emergency planning and similar functions, a document called the *2007 Ohio HIRA* was produced. The *2007 Ohio HIRA* prioritizes hazards utilizing criteria developed to facilitate emergency planning. These criteria include frequency, duration, speed of onset, magnitude, impact on business, impact on people, and impact on property. This method assigns a numerical value to

vulnerability based on the criteria of impacts on businesses, people, and property. The *2007 Ohio HIRA* places more emphasis on life safety issues versus the HIRA performed for the SOHMP which places a similarly high priority on property/facility damage. Also, the *2007 Ohio HIRA* evaluates manmade hazards. These data are valuable as they represent another method to "ground truth" the data in the SOHMP HIRA. The Ohio HIRA has been updated several times since 2007. The most recent version can be found in Appendix I of the SOHMP.

According to the Ohio HIRA, the following are the top ten hazards (ranking score in parenthesis): Riverine Flooding (27.00), Windstorm/tornado (26.25), Flash flood / seiche (23.75), Snow/ice/hail/sleet (23.25), Radiological Incidents (22.25), Disease Human (22.00), Water Control Structure Failure (22.00), Disease – Animal (21.50), building/structure collapse (20.75), and terrorism (20.00). These correspond fairly well with the hazards profiled in the SOHMP HIRA, with the exception of radiological incidents, disease (human and animal), and terrorism (none of which are evaluated in the SOHMP HIRA).

Table 2.1.g

Hazard Index Ranking				
Impact → **Frequency of Occurrence ↓**	**Catastrophic**	**Critical**	**Limited**	**Negligible**
Highly Likely	5 *(Highest)*	4 *(High)*	4 *(High)*	3 *(Medium)*
Likely	5 *(Highest)*	4 *(High)*	3 *(Medium)*	2 *(Low)*
Possible	4 *(High)*	3 *(Medium)*	2 *(Low)*	2 *(Low)*
Unlikely	3 *(Medium)*	2 *(Low)*	1 *(Lowest)*	1 *(Lowest)*
Highly Unlikely	2 *(Low)*	1 *(Lowest)*	1 *(Lowest)*	1 *(Lowest)*

Source: FEMA, 1997

Table 2.1.h

Frequency of Occurrence	
Highly Likely	Near 100 Percent probability in the next year.
Likely	Between 10 and 100 percent probability in the next year, or at least one chance in the next 10 years.
Possible	Between 1 and 10 percent probability in the next year, or at least one chance in the next 100 years.
Unlikely	Less than 1 percent probability in the next year, less than one chance in the next 100 years.
Highly Unlikely	Little to no probability in next 100 years.

Source: FEMA, 1997

Table 2.1.i

Consequences of Impact	
Catastrophic	Multiple Deaths, complete shutdown of facilities for 30 days or more, more than 50 percent of property is severely damaged.
Critical	Multiple severe injuries, complete shutdown of critical facilities for at least 2 weeks, more than 25 percent of property is severely damaged.
Limited	Some injuries, complete shutdown of critical facilities for more than one week, more than 10 percent of property severely damaged.
Negligible	Minor injuries, minimal quality-of-life impact, shutdown of critical facilities and services for 24 hours or less, less than 10 percent of property is severely damaged.

Source: FEMA, 1997

Table 2.1.j

Hazard Ranking Assessment				
Hazard	**Past Federal Declarations**	**Frequency**	**Impact**	**Hazard Ranking**
Natural Hazards				
Coastal Erosion	No	Highly Likely	Negligible	3
Droughts	No	Likely	Negligible	2
Earthquakes	No	Possible	Limited	2
Floods	Yes	Highly Likely	Critical	4
Seiche / Coastal Flooding	No	Likely	Limited	3
Landslides	Yes	Highly Likely	Limited	4
Land Subsidence	No	Possible	Negligible	2
Invasive Species	No	Highly Likely	Limited	4
Severe Thunderstorms	Yes	Highly Likely	Critical	4
Windstorms	Yes	Highly Likely	Critical	4
Hailstorms	No	Likely	Negligible	2
Severe Winter/Ice Storms	Yes	Highly Likely	Critical	4
Tornadoes	Yes	Highly Likely	Critical	4
Wildfire	No	Likely	Limited	3
Tropical Cyclones	No	Unlikely	Negligible	1
Snow Avalanches	No	Highly Unlikely	Negligible	1
Extreme Summer Weather	No	Likely	Negligible	2
Expansive Soils	No	Unlikely	Negligible	1
Tsunami	No	Highly Unlikely	Negligible	1
Volcano	No	Highly Unlikely	Negligible	1
Technological Hazards				
Dam Failure	No	Possible	Critical	3
Hazardous Materials Events	No	Likely	Negligible	2
Terrorism	No	Unlikely	Critical	2
Urban Fire	No	Highly Likely	Negligible	3
Nuclear Accidents	No	Unlikely	Critical	2

Once the hazard ranking was complete an assessment was conducted to narrow the field of hazards (see Table 2.1.j). Several hazards were deleted from the list based on the unlikelihood of occurrence and/or the potential for a negligible impact on the state should they occur. These included tropical cyclones, snow avalanches, extreme summer weather, expansive soils, tsunami events, and volcano events. Other hazards were combined, as many of them are factors in larger hazards (*i.e.*, windstorms are related to tornadoes and hailstorms are usually related to severe summer storms). The final hazard inventory included 15 hazards, which are listed in order of importance below.

- **Flooding** (4) – includes flash flooding and normal riverine flooding. There have been numerous federal and state declarations for this disaster during the past 60 years.

- **Seiche / Coastal Flooding** (4) – this is a geographically specific hazard for areas bordering Lake Erie. There have been no past declarations for this disaster.
- **Tornadoes** (4) – include windstorms. There have been several past declarations for tornadoes and high wind events resulting from severe thunderstorms.
- **Landslides** (4) – include road slips and mudslides. There have been several declarations for this type of disaster many resulting from severe flooding.
- **Winter Storms** (4) – include snowstorms, ice storms and any other winter precipitation. There have been many declarations for this type of disaster.
- **Severe Summer Storms** (4) – these storms have a higher ranking than dam/levee failure because there are many factors associated with severe thunderstorms. In Ohio the primary disaster factors for severe thunderstorms have been flooding, tornadoes, high wind events, and landslides all of which have been addressed separately. Other aspects of severe thunderstorms (hail and lightning) are not as pressing in the overall mitigation process.
- **Invasive Species** (4) – There have been no federal declarations for invasive species to date.
- **Dam / Levee Failure** (3) – Though dam/levee failure is not at the top of the ranking chart, it is still considered an important hazard since it is related to flooding as either a cause or effect.
- **Coastal Erosion** (3) –Erosion from coastal storms and normal Lake Erie fluctuations.
- **Wildfire** (3) – there have been no federal declarations for wildfires to date.
- **Land Subsidence** (2) – there have been no federal declarations for land subsidence to date.
- **Droughts** (2) – there have been no federal declarations for droughts to date.
- **Earthquakes** (2) – there have been no federal declarations for earthquakes to date.
- **Hazardous Materials (HAZMAT)** (2) – which include nuclear accidents. There have been no federal declarations for HAZMAT events to date.
- **Terrorism** (2) – there have been no federal declarations directly referred to as terrorism in the past. However, in August 2003 there was a declaration related to power outage, which began in Cleveland and spanned across a significant portion of the northern United States and southern Canada. This grid could be considered a major target area in future terrorist activity and should be investigated accordingly.

It should be noted the State Hazard Analysis Resource and Planning Portal (SHARPP) collects similar hazard analysis data from local hazard mitigation plans. Similar to the *2007 Ohio HIRA*, local hazard analyses in SHARPP are based on a number of factors, including frequency, magnitude, onset, impact, etc. This allows for an increased ability to "ground truth" local priorities with respect to the SOHMP HIRA. To date, over 50 percent of the counties throughout the state have populated SHARPP with their hazard scores. Since a representative sample of counties have populated these hazard data, it was possible to assess local priorities with regard to the various hazards affecting their communities. Table 2.1.k shows the ranking of the top ten hazards based on local priorities.

Table 2.1.k

SHARPP Overall Local Hazard Ranking		
Hazard	**Adjusted Total Score**	**Rank**
Tornado	18.0	1
Flooding	17.4	2
Winter Storm	16.6	3
Earthquake	16.5	4
Dam/Levee Failure	15.6	5
Severe Summer Storms	15.2	6
Windstorm	15.1	7
Coastal Erosion	13.8	8
Hail Storm	13.1	9
Drought	12.9	10

While there are some differences in the scores and subsequent ranks, the overall ranking is similar to the SOHMP assessment (Table 2.1.j) and the *2007 Ohio HIRA*. Tornadoes, flooding, and winter storms rank at or near the top in all assessments. Once the hazard analyses are populated in SHARPP for all counties, these comparisons will more than likely result in the same conclusion. Additional information about SHARPP and local HIRA data can be found in Appendix J.

This state hazard mitigation plan discusses each of these hazards in more detail with the exception of two technological hazards that were previously mentioned in the 2003 SOHMP – terrorism and hazardous materials. These two hazards are better addressed in ongoing Homeland Security and emergency management planning efforts, and are presented in the *updated Ohio HIRA*.

2.2 FLOOD

Floods are natural and beneficial functions of stream and lacustrine systems. Floods occur when streams or lakes overflow their banks and spill onto the adjoining land area, which is called a floodplain. Loss of life and property can result when people build structures and develop in flood hazard areas. Numerous factors can cause or exacerbate flooding in Ohio including: heavy and/or prolonged periods of rainfall, snowmelt, soil saturation, ground freeze, severe wind events, and inadequate drainage systems. Floods damage private and public property and infrastructure in Ohio every year. Flooding is the most frequently occurring natural disaster in Ohio and the United States.

RISK ASSESSMENT

The two major drainage basins in Ohio are the Lake Erie and Ohio River basins. Streams in the northern third of the state flow into Lake Erie and eventually into the Atlantic Ocean. Streams in the southern two-thirds of the state flow into the Ohio River and eventually into the Gulf of Mexico.

There are many types of flooding that occur in Ohio including: riverine, flash flooding, coastal flooding, and shallow flooding. Riverine flooding is generally characterized by slower rising water, which allows for increased warning time but has the potential to last for longer periods of time. Ohio communities experience riverine flooding on both large basins and smaller tributary streams throughout the state. Major sources of riverine flooding in Ohio include the Ohio River, Scioto River, Great Miami River, Muskingum River, Hocking River, Maumee River, Blanchard River, Sandusky River, Cuyahoga River, Grand River, Little Miami River, the Mahoning River and their larger tributaries.

Flash flooding can occur when a severe storm produces large amounts of rainfall in a short time. Flash flooding is generally characterized by high velocity water that rises and recedes quickly allowing little or no warning time to evacuate. Ohio's Appalachian Region is particularly vulnerable to flash flooding because of the steep terrain and narrow stream valleys. Ohio's urban areas also experience flash flooding that may be attributed to inadequate or poorly maintained storm water infrastructure, increased impervious area, and lost wetland areas. The U.S. Geological Survey (USGS) has concluded that urbanization generally increases the size and frequency of floods and may increase a community's flood risk.

Coastal flooding generally occurs in the counties that border Lake Erie. Flooding in coastal areas can be caused by stream overflow, wave run-up caused by strong winds, and higher than normal lake levels. Annual fluctuations in Lake Erie water levels are the result of seasonal changes and the amount of water flowing into and out of the lake. In-flow for Lake Erie includes drainage from the upper portion of the Great Lakes basin through the Detroit River, water from streams flowing directly into the lake, ground water, and precipitation falling directly into the lake. Out-flow includes discharge into Lake Ontario through the Niagara River, evaporation, and any diversion or other withdrawals. Lake Erie

levels also exhibit a wide range of long-term fluctuations that are the result of prolonged and persistent deviation from average climatic conditions.

Shallow flooding occurs in flat areas with inadequate channels that prevent water from draining easily. There are four types of shallow flooding: sheet flow, ponding, urban drainage and rural drainage. Sheet flow flooding occurs in areas where channels are not defined. Sheet flow flooding moves downhill and covers a large area under a relatively uniform depth.

Ponding occurs in flat areas where runoff collects in depressions and cannot drain. Ponding can occur where glaciers carved out depressions in the landscape, and where man-made features such as roads have blocked drainage outlets.

Urban drainage systems can include combinations of ditches, storm sewers, detention ponds, house gutters, and yard swales. When a rainfall event exceeds the design capacity of the drainage system, it can result in the system's back-up and overflowing ditches. Basements are highly susceptible to flood damage caused by overloaded sewer and drainage systems. Urban drainage flooding can also occur behind levees when rainfall amounts exceed the capacity of pumps or other man-made systems designed to drain the landward side of the levees.

Rural drainage flooding in northwest Ohio is similar to urban drainage flooding in Ohio's cities and villages. Most of northwest Ohio was covered by a large swamp prior to European settlement that was subsequently drained for agriculture. The flat topography of this area is drained by an extensive system of ditches, swales, and small meandering streams. Rural drainage flooding occurs when rainfall exceeds the design capacity of the drainage system.

Ohio's river systems offer many benefits that have contributed to the development of the state such as: transportation, waste disposal, energy, commerce, recreation, and water supply. As a result, most major communities include development in flood hazard areas. Wetland areas have been developed, streamside forests have been removed, and streams have been straightened and channelized resulting in faster and increased runoff. After two centuries, these development patterns have drastically changed Ohio's riparian ecosystems, and resulted in escalating flood damages.

Historically, efforts to manage flooding can be divided into three major era's according to the Federal Interagency Floodplain Management Task Force. The Frontier Era (Pre-1917) is characterized by limited federal involvement in flood control or relief. During this time, many federal policies and programs encouraged land development with the common goal being "to conquer the wild landscape and to promote productive use of the land." Flood hazards were the problem of the individual property owner, or dealt with cooperatively at the local level.

The Structural Era (1917-1959) is characterized by attempts to modify and control floodwater and move water off the land as quickly as possible. The

federal government began assuming the costs to construct dams, levees, reservoirs, and other large structural flood control projects. As this era came to an end, resource managers began to realize that flood control projects were not eliminating flood damage and may be harming the environment.

During the Stewardship Era (1960-present), people began to recognize the important benefits and natural functions provided by floodplain areas such as natural flood and erosion control, water quality maintenance, groundwater recharge, recreation, wildlife habitat, agricultural production and many others. The responsibility of floodplain management began to shift from the federal government to the local level again. The federal government began to focus on providing financial assistance to reduce and recover from the impacts of flooding. Congress created the National Flood Insurance Program (NFIP) in 1968 as a response to mounting flood losses and increasing disaster relief costs. The intent of the program is to reduce future flood damage through community floodplain management regulations, and provide a federally-subsidized insurance alternative to federal disaster relief.

The political jurisdictions in Ohio that are eligible to participate in the NFIP include cities, villages, and unincorporated areas (through the county government). There are 251 cities, 688 villages, and 88 counties in Ohio. There are 745 Ohio communities that participate in the NFIP. FEMA has identified flood hazard areas in every county in the state. As of December 2011, there were 45,068 flood insurance policies in effect for $7,284,384,100 in coverage statewide. Since 1978, the NFIP has paid 25,342 claims totaling $281,618,973.

Location

The four sources of information used to determine the location of flooding in Ohio are: FEMA flood maps and studies, NOAA data, information provided by the Ohio Department of Natural Resources - Division of Soil and Water Resources, and HAZUS analyses. Flood maps generated by FEMA to support the NFIP are the primary source of information on the location of special flood hazard areas (SFHAs) in the state. There are two main types of flood maps: the Flood Hazard Boundary Map (FHBM) and the Flood Insurance Rate Map (FIRM). The FHBM identifies approximate SFHAs based on the best available data at the time the map was created.

Generally, Flood Insurance Studies (FISs) and FIRMs are issued by FEMA following a detailed engineering analysis of flood hazard areas in participating communities. The FIS and FIRM identify 1%-annual-chance flood elevations and boundaries for selected stream reaches in the community. The FIRM will contain flood elevation information for various flood frequencies and may also delineate floodway boundaries.

Flooding occurs in every county in Ohio. There are over 60,000 miles of named, unnamed and intermittent streams in Ohio. FEMA has mapped approximately 2,777 square miles of flood hazard area in the state. Maps 2.2.a -2.2.c display FEMA identified SFHAs in the State of Ohio for the designated Regions.

Region 1 Flood Hazard
Flood Hazard
Region 1 Boundary
WILLIAMS
FULTON
LUCAS
OTTAWA
DEFIANCE
HENRY
WOOD
SANDUSKY
ERIE
PAULDING
SENECA
HURON
PUTNAM
HANCOCK
VAN WERT
WYANDOT
CRAWFORD
ALLEN
HARDIN
AUGLAIZE
MERCER
MARION
MORROW
LOGAN
SHELBY
UNION
DARKE
CHAMPAIGN
MIAMI
CLARK
MADISON
PREBLE
FAYETTE
CLINTON
0 12.5 25 50 Miles
N
W
E
S
This map depicts data not created or maintained by Ohio EMA, and, as such, Ohio EMA does not guarantee their accuracy.
Map Creator: Ohio EMA
Data Source: ODNR (2010)

Map 2.2.a

Region 2 Flood Hazard
Flood Hazard
Region 2 Boundary
LAKE
ASHTABULA
GEAUGA
CUYAHOGA
TRUMBULL
LORAIN
PORTAGE
MEDINA
SUMMIT
MAHONING
ASHLAND
WAYNE
STARK
RICHLAND
KNOX
DELAWARE
LICKING
FRANKLIN
FAIRFIELD
PICKAWAY
MONTGOMERY
GREENE
BUTLER
WARREN
HAMILTON
0 20 40 80 Miles
N
W
E
S
This map depicts data not created or maintained by Ohio EMA, and, as such, Ohio EMA does not guarantee their accuracy.
Map Creator: Ohio EMA
Data Source: ODNR (2010)

Map 2.2.b

Region 3 Flood Hazard
Flood Hazard
Region 3 Boundary
COLUMBIANA
CARROLL
HOLMES
TUSCARAWAS
JEFFERSON
COSHOCTON
HARRISON
GUERNSEY
BELMONT
MUSKINGUM
NOBLE
PERRY
MONROE
MORGAN
HOCKING
WASHINGTON
ROSS
ATHENS
VINTON
HIGHLAND
MEIGS
CLERMONT
PIKE
JACKSON
BROWN
ADAMS
SCIOTO
GALLIA
LAWRENCE
0 12.5 25 50 Miles
N
W
E
S
This map depicts data not created or maintained by Ohio EMA, and, as such, Ohio EMA does not guarantee their accuracy.
Map Creator: Ohio EMA
Data Source: ODNR (2010)

Map 2.2.c

The NOAA's National Climate Data Center (NCDC) Storm Events Database contains information on the location of flood events in Ohio. The database can be searched by county and includes a written description of the location of flood events reported in the state. The database also contains latitude and longitude values for some events and contains information on reported deaths, injuries, and estimated property and crop damage. The database can be found on the NCDC website.

The Ohio Department of Natural Resources, Division of Soil and Water Resources is mandated to be a state repository for flood hazard information (Ohio Revised Code Section 1521.13(C)(2)). The Floodplain Management Program maintains copies of flood hazard data generated by various federal, state, local, and private entities.

Past Occurrences

Profiling past occurrences of flooding at the state level involves gathering and compiling data from many different sources. The data sources used to profile the past occurrences of flooding include FEMA, the ODNR, the Ohio EMA, the NOAA, and the book *Thunder in the Heartland* by Thomas W. and Jeanne Applehans-Schmidlin, 1996. Table 2.2.a displays a summary of historic flooding information from 1860 to 1990 based on the chronicle *Thunder in the Heartland: A Chronicle of Outstanding Weather Events in Ohio.* More specific information on these events as well as events post 1990 can be found in the narrative of this section.

Table 2.2.a

Summary of Historic Flood Events 1860-1990[1]			
Date of Event	**Affected Area(s)**	**Water Bodies Affected**	**Event Description**
8/12/1861	Columbiana County, Elkton, Lisbon	Beaver Creek, Elk Run	Every home in Elkton was damaged and four persons drowned when one home was washed off its foundation.
2/17/1867	Toledo, Maumee	Maumee River	Ice jams destroyed one bridge and damaged several others. Flooding in downtown Toledo.
2/11/1881	Toledo, Grand Rapids, Columbus, Findlay	Maumee River, Scioto River, Blanchard River	Four bridges were damaged by ice jams and debris in Toledo. Flooding in downtown Toledo.
2/1883	Statewide	Auglaize, Blanchard, Maumee, Portage, and Sandusky Rivers	A combination of snowmelt, ice jams, frozen ground and heavy rains caused flooding statewide.
2/14/1884	Statewide	Ohio, Hocking, Maumee, and Muskingum Rivers	Second highest stage on the Ohio River in Cincinnati. Thousands were evacuated and 3000 buildings were submerged.
5/12/1886	Xenia	Shawnee Creek	Flash flooding washed away several homes killing 21 people and destroying one bridge.
1/23/1904	Lorain, Toledo, Waverly	Black, Scioto, Mahoning and Maumee Rivers	Ships, bridges, and structures were damaged by ice jams and flooding.
3/14-18/1907	Ohio River Watershed	Southern 2/3 of Ohio	Large scale flooding in the Ohio River Watershed resulted in 32 casualties, hundreds of flooded structures, utility and infrastructure damage.
3/23-27/1913	Statewide	Statewide	Described as "Ohio's Greatest Weather Disaster". Four days of heavy rain on saturated soils resulted in 467 casualties, over 2,200 homes destroyed, over 40,000 damaged, and over $2.5 Billion damage in 2003 dollars.
7/16/1914	Cambridge	Wills Creek Watershed	Over 7.09 inches of rain in 1.5 hours causing flash flooding.
8/16/1920	Toledo	Maumee River	Flash flooding in downtown Toledo damaged homes, businesses and infrastructure.

Summary of Historic Flood Events 1860-1990[1]			
Date of Event	**Affected Area(s)**	**Water Bodies Affected**	**Event Description**
2/26/1929	Cleveland, Dayton, Mt. Vernon, Bridgeport, Springfield	Little Miami, Maumee, Miami, Rocky, Mad, and Kokosing Rivers, Wheeling and Buck Creeks	Two to three inches of rain, melting snow, and ice jams caused widespread flooding.
3/21/1933	Cincinnati and Southern Ohio	Ohio River	Two periods of heavy rain cause widespread minor flooding.
8/7/1935	Coshocton and surrounding counties	Tuscarawas Watershed	Heavy rain on saturated soils saturated soils caused flash flooding.
3/19/1936	Ohio River Communities from Pittsburgh to Steubenville	Upper Ohio River	Snowmelt and heavy rains in Penn. and W. Virginia caused the Ohio River to rise 20 feet in two days.
1/26/1937	All Ohio River Communities	Ohio River	Described as the "Greatest Flood on the Ohio River". Record levels on the Ohio River from Gallipolis to the confluence with the Mississippi.
7/7/1943	Akron and Steubenville	Cuyahoga River, Cross and Wills Creeks	Six to seven inches of rain in several hours caused flash flooding and landslides.
6/16/1946	Wayne and Holmes Counties	Killbuck and Salt Creeks	Heavy rain caused flash flooding resulting in one death, a train wreck destroying 5 bridges and seriously damaging 55 others.
6/8/1947	Adams, Lawrence and Scioto Counties	South Fork of Scioto Brush Creek and other small tributaries to the south emptying into the Ohio River	Flash flooding damaged many homes, bridges, roads, and crops.
3/21/1948	Counties in the Lake Erie Watershed	Lake Erie Watershed	The most severe damage was reported in along the Chagrin River in Cleveland. Twenty buildings were destroyed and 153 were damaged.
6/16/1950	Crooksville, Roseville	Moxahala Creek Watershed	One of the most intense rainfalls ever known in Ohio caused severe flood damages to homes and businesses.

Summary of Historic Flood Events 1860-1990[1]			
Date of Event	**Affected Area(s)**	**Water Bodies Affected**	**Event Description**
1/21/1959	Statewide	Statewide	Rainfall in January 1959 ranging from 3-6 inches on snow-covered, frozen ground caused the most severe statewide flooding since 1913. Streams reached flood stage from January 21-24 killing 16 people, forcing 49,000 people from their homes, and causing extensive damage to homes, businesses and infrastructure.
6/5/1963	Guernsey County	Wills Creek Watershed	Official records indicate 7.95 inches of rainfall in 16-hours in Cambridge. One railroad bridge was destroyed, all major highways were inundated, and water supplies were polluted.
3/10/1964	Southern and Central Ohio	All Streams in Southern and Central Ohio	Two periods of heavy rain cause widespread flooding resulting in eight deaths, thousands evacuated, 84 homes destroyed, and 8,200 damaged.
7/21/1964	Akron	Ohio Canal and Little Cuyahoga River	Official records indicate 3.05 inches of rain in 75 minutes, but rain distribution was variable. The resulting flooding caused a sewer line to collapse a large section of road killing 3 people.
4/27/1966	Communities Along Lake Erie's Western Basin	Lake Erie's Western Basin	Several hours of winds up to 55 mph from the northeast pushed the western end of Lake Erie to flood stage. Fifteen hundred were evacuated, hundreds of homes were damaged, and utility services were interrupted.
7/12/1966	Erie, Ottawa, and Huron Counties	Sandusky and Huron River Watersheds	Rainfall totals ranging from 9-12 inches of rainfall over and approximately one-day period. Total damages exceed $27 million in 2003 dollars, including damages to 12,000 homes and businesses in Sandusky.
5/23-27/1968	Central and Southern Ohio	Hocking, Scioto, Little Miami	Two periods of heavy rain within 5 days on already saturated soils caused flooding on many streams. Four deaths have been attributed to this event.

Summary of Historic Flood Events 1860-1990[1]			
Date of Event	**Affected Area(s)**	**Water Bodies Affected**	**Event Description**
7/4/1969	Northern Ohio	Lake Erie Watershed	Severe thunderstorms moved from Lake Erie into Ohio's coastal communities on July 4, 1969. Flooding combined with strong wind and tornadoes caused 41 deaths and injured 559 people. Loss estimates for this event totaled $65 million dollars in 1969, or over $328 billion in 2003 dollars.
11/14/1972	Coastal communities from Toledo to Cedar Point	Lake Erie	Northeast wind setup caused Lake Erie to rise 3 feet at Toledo and fall 4 feet at Buffalo resulting in coastal flooding. Total damages were estimated at $22 million in 1972 dollars.
4/9/1973	Coastal communities from Toledo to Port Clinton	Lake Erie	Northeast winds caused 8 to 10 foot waves and flooding.
9/14/1979	Southeastern half of the state		The remains of Hurricane Frederic brought six inches of rain in a band from Cincinnati to Youngstown causing widespread flooding.
3/12/1982	Communities in the Maumee River Watershed	Maumee River Watershed	Two inches of rainfall on snow covered, frozen ground caused flooding. Loss estimates totaled $11 million in 1982 dollars with Defiance County being the hardest hit.
6/14/1990	Shadyside in Belmont County	Pipe Creek and Wegee Creek	Twenty-six people died in a flash flood near Shadyside. Approximately 80 homes were destroyed and 250 were damaged. An estimated that 3-4 inches of rain fell in a little over an hour.
12/31/1990	Widespread	Widespread	The wettest year on record ended with extensive flooding on New Year's Eve causing $50 million (1990 dollars) in damages.

1 - Information summarized from the book: *Thunder in the Heartland A Chronicle of Outstanding Weather Events in Ohio*, Schmidlin, Thomas W., and Jeanne A., Kent State University Press, 1996.

Historically, significant floods in Ohio occurred in 1913, 1937, 1959 and 1969. Heavy rain on saturated soils caused flooding throughout Ohio during March 23-27, 1913 killing 467 people, destroying 2,200 homes, and flooding 40,637 residences. Losses totaled $113 million in 1913 dollars ($2.5 billion in 2010 dollars), including: $78 million to buildings and personal property, $12 million to roads and bridges, $12 million to railroad property, which includes lost profit, $6 million to the agricultural industry, and $4 million dollars to machinery. This flood set record water levels on many Ohio streams. The Miami River Watershed experienced the highest casualties and damages during this event.

The flood of record for the Ohio River occurred the last two weeks in January 1937. Normal January precipitation in Ohio is 2-3 inches. The statewide average rainfall in January 1937 was 9.57 inches, with some stations recording over 14 inches. Ohio River levels on January 26-27 were the highest ever recorded from Gallipolis, Ohio to the confluence with the Mississippi River. Every Ohio community along the river was flooded resulting in 10 casualties, 16 injuries, thousands of damaged structures, and over 54,000 evacuations statewide.

Rainfall in January 1959 ranging from 3-6 inches on snow-covered, frozen ground caused the most severe statewide flooding since 1913. Streams reached flood stage from January 21-24 killing 16 people, forcing 49,000 people from their homes, and causing extensive damage to homes, businesses and infrastructure. Loss estimates for this event totaled $100 million in 1959, or over $752 million in 2010 dollars. Some of the factors that reduced casualties and damages from the 1913 flood include: less intense rainfall amounts, the construction of flood-control reservoirs built after 1913, and improved emergency management procedures and capabilities.

Severe thunderstorms moved from Lake Erie into Ohio's coastal communities on July 4, 1969. This line of storms became nearly stationary for more than eight hours aligned from Toledo southeast to Wooster. Official records indicate over 10 inches of precipitation lasting over a 2-day period. Flooding combined with strong winds and tornadoes caused 41 deaths and injured 559 people. Loss estimates for this event totaled $65 million dollars in 1969, or over $388 million in 2010 dollars. This flood caused extensive damage to homes, businesses, infrastructure, utilities, boats and automobiles.

Twenty-six people died in a flash flood near Shadyside, Ohio on June 14, 1990. The National Weather Service estimated that 3-4 inches of rain fell in a little over an hour near Pipe Creek and Wegee Creek. Total rainfall is estimated at 5.5 inches in three hours. The saturated soils and narrow, steep-sided valleys caused the water to drain quickly into the creeks. Flash flooding began at 9:30PM and was over in 30 minutes. During that time a wall of water six feet high (reported to be 20 feet in some areas) rushed through the valley at seven to ten miles-per-hour. Approximately 80 homes were destroyed and 250 were damaged.

Storms that produced heavy rains during March 1-2, 1997, resulted in severe flooding in southern Ohio. The largest accumulations of rainfall were recorded in southern Adams and Brown Counties and ranged from 10-12 inches over the two-day period. Generally, rainfall amounts of four or more inches fell on most of the counties along or near the southern border of Ohio. Widespread damages to private and public property occurred throughout the area. Preliminary loss estimates totaled nearly $180 million in 1997, or over $245 million in 2010 dollars. Approximately 20,000 people were evacuated and 6,500 residences and 833 businesses were affected. Five deaths were attributed to flooding; all of the fatalities were the result of attempts to drive through flooded roads.

Storms during June 26-30, 1998, resulted in flooding and widespread damage throughout much of central, east-central and southeastern Ohio. More than 10 inches of rain fell during a four-day period in parts of southeast Ohio. Twelve storm or flood-related fatalities were reported and infrastructure and utilities were heavily impacted. Loss estimates totaled nearly $178 million in 1998, or over $239 million in 2010 dollars.

Between the 2005 and 2014 plan updates, five flood events resulted in Presidential disaster declarations. These five events are described below.

<u>DR-1651-OH declared July 2, 2006</u>

Severe thunderstorms and tornado touchdowns caused two deaths and widespread damage in northern Ohio from June 21-23, 2006. The primary causes of damage in this event were flash flooding, which overwhelmed urban stormwater infrastructure, and riverine flooding. Huron County and the City of Brecksville were especially impacted. The communities of Toledo, Norwalk, Valley View and Independence also experienced significant flooding.

The USGS estimated flood recurrence intervals for gaged streams based on flood stage for this event. The flooding on the Vermilion River was estimated to be a 50-year event. The flooding on the Cuyahoga River and Tinkers Creek were estimated to be 25 to 50-year events.

<u>DR-1656-OH declared August 1, 2006</u>

Two separate weather systems produced storms resulting in more than 11 inches of rain in parts of Lake County, Ohio on July 27-28, 2006. As a result of the storms and ensuing flooding, the counties of Lake, Geauga and Ashtabula were declared Federal disaster areas. The flooding caused one fatality and 600 evacuations in Lake County. Over all of Lake County, 100 homes and businesses were destroyed and an additional 731 homes and businesses were damaged. Flooding destroyed five bridges in Lake County and closed 13 roads. The City of Painesville experienced heavy damages.

The USGS stream flow-gaging station at the Grand River near Painesville, Ohio had record peak stream flow and peak stage. The recurrence interval for this event was estimated to be 500 years (Ebner, A.D.; Sherwood, J.M.; Astifan, Brian; and Lombardy, Kirk, 2007, Flood of July 27-31, 2006, on the Grand River near Painesville, Ohio: U.S. Geological Survey Open-File Report 2007-1164).

DR-1720-OH declared August 26, 2007

Heavy rainfall inundated multiple communities across northern Ohio during a two-day period. The rain developed along a nearly stationary frontal boundary that was oriented from west to east across north central Ohio. Moisture from the Gulf of Mexico, as well as the remnants of Tropical Depression Erin, was drawn northward resulting in tropical downpours. The heaviest rains redeveloped each night, starting Sunday night August 19, 2007 into Monday morning and then again on Monday night into the early morning hours of Tuesday, August 21, 2007. Stream gage reports from four locations in the affected area indicated that 24-hour rainfall totals ending at 8AM on August 21, 2007 exceeded the 1,000 year/24-hour rainfall frequency. Peak flood stage of the Blanchard River in the City of Findlay was 0.04 less than the flood of record in 1913 (National Weather Service Forecast Office in Cleveland, Ohio).

Communities in the Blanchard, Sandusky and Mohican River watersheds were heavily impacted. There were approximately 2,500 flooded structures in the City of Findlay. The communities of Ottawa, Bucyrus, Shelby, Lima, Carey, and Bluffton also had many flooded structures. Recovery efforts are still progressing in these areas.

DR-4002-OH declared July 13, 2011

Heavy rains and thunderstorms moved through the state on February 27, 2011 as 3-4 inches of rain accumulated over a 24-hour period in already saturated areas across northern Ohio. This system exited the state and a second wave of precipitation moved through Southern Ohio. Warm temperatures, heavy snow pack and snow melt resulted in moderate to major flooding in many areas of the state. The State monitored river crests and falling temperatures over a 48-hour period for impacts, including potential issues with debris, waste water, sewage, and shelters. Major to moderate flood river levels were recorded in Northern Ohio. The Cuyahoga River reached near-record flood levels.

In March and April, much of Ohio continued to experience heavy rain, severe storms, flooding, and flash flooding across the southern portion of the state. The cumulative effect of these conditions, coupled with flooding in neighboring states along the Ohio and Mississippi Rivers, resulted in dangerous conditions and damages which affected the health, safety and welfare in 21 southern Ohio counties.

More severe storms moved across the south central part of the state in May, producing heavy rain and high winds. These conditions further intensified the previously affected citizens in Gallia, Jackson, Lawrence, Pike, Ross, Scioto and Vinton Counties. During this time, the Governor had issued two proclamations and requested a Presidentially-declared disaster for 13 counties along the Ohio River and 8 adjacent counties.

DR-4098-OH declared January 3, 2013

Hurricane Sandy brought heavy rainfall and significant flooding to northern portions of Ohio on October 29-30, 2012. The flooding was the result of three consecutive weather events; a cold front, hurricane Sandy remnants, and lake enhanced showers. Rain started on October 26th as a slow moving cold front moved into the Ohio Valley. This front brought widespread 0.75 to 2.0 inches of rainfall to northern Ohio, highest near the lake.

By Monday the remnants of Hurricane Sandy moved into Pennsylvania, and the pressure gradient between it and high pressure over Missouri produced storm force winds over Lake Erie. Moisture from Sandy moved into the region producing an additional rainfall of 2 to 3 inches by Tuesday the 30th. Rain continued at a rate averaging 0.10 inches per hour for the day, but increased to 0.75 inches per hour overnight and early Wednesday morning. This band of heavier rain caused the rivers which were receding to once again rise.

Areal flooding was limited to more northern counties; however some small streams and creeks came out of their banks as far south as Ashland County. Numerous roads were closed due to flooding in Cuyahoga, Lake, and Medina Counties. In Ashtabula County, docks were damaged at the Port of Ashtabula due to severe wind and violent wave actions on Lake Erie, and marinas had to be dredged at the Port Authority of Conneaut. A flood watch was in effect for the lake front counties and flood advisories were issued during the event.

A few dozen homes and businesses were impacted as water inundated basements or first floors. A number of homes affected were located in the flood plain of the rivers or along the shoreline where the raised lake level combined with the increased stream flows to produce flooding in areas not typically affected. Two rivers along the lakeshore reached major flood stage (based on NWS stage categories), the Cuyahoga and the Huron Rivers. The rest of the Lake Erie tributaries saw minor or moderate flooding. Many basements flooded further inland as sump pumps failed due to power outages. As the result of Hurricane Sandy, and estimated $13,406,088 in public assistance funds has been awarded to this point.

NOAA Data Summary

Table 2.2.b lists the number of reported floods in Ohio since the year 2000, and associated loss totals according to the NOAA's NCDC Storm Events Database. The information in this database comes from NWS, who receives their data from a variety of sources including: county, state, and federal emergency management officials, local law enforcement officials, weather spotters, NWS damage surveys, newspaper clipping service, the insurance industry and the public. An effort is made to use the best available information, but because of time and resource constraints, information from these sources may be unverified by the NWS.

Table 2.2.b

Ohio Flood Data Summary from the National Climatic Data Center					
Year	**Number of Reported Flood Events 1**	**Deaths**	**Injuries**	**Estimated Property Damage ($) 2**	**Crop Damage ($)**
2000	44	3	2	$10,759,000	None Reported
2001	37	3	1	$14,818,000	None Reported
2002	38	1	None Reported	$2,598,000	None Reported
2003	63	4	None Reported	$358,929,000	$2,994,000
2004	40	2	None Reported	$151,046,000	$985,000
2005	39	3	None Reported	$66,053,000	None Reported
2006	33	4	1	$569,553,000	$38,934,000
2007	115	None Reported	None Reported	$254,952,000	$16,749,000
2008	105	1	None Reported	$5,387,000	$46,000
2009	38	1	None Reported	$4,591,000	$54,000
2010	71	5	4	$13,748,000	$1,000
2011	47	2	0	$44,760,000	$178,000
2012	25	0	2	$319,000	$0
2013	31	0	0	$4,080,000	$100,000
Total:	**726**	**29**	**10**	**$1,501,593,000**	**$59,941,000**

1 - The number of reported flood events was calculated by adding one record for each date in the data set.

2 - Property damage values prior to 2011 were converted to 2011 dollars.

Source: NOAA, NCDC, Storm Events Database

Probability of Future Events

The probability of occurrence of flooding is the likelihood that a specific event will happen. The likelihood of a flood event happening is usually expressed in terms of frequency. The NFIP provides maps and studies that use the 1%-annual-chance floodplain area (area inundated during a 100-year flood) as the national standard for regulating floodplain development. It is critical to establish the probability of occurrence for flooding so that the state and local communities can make informed decisions about the sustainability of future development, and determine the feasibility of proposed mitigation projects.

The primary sources of data for determining the probability of occurrence of flooding are the FEMA FISs and FIRMs. Nearly every community that participates in the NFIP has a map that identifies at least some area of flood hazard in the community that has a 1%-annual chance of being equaled or exceeded in any given year. This area is referred to as the 1%-annual-chance floodplain, or the 100-year floodplain, and is graphically represented on a FIRM or FHBM.

Communities that do not have FISs, usually have an FHBM or FIRM that shows the approximate area that would be inundated by the 1%-annual-chance flood. An FHBM was intended for interim use in most communities, until a FIS could be completed. FHBMs are still being used in some Ohio communities where a detailed FIS has yet to be produced.

Approximately 81 percent of Ohio communities that participate in the NFIP have a portion of their flood hazard areas identified in an FIS. The purpose of a FIS is to investigate the existence and severity of flood hazards in a certain geographic area. The information in an FIS is used to establish actuarial flood insurance rates and assist the community in its efforts to regulate flood hazard areas. An FIS contains data on: historical flood events, the area and flood sources studied, and the engineering methods employed to generate the flood hazard data. An FIS will have flood elevation profiles for the 100-year recurrence probability flood, and usually the 10-, 50-, and/or 500-year floods. It may also contain tables summarizing floodway data and other flood hazard information; however it does not usually contain data for every flood hazard area in a community. The remaining areas may have approximate flood hazard data, or none at all.

There are several other possible data sources for determining the area affected by a particular probability flood event. The Ohio Department of Natural Resources, Division of Soil and Water Resources, is the state repository for flood hazard information and has copies of flood hazard information generated by various federal, state, local and private entities. The Floodplain Management Program maintains current copies of all FEMA FISs and flood maps in the state.

LHMP Data

As stated at the beginning of Section 2, integration of LHMP data into the state HIRA is an ongoing effort. As local plans continue to expire and jurisdictions update their plans, vulnerability information and loss estimation are collected and assembled. Highlighted below is some of the more notable jurisdictional plan information that has been assembled and integrated into the state HIRA.

Hamilton County. The 2013 updated Multi-Hazard Mitigation Plan examined flash flooding, river flooding and urban flooding (categorized in their plan as Non-Flood Zone flooding). Since the previously approved plan in October 2006, Hamilton County has experienced 31 events with a total of $82,000 in property damage. Additionally, river flooding assessment is conducted for each of the major watersheds that affect the county: the Great Miami River, the Little Miami River, the Ohio River and the Mill Creek watershed plus its tributaries. Each of the watersheds are mapped and analyzed to include properties, repetitive loss areas and critical facilities. These analyses projected 2,377 residential structures at risk at a value of $72,428,000, an estimated 750 non-residential structures valued at $319,464,000 and 173 critical facilities valued at $30,404,000.

Belmont County. The 2013-2018 Belmont County Multi-Jurisdictional Hazard Mitigation Plan provides an analysis of riverine and flash flooding. Although it is considered to be a small, rural county, projections show potential losses approaching $2 billion. A Level-1 HAZUS-MH 100-year flood scenario estimated 10,469 residential structures at risk at a value of $1,388,080,000, an estimated 3,552 non-residential structures valued at $471,071,000 and 839 critical facilities valued at $113,140,000. Flooding continues to be a frequent and damaging hazard as a result of the Ohio River, several streams and creeks. There have been eight Presidential declarations due to flooding since 1980, three of which

occurred in the month of June. However riverine flooding occurs in the winter as well. In January 1996, floodwaters from the conveyance of two rivers in Pittsburgh caused the Ohio River to crest over 4 feet above flood stage. This caused 61 residences to be destroyed, 136 with major damage, 107 with minor damage and 14 residences to be affected. Belmont County also has 52 repetitive loss properties: 37 are residential with 36 losses while 15 are classified as non-residential with 87 losses. One of the residential properties is a Severe Repetitive Loss property with four losses. Flash flooding occurs more often than riverine flooding with 65 events recorded between 1996 to 2013 and damaging $7,159,000 in property and $5 million in crop losses. The most significant event was in June 1990, recorded as the most devastating flash flood to strike Ohio in recent years, resulting in 26 fatalities.

Jackson County. The Jackson County Natural Hazards Mitigation Plan of February 2011 used HAZUS-MH to project damage in its most flood prone areas. These are identified as the Cities of Jackson and Wellston, and the Villages of Coalton and Oak Hill and various unincorporated jurisdictions. These areas experienced flooding in 1997 when the Little Salt Creek, Meadow Run, Little Raccoon Creek and other watersheds exceeded their banks. A Level-1 HAZUS-MH 100-year flood scenario performed in 2011, estimated 2,474 residential structures at risk at a value of $297,782,000, an estimated 958 non-residential structures valued at $115,769,000 and 175 critical facilities valued at $21,137,000.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Considering all hazards identified in the local plans, flooding ranked the highest in terms of frequency among the counties in the state (Chart 2.2.a). While ranking high for frequency, flooding ranked relatively low in terms of local magnitude (sixth), as the flood hazard areas in most counties represent less than 10 percent of their land area. However, this hazard ranked second for local economic effects, including both impact on businesses and impact on property. On the average, counties indicated that a flood results in business shutdown of approximately one week. Concerning property in flood hazard areas, counties suggested flooding affects approximately 10 – 25 percent of individual assets given a moderate flood magnitude. These and additional HIRA data queried from SHARPP can be found in Appendix J. As local mitigation plans are updated, county HIRA, vulnerability assessment , and mitigation action item data will continue to be added by local officials. The collection and analysis of this data will strengthen mitigation planning efforts statewide. The following information is reported with available information and data input:

SHARPP Flooding Hazard Analysis				
Region:	**One**	**Two**	**Three**	**State**
Frequency	High	High to Excessive	Almost High	Almost High
Response	< 1 day	< 1 day	< 1 week	< 1 day
Onset	< 24 hours	12- 24 hours	12- 24 hours	12- 24 hours
Impact (Magnitude)	Limited to Critical: 12% Land Area	Limited to Critical: 12% Land Area	Critical: 25-50% Land Area	Limited to Critical: 20% Land Area
Business Impact	<24 hours	<24 hours	1 week	<24 hours
Human Impact	Minimum: Minor Injuries	Minimum: Minor Injuries	Low: Some Injuries	Minimum: Minor Injuries
Property Impact	< 10% damaged	< 10% damaged	10-25% damaged	< 10% damaged

Chart 2.2.a
Hazard Frequency Scores

Using date input from local hazard mitigation plans, SHARPP estimates frequency on a 5-point scale with 1 identified as low and 5 as excessive. Using available data, SHARPP estimates flooding to have an adjusted frequency of 4.83 or close to excessive. It is also significantly probable for Ohio to experience over 53 events per year, with 2 fatalities, one injury, over $115 million in property damage and $4.6 million in crop loss.

VULNERABILITY ANALYSIS

Flooding vulnerability is the likelihood of something to be damaged in a flood. A vulnerability analysis is a measurement of a community's flood risk. Vulnerability can be measured using many different methods. The method selected is highly dependent on the type and format of available data. If site-specific information on flood elevation, lowest floor elevation, structure type, and replacement value exist, a detailed vulnerability analysis can be performed using flood damage curves. The State of Ohio, and most communities in the state lack all or a component of the data required for a detailed analysis and must use more simplified methods. Several different data sources are utilized in this discussion to help develop a clearer picture of Ohio's flood vulnerability including: local natural hazard mitigation plans, presidential disaster declaration data, the statewide Structure Inventory, NFIP repetitive loss data, HAZUS-MH analyses, and local data uploaded into SHARPP.

ODNR Structure Inventory

The ODNR, Division of Soil and Water Resources, Floodplain Management Program developed a statewide coverage of the federally identified 1%-annual-chance floodplains. This coverage was combined with Digital Ortho Quarter Quadrangles to identify structures located within that flood hazard area. Every structure in or near the 100-year floodplain was georeferenced and was assigned a unique structure ID number. The number assigned to each structure was entered into a database that contains attribute fields for each structure, including: structure use (residential, commercial etc.), lowest floor elevation, and Base Flood Elevation. The initial baseline of flood-prone structures and the accompanying database provide a tool that communities can use to develop comprehensive flood vulnerability analyses. These data were disseminated to all counties for use in their daily floodplain management duties and planning initiatives.

According to the Structure Inventory, there are 139,644 structures in FEMA-identified SFHA in the State of Ohio. Once a county's structure inventory database is populated, it can be used to complete a risk assessment by: classifying flood-prone structures by address, use category, repetitive loss status, construction date, foundation type, construction type and several other categories. A populated structure inventory database can also distinguish between structures that have reduced risk because they are built in compliance with local flood damage prevention regulations, and those that are not. This will allow communities to track how and where they are reducing future flood risks. This tool can also be used to identify structures that may be good candidates for future mitigation projects.

Likewise, the structure inventory can be used by counties to conduct a vulnerability analysis. This analysis should include an accurate estimate of the value of flood-prone assets. The most accurate assessment of structure values in the State of Ohio is maintained at the individual county auditor's offices. Each county auditor's office maintains the current tax assessed value of structures in

their county, many of which are available in a GIS format. If a county auditor can provide the value of structures in the SFHA, it can be used with the structure inventory to provide improved vulnerability analyses.

Communities that are beginning the mitigation planning process, or updating their plan, are encouraged to use the Structure Inventory to collect data about flood-prone structures in their community. Copies of the Structure Inventory were delivered to all county emergency management agency directors and every local floodplain administrator in the state prior to November 2004. It should be noted that most communities throughout the state did not incorporate these data into their mitigation actions as most communities did not possess GIS resources and capability at the time. In addition, there has been much developmental change in flood hazard areas throughout the state, and these changes would not be present in the data. As more communities develop GIS capabilities and more flood hazard data are developed, updated structure inventories can be collected and maintained for future vulnerability analyses.

For the purposes of this Enhanced State Plan Update, the structure inventory provides the most accurate quantification of potential structures at risk from flooding, especially when coupled with the HAZUS-MH results. When these results are paired with data housed in SHARPP, the state can make informed decisions regarding mitigation strategies and priorities.

Presidential Disaster Declaration Data

Flood vulnerability can also be expressed as historic expenditures on disaster recovery for flood events. Total expenditures for programs triggered by a Presidential Disaster Declarations are tracked and summarized by Ohio EMA (Appendix A).

NFIP Repetitive Loss Properties

The NFIP has identified a subset of structures covered by flood insurance policies that are referred to as “repetitive loss” and “severe repetitive loss.”(see Appendix B). For this analysis, a repetitive loss structure is any property covered under an NFIP flood insurance policy with two or more losses in any 10-year rolling period, and at least two losses that are more than 10 days apart. As of September 25, 2013, the NFIP identified 2,317 structures in Ohio that meet this definition, with a combined building and content loss of $125,021,664.80.

Severe repetitive loss (SRL) structures are defined as residential structures that are covered under an NFIP flood insurance policy and a) that have at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amounts of such claims payments exceed $20,000; or b) for which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart. Currently, there are 68 structures on the SRL list with a combined building and content loss of $6,455,283.79.

NFIP repetitive loss data can be used to identify some of the structures vulnerable to flooding throughout the state. In Ohio, it is estimated that approximately 75% of the structures in the SFHA are not covered by flood insurance for any number of reasons. Some reasons include: misinformation about flood insurance as a mitigation option; the structure is not required to be covered by flood insurance because there is no current mortgage; lack of resources to purchase coverage; and lack of enforcement by mortgage holder.

Recent legislation is focused on reducing the number of repetitive loss structures by offering mitigation options to the owners. FEMA mitigation grant programs have also prioritized the mitigation of repetitive loss structures including Severe Repetitive Loss, Repetitive Flood Claims, HMGP, FMA, and the PDM-C. The repetitive loss data should be used to identify areas that are repetitively flooded in a community. Given the current prioritization of repetitive loss structures, these structures should be considered when developing mitigation projects that utilize FEMA funding.

HAZARDS U.S.-MULTI-HAZARD (HAZUS-MH)

Ohio EMA and ODNR cooperated with the US Army Corps of Engineers (USACE) to undertake a HAZUS analysis project under the USACE's Planning Assistance to States program (50/50 cost share program). In this project, the ODNR-FPM and USACE combined to complete Level 1 flood analysis for 49 counties. The Corps analyzed Adams, Ashland, Athens, Coshocton, Delaware, Fairfield, Fayette, Franklin, Gallia, Guernsey, Harrison, Highland, Hocking, Holmes, Jackson, Knox, Lawrence, Licking, Madison, Marion, Medina, Meigs, Monroe, Morgan, Morrow, Muskingum, Noble, Perry, Pickaway, Pike, Richland, Ross, Scioto, Stark, Tuscarawas, Union, Vinton, Washington and Wayne Counties. The ODNR analyzed Belmont, Carroll, Columbiana, Jefferson, Mahoning, Portage, Summit and Trumbull. The remainder of the state was analyzed by Ohio EMA from 2009 to 2010. The analyses completed for all counties in the state included the 100-year and 25-year flood intervals using a drainage area of four square miles. Results of these and other HAZUS-MH runs are shared with counties and jurisdictions when possible to assist in updating local mitigation plans.

LOSS ESTIMATION

ODNR Structure Inventory

Each county (and communities within) is now able to identify the baseline number of structures at risk in identified flood hazard areas of their community. The attribute database will support the measurement of structures with reduced risk through NFIP compliance or mitigation actions (e.g. acquisitions, retrofits, and elevations). Given increased development throughout the state, some communities may find it advantageous to update their structure inventory by using updated aerial photography, such as the data produced by the Ohio Statewide Imagery Program (OSIP). Since local GIS capabilities have grown

exponentially over the past five years, many local mitigation plans should be able to assess their vulnerability to flooding in a more accurate manner.

Presidential Disaster Declaration Data

Since 1964 there has been $504,489,149 in Public Assistance funds, $276,396,684 in Individual Assistance funds, $61,100,951 in Hazard Mitigation Grant Program funds, $9,348,252 in State Controlling Board funds, $5,274,171 in State Disaster Relief Program funds, $10,410,817 in Natural Resources Conservation funds, $350,000 in Community Development Block Grant funds, and $25,457,115 in State funds used as to match federal funds spent as a result of disaster declarations related to floods within Ohio. The dollar totals listed above are not in current dollars and exclude insured and unreported losses.

NFIP Repetitive Loss Data

Appendix B lists the repetitive loss properties by county and region, indicates the status of flood insurance, estimates the structure and content value, and demonstrates the number of flood losses per structure.

Region 1 has the highest number of repetitive loss structures in the state as identified by the NFIP (877 structures). The amount paid out for repair of their structures through September 25, 2013 is $41,090,795.42 for structure repairs and contents replacements. Within Region 1 the most significant concentration of repetitive loss structures is located in the City of Findlay (Hancock County), which is along the Blanchard River. In total, Findlay has 222 repetitive loss structures identified with 678 losses, which have paid a total of $16,615,468.60 for structure repairs and contents replacements.

Region 2 is identified as having the second highest number of repetitive loss structures in the State. All of the counties within the region have identified repetitive loss structures. As a whole Region 2 has 749 repetitive loss structures identified, with the highest value of contents replacements and total payments equaling $51,180,618.48 in paid claims. There are two areas of significant loss identified with in the region. The City of Cincinnati (Hamilton County) is located in the southwestern portion of the state on the Ohio River. It has 59 repetitive loss structures with 192 claims for $5,406,440.69, in repairs paid and contents replaced. The second area includes the City of Eastlake (Lake County), situated in the northeastern portion of the state on Lake Erie. Eastlake has 37 identified repetitive loss structures with 105 claims for a total of $892,093.94.

Region 3 is third in the state for all statistics regarding repetitive loss structures. In total, there are 714 repetitive loss structures with 1,784 losses totaling $33,724,863.35 in repairs and contents paid. The City of Marietta (Washington County) has 118 repetitive loss structures with 289 reported claims representing $7,789,481.17 in repairs and contents replacements. The second highest RFC count in this region resides in the unincorporated area of Washington County; 52 structures with 127 losses totaling $2,322,373.30 in repairs and contents replacements. Collectively the counties, which border the Ohio River, represent the largest exposure in this region.

HAZUS-MH

The results of the HAZUS-MH runs have been broken down by region and are reported by county for total building exposure, number of structures impacted by percentage damaged, number of critical facilities impacted, total business interruption losses, and the total building loss (See Tables 2.2.c, 2.2.d, 2.2.e, 2.2.f, 2.2.g and 2.2.h). Tables ending in c, d and e contain the results based on a 100-year event while f, g and h contain the 25-year results. It is important to remember all the information reported via the state's HAZUS-MH analyses is an estimate and cannot be interpreted as precise losses. Future HAZUS analyses will include more refined property, flood, and topographic data to reduce this uncertainty.

Table 2.2.c

Estimate of Potential Losses from Flooding in the 100-Year Event Region 1											
County	Population	Building Exposure Value (thousands)	1-10% Damage Count	11-20 % Damage Count	21-30% Damage Count	31-40% Damage Count	41-50% Damage Count	Substantial Damage Count	Essential Facilities Count	Estimated Business Interrupt	Estimated Building Loss
Allen	108,437	$8,276,610	4	32	73	128	111	74	8	$111,400,000	$208,570,000
Auglaize	46,699	$3,493,414	0	6	21	34	58	36	4	$84,550,000	$83,330,000
Champaign	39,713	$2,778,965	0	15	17	27	8	3	0	$50,420,000	$49,940,000
Clark	139,671	$10,893,369	0	47	79	112	82	134	0	$237,480,000	$237,520,000
Clinton	43,058	$2,981,570	1	3	7	12	28	21	1	$52,300,000	$51,950,000
Crawford	43,403	$3,556,521	0	8	15	23	35	9	1	$60,150,000	$59,650,000
Darke	51,814	$3,766,740	0	6	9	23	47	54	0	$86,820,000	$86,290,000
Defiance	38,432	$3,261,057	0	8	29	21	30	9	1	$66,280,000	$65,660,000
Erie*	76,603	$7,149,357	27	531	567	699	702	426	5	$8,710,000	$788,310,000
Fayette	28,117	$720,173	0	4	26	49	52	13	2	$400,000	$65,680,000
Fulton	42,402	$3,729,167	0	1	6	11	14	11	0	$36,230,000	$35,940,000
Hancock	74,538	$6,017,435	7	34	43	57	51	52	2	$201,350,000	$197,630,000
Hardin	31,818	$729,078	0	7	14	24	17	14	0	$540,000	$36,690,000
Henry	28,648	$2,157,169	0	2	9	12	14	3	0	$46,680,000	$45,730,000
Huron	59,849	$4,320,061	0	3	16	30	47	32	0	$78,710,000	$78,350,000
Logan	46,582	$3,496,616	1	10	11	17	9	10	0	$38,150,000	$38,150,000
Lucas*	463,493	$39,329,470	13	209	321	357	756	493	15	$1,691,200,000	$1,676,530,000
Madison	42,539	$993,168	0	4	17	31	46	42	0	$300,000	$53,840,000
Marion	65,655	$949,651	1	5	29	66	88	40	6	$870,000	$86,980,000
Mercer	40,666	$2,933,239	0	5	7	6	6	3	0	$37,630,000	$37,300,000
Miami	101,256	$8,311,276	22	81	109	187	154	96	5	$305,560,000	$301,400,000
Morrow	34,642	$604,955	0	2	6	12	15	7	0	$230,000	$42,840,000
Ottawa*	40,945	$4,495,965	29	1,049	1,471	773	547	1,310	14	$6,450,000	$716,570,000
Paulding	18,994	$1,432,929	0	0	13	27	53	98	1	$69,940,000	$69,370,000
Preble	41,422	$2,966,577	0	5	27	28	40	32	0	$102,820,000	$102,430,000
Putnam	34,377	$2,490,483	1	15	23	43	61	45	2	$127,840,000	$126,780,000
Sandusky	60,071	$4,969,968	0	14	36	48	25	10	3	$79,180,000	$78,540,000
Seneca	56,152	$1,708,396	0	11	44	74	102	88	0	$1,020,000	$152,990,000
Shelby	48,990	$3,801,918	0	1	9	23	60	51	0	$75,080,000	$71,590,000
Union	48,903	$1,013,990	0	1	18	40	64	50	1	$480,000	$68,580,000
Van Wert	28,496	$2,055,854	0	6	33	57	45	19	0	$105,720,000	$104,500,000
Williams	37,816	$3,190,059	0	6	23	52	50	34	0	$92,420,000	$93,070,000
Wood	125,380	$10,501,105	5	47	60	79	150	47	4	$237,830,000	$234,870,000
Wyandot	22,394	$711,737	0	5	17	17	23	8	0	$360,000	$41,800,000
TOTAL	**2,211,975**	**$159,788,042**	**111**	**2,183**	**3,205**	**3,199**	**3,590**	**3,374**	**75**	**$4,095,100,000**	**$6,189,370,000**

*Values will need to be reassessed with the next plan update as HAZUS seemed to have difficulty with the flat terrain and coarse topographic data. The next update will incorporate more refined topographic data to better depict the limited relief.

Table 2.2.d

Estimate of Potential Losses from Flooding in the 100-Year Event Region 2											
County	Population	Building Exposure Value (thousands)	1-10% Damage Count	11-20 % Damage Count	21-30% Damage Count	31-40% Damage Count	41-50% Damage Count	Substantial Damage Count	Essential Facilities Count	Estimated Business Interrupt	Estimated Building Loss
Ashland	5,044	$983,692	1	5	9	17	22	31	1	$1,220,000	$81,790,000
Ashtabula	100,767	$7,704,317	0	38	93	47	130	112	0	$154,740,000	$153,730,000
Butler	363,184	$26,013,775	12	376	532	710	838	772	0	$1,378,000	$1,348,000
Cuyahoga*	1,275,709	$126,156,607	5	151	369	284	394	213	4	$8,690,000	$1,062,260,000
Delaware	168,708	$2,648,854	0	9	24	44	89	131	4	$2,820,000	$168,200,000
Fairfield	143,712	$2,408,997	0	55	147	216	285	97	0	$2,720,000	$271,740,000
Franklin	1,150,122	$12,346,646	13	350	607	850	700	618	13	$21,160,000	$1,679,900,000
Geauga	99,060	$7,865,765	0	7	7	16	14	0	1	$54,290,000	$53,970,000
Greene	159,823	$11,674,521	5	39	50	81	47	33	1	$156,780,000	$153,590,000
Hamilton	855,062	$72,577,343	8	106	154	278	578	1,213	12	$2,820,970,000	$2,800,570,000
Knox	59,637	$1,551,108	9	36	34	51	33	18	4	$1,370,000	$236,500,000
Lake	236,775	$19,802,188	0	314	348	364	394	264	0	$386,860,000	$383,860,000
Licking	158,488	$3,341,506	5	68	108	157	198	185	4	$3,120,000	$331,060,000
Lorain	305,707	$25,063,726	2	94	125	214	279	259	0	$533,600,000	$527,680,000
Mahoning	236,735	$3,047,225	2	23	30	46	28	9	0	$910,000	$129,110,000
Medina	174,035	$12,805,401	0	6	21	42	28	6	0	$83,940,000	$83,300,000
Montgomery	532,562	$45,503,377	128	402	517	762	907	696	34	$1,487,350,000	$1,461,580,000
Pickaway	54,734	$3,263,028	1	9	20	34	46	21	0	$79,600,000	$78,430,000
Portage	157,530	$2,513,342	1	9	28	66	54	57	1	$990,000	$139,080,000
Richland	124,490	$1,712,439	0	11	17	29	35	12	3	$1,110,000	$157,290,000
Stark	379,466	$5,239,841	18	108	119	184	155	92	0	$6,030,000	$463,210,000
Summit	542,405	$6,441,938	4	119	151	180	147	66	5	$4,620,000	$487,190,000
Trumbull	210,157	$17,584,336	3	63	119	159	209	310	3	$408,710,000	$404,430,000
Warren	210,712	$12,832,986	3	43	180	316	543	618	9	$475,650,000	$472,470,000
Wayne	114,222	$1,981,029	1	18	17	36	24	16	2	$1,030,000	$131,120,000
TOTAL	**7,818,846**	**$433,063,987**	**221**	**2,459**	**3,826**	**5,183**	**6,177**	**5,849**	**101**	**$6,699,658,000**	**$11,913,408,000**

*Values will need to be reassessed with the next plan update as HAZUS seemed to have difficulty with the flat terrain and coarse topographic data. The next update will incorporate more refined topographic data to better depict the limited relief.

Table 2.2.e

Estimate of Potential Losses from Flooding in the 100-Year Event Region 3											
County	Population	Building Exposure Value (thousands)	1-10% Damage Count	11-20 % Damage Count	21-30% Damage Count	31-40% Damage Count	41-50% Damage Count	Substantial Damage Count	Essential Facilities Count	Estimated Business Interrupt	Estimated Building Loss
Adams	28,043	$682,584	0	0	0	7	36	559	2	$1,240,000	$155,190,000
Athens	63,026	$1,765,399	0	28	51	88	156	316	11	$6,060,000	$511,860,000
Belmont	68,066	$1,138,503	0	0	1	6	46	332	3	$960,000	$154,830,000
Brown	44,033	$2,514,600	0	0	3	7	72	955	8	$317,550,000	$781,420,000
Carroll	28,539	$730,209	2	18	46	64	52	49	3	$650,000	$66,270,000
Clermont	196,364	$12,865,575	0	8	24	52	104	88	0	$313,130	$310,700
Columbiana	107,722	$2,177,124	0	2	14	27	85	1,795	7	$3,860,000	$634,560,000
Coshocton	35,767	$857,993	0	10	24	53	67	213	3	$1,510,000	$192,490,000
Gallia	30,694	$1,220,816	1	24	45	91	203	719	5	$5,160,000	$461,650,000
Guernsey	40,054	$1,107,630	1	13	16	50	47	84	3	$2,810,000	$152,520,000
Harrison	15,268	$306,687	0	0	1	6	11	5	1	$210,000	$22,990,000
Highland	42,178	$742,915	0	2	2	5	8	1	0	$410,000	$40,590,000
Hocking	28,912	$946,995	0	7	30	41	45	51	6	$1,290,000	$103,020,000
Holmes	41,854	$712,710	0	1	6	12	26	15	2	$360,000	$40,950,000
Jackson	33,440	$611,569	1	7	7	12	11	3	0	$400,000	$39,520,000
Jefferson	67,691	$1,932,238	0	5	26	78	353	1,992	25	$7,380,000	$817,470,000
Lawrence	62,744	$2,930,308	1	58	236	522	1,355	4,306	21	$12,060,000	$1,528,600,000
Meigs	22,838	$896,860	0	14	50	83	221	549	10	$2,510,000	$271,900,000
Monroe	14,058	$1,887,497	0	8	116	88	552	1,562	14	$6,750,000	$875,790,000
Morgan	14,288	$575,845	0	1	2	10	48	894	2	$1,440,000	$201,710,000
Muskingum	84,884	$1,770,099	1	8	49	107	206	368	3	$2,670,000	$286,340,000
Noble	14,311	$317,128	0	2	2	3	6	6	1	$840,000	$27,600,000
Perry	35,359	$695,152	0	8	16	32	27	26	6	$590,000	$58,400,000
Pike	27,722	$890,437	0	5	11	28	52	172	1	$2,360,000	$144,500,000
Ross	75,972	$1,655,760	4	11	39	87	146	224	7	$4,400,000	$178,740,000
Scioto	76,334	$2,448,603	0	62	136	242	532	1,689	15	$13,330,000	$1,090,740,000
Tuscarawas	91,137	$2,142,377	5	67	81	142	187	311	2	$4,760,000	$362,750,000
Vinton	13,228	$269,073	0	0	1	2	2	4	0	$70,000	$14,700,000
Washington	61,048	$2,604,032	0	2	22	71	420	2,839	15	$11,950,000	$1,230,710,000
TOTAL	**1,465,574**	**$49,396,718**	**16**	**371**	**1,057**	**2,016**	**5,076**	**20,127**	**176**	**$413,893,130**	**$10,448,120,700**

Table 2.2.f

Estimate of Potential Losses from Flooding in the 25-Year Event Region 1											
County	Population	Building Exposure Value (thousands)	1-10% Damage Count	11-20 % Damage Count	21-30% Damage Count	31-40% Damage Count	41-50% Damage Count	Substantial Damage Count	Essential Facilities Count	Estimated Business Interrupt	Estimated Building Loss
Allen	108,437	$8,276,610	6	30	66	96	94	61	8	$182,460,000	$180,140,000
Auglaize	46,699	$3,493,414	0	4	15	24	36	17	2	$52,160,000	$51,410,000
Champaign	39,713	$2,778,965	0	10	11	16	3	1	0	$40,050,000	$12,160,000
Clark	139,671	$10,893,369	0	35	56	89	49	115	0	$159,630,000	$158,040,000
Clinton	43,058	$2,981,570	2	2	5	9	22	17	1	$43,340,000	$43,040,000
Crawford	43,403	$3,556,521	0	7	12	15	37	46	0	$61,450,000	$60,960,000
Darke	51,814	$3,766,740	0	3	8	23	45	39	0	$73,000,000	$2,540,000
Defiance	38,432	$3,261,057	0	11	30	16	15	6	1	$54,630,000	$54,090,000
Erie*	76,603	$7,149,397	14	349	986	161	649	400	3	$7,080,000	$671,720,000
Fayette	28,117	$720,173	0	6	24	44	33	6	2	$350,000	$55,560,000
Fulton	42,402	$3,729,167	0	1	6	12	9	7	0	$31,400,000	$31,140,000
Hancock	74,538	$6,017,435	7	26	40	48	45	36	2	$171,970,000	$168,530,000
Hardin	31,818	$729,078	0	5	8	15	11	6	0	$454,000	$29,719,000
Henry	28,648	$2,157,169	0	1	11	8	11	2	0	$39,890,000	$39,090,000
Huron	59,849	$4,320,061	0	3	14	26	45	29	0	$68,980,000	$68,650,000
Logan	46,582	$3,496,616	1	10	9	6	9	5	0	$30,760,000	$30,280,000
Lucas*	463,493	$39,329,470	15	152	319	384	682	372	7	$1,217,510,000	$1,209,200,000
Madison	42,539	$993,168	0	4	17	29	35	25	0	$250,000	$44,830,000
Marion	65,655	$949,651	0	8	24	69	49	35	6	$770,000	$73,150,000
Mercer	40,666	$2,933,239	0	2	4	4	4	1	0	$32,760,000	$32,480,000
Miami	101,256	$8,311,276	6	45	57	92	87	71	2	$225,490,000	$222,240,000
Morrow	34,642	$604,955	0	2	4	9	11	2	0	$210,000	$35,210,000
Ottawa*	40,945	$4,495,969	17	838	931	526	435	899	1	$5,002,000	$520,390,000
Paulding	18,994	$1,432,929	0	0	12	226	42	80	1	$58,270,000	$57,860,000
Preble	41,422	$2,966,577	0	9	17	25	28	22	0	$88,540,000	$88,230,000
Putnam	34,377	$2,490,483	1	8	14	33	44	43	2	$102,650,000	$101,770,000
Sandusky	60,071	$4,969,968	1	16	24	24	21	12	0	$80,410,000	$79,780,000
Seneca	56,152	$1,708,396	0	7	26	47	67	40	0	$857,000	$123,924,000
Shelby	48,990	$3,801,918	0	0	9	27	52	38	0	$65,690,000	$65,250,000
Union	48,903	$1,013,990	0	2	19	40	50	32	1	$390,000	$56,720,000
Van Wert	28,496	$2,055,854	0	3	27	39	33	10	0	$89,270,000	$88,200,000
Williams	37,816	$3,190,059	0	6	18	32	42	15	0	$70,530,000	$69,580,000
Wood	125,380	$10,501,105	2	31	39	57	105	27	2	$200,950,000	$193,080,000
Wyandot	22,394	$711,737	0	3	10	11	15	4	0	$303,000	$33,858,000
TOTAL	**2,211,975**	**$159,788,086**	**72**	**1,639**	**2,872**	**2,282**	**2,915**	**2,521**	**41**	**$3,257,456,000**	**$4,752,821,000**

*Values will need to be reassessed with the next plan update as HAZUS seemed to have difficulty with the flat terrain and coarse topographic data. The next update will incorporate more refined topographic data to better depict the limited relief.

Table 2.2.g

Estimate of Potential Losses from Flooding in the 25-Year Event Region 2											
County	Population	Building Exposure Value (thousands)	1-10% Damage Count	11-20 % Damage Count	21-30% Damage Count	31-40% Damage Count	41-50% Damage Count	Substantial Damage Count	Essential Facilities Count	Estimated Business Interrupt	Estimated Building Loss
Ashland	5,044	$983,692	0	4	8	14	22	23	1	$1,060,000	$68,630,000
Ashtabula	100,767	$7,704,317	0	36	89	38	112	85	0	$130,370,000	$128,560,000
Butler	363,184	$26,013,775	8	181	448	710	796	523	0	$916,250,000	$825,620,000
Cuyahoga	1,275,709	$126,156,607	7	127	307	229	362	167	5	$2,550,000	$933,100,000
Delaware	168,708	$2,648,854	1	9	22	35	88	108	2	$2,500,000	$142,790,000
Fairfield	143,712	$2,408,997	0	70	120	188	129	39	0	$2,410,000	$212,350,000
Franklin	1,150,122	$12,346,646	17	309	515	714	574	483	11	$18,180,000	$1,398,090,000
Geauga	99,060	$7,865,765	0	5	4	8	3	0	1	$43,530,000	$43,240,000
Greene	159,823	$11,674,521	4	33	41	56	33	25	1	$134,400,000	$131,530,000
Hamilton	855,062	$72,577,343	11	101	117	231	365	603	7	$1,801,500,000	$1,788,860,000
Knox	59,637	$1,551,108	9	43	32	53	22	10	4	$1,270,000	$210,650,000
Lake	236,775	$19,802,188	0	238	480	118	344	219	0	$327,480,000	$325,000,000
Licking	158,488	$3,341,506	6	53	91	122	155	126	4	$2,670,000	$270,130,000
Lorain	305,707	$25,063,726	1	82	188	116	226	211	1	$483,740,000	$478,080,000
Mahoning	236,735	$3,047,225	2	23	24	29	24	9	1	$1,290,000	$146,360,000
Medina	174,035	$12,805,401	0	1	10	23	11	1	0	$59,190,000	$58,760,000
Montgomery	532,562	$45,503,377	102	340	418	615	643	449	27	$1,220,730,000	$1,200,690,000
Pickaway	54,734	$3,263,028	3	6	18	32	28	18	0	$69,670,000	$68,600,000
Portage	157,530	$2,513,342	1	12	37	65	48	59	1	$940,000	$130,740,000
Richland	124,490	$1,712,439	0	10	15	33	18	6	3	$930,000	$128,920,000
Stark	379,466	$5,239,841	20	83	111	156	120	63	11	$5,310,000	$385,790,000
Summit	542,405	$6,441,938	6	94	103	112	74	33	5	$4,140,000	$404,480,000
Trumbull	210,157	$17,584,336	2	46	79	95	150	183	2	$82,120,000	$279,300,000
Warren	210,712	$12,832,986	2	49	164	294	407	484	9	$416,910,000	$413,980,000
Wayne	114,222	$1,981,029	1	12	10	23	16	7	1	$866,000	$106,208,000
TOTAL	**7,818,846**	**$433,063,987**	**203**	**1,967**	**3,451**	**4,109**	**4,770**	**3,934**	**97**	**$5,730,006,000**	**$10,280,458,000**

Table 2.2.h.

Estimate of Potential Losses from Flooding in the 25-Year Event Region 3											
County	**Population**	**Building Exposure Value (thousands)**	**1-10% Damage Count**	**11-20 % Damage Count**	**21-30% Damage Count**	**31-40% Damage Count**	**41-50% Damage Count**	**Substantial Damage Count**	**Essential Facilities Count**	**Estimated Business Interrupt**	**Estimated Building Loss**
Adams	28,043	$682,584	0	0	3	6	43	501	2	$1,220,000	$147,910,000
Athens	63,026	$1,765,399	1	22	42	86	138	272	6	$5,000,000	$446,570,000
Belmont	68,066	$1,138,503	0	0	1	4	42	288	4	$950,000	$142,180,000
Brown	44,033	$2,514,600	0	0	7	20	82	840	6	$289,840,000	$287,700,000
Carroll	28,539	$730,209	0	19	36	53	32	40	1	$640,000	$58,150,000
Clermont	196,364	$12,865,575	0	8	15	41	104	69	0	$231,030	$229,670
Columbiana	107,722	$2,177,124	0	1	14	32	96	1,606	6	$3,730,000	$590,960,000
Coshocton	35,767	$857,993	0	8	23	40	60	179	3	$1,290,000	$164,210,000
Gallia	30,694	$1,220,816	1	12	38	56	161	618	5	$4,190,000	$388,090,000
Guernsey	40,054	$1,107,630	0	18	15	30	35	53	4	$2,130,000	$142,590,000
Harrison	15,268	$306,687	0	0	1	4	7	3	1	$190,000	$19,910,000
Highland	42,178	$742,915	0	2	2	3	8	1	0	$370,000	$34,810,000
Hocking	28,912	$946,995	0	5	18	33	33	34	6	$1,140,000	$84,380,000
Holmes	41,854	$712,710	0	1	6	10	18	13	3	$330,000	$34,030,000
Jackson	33,440	$611,569	3	7	4	11	2	2	0	$400,000	$32,890,000
Jefferson	67,691	$1,932,238	0	4	28	104	368	1,699	19	$5,850,000	$694,310,000
Lawrence	62,744	$2,930,308	1	71	263	585	1,211	3,640	20	$10,850,000	$1,349,080,000
Meigs	22,838	$896,860	1	28	58	94	131	390	10	$2,200,000	$219,130,000
Monroe	14,058	$1,887,497	0	12	100	64	415	1,029	12	$4,560,000	$630,250,000
Morgan	14,288	$575,845	0	0	2	10	63	763	2	$1,130,000	$169,800,000
Muskingum	84,884	$1,770,099	1	11	49	104	161	276	2	$2,260,000	$237,860,000
Noble	14,311	$317,128	0	2	2	2	5	3	1	$760,000	$23,430,000
Perry	35,359	$695,152	0	9	15	23	20	17	4	$520,000	$49,610,000
Pike	27,722	$890,437	0	5	11	24	41	128	0	$2,070,000	$117,090,000
Ross	75,972	$1,655,760	2	7	37	62	139	144	7	$3,520,000	$134,270,000
Scioto	76,334	$2,448,603	0	18	52	114	386	1,327	10	$7,260,000	$635,040,000
Tuscarawas	91,137	$2,142,377	5	55	67	132	140	266	1	$4,460,000	$317,550,000
Vinton	13,228	$269,073	0	0	0	1	1	2	0	$60,000	$12,430,000
Washington	61,048	$2,604,032	0	11	49	141	516	2,266	15	$10,700,000	$1,064,680,000
TOTAL	**1,465,574**	**$49,396,718**	**15**	**336**	**958**	**1,889**	**4,458**	**16,469**	**150**	**$367,851,030**	**$8,229,139,670**

Region 1 collectively has approximately $159,788,042,000 in total building exposure to flooding for the 1%-annual-chance event. A total of 3,374 structures are estimated to be substantially damaged, meaning damages that total 50 percent or more of the structures' pre-flood market values. There are an estimated 75 critical facilities impacted, which include police, fire, hospitals and schools. The overall estimated building loss is expected to approach $6,189,370,000 with an additional $4,095,100,000 in business interruption. Changing to a 4%-annual-chance event (25-year flood), a total of 2,521 structures are estimated to be substantially damaged. There are an estimated 41 critical facilities impacted. Finally, the overall estimated building loss is projected to approach $4,752,821,000, with an additional $3,257,456,000 in business interruption.

Region 2 collectively has $433,063,987,000 in total building exposure to flooding for the 100-year event. A total of 5,849 structures are estimated to be substantially damaged, meaning damages that total 50 percent or more of the structures' pre-flood market values. There are an estimated 101 critical facilities impacted, which include police, fire, hospitals and schools. The overall estimated building loss should approach $11,913,408,000, with an additional $6,699,658,000 in business interruption. Changing to a 25-year event, a total of 3,934 structures are estimated to be substantially damaged. There are an estimated 97 critical facilities impacted. Finally, the overall estimated building loss is $10,280,458,000 with an additional $5,730,006,000 in business interruption. According to the HAZUS-MH runs, there appear to be more critical facilities impacted during a 25-year event than a 100-year event. We have no explanation for this occurrence.

Region 3 collectively has $49,396,718,000 in total building exposure to flooding for the100-year event. A total of 20,127 structures are estimated to be substantially damaged, meaning damages that total 50 percent or more of the structures' pre-flood market values. There are an estimated 176 critical facilities impacted, which include police, fire, hospitals and schools. The overall estimated building loss is expected to approach $10,448,120,700 with an additional $413,893,130 in business interruption. Changing to a 25-year event, a total of 16,469 structures are estimated to be substantially damaged. There are an estimated 150 critical facilities impacted. Finally, the overall estimated building loss should approach $8,229,139,670 with an additional $367,851,030 in business interruption.

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

The estimates for losses to state-owned and state-leased critical facilities were developed using the DAS-maintained databases discussed in Section 2.1. An updated 1-percent-annual-chance floodplain shapefile was obtained from the ODNR so the most recent DFIRM data could be used for this analysis. Tables 2.2.i – k list regional exposure for state-owned critical and non-critical facilities, and Tables 2.2.l – n list regional exposure for state-leased critical and non-critical

facilities. Because first-floor elevations have not been collected for these structures, estimated damages cannot be calculated via depth/damage curves. Therefore, loss estimations are based on a 25-percent loss for each state-owned structure located in the special flood hazard area. For those state-owned structures located in a special flood hazard area AND FEMA-identified floodway, it is assumed that 50 percent damage will be incurred. It should be noted that floodways are not identified for every flood hazard area in the state.

The assumptions used for loss estimation of state-owned structures were different than those used for state-leased facilities because replacement values are not known for leases. Considering annual rental costs are known for leased structures, loss estimation is based on loss of function for a damaged facility. For a 25-percent loss, the loss of function is assumed to be six months, and for a 50-percent loss, the loss of function is assumed to be one year. These loss-of-function quantities are based on values used by HAZUS-MH and FEMA's Benefit-Cost Analysis software when evaluating loss of function for businesses.

Region 1 has a total of 91 state-owned facilities in the flood hazard areas, and eight of those are located within the floodway. This represents over $33 million exposed to flooding, and approximately $725,777 in the destructive area of the floodway. Based on the loss estimation assumptions described herein, during a 1-percent-annual-chance flood, Region 1 would experience over $8.4 million in damages.

Critical facilities in Region 1 represent 45 percent of the state-owned facilities exposed to flood hazard areas in this region, and four of those are located in the floodway. Over one-third of this exposure is in Mercer County, but none of these structures are in the floodway. Overall, this Region ranks second in estimated losses to state-owned critical facilities given a 1-percent-annual-chance flood when compared with Regions 2 and 3. This makes sense since Region 1 is characterized with a smaller percent of land area designated as flood-prone on FEMA FIRMs and/or DFIRMs.

Concerning state-leased facilities in Region 1, there is a total of five structures exposed to flood hazards with one located in the floodway (Huron County). While all five of these structures are non-critical to recovery, during a 1-percent-annual-chance flood Ohio could expect over $95,000 in lost rent. This is lowest estimate of losses for state-leased facilities among the three regions discussed in this plan.

Region 2 has a total of 94 state-owned facilities in the flood hazard areas, and eight of those are located within the floodway. This represents over $40 million exposed to flooding, with approximately $915,535 in the highest velocity of that flood-prone area—the floodway. Overall, this Region shows the highest estimated loss given a 1-percent-annual-chance flood when compared with the other two regions. The estimated losses for state-owned facilities in the flood fringe and floodway are over $10 million, which correlates with the high development and high population characteristics of Region 2.

Critical facilities in Region 2 represent 24 percent of the state-owned facilities exposed to flood hazard areas in this region, and eight of those are located in the floodway. Three-fourths of these structures are in Licking County and are mainly associated with the Department of Transportation. All of the state-owned critical facilities in Licking County are located within the floodway, which increases the risk of high losses during a major flood event. Overall, this Region ranks third in estimated losses to state-owned critical facilities given a 1-percent-annual-chance flood when compared with Regions 2 and 3. However, a large percentage (27 percent) of those losses is expected to occur in the floodway.

Concerning state-leased facilities in Region 2, there is a total of five structures exposed to flood hazards with four located in the floodway (administrative facilities in Franklin County). Two of the aforementioned structures are critical in nature and represent an expected loss of $310,776 in rent. Taken as a whole, more losses are expected with state-leased facilities in Region 2 than Regions 1 and 3 combined.

Region 3 has a total of 120 state-owned facilities in the flood hazard areas, and nine of those are located within the floodway. This represents an estimated $39.4 million exposed to flooding, with approximately $677,645 in the floodway. Overall, this Region shows the highest number of structures and the second highest dollars at risk among the three regions. While this region is sparsely populated compared to Region 2, Ohio could expect losses to exceed $10 million given a one-percent-annual-chance flood.

There are 537 state-owned critical facilities in Region 3 (Appendix C), and 63 of those are located in identified flood hazard areas, which represents over $19 million in exposure. Nine structures are located within the floodway, and given a major flood, Ohio could expect losses to approach $340,000 in that high-hazard area alone. Collectively, state-owned critical facility loss estimates would climb above $5 million in Region 3, which is 75 percent higher than Regions 1 and 2 combined. Again, the majority of these critical facilities are associated with the Department of Transportation.

Ten state-leased facilities are located in the flood hazard areas in Region 3, with one non-critical structure located in the floodway (Hocking County). Expected losses in this Region would approach $500,000, which ranks second among the three regions in the state.

Additional building stock data for state-owned and state-leased facilities for counties in each Region can be found in Appendix C.

Table 2.2.i

Region 1 State-Owned Critical and Non-Critical Facilities in the SFHA or Floodway									
County	Critical Facilities in SFHA (in FW)	Value of Critical Facilities in SFHA (in FW)	Loss Estimate for Critical Facilities in SFHA (in FW)	Non-Critical Facilities in SFHA (in FW)	Value of Non-Critical Facilities in SFHA (in FW)	Loss Estimate for Non-Critical Facilities in SFHA (in FW)	Total Number State-Owned Facilities in SFHA (in FW)	Value of All State-Owned Facilities in SFHA (in FW)	Loss Estimate for All State-Owned Facilities in SFHA (in FW)
Allen	3	$0	$0	0	$0	$0	3	$0	$0
Auglaize	0	$0	$0	1	$25,500	$6,375	1	$25,500	$6,375
Champaign	0	$0	$0	0	$0	$0	0	$0	$0
Clark	6	$1,227,472	$306,868	0	$0	$0	6	$1,227,472	$306,868
Clinton	0	$0	$0	0	$0	$0	0	$0	$0
Crawford	0	$0	$0	0	$0	$0	0	$0	$0
Darke	0	$0	$0	0	$0	$0	0	$0	$0
Defiance	0	$0	$0	0	$0	$0	0	$0	$0
Erie	0	$0	$0	5	$674,495	$168,624	5	$674,495	$168,624
Fayette	0	$0	$0	0	$0	$0	0	$0	$0
Fulton	0	$0	$0	0	$0	$0	0	$0	$0
Hancock	1	$648,983	$162,246	1	$51,000	$12,750	2	$699,983	$174,996
Hardin	8	$1,111,504	$277,876	0	$0	$0	8	$1,111,504	$277,876
Henry	0	$0	$0	0	$0	$0	0	$0	$0
Huron	2	$1,136,768	$284,192	0	$0	$0	2	$1,136,768	$284,192
Logan	0	$0	$0	0	$0	$0	0	$0	$0
Lucas	1	$153,000	$38,250	33	$24,256,560	$6,064,140	34	$24,409,560	$6,102,390
Madison	0	$0	$0	0	$0	$0	0	$0	$0
Marion	0	$0	$0	0	$0	$0	0	$0	$0
Mercer	16	$2,344,872	$586,218	0	$0	$0	16	$2,344,872	$586,218
Miami	4 (4)	$369,158 ($369,158)	$0 ($184,579)	2 (2)	$50,619 ($50,619)	$0 ($25,310)	6 (6)	$419,777 ($419,777)	$0 ($209,889)
Morrow	0	$0	$0	0	$0	$0	0	$0	$0
Ottawa	0	$0	$0	0	$0	$0	0	$0	$0
Paulding	0	$0	$0	0	$0	$0	0	$0	$0
Preble	0	$0	$0	0	$0	$0	0	$0	$0
Putnam	0	$0	$0	0	$0	$0	0	$0	$0
Sandusky	0	$0	$0	6	$799,680	$199,920	6	$799,680	$199,920

Seneca	0	$0	$0	0	$0	$0	0	$0	$0
Shelby	0	$0	$0	2 (2)	$306,000 ($306,000)	$0 ($153,000)	2 (2)	$306,000 ($306,000)	$0 ($153,000)
Union	0	$0	$0	0	$0	$0	0	$0	$0
Van Wert	0	$0	$0	0	$0	$0	0	$0	$0
Williams	0	$0	$0	0	$0	$0	0	$0	$0
Wood	0	$0	$0	0	$0	$0	0	$0	$0
Wyandot	0	$0	$0	0	$0	$0	0	$0	$0
REGIONAL TOTALS	41 (4)	$6,991,757 ($369,158)	$1,655,650 ($184,579)	50 (4)	$26,163,854 ($356,619)	$6,451,809 ($178,310)	91 (8)	$33,155,611 ($725,777)	$8,107,458 ($362,889)

Table 2.2.j

Region 2 State-Owned Critical and Non-Critical Facilities in the SFHA or Floodway									
County	**Critical Facilities in SFHA (in FW)**	**Value of Critical Facilities in SFHA (in FW)**	**Loss Estimate for Critical Facilities in SFHA (in FW)**	**Non-Critical Facilities in SFHA (in FW)**	**Value of Non-Critical Facilities in SFHA (in FW)**	**Loss Estimate for Non-Critical Facilities in SFHA (in FW)**	**Total Number State-Owned Facilities in SFHA (in FW)**	**Value of All State-Owned Facilities in SFHA (in FW)**	**Loss Estimate for All State-Owned Facilities in SFHA (in FW)**
Ashland	5	$347,956	$86,989	43	$24,409,800	$6,102,450	48	$24,757,756	$6,189,439
Ashtabula	0	$0	$0	0	$0	$0	0	$0	$0
Butler	0	$0	$0	0	$0	$0	0	$0	$0
Cuyahoga	7	$430,044	$107,511	0	$0	$0	7	$430,044	$107,511
Delaware	0	$0	$0	10	$1,791,120	$447,780	10	$1,791,120	$447,780
Fairfield	0	$0	$0	1	$144,621	$36,155	1	$144,621	$36,155
Franklin	2 (2)	$29,425 ($29,425)	$0 ($14,713)	0	$0	$0	2 (2)	$29,425 ($29,425)	$0 ($14,713)
Geauga	0	$0	$0	0	$0	$0	0	$0	$0
Greene	0	$0	$0	0	$0	$0	0	$0	$0
Hamilton	0	$0	$0	0	$0	$0	0	$0	$0
Knox	1	$345,091	$86,273	0	$0	$0	1	$345,091	$86,273
Lake	0	$0	$0	0	$0	$0	0	$0	$0
Licking	6 (6)	$886,110 ($886,110)	$0 ($443,055)	6	$1,775,635	$443,909	12 (6)	$2,661,745 ($886,110)	$443,909 ($443,055)
Lorain	0	$0	$0	1	$9,000	$2,250	1	$9,000	$2,250
Mahoning	0	$0	$0	0	$0	$0	0	$0	$0
Medina	0	$0	$0	0	$0	$0	0	$0	$0
Montgomery	0	$0	$0	0	$0	$0	0	$0	$0
Pickaway	0	$0	$0	8	$8,588,045	$2,147,011	8	$8,588,045	$2,147,011
Portage	0	$0	$0	0	$0	$0	0	$0	$0
Richland	1	$1,266,871	$316,718	0	$0	$0	1	$1,266,871	$316,718
Stark	0	$0	$0	0	$0	$0	0	$0	$0
Summit	0	$0	$0	0	$0	$0	0	$0	$0
Trumbull	1	$60,543	$15,136	0	$0	$0	1	$60,543	$15,136
Warren	0	$0	$0	2	$357,000	$89,250	2	$357,000	$89,250
Wayne	0	$0	$0	0	$0	$0	0	$0	$0
REGIONAL TOTALS	23 (8)	$3,366,040 ($915,535)	$612,626 ($457,768)	71	$37,075,221	$9,268,805	94 (8)	$40,441,261 ($915,535)	$9,931,432 ($457,768)

Table 2.2.k

Region 3 State-Owned Critical and Non-Critical Facilities in the SFHA or Floodway									
County	Critical Facilities in SFHA (in FW)	Value of Critical Facilities in SFHA (in FW)	Loss Estimate for Critical Facilities in SFHA (in FW)	Non-Critical Facilities in SFHA (in FW)	Value of Non-Critical Facilities in SFHA (in FW)	Loss Estimate for Non-Critical Facilities in SFHA (in FW)	Total Number State-Owned Facilities in SFHA (in FW)	Value of All State-Owned Facilities in SFHA (in FW)	Loss Estimate for All State-Owned Facilities in SFHA (in FW)
Adams	0	$0	$0	0	$0	$0	0	$0	$0
Athens	2 (2)	$110,429 ($110,429)	$0 ($55,215)	1	$11,341,927	$2,835,482	3 (2)	$11,452,356 ($110,429)	$2,835,482 ($55,215)
Belmont	4	$77,802	$19,451	0	$0	$0	4	$77,802	$19,451
Brown	0	$0	$0	0	$0	$0	0	$0	$0
Carroll	0	$0	$0	0	$0	$0	0	$0	$0
Clermont	1	$41,540	$10,385	0	$0	$0	1	$41,540	$10,385
Columbiana	0	$0	$0	0	$0	$0	0	$0	$0
Coshocton	2	$430,644	$107,661	0	$0	$0	2	$430,644	$107,661
Gallia	0	$0	$0	2	$46,206	$11,552	2	$46,206	$11,552
Guernsey	0	$0	$0	0	$0	$0	0	$0	$0
Harrison	0	$0	$0	0	$0	$0	0	$0	$0
Highland	0	$0	$0	0	$0	$0	0	$0	$0
Hocking	0	$0	$0	0	$0	$0	0	$0	$0
Holmes	3	$146,050	$36,513	0	$0	$0	3	$146,050	$36,513
Jackson	0	$0	$0	0	$0	$0	0	$0	$0
Jefferson	3	$196,102	$49,026	0	$0	$0	3	$196,102	$49,026
Lawrence	0	$0	$0	0	$0	$0	0	$0	$0
Meigs	0	$0	$0	0	$0	$0	0	$0	$0
Monroe	2 (2)	$218,337 ($218,337)	$0 ($109,169)	0	$0	$0	2 (2)	$218,337 ($218,337)	$0 ($109,169)
Morgan	0	$0	$0	2	$150,348	$37,587	2	$150,348	$37,587
Muskingum	3	$160,656	$40,164	0	$0	$0	3	$160,656	$40,164
Noble	5 (5)	$348,879 ($348,879)	$0 ($174,440)	0	$0	$0	5 (5)	$348,879 ($348,879)	$0 ($174,440)
Perry	0	$0	$0	0	$0	$0	0	$0	$0
Pike	0	$0	$0	18	$803,760	$200,940	18	$803,760	$200,940
Ross	0	$0	$0	0	$0	$0	0	$0	$0
Scioto	0	$0	$0	3	$357,000	$89,250	3	$357,000	$89,250

Tuscarawas	38	$18,053,058	$4,513,265	22	$4,330,259	$1,082,565	60	$22,383,317	$5,595,829
Vinton	0	$0	$0	1	$510,000	$127,500	1	$510,000	$127,500
Washington	0	$0	$0	8	$2,118,188	$529,547	8	$2,118,188	$529,547
REGIONAL TOTALS	63 (9)	$19,783,497 ($677,645)	$4,776,463 ($338,823)	57	$19,657,688	$4,914,422	120 (9)	$39,441,185 (677,645)	$9,690,885 ($338,823)

Table 2.2.l

Region 1 State-Leased Critical and Non-Critical Facilities in the SFHA or Floodway									
County	Critical Facilities in SFHA (in FW)	Value of Critical Facilities in SFHA (in FW)	Loss Estimate for Critical Facilities in SFHA (in FW)	Non-Critical Facilities in SFHA (in FW)	Value of Non-Critical Facilities in SFHA (in FW)	Loss Estimate for Non-Critical Facilities in SFHA (in FW)	Total Number State-Leased Facilities in SFHA (in FW)	Value of All State-Leased Facilities in SFHA (in FW)	Loss Estimate for All State-Leased Facilities in SFHA (in FW)
Allen	0	$0	$0	0	$0	$0	0	$0	$0
Auglaize	0	$0	$0	0	$0	$0	0	$0	$0
Champaign	0	$0	$0	0	$0	$0	0	$0	$0
Clark	0	$0	$0	0	$0	$0	0	$0	$0
Clinton	0	$0	$0	0	$0	$0	0	$0	$0
Crawford	0	$0	$0	0	$0	$0	0	$0	$0
Darke	0	$0	$0	0	$0	$0	0	$0	$0
Defiance	0	$0	$0	2	$67,332	$33,666	2	$67,332	$33,666
Erie	0	$0	$0	1	$82,131	$41,066	1	$82,131	$41,066
Fayette	0	$0	$0	0	$0	$0	0	$0	$0
Fulton	0	$0	$0	0	$0	$0	0	$0	$0
Hancock	0	$0	$0	0	$0	$0	0	$0	$0
Hardin	0	$0	$0	0	$0	$0	0	$0	$0
Henry	0	$0	$0	0	$0	$0	0	$0	$0
Huron	0	$0	$0	1 (1)	$10,968 ($10,968)	$0 ($10,968)	1 (1)	$10,968 ($10,968)	$0 ($10,968)
Logan	0	$0	$0	0	$0	$0	0	$0	$0
Lucas	0	$0	$0	0	$0	$0	0	$0	$0
Madison	0	$0	$0	0	$0	$0	0	$0	$0
Marion	0	$0	$0	0	$0	$0	0	$0	$0
Mercer	0	$0	$0	0	$0	$0	0	$0	$0
Miami	0	$0	$0	1	$19,932	$9,966	1	$19,932	$9,966
Morrow	0	$0	$0	0	$0	$0	0	$0	$0
Ottawa	0	$0	$0	0	$0	$0	0	$0	$0
Paulding	0	$0	$0	0	$0	$0	0	$0	$0
Preble	0	$0	$0	0	$0	$0	0	$0	$0
Putnam	0	$0	$0	0	$0	$0	0	$0	$0

Sandusky	0	$0	$0	0	$0	$0	0	$0	$0
Seneca	0	$0	$0	0	$0	$0	0	$0	$0
Shelby	0	$0	$0	0	$0	$0	0	$0	$0
Union	0	$0	$0	0	$0	$0	0	$0	$0
Van Wert	0	$0	$0	0	$0	$0	0	$0	$0
Williams	0	$0	$0	0	$0	$0	0	$0	$0
Wood	0	$0	$0	0	$0	$0	0	$0	$0
Wyandot	0	$0	$0	0	$0	$0	0	$0	$0
REGIONAL TOTALS	0	$0	$0	5 (1)	$180,363 ($10,968)	$84,698 ($10,968)	5 (1)	$180,363 ($10,968)	$84,698 ($10,968)

Table 2.2.m

Region 2 State-Leased Critical and Non-Critical Facilities in the SFHA or Floodway									
County	**Critical Facilities in SFHA (in FW)**	**Value of Critical Facilities in SFHA (in FW)**	**Loss Estimate for Critical Facilities in SFHA (in FW)**	**Non-Critical Facilities in SFHA (in FW)**	**Value of Non-Critical Facilities in SFHA (in FW)**	**Loss Estimate for Non-Critical Facilities in SFHA (in FW)**	**Total Number State-Leased Facilities in SFHA (in FW)**	**Value of All State-Leased Facilities in SFHA (in FW)**	**Loss Estimate for All State-Leased Facilities in SFHA (in FW)**
Ashland	0	$0	$0	0	$0	$0	0	$0	$0
Ashtabula	0	$0	$0	0	$0	$0	0	$0	$0
Butler	0	$0	$0	0	$0	$0	0	$0	$0
Cuyahoga	0	$0	$0	0	$0	$0	0	$0	$0
Delaware	0	$0	$0	0	$0	$0	0	$0	$0
Fairfield	0	$0	$0	0	$0	$0	0	$0	$0
Franklin	2 (2)	$310,776 ($310,776)	$0 ($310,776)	3 (2)	$1,070,916 ($280,032)	$395,442 ($280,032)	5 (4)	$1,381,692 ($590,808)	$395,442 ($590,808)
Geauga	0	$0	$0	0	$0	$0	0	$0	$0
Greene	0	$0	$0	0	$0	$0	0	$0	$0
Hamilton	0	$0	$0	0	$0	$0	0	$0	$0
Knox	0	$0	$0	0	$0	$0	0	$0	$0
Lake	0	$0	$0	0	$0	$0	0	$0	$0
Licking	0	$0	$0	0	$0	$0	0	$0	$0
Lorain	0	$0	$0	0	$0	$0	0	$0	$0
Mahoning	0	$0	$0	0	$0	$0	0	$0	$0
Medina	0	$0	$0	0	$0	$0	0	$0	$0
Montgomery	0	$0	$0	0	$0	$0	0	$0	$0
Pickaway	0	$0	$0	0	$0	$0	0	$0	$0
Portage	0	$0	$0	0	$0	$0	0	$0	$0
Richland	0	$0	$0	0	$0	$0	0	$0	$0
Stark	0	$0	$0	0	$0	$0	0	$0	$0
Summit	0	$0	$0	0	$0	$0	0	$0	$0
Trumbull	0	$0	$0	0	$0	$0	0	$0	$0
Warren	0	$0	$0	0	$0	$0	0	$0	$0
Wayne	0	$0	$0	0	$0	$0	0	$0	$0
REGIONAL TOTALS	2 (2)	$310,776 ($310,776)	$0 ($310,776)	3 (2)	$1,070,916 ($280,032)	$395,442 ($280,032)	5 (4)	$1,381,692 ($590,808)	$395,442 ($590,808)

Table 2.2.n

Region 3 State-Leased Critical and Non-Critical Facilities in the SFHA or Floodway									
County	Critical Facilities in SFHA (in FW)	Value of Critical Facilities in SFHA (in FW)	Loss Estimate for Critical Facilities in SFHA (in FW)	Non-Critical Facilities in SFHA (in FW)	Value of Non-Critical Facilities in SFHA (in FW)	Loss Estimate for Non-Critical Facilities in SFHA (in FW)	Total Number State-Leased Facilities in SFHA (in FW)	Value of All State-Leased Facilities in SFHA (in FW)	Loss Estimate for All State-Leased Facilities in SFHA (in FW)
Adams	0	$0	$0	0	$0	$0	0	$0	$0
Athens	0	$0	$0	3	$90,060	$45,030	3	$90,060	$45,030
Belmont	0	$0	$0	3	$241,344	$120,672	3	$241,344	$120,672
Brown	0	$0	$0	0	$0	$0	0	$0	$0
Carroll	0	$0	$0	0	$0	$0	0	$0	$0
Clermont	0	$0	$0	0	$0	$0	0	$0	$0
Columbiana	0	$0	$0	0	$0	$0	0	$0	$0
Coshocton	0	$0	$0	0	$0	$0	0	$0	$0
Gallia	0	$0	$0	0	$0	$0	0	$0	$0
Guernsey	0	$0	$0	0	$0	$0	0	$0	$0
Harrison	0	$0	$0	0	$0	$0	0	$0	$0
Highland	0	$0	$0	0	$0	$0	0	$0	$0
Hocking	1	$425,376	$212,688	1 (1)	$106,956 ($106,956)	$0 ($106,956)	2 (1)	$532,332 ($106,956)	$212,688 ($106,956)
Holmes	0	$0	$0	0	$0	$0	0	$0	$0
Jackson	0	$0	$0	0	$0	$0	0	$0	$0
Jefferson	0	$0	$0	0	$0	$0	0	$0	$0
Lawrence	0	$0	$0	0	$0	$0	0	$0	$0
Meigs	0	$0	$0	0	$0	$0	0	$0	$0
Monroe	0	$0	$0	0	$0	$0	0	$0	$0
Morgan	0	$0	$0	0	$0	$0	0	$0	$0
Muskingum	0	$0	$0	0	$0	$0	0	$0	$0
Noble	0	$0	$0	0	$0	$0	0	$0	$0
Perry	0	$0	$0	0	$0	$0	0	$0	$0
Pike	0	$0	$0	0	$0	$0	0	$0	$0
Ross	0	$0	$0	0	$0	$0	0	$0	$0
Scioto	0	$0	$0	0	$0	$0	0	$0	$0
Tuscarawas	0	$0	$0	0	$0	$0	0	$0	$0

Vinton	0	$0	$0	0	$0	$0	0	$0	$0
Washington	0	$0	$0	2	$32,004	$16,002	2	$32,004	$16,002
REGIONAL TOTALS	1	$425,376	$212,688	9 (1)	$470,363 ($106,956)	$181,704 ($106,956)	10 (1)	$895,739 ($106,956)	$394,392 ($106,956)

2.3 TORNADO

Tornadoes are rapidly rotating funnels of wind extending from storm clouds to the ground. They form during severe thunderstorms when cold air overrides a layer of warm air, causing the warm air to rise rapidly. The midsection of the United States experiences a higher rate of tornadoes than other parts of the country because of the recurrent collision of this moist, warm air moving north from the Gulf of Mexico with colder fronts moving east from the Rocky Mountains (FEMA, MHIRA 40).

Tornadoes are the most hazardous when they occur in populated areas. Tornadoes can topple mobile homes, lift cars, snap trees, and turn objects into destructive missiles. Among the most unpredictable of weather phenomena, tornadoes can occur at any time of day, in any state in the union, and in any season. While the majority of tornadoes cause little or no damage, some are capable of tremendous destruction, reaching wind speeds of 200 mph or more.

Tornadoes are non-spatial hazards; therefore, it is often difficult to profile tornadoes and determine the exact risk. However, estimations can be developed by analyzing historic occurrences and past declarations. While Ohio does not rank among the top states for the number of tornado events, it does rank within the top 20 states in the nation for fatalities, injuries, and dollar losses, indicating that it has a relatively high likelihood for damages resulting from tornadoes.

Tornadoes are measured by damage scale for their winds—greater damage equates to greater wind speed. The original Fujita-scale (F-scale) was developed without considering a structure's integrity or condition as it relates to the wind speed necessary to damage it. Varying wind speeds may be needed to cause the same damage depending on how well-built a structure is. Also, the process of rating the damage was subjective with the original F-scale; arbitrary judgments were the norm. In order to reduce this subjectivity, the Enhanced F-scale (EF-scale) took effect February 1, 2007.

The Enhanced F-scale uses the original F-scale (i.e., F0-F5) and classifies tornado damage across 28 different types of damage indicators, which mostly involve building/structure type, and these are assessed at eight damage levels (1-8). Therefore, construction types and their strengths and weaknesses are incorporated into the EF classification given to a particular tornado. The most intense damage within the tornado path will generally determine the EF-scale given the tornado. Table 2.3.a. lists the classifications under the EF- and F-scale. It should be noted the wind speeds listed are estimates based on damage rather than measurements. Also, there are no plans by NOAA or the NWS to re-evaluate the historical tornado data using the Enhanced scale. Therefore, this plan and subsequent plans will reference both scales, as needed, until a complete switchover is deemed necessary.

Table 2.3.a.

Fujita Scale		Examples of Possible Damage	Enhanced Fujita Scale	
F Number	3-Second Gust (mph)		EF Number	3-Second Gust (mph)
0	45-78	Light damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage to sign boards.	0	65-85
1	79-117	Moderate damage. Surface peeled off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads.	1	86-110
2	118-161	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.	2	111-135
3	162-209	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; cars lifted off ground and thrown.	3	136-165
4	210-261	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.	4	166-200
5	262-317	Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 100-yards; trees debarked; incredible phenomena will occur.	5	Over 200

Source: http://www.spc.noaa.gov/faq/tornado/ef-scale.html

RISK ASSESSMENT

Location

Ohio has a significant history of past tornado events. Map 2.3.a depicts the touchdowns of 1,013 tornadoes that have struck the State of Ohio between 1950 and 2013, and Map 2.3.b shows F3 – F5 tornado paths in the three Ohio Regions. In Ohio, tornadoes have higher frequency in the spring and summer months of April, May, June, and July (see Chart 2.3.a). These storms have caused nearly 300 deaths and over 5,300 injuries in the State. Between 1964 and 2004 ten tornadoes caused damage that resulted in federal disaster declarations (see Table 2.3.b). This number represents all three regions in Ohio.

LHMP Data

Clermont County. There were two events in 2012 that caused significant damages. The first was on March 2, 2012. This tornado was categorized as an EF3. The Village of Moscow, parts of Franklin, Washington, & Tate Townships were all in the direct path with 353 structures damaged and 18 residential structures destroyed causing roughly $3,700,000 in damages with three lives lost

and 13 injured. The second tornado event occurred on September 8, 2012, the Village of Moscow was hit the hardest with 2 homes destroyed. The location, frequency and impacts of tornadoes cannot be accurately predicted. However, an analysis of historic events can provide a reasonable understanding of expected future risks. Clermont County has had 9 tornadoes in 17 years and since 1953, they have sustained total losses of approximately $11.5 million. The annual chance of occurrence for a tornado is 23%. The annualized risk is approximately $190,883 with 1 injury and 3% chance of life loss.

Greene County. Although tornadoes can occur throughout the state, the City of Xenia appears to be especially tornado-prone. According to the Greene County LHMP, "Nineteen tornadoes were reported in Greene County, Ohio since 1884. These tornadoes caused 43 deaths, 1,377 injuries and over $1 billion dollars of damage. Xenia was the location of seven tornadoes, responsible for the majority of the fatalities and caused the highest amount of damage." Greene County considers tornadoes major hazards with the potential of high damage, personal injury, and loss of life. They have conducted a number of studies involving tornadoes and have incorporated those studies into their LHMP.

Wayne County. The Wayne County All Hazards Mitigation Plan of October 2006 provides a "Current State of Mitigation" Section of their plan which credits storm watcher programs, public awareness campaigns and weather sirens to preventing any loss of life throughout 21 tornadoes since May 1957. Regardless of these successes, the plan also focuses on actions such as the need for updating siren systems for outdoor notification, NOAA weather radios for indoor notification, alert systems for critical facilities and improving building codes for residential and commercial construction. Also, the greatest loss estimation was based on an EF-5 scenario hitting the City of Wooster with an estimated affected general building stock of over $544 million. In addition to property loss, Wayne County estimated loss of commercial inventory, productivity, shipping capability and potential contracts that may lead to job elimination to compensate for total losses.

Map 2.3a

Map 2.3b

Van Wert County. The aftermath of the 2002 Veteran's Day Weekend Tornado Outbreak left Van Wert County in the emergency management spotlight for saving lives through aggressive public education campaigns for several years prior to the event. Although the event incurred two fatalities and 17 injured, the outcome could have been worse. The tornado slammed into a movie theater; however, people knew to take shelter in reinforced mason latrines when the tornado warnings were issued. These actions saved over 60 lives, which is contrary to the 1924 Lorain-Sandusky tornado where 72 people died, including 15 inside a collapsed cinema. The October 2005 Countywide All Natural Hazards Mitigation Plan determined that the occurrence of tornadoes was low, however, the damage was evaluated as an excessive impact to infrastructure. Also, the multi-hazard map shows that tornadoes travel in a northeasterly direction. The 2002 tornado almost traversed the entire county diagonally from the southwest to the northeast. Loss estimates were approximately $2.6 million per event, with the exception of 2002 where damage resulted in $30 million. There were many businesses that were disrupted by the clean-up process. The plan also states that since Van Wert has a relatively small population, many communities rely on the support of others throughout the county for recovery.

Lorain County. The June 2009 County All Natural Hazards Plan mapped the F-4 tornadoes of 1953 and 1965. These tornadoes resulted in extensive property damage with $36.2 million in 1953 and $25 million in 1965. An F-2 tornado left behind $2.5 million in damage in 1986. Another tornado caused $7.5 million in property damage in 1992. It was determined that even though the frequency of tornadoes in the county was low, they still caused moderate property damage, as the general building stock is estimated at over $8 billion. Since 1953, there have been 18 recorded deaths and approximately 160 injuries attributed to tornadoes in Lorain County. The plan also states that as the population is forecasted to increase, the potential for injury or death will increase as well.

Chart 2.3.a

Frequency of Ohio Tornadoes by Month, 1950 - 2013

Source: SeverePlot Software, NOAA, http://spc.noaa.gov/software/svrplot2/

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Considering all hazards identified in the local plans, tornadoes ranked first in terms of frequency among the counties in the state (Chart 2.1.k). Since many tornado occurrences are localized, it makes sense this hazard was ranked relatively low for response and magnitude (land area impacted). However, it ranked the highest for human and property impacts, and it ranked second for onset. When evaluating all of the factors associated with the hazard analysis in SHARPP, tornadoes ranked the highest of the 15 hazards identified. These and additional HIRA data queried from SHARPP can be found in Appendix J.

Table 2.3.b

Tornado Disaster Declarations by Region

Region 1

County	DR-191	DR-238	DR-421	DR-642	DR-738	DR-870	DR-1227	DR-1343	DR-1444		DR-1484
Allen	X										
Auglaize									X		
Champaign											
Clark			X								
Clinton											
Crawford											
Defiance											
Darke											
Erie											
Fayette			X								
Fulton											
Hancock	X			X					X		
Hardin											
Henry									X		
Huron									X		
Logan											
Lucas	X										
Madison			X								
Marion											
Morrow	X			X			X				
Mercer	X										
Miami											
Ottawa							X		X		
Paulding			X						X		
Preble											
Putnam			X	X					X		
Sandusky							X		X		
Seneca	X								X		
Shelby	X										
Union											
Van Wert	X										
Williams											
Wood											
Wyandot				X							

Region 2

County	DR-191	DR-238	DR-421	DR-642	DR-738	DR-870	DR-1227	DR-1343	DR-1444	DR-1484
Ashland									X	
Ashtabula					X					
Butler			X			X				
Cuyahoga	X								X	X
Delaware	X		X							
Fairfield						X				
Franklin			X			X	X		X	X
Geauga						X				
Greene			X					X		
Hamilton			X							
Knox							X			
Lake										
Licking					X					
Lorain	X					X			X	
Mahoning						X				X
Medina	X					X			X	X
Montgomery										
Pickaway	X		X				X			
Portage					X	X				X
Richland							X			X
Stark										X
Summit			X			X			X	X
Trumbull					X	X				X
Warren			X							
Wayne										

Region 3

County	DR-191	DR-238	DR-421	DR-642	DR-738	DR-870	DR-1227	DR-1343	DR-1444	DR-1484
Adams			X							X
Athens						X	X			
Belmont						X	X			
Brown		X								
Carroll										X
Clermont		X				X				
Columbiana					X	X				X
Coshocton					X		X		X	
Gallia		X								
Guernsey							X			
Harrison	X					X	X			
Highland	X									
Hocking						X				
Holmes										
Jackson						X	X			
Jefferson						X	X			X
Lawrence						X				
Meigs							X			
Monroe						X	X			
Morgan							X			
Muskingum						X	X			
Noble							X			
Perry						X	X			
Pike						X				
Ross						X				
Scioto		X								
Tuscarawas							X			
Vinton						X				X
Washington							X			

Past Occurrences

One of the most significant storms is the April 1974 storm known as the Super-outbreak. One-hundred forty-eight tornadoes charged across Alabama, Georgia, Illinois, Indiana, Kentucky, Michigan, Mississippi, North Carolina, Ohio, South Carolina, Tennessee, Virginia, and West Virginia, killing 330 people and injuring 5,484 others. Within Ohio, the storm particularly affected Xenia, a municipality in Greene County (Region 1), where 37 tornadoes left 30 people dead, 1,100 injured, and more than 1,000 homes destroyed (NOAA, http://www.publicaffairs.noaa.gov/storms/). In September 2000, Xenia was again struck by an F4 tornado, damaging or destroying 300 homes and businesses, killing one person, and injuring 115 (Xenia 3-3).

Another notable storm occurred in April 1999 in the counties of Clinton, Hamilton, and Warren. The tornadoes killed four people, injured 42, and damaged or destroyed 400 structures, causing about $82 million in losses (Ohio EMA 16).

In more recent years there have been two disaster declarations DR-1444, which was for tornado-related damage, and DR-1484, which covered tornado and flood related damage. DR-1444 was in November 2002 and affected several counties in Region 1 and Region 2 and caused damage in Coshocton County, which is located in Region 3. The damage from this disaster was relative to a tornado that registers an F-4 on the Fujita Scale. Many of the residents of the impacted counties were left homeless, many were trapped in debris, damage to commercial structures created localized unemployment, hundreds of injuries were reported, and multiple lives were lost.

DR-1484 occurred in August 2003 and was the most recent declaration that included tornadic damage. The primary damage from this disaster was flood related, and a more thorough discussion of those issues can be found in the flood section of the Risk Assessment. However, Mahoning County was damaged by a tornado that spawned from the storm. The tornado was confirmed as an F-1 and affected part of the City of Youngstown and parts of the unincorporated areas of the County. The tornado was 50-100 yards wide and eight miles long. Sixty homes received major damage and 20 received minor damage. The estimated loss from this tornado was $900,000 and approximately 33% of the structures were insured.

In 2010, there were three significant events where tornadoes severely impacted Ohio communities.

The first event occurred in June 5 - 6, when a major tornado outbreak affected the Midwestern United States and Great Lakes Region. At least 46 tornadoes were confirmed from Iowa to southern Ontario and Ohio as well as northern New England. Tornadoes moved through northern Ohio affecting Fulton, Lucas, Wood, Ottawa, Richland, Holmes and Tuscarawas Counties. While all counties sustained heavy structural damage, the event resulted in seven people dead in Wood County. The Governor of Ohio issued an Emergency Proclamation for the event and requested a Presidential Declaration for the area, however, none was

granted. Regardless, tornadoes ranged from EF-0 northeast of Lucas, Ohio in Richland County, to an EF-4 tornado that resulted in 78 homes with major damage and 97 with minor damage. The total residential loss was approximately $7,545,300. Thirty-two businesses had major damage and three had minor damage resulting in $4,661,000 in losses. The Counties experienced a total of $1,263,858 in infrastructure damage.

The second event occurred when severe weather and tornadoes swept across the state in the afternoon of September 16th. The National Weather Service confirmed 11 tornadoes in Wayne, Holmes, Fairfield, Athens, Perry, Meigs, Delaware and Tuscarawas Counties and in the Tarlton, Ohio area that borders 3 counties. The tornadoes ranged from EF-0 to EF-3. Athens, Meigs, Pickaway, Perry and Wayne Counties declared a local state of emergency. Thirteen people were injured in Athens County, while six were injured in Meigs County. State and county teams assessed the damaged structures to be 62 destroyed, 77 with major damage, 113 with minor damage and 373 structures as affected. Residential loss equated to 2,227 claims amounting in $11,400,000, while business losses included 287 claims amounting in $4,700,000. There were 421 auto claims resulting in a loss of $1,200,000.

The third event occurred October 27th when a very intense area of low pressure pushed east through the Great Lakes Region, with a strong cold front moving through the Ohio Valley. This led to the development of a squall line producing 50-60 mph wind gusts in some areas. In addition, the strong wind shear associated with the weather system created a favorable environment for the development of tornadoes. The National Weather Service confirmed eight tornadoes in Auglaize, Fayette, Franklin, Licking, Paulding, Pickaway and Van Wert Counties. The tornadoes ranged from EF-0 to EF-2. The most severe impact occurred in the Cridersville area of Auglaize County. Preliminary damage assessments resulted in seven destroyed homes, five with major damage, four with minor damage and 29 affected. No businesses were reported to be affected.

The northwestern and central Ohio areas were impacted in April 2011 with tornadoes ranging from EF-0 to EF-2 in strength. An area of strong low pressure moved over the Great Plains at midday on April 19th and passed to the north of Lake Erie during the morning hours of the 20th. At the beginning of tornadic activity, the path of the tornadoes ran near Lake Street in Celina, Mercer County. The tornadoes caused substantial roof and chimney damage and very large trees were uprooted and snapped. Further to the northeast, wooden fence walls were down and snapped at the base of their four by four fence posts. Nearby, numerous power poles were snapped and metal light posts were down. A large brick free standing grocery building suffered major damage, including nearly all of the roof being lifted off and one of the brick walls collapsing. Although no fatalities or injuries were reported, tornadoes caused an estimated $1,045,000 in property damage for all areas affected.

EF-0 and EF-1 tornadoes ravaged the northern Ohio and the western side of the state from May 23–26, 2011. In Moore's Fork, Clermont County, a tornado blew down two high voltage towers along the Taylor Pike Road and destroyed a metal barn. The debris from the barn was deposited 300 to 400 feet across a field and into a tree line. A couple pieces of debris from the frame of the barn were impaled into the field. There were also some snapped trees and branches down along the tree line. The maximum estimated wind speed based on damage was 85 miles per hour. An EF1 tornado touched down in a cemetery on the southeast side of Monroeville, Huron County. This tornado then continued east on the ground for about eight miles before lifting near a roadway intersection on the southeast side of Norwalk. The path was parallel and just south of U.S. Route 20 for several miles. In Summit County, most of the damage was from fallen trees, but some buildings were also damaged. A church in Fairlawn lost its roof and several buildings sustained roof damage in downtown Cuyahoga Falls. Dozens of trees were either uprooted or snapped by the tornado. Several witnesses reported seeing a tornado in contact with the ground. An EF0 tornado touched down west of Pierpont in Ashtabula County near the intersection of Lewis Road and State Route 167. The tornado continued east along State Route 167 for just over a mile before lifting just west of the center of Pierpont. Ten homes and buildings along the damage path sustained damage, mainly from lost roofing or siding. Many trees were also downed. Although no fatalities or injuries were reported, tornadoes caused an estimated $1,045,000 in property damage for all areas affected.

In early March 2012, Brown and Clermont Counties experienced a devastating EF-3 tornado that came up from Kentucky and into Ohio. Thunderstorms developed during the afternoon in a high wind shear environment ahead of a strengthening low pressure system. Many of these storms became severe, with large hail, damaging thunderstorm winds, and tornadoes all being the main threats. The tornado traveled 7 miles in the Kentucky counties of Campbell and Pendleton. The tornado then moved into Clermont County, Ohio at 4:46 pm, where it hit the town of Moscow. It continued on the ground across Clermont County, crossing into Brown County around 4:58 pm. It then lifted south of Hamersville in western Brown County. This tornado caused extensive damage to structures and trees along its entire path on both sides of the Ohio River. Numerous homes were very heavily damaged or destroyed. Many homes lost their roofs, having complete exterior wall failure. Some modular homes were completely removed from their foundations, lifted, and thrown in excess of 100 yards where they were destroyed. The damage in Ohio from this tornado was consistent with maximum winds estimated at 160 miles per hour in Clermont County, and 100 miles per hour in Brown County. Clermont County experienced three deaths from the tornado. One fatality occurred in Moscow in Clermont County, while two others occurred in Bethel. Thirteen injuries were reported resulting from this storm. Property damage was estimated at $5,660,000.

As this same system moved into Adams County it caused an additional fatality. A tornado touched down just east of Highway 41, about 2 miles northeast of West Union. The tornado then traveled east northeast for just over 11 miles, destroying at least 5 mobile homes and damaging two other houses. One of these homes was built of brick. A 99 year old woman was in her mobile home in Tiffin Township when the tornado struck. She was injured from this tornado and passed away several days later. Two other people were also injured from this tornado. A dozen cattle were killed and major power transmission poles were knocked over. Numerous trees were snapped or uprooted. Based on the damage surveyed, the maximum estimated wind speed of this tornado was 125 miles per hour and caused an estimated $2 million in damage. The path of the tornado continued east into Pike and Scioto Counties causing an additional estimated $230,000 in damage, but no other fatalities or injuries were reported.

Probability of Future Events

Between 1950 and 2013, Ohio has experienced 1,126 tornadoes, an average of 17.87 tornadoes annually. Considering more tornadoes have formed in June than any other month, there is approximately a 13 percent chance of a tornado on any day in June (given 17.87storms annually, 2.32 of which should occur in June). The likelihood of a tornado is normally lower during the winter and higher during the summer, as indicated in Chart 2.3.a. While most tornadoes exhibit wind speeds less than 110 mph, 9.3 percent of past occurrences (1950 – 2011) involve F3 - F5 tornadoes with wind speeds of at least 162 mph. Table 2.3.c shows that the majority of tornadoes in Ohio (over 70 percent), fall in the gale to moderate categories (F0 to F1) causing light to moderate damage, such as breaking tree limbs or overturning mobile homes. Thirty-eight tornadoes, or 3.7 percent, have been F4 or F5 with wind speeds similar to those that affected Xenia in the 1974 Super Outbreak.

Table 2.3.c

Number and Percent of F0 –F5 Tornadoes in Ohio			
Category	**Estimated Wind Speed (mph)**	**Number of Tornadoes***	**Percent of Tornadoes***
F0	65 – 85	380	33.75%
F1	86 – 110	446	39.61%
F2	111 – 135	202	17.94%
F3	136 – 165	60	5.33%
F4	166 – 200	29	2.58%
F5	200+	9	0.80%
Total Tornadoes from 1950 - 2013		**1,126**	**100%**

*As of January 14, 2014. The numbers and percentages of tornadoes were based on the Fijuita scale.

Source: NOAA National Climatic Data Center, Storm Event Database, November 2011.

For a more detailed review of the probability of future occurrence for the state, Tables 2.3.d, 2.3.e, and 2.3.f project the probability of future tornadoes based on past occurrences in each county.

In Region 1, Clinton, Huron, Van Wert and Wood Counties have the highest incidence of tornadoes, as their combined occurrences account for 9.37 percent of the tornadoes that have touched down in Ohio from 1950 - 2013. Over 49.22 percent of the F0 and F3 tornadoes in the state have occurred in this Region, and over 48.33 percent of all 1,126 tornadoes have occurred here.

In Region 2, Franklin, Licking, Lorain, Pickaway, Richland, Warren, and Wayne, Counties have the highest incidence of tornadoes, as their combined occurrences account for 15.37 percent of the tornadoes that have touched down in Ohio from 1950 - 2013. Over 48.28 percent of the F4 tornadoes and over 55.56 percent of the F5 tornadoes in the state have occurred in this Region. Overall, this region accounts for over 36.57 percent of the tornadoes that have occurred in the state, and when this is analyzed with the region's high population and development trends, it makes sense that more damage has occurred here than any other region (this will be discussed further in the next section).

In Region 3, Adams, Brown, Clermont, and Columbiana Counties have the highest incidence of tornadoes, as their combined occurrences account for 6.71 percent of the tornadoes that have touched down in Ohio from 1950 - 2013. Combined, over 21.29 percent of all tornado touchdowns recorded during that 63-year period occurred in this Region.

Table 2.3.d

Number and Incidence of Tornadoes in Region 1														
County	F0		F1		F2		F3		F4		F5		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Allen	10	2.60%	8	1.83%	0	0.00%	2	3.33%	1	3.45%	0	0.00%	21	1.86%
Auglaize	8	2.08%	5	1.15%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	14	1.24%
Champaign	0	0.00%	1	0.23%	2	0.95%	1	1.67%	0	0.00%	0	0.00%	4	0.35%
Clark	8	2.08%	8	1.83%	1	0.47%	1	1.67%	0	0.00%	1	11.11%	19	1.68%
Clinton	18	4.69%	6	1.38%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	26	2.30%
Crawford	1	0.26%	9	2.06%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	11	0.97%
Darke	9	2.34%	4	0.92%	2	0.95%	3	5.00%	0	0.00%	0	0.00%	18	1.59%
Defiance	6	1.56%	0	0.00%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	8	0.71%
Erie	6	1.56%	4	0.92%	2	0.95%	0	0.00%	1	3.45%	0	0.00%	13	1.15%
Fayette	8	2.08%	3	0.69%	3	1.42%	1	1.67%	0	0.00%	0	0.00%	15	1.33%
Fulton	4	1.04%	6	1.38%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	12	1.06%
Hancock	2	0.52%	4	0.92%	5	2.37%	0	0.00%	0	0.00%	0	0.00%	11	0.97%
Hardin	3	0.78%	4	0.92%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	8	0.71%
Henry	7	1.82%	2	0.46%	2	0.95%	0	0.00%	1	3.45%	0	0.00%	12	1.06%
Huron	7	1.82%	8	1.83%	7	3.32%	1	1.67%	0	0.00%	0	0.00%	23	2.03%
Logan	2	0.52%	2	0.46%	1	0.47%	2	3.33%	0	0.00%	0	0.00%	7	0.62%
Lucas	2	0.52%	3	0.69%	2	0.95%	1	1.67%	0	0.00%	0	0.00%	8	0.71%
Madison	2	0.52%	5	1.15%	1	0.47%	1	1.67%	0	0.00%	0	0.00%	9	0.80%
Marion	5	1.30%	5	1.15%	5	2.37%	0	0.00%	0	0.00%	0	0.00%	15	1.33%
Mercer	9	2.34%	7	1.61%	3	1.42%	0	0.00%	1	3.45%	0	0.00%	20	1.77%
Miami	7	1.82%	9	2.06%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	18	1.59%
Morrow	5	1.30%	3	0.69%	7	3.32%	1	1.67%	0	0.00%	0	0.00%	16	1.41%
Ottawa	5	1.30%	2	0.46%	3	1.42%	1	1.67%	0	0.00%	0	0.00%	11	0.97%
Paulding	0	0.00%	7	1.61%	1	0.47%	2	3.33%	0	0.00%	0	0.00%	10	0.88%
Preble	4	1.04%	4	0.92%	1	0.47%	1	1.67%	1	3.45%	0	0.00%	11	0.97%
Putnam	5	1.30%	9	2.06%	1	0.47%	3	5.00%	0	0.00%	0	0.00%	18	1.59%
Sandusky	2	0.52%	4	0.92%	0	0.00%	0	0.00%	1	3.45%	0	0.00%	7	0.62%
Seneca	6	1.56%	8	1.83%	3	1.42%	3	5.00%	0	0.00%	0	0.00%	20	1.77%
Shelby	4	1.04%	0	0.00%	1	0.47%	1	1.67%	1	3.45%	0	0.00%	7	0.62%
Union	4	1.04%	5	1.15%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	10	0.88%
Van Wert	15	3.91%	13	2.98%	2	0.95%	0	0.00%	3	10.34%	0	0.00%	33	2.92%
Williams	2	0.52%	2	0.46%	3	1.42%	2	3.33%	0	0.00%	0	0.00%	9	0.80%
Wood	11	2.86%	5	1.15%	5	2.37%	2	3.33%	1	3.45%	0	0.00%	24	2.12%
Wyandot	2	0.52%	4	0.92%	3	1.42%	0	0.00%	0	0.00%	0	0.00%	9	0.80%
TOTAL	**189**	**49.22%**	**169**	**38.76%**	**78**	**36.97%**	**29**	**48.33%**	**11**	**37.93%**	**1**	**11.11%**	**477**	**42.14%**

Table 2.3.e

County	F0		F1		F2		F3		F4		F5		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Ashland	7	1.82%	7	1.61%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	16	1.41%
Ashtabula	2	0.52%	6	1.38%	5	2.37%	1	1.67%	1	3.45%	0	0.00%	15	1.33%
Butler	4	1.04%	6	1.38%	4	1.90%	1	1.67%	2	6.90%	0	0.00%	17	1.50%
Cuyahoga	4	1.04%	4	0.92%	3	1.42%	2	3.33%	2	6.90%	0	0.00%	15	1.33%
Delaware	3	0.78%	2	0.46%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	7	0.62%
Fairfield	4	1.04%	14	3.21%	1	0.47%	1	1.67%	0	0.00%	0	0.00%	20	1.77%
Franklin	14	3.65%	10	2.29%	6	2.84%	2	3.33%	0	0.00%	0	0.00%	32	2.83%
Geauga	4	1.04%	5	1.15%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	11	0.97%
Greene	3	0.78%	6	1.38%	5	2.37%	0	0.00%	1	3.45%	1	11.11%	16	1.41%
Hamilton	1	0.26%	5	1.15%	2	0.95%	2	3.33%	3	10.34%	1	11.11%	14	1.24%
Knox	5	1.30%	1	0.23%	5	2.37%	0	0.00%	0	0.00%	0	0.00%	11	0.97%
Lake	1	0.26%	0	0.00%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	2	0.18%
Licking	6	1.56%	11	2.52%	5	2.37%	1	1.67%	0	0.00%	0	0.00%	23	2.03%
Lorain	14	3.65%	8	1.83%	3	1.42%	0	0.00%	2	6.90%	0	0.00%	27	2.39%
Mahoning	5	1.30%	6	1.38%	4	1.90%	0	0.00%	0	0.00%	0	0.00%	15	1.33%
Medina	8	2.08%	11	2.52%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	21	1.86%
Montgomery	3	0.78%	6	1.38%	0	0.00%	1	1.67%	0	0.00%	0	0.00%	10	0.88%
Pickaway	6	1.56%	9	2.06%	5	2.37%	2	3.33%	0	0.00%	0	0.00%	22	1.94%
Portage	4	1.04%	4	0.92%	1	0.47%	1	1.67%	0	0.00%	1	11.11%	11	0.97%
Richland	8	2.08%	11	2.52%	7	3.32%	0	0.00%	0	0.00%	0	0.00%	26	2.30%
Stark	1	0.26%	7	1.61%	3	1.42%	0	0.00%	0	0.00%	0	0.00%	11	0.97%
Summit	5	1.30%	3	0.69%	2	0.95%	2	3.33%	0	0.00%	0	0.00%	12	1.06%
Trumbull	6	1.56%	4	0.92%	1	0.47%	2	3.33%	1	3.45%	2	22.22%	16	1.41%
Warren	10	2.60%	5	1.15%	4	1.90%	1	1.67%	2	6.90%	0	0.00%	22	1.94%
Wayne	3	0.78%	12	2.75%	7	3.32%	0	0.00%	0	0.00%	0	0.00%	22	1.94%
TOTAL	**131**	**34.11%**	**163**	**37.39%**	**82**	**38.86%**	**19**	**31.67%**	**14**	**48.28%**	**5**	**55.56%**	**414**	36.57%

Table 2.3.f

Number and Incidence of Tornadoes in Region 3														
County	F0		F1		F2		F3		F4		F5		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Adams	2	0.52%	9	2.06%	10	4.74%	1	1.67%	1	3.45%	0	0.00%	23	2.03%
Athens	1	0.26%	0	0.00%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	2	0.18%
Belmont	1	0.26%	1	0.23%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	0.18%
Brown	6	1.56%	9	2.06%	1	0.47%	0	0.00%	2	6.90%	0	0.00%	18	1.59%
Carroll	3	0.78%	4	0.92%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	8	0.71%
Clermont	9	2.34%	5	1.15%	1	0.47%	3	5.00%	1	3.45%	0	0.00%	19	1.68%
Columbiana	8	2.08%	4	0.92%	3	1.42%	1	1.67%	0	0.00%	0	0.00%	16	1.41%
Coshocton	0	0.00%	3	0.69%	1	0.47%	1	1.67%	0	0.00%	0	0.00%	5	0.44%
Gallia	1	0.26%	3	0.69%	2	0.95%	0	0.00%	0	0.00%	1	11.11%	7	0.62%
Guernsey	4	1.04%	2	0.46%	3	1.42%	0	0.00%	0	0.00%	0	0.00%	9	0.80%
Harrison	0	0.00%	1	0.23%	1	0.47%	1	1.67%	0	0.00%	0	0.00%	3	0.27%
Highland	2	0.52%	4	0.92%	3	1.42%	2	3.33%	0	0.00%	0	0.00%	11	0.97%
Hocking	0	0.00%	3	0.69%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	0.27%
Holmes	0	0.00%	6	1.38%	3	1.42%	0	0.00%	0	0.00%	0	0.00%	9	0.80%
Jackson	2	0.52%	1	0.23%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3	0.27%
Jefferson	1	0.26%	2	0.46%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	4	0.35%
Lawrence	1	0.26%	3	0.69%	0	0.00%	0	0.00%	0	0.00%	1	11.11%	5	0.44%
Meigs	0	0.00%	2	0.46%	1	0.47%	1	1.67%	0	0.00%	0	0.00%	4	0.35%
Monroe	1	0.26%	1	0.23%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	0.18%
Morgan	1	0.26%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	0.09%
Muskingum	0	0.00%	9	2.06%	6	2.84%	0	0.00%	0	0.00%	0	0.00%	15	1.33%
Noble	0	0.00%	2	0.46%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	3	0.27%
Perry	0	0.00%	7	1.61%	2	0.95%	1	1.67%	0	0.00%	0	0.00%	10	0.88%
Pike	10	2.60%	2	0.46%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	14	1.24%
Ross	3	0.78%	7	1.61%	1	0.47%	0	0.00%	0	0.00%	0	0.00%	11	0.97%
Scioto	3	0.78%	7	1.61%	2	0.95%	1	1.67%	0	0.00%	1	11.11%	14	1.24%
Tuscarawas	3	0.78%	7	1.61%	3	1.42%	0	0.00%	0	0.00%	0	0.00%	13	1.15%
Vinton	0	0.00%	1	0.23%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	0.09%
Washington	2	0.52%	2	0.46%	2	0.95%	0	0.00%	0	0.00%	0	0.00%	6	0.53%
TOTAL	**64**	**16.67%**	**107**	**24.54%**	**51**	**24.17%**	**12**	**20.00%**	**4**	**13.79%**	**3**	**33.33%**	**241**	**21.29%**

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

"Tornado Relative Risk" indicates whether there is a *low*, *medium*, or *high* probability of a damaging tornado occurrence based on historic events from 1950 – 2013 (Tables 2.3.d, 2.3.e, and 2.3.f). These classifications are based on a weighted scoring system whereby each tornado magnitude, F0 – F5, was assigned a weight, 1 – 6, respectively. The total "risk" for each county is based on the sum of the products of the weights and the number of tornadoes for each magnitude. Counties were sorted into three groups (*low*, *medium*, or *high*) based on these total risk scores.

Another assumption made in this methodology considers a high probability that mobile homes and residential units built without wind-resistant construction standards would suffer a significant amount of damage as a result of tornado. On a statewide basis, Ohio does not have building codes that address wind resistance for most types of residential dwellings. However, since 1990 many local codes that address wind resistance have been adopted. Therefore, the tornado vulnerability analysis evaluated the structures constructed prior to 1990. Additionally, all mobile homes were considered highly vulnerable to significant damage from a tornado given their less permanent construction.

2010 U.S. Census Bureau (2010 Census Data) housing data were assessed at the countywide level for all residential structures built prior to 1990. Also, the 2010 Census Data provide countywide estimates of mobile homes. The actual numbers of vulnerable residential housing units in each county was determined by adding the values for pre-1990 residential structures and mobile homes. Vulnerable structures represent a percentage of the residential and total building units, indicating the relative exposure of the county to tornado damage.

The average residential home value for pre-1990 structures and mobile homes was based upon 2010 Census Data for each county as well. Given this group's predisposition to damage from tornadoes, this analysis strictly evaluates an entire loss, or 100 percent of the structure replacement value. Map 2.3.c shows the number of vulnerable, residential structures (pre-1990 structures and mobile homes) by county. Map 2.3.d shows the same vulnerability in terms of dollars in each county.

Map 2.3.c

Residential Structures Vulnerable to Tornadoes By County

- < 20,000
- 20,000 - 40,000
- 40,001 - 60,000
- 60,001 - 80,000
- > 80,000

Assumption:
Prior to 1990, most residential structures were built without wind-resistant construction standards. Residential structures referenced here include those built prior to 1990 and mobile homes.

Data shown on this map were developed from 2010 US Census Data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

Map 2.3.d

Residential Vulnerability To Tornadoes By County

- < $2.5 Billion
- $2.5 - $5 Billion
- $5 - $7.5 Billion
- $7.5 - $10 Billion
- > $10 Billion

Assumption:
Prior to 1990, most residential structures were built without wind-resistant construction standards. Residential structures referenced here include those built prior to 1990 and mobile homes.

Data shown on this map were developed from 2010 US Census Data and 2011 NCDC climatological data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

"At-Risk Total Values" represent the product of the average residential value and number of vulnerable structures (pre-1990 residential structures and mobile homes).

County commercial and governmental unit counts have been calculated from the number of structures per census block according to the general building stock data in HAZUS-MH. Average values for commercial and governmental units have been based on 2010 Census Data average residential values. Commercial unit average value equals three times the average residential value, and governmental unit average value equals four times the average residential value. Commercial and governmental pre-1995 structures have been based on HAZUS-MH census block construction year ranges, as pre-1990 was not an option.

Historical damages include 62-year tornado damage totals for each county provided by the most current NCDC storm event database. These historic damages are not separated for residential, commercial, and governmental; they are listed to show the significance tornadoes play in each county's hazard analysis.

Results

Tables 2.3.g, 2.3.h, and 2.3.i provide information on the number of residential structures and the estimate of potential residential loss based on the number of structures, date of construction and average value by county for each Region.

Table 2.3.g

Tornado Vulnerability and Estimate of Potential Residential Losses for Region 1									
County	Tornado Relative Risk	Res. Units (Incl. Mobile Homes)	Avg. Res. Home Value	Non Mobile Home Res. Units Pre-1990	Mobile Homes	Pre-1990 Res. + Mobile Homes	% Res. Pre-1990 & MH (At Risk Pop.)	$ Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1990 Res. + All Mobile Homes) x$1,000
Allen	HIGH	45,057	$106,300	36,094	1,990	38,084	85%	$5,907,000	$4,048,000
Auglaize	MEDIUM	19,567	$127,800	14,691	765	15,456	79%	$3,705,000	$1,975,000
Champaign	LOW	16,776	$122,800	12,319	1,080	13,399	80%	$578,000	$1,645,000
Clark	HIGH	61,567	$108,800	50,254	3,056	53,310	87%	$3,179,000	$5,800,000
Clinton	HIGH	18,132	$125,000	11,427	1,375	12,802	71%	$8,232,000	$1,600,000
Crawford	MEDIUM	20,229	$93,700	17,103	955	18,058	89%	$1,780,000	$1,692,000
Darke	HIGH	22,701	$112,800	18,999	1000	19,999	88%	$30,788,000	$2,256,000
Defiance	LOW	16,748	$107,500	12,709	1,152	13,861	83%	$2,678,000	$1,490,000
Erie	MEDIUM	37,863	$142,500	29,388	1,457	30,845	81%	$3,485,000	$4,395,000
Fayette	MEDIUM	12,694	$111,200	9,031	619	9,650	76%	$5,795,000	$1,073,000
Fulton	MEDIUM	17,376	$136,000	11,935	1,449	13,384	77%	$5,853,000	$1,820,000
Hancock	MEDIUM	33,182	$134,200	22,839	1,734	24,573	74%	$15,553,000	$3,298,000
Hardin	LOW	13,121	$102,900	10,172	945	11,117	85%	$553,000	$1,144,000
Henry	MEDIUM	11,996	$123,300	9,261	1,018	10,279	86%	$2,653,000	$1,267,000
Huron	HIGH	25,185	$121,500	17,870	2,163	20,033	80%	$10,163,000	$2,434,000
Logan	LOW	23,178	$128,800	15,464	2,629	18,093	78%	$380,000	$2,330,000
Lucas	LOW	202,864	$119,900	171,974	5,256	177,230	87%	$30,650,000	$21,250,000
Madison	MEDIUM	15,907	$146,900	10,620	1,132	11,752	74%	$5,808,000	$1,726,000
Marion	MEDIUM	27,862	$98,700	22,491	1,212	23,703	85%	$1,440,000	$2,339,000
Mercer	HIGH	17,562	$122,900	12,828	1,034	13,862	79%	$6,555,000	$1,704,000
Miami	MEDIUM	44,085	$138,300	34,383	720	35,103	80%	$3,913,000	$4,855,000
Morrow	HIGH	14,077	$129,600	8,484	1,721	10,205	72%	$33,565,000	$1,323,000
Ottawa	MEDIUM	27,851	$147,000	17,725	3,772	21,497	77%	$41,250,000	$3,160,000
Paulding	MEDIUM	8,478	$73,800	6,331	1,142	7,473	88%	$1,275,000	$552,000
Preble	MEDIUM	17,883	$121,800	13,976	670	14,646	82%	$27,900,000	$1,784,000
Putnam	HIGH	13,717	$131,000	10,000	591	10,591	77%	$8,145,000	$1,387,000
Sandusky	LOW	26,398	$114,000	20,770	1,544	22,314	85%	$26,578,000	$2,544,000
Seneca	HIGH	24,174	$101,000	19,637	1,577	21,214	88%	$18,838,000	$2,143,000
Shelby	LOW	20,146	$124,800	15,075	988	16,063	80%	$3,002,000	$2,005,000
Union	LOW	19,302	$176,900	9,918	852	10,770	56%	$944,000	$1,905,000
Van Wert	HIGH	12,640	$89,200	10,457	812	11,269	89%	$34,654,000	$1,005,000
Williams	MEDIUM	16,704	$99,900	12,151	1,463	13,614	81%	$27,832,000	$1,360,000
Wood	HIGH	53,219	$156,200	34,679	3,858	38,537	72%	$130,832,000	$6,019,000
Wyandot	MEDIUM	9,871	$104,600	7,774	606	8,380	85%	$1,600,000	$877,000
REGIONAL TOTALS		968,112	$4,101,600	738,828	52,337	791,165	82%	$506,063,000	$96,205,000

Table 2.3.h

Tornado Vulnerability and Estimate of Potential Residential Losses for Region 2									
County	Tornado Relative Risk	Res. Units (Incl. Mobile Homes)	Avg. Res. Home Value	Non Mobile Home Res. Units Pre-1990	Mobile Homes	Pre-1990 Res. + Mobile Homes	% Res. Pre-1990 & MH (At Risk Pop.)	$ Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1990 Res. + All Mobile Homes) x$1,000
Ashland	MEDIUM	22,156	$126,900	14,945	1,073	16,018	72%	$8,753,000	$2,033,000
Ashtabula	HIGH	46,088	$117,500	35,144	2,838	37,982	82%	$6,353,000	$4,463,000
Butler	HIGH	147,766	$160,900	101,894	3,772	105,666	72%	$61,013,000	$17,002,000
Cuyahoga	HIGH	622,229	$135,900	561,549	3,644	565,193	91%	$67,753,000	$76,810,000
Delaware	LOW	65,577	$255,100	23,506	1,465	24,971	38%	$3,803,000	$6,370,000
Fairfield	HIGH	58,432	$166,400	35,487	1,442	36,929	63%	$1,753,000	$6,145,000
Franklin	HIGH	526,005	$156,600	383,066	4,150	387,216	74%	$56,830,000	$60,638,000
Geauga	LOW	36,467	$231,400	25,795	1,372	27,167	74%	$2,153,000	$6,286,000
Greene	HIGH	67,978	$159,100	48,490	1185	49,675	73%	$268,864,000	$7,903,000
Hamilton	HIGH	378,278	$149,400	328,586	3,081	331,667	88%	$138,490,000	$49,551,000
Knox	MEDIUM	25,035	$137,000	16,525	1,315	17,840	71%	$1,540,000	$2,444,000
Lake	LOW	27,625	$94,100	17,670	4,327	21,997	80%	$275,000	$2,070,000
Licking	HIGH	68,986	$153,100	44,513	2,940	47,453	69%	$30,533,000	$7,265,000
Lorain	HIGH	126,517	$147,600	93,253	2,850	96,103	76%	$36,613,000	$14,185,000
Mahoning	MEDIUM	112,133	$97,300	94,510	1,672	96,182	86%	$5,195,000	$9,359,000
Medina	HIGH	68,740	$187,500	41,226	855	42,081	61%	$6,623,000	$7,890,000
Montgomery	LOW	254,883	$119,100	218,808	3,254	222,062	87%	$2,660,000	$26,448,000
Pickaway	HIGH	21,142	$147,000	13,031	2,217	15,248	72%	$8,144,000	$2,242,000
Portage	MEDIUM	67,270	$157,400	44,036	5,021	49,057	73%	$250,850,000	$7,722,000
Richland	HIGH	54,686	$109,900	43,679	2,574	46,253	85%	$9,823,000	$5,083,000
Stark	MEDIUM	165,131	$126,500	133,856	3,603	137,459	83%	$51,625,000	$17,389,000
Summit	MEDIUM	244,936	$142,100	194,540	2,287	196,827	80%	$24,305,000	$27,969,000
Trumbull	HIGH	96,333	$102,000	79,678	4,549	84,227	87%	$506,605,000	$8,591,000
Warren	HIGH	80,094	$193,900	38,080	739	38,819	48%	$39,560,000	$7,527,000
Wayne	HIGH	45,822	$136,800	32,160	3,753	35,913	78%	$57,756,000	$4,913,000
REGIONAL TOTALS		3,430,309	$3,710,500	$2,664,027	65,978	2,730,005	80%	$1,647,872,000	$388,298,000

Table 2.3.i

Tornado Vulnerability and Estimate of Potential Residential Losses for Region 3									
County	Tornado Relative Risk	Res. Units (Incl. Mobile Homes)	Avg. Res. Home Value	Non Mobile Home Res. Units Pre-1990	Mobile Homes	Pre-1990 Res. + Mobile Homes	% Res. Pre-1990 & MH (At Risk Pop.)	$ Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1990 Res. + All Mobile Homes) x$1,000
Adams	MEDIUM	12,925	$99,800	6,774	3,359	10,133	78%	$720,000	$1,011,000
Athens	LOW	26,283	$117,700	15,159	4,656	19,815	75%	$250,000	$2,332,000
Belmont	LOW	32,403	$84,800	25,952	2,477	28,429	88%	$50,000	$2,411,000
Brown	HIGH	19,242	$122,200	10,634	3,203	13,837	72%	$10,333,000	$1,691,000
Carroll	LOW	13,667	$111,300	8,826	1,940	10,766	79%	$350,000	$1,198,000
Clermont	HIGH	80,317	$163,000	47,098	5,028	52,126	65%	$5,791,000	$8,496,000
Columbiana	MEDIUM	47,148	$96,300	35,784	3,835	39,619	84%	$28,860,000	$3,815,000
Coshocton	LOW	16,556	$94,700	10,601	2,923	13,524	82%	$27,530,000	$1,281,000
Gallia	MEDIUM	13,907	$110,500	7,334	3,054	10,388	75%	$9,150,000	$1,148,000
Guernsey	LOW	19,244	$92,500	12,728	2,627	15,355	80%	$3,353,000	$1,420,000
Harrison	LOW	7,680	$58,400	5,675	1,289	6,964	91%	$353,000	$407,000
Highland	MEDIUM	19,313	$104,500	11,161	3,419	14,580	75%	$1,230,000	$1,524,000
Hocking	LOW	13,348	$114,900	7,447	2,462	9,909	74%	$44,000	$1,139,000
Holmes	MEDIUM	13,603	$158,200	8,881	1,550	10,431	77%	$4,553,000	$1,650,000
Jackson	LOW	14,599	$93,200	8,448	2,558	11,006	75%	$2,800,000	$1,026,000
Jefferson	LOW	32,929	$85,500	27,852	2,057	29,909	91%	$360,000	$2,557,000
Lawrence	LOW	100,924	$158,700	79,008	2,327	81,335	81%	$2,750,000	$12,908,000
Meigs	LOW	11,200	$84,400	6,400	2,283	8,683	78%	$2,425,000	$733,000
Monroe	LOW	7,212	$62,500	5,037	1,393	6,430	89%	$275,000	$402,000
Morgan	LOW	7,771	$66,800	5,087	1,853	6,940	89%	$60,000	$464,000
Muskingum	HIGH	37,881	$109,900	25,961	3,992	29,953	79%	$6,845,000	$3,292,000
Noble	LOW	5,480	$63,700	3,603	1,141	4,744	87%	$328,000	$302,000
Perry	MEDIUM	15,136	$97,300	8,907	2,578	11,485	76%	$4,463,000	$1,118,000
Pike	LOW	12,454	$94,400	6,134	2,966	9,100	73%	$463,000	$859,000
Ross	MEDIUM	32,013	$115,000	20,064	4,308	24,372	76%	$3,460,000	$2,803,000
Scioto	MEDIUM	34,236	$88,000	23,069	4,847	27,916	82%	$4,875,000	$2,457,000
Tuscarawas	MEDIUM	40,140	$111,900	27,113	4,566	31,679	79%	$3,940,000	$3,545,000
Vinton	LOW	5,653	$64,400	2,914	1,901	4,815	85%	$0	$310,000
Washington	LOW	28,393	$108,100	19,895	3,747	23,642	83%	$1,400,000	$2,556,000
REGIONAL TOTALS		721,657	$2,932,600	483,547	84,339	567,886	79%	$127,011,000	$64,855,000

Tables 2.3.j, 2.3.k, and 2.3.l provide information on the number of commercial structures and the estimate of potential commercial structure loss based on the number of structures, date of construction and average value by county for each Region.

Table 2.3.j

Tornado Vulnerability and Estimate of Potential Commercial Losses for Region 1							
County	Tornado Relative Risk	Commercial Units	Average Commercial Value (3x Res. Ave. Value)	Commercial Units Pre-1995	% Comm. Pre-1995	Dollar Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1995 Commercial)
Allen	HIGH	466	$318,900	386	83%	$5,907,000	$123,095,400
Auglaize	MEDIUM	112	$383,400	97	87%	$3,705,000	$37,189,800
Champaign	LOW	84	$368,400	72	86%	$578,000	$26,524,800
Clark	HIGH	385	$326,400	306	79%	$3,179,000	$99,878,400
Clinton	HIGH	108	$375,000	89	82%	$8,232,000	$33,375,000
Crawford	MEDIUM	80	$281,100	67	84%	$1,780,000	$18,833,700
Darke	HIGH	107	$338,400	91	85%	$30,788,000	$30,794,400
Defiance	LOW	108	$322,500	90	83%	$2,678,000	$29,025,000
Erie	MEDIUM	332	$427,500	267	80%	$3,485,000	$114,142,500
Fayette	MEDIUM	71	$333,600	60	85%	$5,795,000	$20,016,000
Fulton	MEDIUM	110	$408,000	94	85%	$5,853,000	$38,352,000
Hancock	MEDIUM	279	$402,600	226	81%	$15,553,000	$90,987,600
Hardin	LOW	62	$308,700	52	84%	$553,000	$16,052,400
Henry	MEDIUM	61	$369,900	53	87%	$2,653,000	$19,604,700
Huron	HIGH	160	$364,500	136	85%	$10,163,000	$49,572,000
Logan	LOW	114	$386,400	96	84%	$380,000	$37,094,400
Lucas	LOW	2,027	$359,700	1703	84%	$30,650,000	$612,569,100
Madison	MEDIUM	59	$440,700	49	83%	$5,808,000	$21,594,300
Marion	MEDIUM	224	$296,100	185	83%	$1,440,000	$54,778,500
Mercer	HIGH	86	$368,700	72	84%	$6,555,000	$26,546,400
Miami	MEDIUM	305	$414,900	247	81%	$3,913,000	$102,480,300
Morrow	HIGH	30	$388,800	25	83%	$33,565,000	$9,720,000
Ottawa	MEDIUM	147	$441,000	121	82%	$41,250,000	$53,361,000
Paulding	MEDIUM	24	$221,400	19	79%	$1,275,000	$4,206,600
Preble	MEDIUM	72	$365,400	62	86%	$27,900,000	$22,654,800
Putnam	HIGH	101	$393,000	86	85%	$8,145,000	$33,798,000
Sandusky	LOW	142	$342,000	125	88%	$26,578,000	$42,750,000
Seneca	HIGH	147	$303,000	129	88%	$18,838,000	$39,087,000
Shelby	LOW	96	$374,400	80	83%	$3,002,000	$29,952,000
Union	LOW	86	$530,700	71	83%	$944,000	$37,679,700
Van Wert	HIGH	79	$267,600	70	89%	$34,654,000	$18,732,000
Williams	MEDIUM	93	$299,700	78	84%	$27,832,000	$23,376,600
Wood	HIGH	501	$468,600	416	83%	$130,832,000	$194,937,600
Wyandot	MEDIUM	62	$313,800	55	89%	$1,600,000	$17,259,000
REGIONAL TOTALS		6,920	$12,304,800	5,775	83%	$506,063,000	$2,130,021,000

Table 2.3.k

Tornado Vulnerability and Estimate of Potential Commercial Losses for Region 2							
County	Tornado Relative Risk	Commercial Units	Average Commercial Value (3x Res. Ave. Value)	Commercial Units Pre-1995	% Comm. Pre-1995	Dollar Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1995 Commercial)
Ashland	MEDIUM	96	$380,700	82	85%	$8,753,000	$31,217,400
Ashtabula	HIGH	224	$352,500	193	86%	$6,353,000	$68,032,500
Butler	HIGH	1,304	$482,700	1052	81%	$61,013,000	$507,800,400
Cuyahoga	HIGH	7,165	$407,700	5600	78%	$67,753,000	$2,283,120,000
Delaware	LOW	383	$765,300	284	74%	$3,803,000	$217,345,200
Fairfield	HIGH	319	$499,200	263	82%	$1,753,000	$131,289,600
Franklin	HIGH	5,004	$469,800	3855	77%	$56,830,000	$1,811,079,000
Geauga	LOW	299	$694,200	240	80%	$2,153,000	$166,608,000
Greene	HIGH	431	$477,300	326	76%	$268,864,000	$155,599,800
Hamilton	HIGH	4,606	$448,200	3716	81%	$138,490,000	$1,665,511,200
Knox	MEDIUM	95	$411,000	80	84%	$1,540,000	$32,880,000
Lake	LOW	1,005	$282,300	792	79%	$275,000	$223,581,600
Licking	HIGH	481	$459,300	382	79%	$30,533,000	$175,452,600
Lorain	HIGH	1,144	$442,800	900	79%	$36,613,000	$398,520,000
Mahoning	MEDIUM	1,097	$291,900	900	82%	$5,195,000	$262,710,000
Medina	HIGH	698	$562,500	563	81%	$6,623,000	$316,687,500
Montgomery	LOW	2,393	$357,300	1857	78%	$2,660,000	$663,506,100
Pickaway	HIGH	88	$441,000	71	81%	$8,144,000	$31,311,000
Portage	MEDIUM	432	$472,200	334	77%	$250,850,000	$157,714,800
Richland	HIGH	443	$329,700	358	81%	$9,823,000	$118,032,600
Stark	MEDIUM	1,453	$379,500	1196	82%	$51,625,000	$453,882,000
Summit	MEDIUM	2,412	$426,300	1946	81%	$24,305,000	$829,579,800
Trumbull	HIGH	759	$306,000	618	81%	$506,605,000	$189,108,000
Warren	HIGH	457	$581,700	345	75%	$39,560,000	$200,686,500
Wayne	HIGH	272	$410,400	224	82%	$57,756,000	$91,929,600
REGIONAL TOTALS		33,060	$11,131,500	26,177	79%	$1,647,872,000	$11,183,185,200

Table 2.3.l

Tornado Vulnerability and Estimate of Potential Commercial Losses for Region 3							
County	Tornado Relative Risk	Commercial Units	Average Commercial Value (3x Res. Ave. Value)	Commercial Units Pre-1995	% Comm. Pre-1995	Dollar Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1995 Commercial)
Adams	MEDIUM	38	$299,400	32	84%	$720,000	$9,580,800
Athens	HIGH	159	$353,100	130	82%	$250,000	$45,903,000
Belmont	HIGH	236	$254,400	207	88%	$50,000	$52,660,800
Brown	HIGH	56	$366,600	46	82%	$10,333,000	$16,863,600
Carroll	HIGH	43	$333,900	36	84%	$350,000	$12,020,400
Clermont	HIGH	594	$489,000	484	81%	$5,791,000	$236,676,000
Columbiana	MEDIUM	257	$288,900	220	86%	$28,860,000	$63,558,000
Coshocton	HIGH	87	$284,100	73	84%	$27,530,000	$20,739,300
Gallia	MEDIUM	102	$331,500	83	81%	$9,150,000	$27,514,500
Guernsey	HIGH	113	$277,500	96	85%	$3,353,000	$26,640,000
Harrison	HIGH	23	$175,200	20	87%	$353,000	$3,504,000
Highland	MEDIUM	84	$313,500	69	82%	$1,230,000	$21,631,500
Hocking	HIGH	48	$344,700	40	83%	$44,000	$13,788,000
Holmes	MEDIUM	182	$474,600	154	85%	$4,553,000	$73,088,400
Jackson	HIGH	61	$279,600	51	84%	$2,800,000	$14,259,600
Jefferson	HIGH	216	$256,500	178	82%	$360,000	$45,657,000
Lawrence	HIGH	78	$476,100	62	79%	$2,750,000	$29,518,200
Meigs	HIGH	38	$253,200	32	84%	$2,425,000	$8,102,400
Monroe	HIGH	38	$187,500	33	87%	$275,000	$6,187,500
Morgan	HIGH	30	$200,400	25	83%	$60,000	$5,010,000
Muskingum	HIGH	286	$329,700	238	83%	$6,845,000	$78,468,600
Noble	HIGH	25	$191,100	22	88%	$328,000	$4,204,200
Perry	MEDIUM	37	$291,900	32	86%	$4,463,000	$9,340,800
Pike	HIGH	60	$283,200	49	82%	$463,000	$13,876,800
Ross	MEDIUM	185	$345,000	152	82%	$3,460,000	$52,440,000
Scioto	MEDIUM	188	$264,000	158	84%	$4,875,000	$41,712,000
Tuscarawas	MEDIUM	223	$335,700	192	86%	$3,940,000	$64,454,400
Vinton	HIGH	15	$193,200	13	87%	$0	$2,511,600
Washington	HIGH	183	$324,300	153	84%	$1,400,000	$49,617,900
REGIONAL TOTAL		3,685	$8,797,800	3,080	84%	$127,011,000	$1,049,529,300

Tables 2.3.m, 2.3.n, and 2.3.o provide information on the number of local governmental structures and the estimate of potential local governmental structure loss based on the number of structures, date of construction and average value by county for each Region.

Table 2.3.m

Tornado Vulnerability and Estimate of Potential Local Governmental Losses for Region 1							
County	Tornado Relative Risk	Gov. Units	Average Governmental Value (4x Res. Ave. Value)	Governmental Units Pre-1995	% Gov. Pre-1995	Dollar Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1995 Governmental)
Allen	HIGH	27	$425,200	22	81%	$5,907,000	$9,354,400
Auglaize	MEDIUM	5	$511,200	4	80%	$3,705,000	$2,044,800
Champaign	LOW	4	$491,200	3	75%	$578,000	$1,473,600
Clark	HIGH	6	$435,200	5	83%	$3,179,000	$2,176,000
Clinton	HIGH	15	$500,000	12	80%	$8,232,000	$6,000,000
Crawford	MEDIUM	6	$374,800	5	83%	$1,780,000	$1,874,000
Darke	HIGH	4	$451,200	3	75%	$30,788,000	$1,353,600
Defiance	LOW	5	$430,000	4	80%	$2,678,000	$1,720,000
Erie	MEDIUM	16	$570,000	13	81%	$3,485,000	$7,410,000
Fayette	MEDIUM	4	$444,800	3	75%	$5,795,000	$1,334,400
Fulton	MEDIUM	6	$544,000	5	83%	$5,853,000	$2,720,000
Hancock	MEDIUM	6	$536,800	5	83%	$15,553,000	$2,684,000
Hardin	LOW	3	$411,600	3	100%	$553,000	$1,234,800
Henry	MEDIUM	4	$493,200	3	75%	$2,653,000	$1,479,600
Huron	HIGH	8	$486,000	7	88%	$10,163,000	$3,402,000
Logan	LOW	3	$515,200	3	100%	$380,000	$1,545,600
Lucas	LOW	27	$479,600	23	85%	$30,650,000	$11,030,800
Madison	MEDIUM	10	$587,600	8	80%	$5,808,000	$4,700,800
Marion	MEDIUM	11	$394,800	9	82%	$1,440,000	$3,553,200
Mercer	HIGH	3	$491,600	3	100%	$6,555,000	$1,474,800
Miami	MEDIUM	10	$553,200	8	80%	$3,913,000	$4,425,600
Morrow	HIGH	3	$518,400	2	67%	$33,565,000	$1,036,800
Ottawa	MEDIUM	4	$588,000	3	75%	$41,250,000	$1,764,000
Paulding	MEDIUM	3	$295,200	2	67%	$1,275,000	$590,400
Preble	MEDIUM	9	$487,200	8	89%	$27,900,000	$3,897,600
Putnam	HIGH	3	$524,000	3	100%	$8,145,000	$1,572,000
Sandusky	LOW	4	$456,000	4	100%	$26,578,000	$1,824,000
Seneca	HIGH	5	$404,000	4	80%	$18,838,000	$1,616,000
Shelby	LOW	4	$499,200	3	75%	$3,002,000	$1,497,600
Union	LOW	1	$707,600	1	100%	$944,000	$707,600
Van Wert	HIGH	2	$356,800	2	100%	$34,654,000	$713,600
Williams	MEDIUM	3	$399,600	3	100%	$27,832,000	$1,198,800
Wood	HIGH	13	$624,800	11	85%	$130,832,000	$6,872,800
Wyandot	MEDIUM	6	$418,400	5	83%	$1,600,000	$2,092,000
REGIONAL TOTALS		243	$16,406,400	202	83%	$506,063,000	$98,375,200

Table 2.3.n

Tornado Vulnerability and Estimate of Potential Local Governmental Losses for Region 2							
County	Tornado Relative Risk	Gov. Units	Average Governmental Value (4x Res. Ave. Value)	Governmental Units Pre-1995	% Gov. Pre-1995	Dollar Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1995 Governmental)
Ashland	MEDIUM	7	$507,600	6	86%	$8,753,000	$3,045,600
Ashtabula	HIGH	18	$470,000	16	89%	$6,353,000	$7,520,000
Butler	HIGH	45	$643,600	36	80%	$61,013,000	$23,169,600
Cuyahoga	HIGH	267	$543,600	209	78%	$67,753,000	$113,612,400
Delaware	LOW	7	$1,020,400	5	71%	$3,803,000	$5,102,000
Fairfield	HIGH	12	$665,600	10	83%	$1,753,000	$6,656,000
Franklin	HIGH	562	$626,400	433	77%	$56,830,000	$271,231,200
Geauga	LOW	10	$925,600	8	80%	$2,153,000	$7,404,800
Greene	HIGH	31	$636,400	23	74%	$268,864,000	$14,637,200
Hamilton	HIGH	136	$597,600	110	81%	$138,490,000	$65,736,000
Knox	MEDIUM	7	$548,000	6	86%	$1,540,000	$3,288,000
Lake	LOW	37	$376,400	29	78%	$275,000	$10,915,600
Licking	HIGH	26	$612,400	21	81%	$30,533,000	$12,860,400
Lorain	HIGH	28	$590,400	22	79%	$36,613,000	$12,988,800
Mahoning	MEDIUM	44	$389,200	36	82%	$5,195,000	$14,011,200
Medina	HIGH	24	$750,000	19	79%	$6,623,000	$14,250,000
Montgomery	LOW	90	$476,400	70	78%	$2,660,000	$33,348,000
Pickaway	HIGH	16	$588,000	13	81%	$8,144,000	$7,644,000
Portage	MEDIUM	11	$629,600	8	73%	$250,850,000	$5,036,800
Richland	HIGH	8	$439,600	6	75%	$9,823,000	$2,637,600
Stark	MEDIUM	23	$506,000	19	83%	$51,625,000	$9,614,000
Summit	MEDIUM	69	$568,400	56	81%	$24,305,000	$31,830,400
Trumbull	HIGH	24	$408,000	20	83%	$506,605,000	$8,160,000
Warren	HIGH	7	$775,600	5	71%	$39,560,000	$3,878,000
Wayne	HIGH	9	$547,200	7	78%	$57,756,000	$3,830,400
REGIONAL TOTALS		1,518	$14,842,000	1,193	79%	$1,647,872,000	$692,408,000

Table 2.3.o

Tornado Vulnerability and Estimate of Potential Local Governmental Losses for Region 3							
County	Tornado Relative Risk	Gov. Units	Average Governmental Value (4x Res. Ave. Value)	Governmental Units Pre-1995	% Gov. Pre-1995	Dollar Value of Historic Tornado Damages (60+ yrs. NOAA)	At Risk Total Value (Pre-1995 Governmental)
Adams	MEDIUM	4	$399,200	3	75%	$720,000	$1,197,600
Athens	HIGH	12	$470,800	10	83%	$250,000	$4,708,000
Belmont	HIGH	13	$339,200	11	85%	$50,000	$3,731,200
Brown	HIGH	3	$488,800	2	67%	$10,333,000	$977,600
Carroll	HIGH	6	$445,200	5	83%	$350,000	$2,226,000
Clermont	HIGH	16	$652,000	13	81%	$5,791,000	$8,476,000
Columbiana	MEDIUM	9	$385,200	8	89%	$28,860,000	$3,081,600
Coshocton	HIGH	3	$378,800	3	100%	$27,530,000	$1,136,400
Gallia	MEDIUM	2	$442,000	2	100%	$9,150,000	$884,000
Guernsey	HIGH	3	$370,000	3	100%	$3,353,000	$1,110,000
Harrison	HIGH	3	$233,600	3	100%	$353,000	$700,800
Highland	MEDIUM	6	$418,000	5	83%	$1,230,000	$2,090,000
Hocking	HIGH	8	$459,600	7	88%	$44,000	$3,217,200
Holmes	MEDIUM	5	$632,800	4	80%	$4,553,000	$2,531,200
Jackson	HIGH	5	$372,800	4	80%	$2,800,000	$1,491,200
Jefferson	HIGH	7	$342,000	6	86%	$360,000	$2,052,000
Lawrence	HIGH	6	$634,800	5	83%	$2,750,000	$3,174,000
Meigs	HIGH	2	$337,600	2	100%	$2,425,000	$675,200
Monroe	HIGH	4	$250,000	3	75%	$275,000	$750,000
Morgan	HIGH	2	$267,200	2	100%	$60,000	$534,400
Muskingum	HIGH	10	$439,600	8	80%	$6,845,000	$3,516,800
Noble	HIGH	2	$254,800	2	100%	$328,000	$509,600
Perry	MEDIUM	5	$389,200	4	80%	$4,463,000	$1,556,800
Pike	HIGH	4	$377,600	3	75%	$463,000	$1,132,800
Ross	MEDIUM	6	$460,000	5	83%	$3,460,000	$2,300,000
Scioto	MEDIUM	8	$352,000	7	88%	$4,875,000	$2,464,000
Tuscarawas	MEDIUM	6	$447,600	5	83%	$3,940,000	$2,238,000
Vinton	HIGH	3	$257,600	3	100%	$0	$772,800
Washington	HIGH	5	$432,400	4	80%	$1,400,000	$1,729,600
REGIONAL TOTALS		168	$11,730,400	142	85%	$127,011,000	$60,964,800

Region 1 has the second highest number (791,165) of vulnerable residential structures with an estimated potential loss of $96,205,000,000, which represents approximately 82 percent of the region's populace. Within Region 1, Lucas County has the largest number of residential structures (177,230) that include pre-1990 and mobile homes. As a result, Lucas has the highest estimate of potential residential loss in the Region ($21,250,000,000). However, Lucas County exhibits a *low* relative tornado risk given past occurrences. Wood County has a *high* relative risk and demonstrates the second highest potential residential loss in this region ($6,019,000,000). Also, Wood County has the highest historical damage value due to tornadoes in Region 1 ($130,832,000).

Additionally, Region 1 has the second highest number (5,775) of commercial structures vulnerable to tornadoes with a total at-risk value of $2,130,021,000. Within Region 1, Lucas County has the largest number of commercial structures vulnerable with a total estimated, potential loss of $612,569,100. Since Lucas County exhibits a *low* relative tornado risk, it should be noted that Wood County shows the second highest potential commercial loss ($194,937,000) and has a *high* relative tornado risk.

Region 1 also has the second highest number of local governmental structures vulnerable to tornadoes (202), worth an estimated $98,375,200. Again, Lucas County has the highest vulnerability within the Region with a total of 23 local governmental structures at risk, but with a *high* relative risk, Allen County should be noted with an at-risk value of $9,354,400.

Region 2 has the highest number (2,730,005) of vulnerable residential structures with an estimated potential loss of $388,298,000,000. Within the Region, Cuyahoga County has the largest number of residential structures that were built prior to 1990, and this county is characterized by *high* relative tornado risk. As a result, Cuyahoga County has the highest estimate of potential residential loss in the Region ($76,810,000,000). It should also be noted that more tornadoes have occurred within Franklin County than any other county in the state, and it exhibits over 387,000 structures at risk for an at-risk value of $60,638,000,000.

Region 2 greatly supersedes Regions 1 and 3 in the number (26,177) of commercial structures vulnerable to tornadoes, with an estimated vulnerability of $11,183,185,200. Within Region 2, Cuyahoga County has the largest number of commercial structures vulnerable with a total estimated vulnerability of $2,283,120,000. Pickaway County has the least amount of commercial structures at risk (71) with a total estimated vulnerability of $31,311,000.

As with residential and commercial vulnerability, Region 2 has the highest vulnerability to tornadoes for local governmental structures with a total of 1,193 structures worth $692,408,000. Franklin County has the highest number of local governmental structures vulnerable (433) with a total estimated value of $271,231,200.

Region 3 has the lowest number (567,886) of vulnerable residential structures worth an estimated $64,855,000,000. However, the number of mobile homes in this region is higher than any other region (84,339). Clermont County has the largest number of residential structures built prior to 1990. As a result, Clermont County has the highest estimate of potential residential loss in the Region ($8,496,000,000). Noble County has the lowest number of vulnerable residential structures within the state (4,744), also exhibiting the lowest at-risk value in the state ($302,000,000).

In addition to the lowest number of residential structures vulnerable to tornadoes, Region 3 also has the lowest number of commercial structures (3,080) vulnerable to tornadoes. The total estimated dollars at risk for these commercial structures is $1,049,529,300. Within the Region Clermont County has the largest number

(484) of commercial structures vulnerable with a total, estimated risk of $236,676,000.

As with residential and commercial, Region 3 has the least governmental structure vulnerability. The Region has 142 local governmental structures vulnerable to tornadoes, with a total at-risk value of $60,964,800. Within the Region Clermont County has the highest vulnerability with 13 local, governmental structures worth an estimated $8,476,000.

Statewide Tornado Mitigation Initiatives

The state of Ohio makes funding available for tornado warning sirens through EMPG Special Project funds, and HMGP 5% project funds. Many communities in the state have outdoor warning systems that cover their entire population. Other communities choose to rely on reverse 911 system, television, internet, radio, and social media for weather warning.

In addition to promoting tornado warning, the Ohio EMA also implements the Ohio Safe Room Rebate Program. This program provides a rebate to homeowners for a portion of the costs to construct/install a residential safe room that complies with FEMA publication 320 and 361. The program has been implemented several times and could be made available to residents rebuilding after a tornado.

The Ohio EMA received a grant in 2013 to implement a wind mitigation and education campaign. There are several components to the scope of work for this project. The first component is the construction of a life-size mobile safe room display that will be used to educate citizens about residential safe rooms. The project also involves working with the Ohio Manufactured Home Park Commission to develop community safe room outreach materials for manufactured home park owners and residents. The last phase of the wind mitigation and education campaign involves printing mitigation themed coloring books and other similar materials that can be distributed at public events.

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

The methodology to determine the vulnerability of state-owned critical and non-critical facilities to tornadoes is very similar to that discussed previously in this section. Since tornadoes are non-spatial hazards and have the potential to affect all state-owned structures, the determination was made to assess total replacement costs for the two categories of state-owned facilities (critical and non-critical). Additionally, many state-government facilities are leased, and the replacement costs associated with these structures are based on the annual rental fees. Additional information about these state datasets can be found in section 2.1 of this plan. All facility numbers and at-risk dollars referenced in this section are listed by county in Appendix C. Maps C-1 and C-2 show the at-risk

values for state-owned and state-leased critical facilities, and these maps are located in Appendix C.

Region 1 has the highest number (906) of state-owned critical facilities in the state, with an estimated at-risk value of $845,529,480. This represents approximately 39 percent of the state-owned critical facilities in the state. Ottawa County has the highest number of critical facilities within this region (91), which are mostly associated with a facility operated by the Adjutant General's Office. The highest at-risk value is $421,369,273, which is mostly associated with a correctional facility in Marion County. The second highest number of state-owned critical facilities in this region is within Allen County. Since this county has a *high* relative tornado risk, it is important to note that those 87 structures represent approximately $129,644,317 of vulnerability.

Region 2 has the second highest number (900) of state-owned critical facilities in the state, with an estimated at-risk value of $1,543,696,210. This vulnerability is nearly double that shown for Region 1 because of the large number of state administration buildings located in Franklin County (state capital). It makes sense that Franklin County contains the highest number (99) of state-owned critical facilities in the state, worth an estimated $675,509,073. This region also contains the highest number of state-owned structures (critical and non-critical) in the state, with over 1,700.

Region 3 has the lowest number (537) of state-owned critical facilities in the state, with an estimated at-risk value of $389,733,587. Ross County has the highest number (60) of critical facilities within this region, which are mostly associated with two state correctional institutes.

In terms of state-leased critical facilities, Region 2 has the highest number (24) and vulnerability ($7,841,431). Over half of these leases (14) are within Franklin County, which corresponds to previously discussed results. Regions 1 and 3 have three facilities per region that are critical in nature to response and recovery, with at-risk values of $654,528 and $476,832, respectively.

2.4 WINTER STORM

Canadian and Arctic cold fronts that push cold temperatures, ice, and snow into the State generally cause winter storms, blizzards, and ice storms in Ohio. 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.

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, and,
- temperatures of 20º F or lower.

Severe blizzards have wind speeds exceeding 45 mph, visibility near zero, and temperatures of 10º F or lower.

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” (see Figure 2.4.a). 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 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.

Figure 2.4.a

Generation of Lake Effect Snow

Source: The Weather Doctor, http://www.islandnet.com/~see/weather/elements/lkefsnw2.htm

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.

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.

RISK ASSESSMENT

Location

Winter storms are non-spatial hazards; therefore, it is difficult to determine the actual location of the damage that may result from a winter storm event. In an effort to conquer this limitation the mean annual snow depth from 1994 to 2003 was mapped (see Map 2.4.a).

Map 2.4.a

State of Ohio Annual Mean Snow Depth 1994 - 2003

- < 24"
- 24.1" - 36"
- 36.1" - 48"
- 48.1" - 72"
- > 72"

The NOAA Storm Events Database contains data from the following sources: All Weather Events 1994 - 1995, as entered into Storm Data (No Latitude/Longitude); All Weather Events 1996 - 2003, as entered into Storm Data (including Latitude/Longitude).

Data shown on this map were developed from NOAA storm data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

Most of the counties in Region 1 have experienced a mid-level (24.1" – 36") of snow in the time frame specified. However, Lucas, Van Wert, Auglaize, Logan, and Hardin counties have sparse areas where higher snow levels have been experienced.

Historically, Region 2 has experienced the highest mean annual snow depth. The Region contains all of the counties that have experienced the highest annual mean snow depth, with parts of Geauga and Ashtabula counties having the highest in the state, and Lake, Cuyahoga, Portage, and Trumbull having the second highest in the state.

The largest number of counties within the lower portion of Region 3 has had a moderate mean annual snow depth. The upper section of the region has, for the most part, a medium depth with parts of Columbiana, Carroll, and Tuscarawas having higher depths than other counties in the region. As a result, it appears that the lower portions of this region have the least chance of receiving a significant event when compared to upper portions of the region.

Past Occurrences

Ohio experienced more than 280 severe winter storms between 1925 and 2014. Several storms were notable and, since 1964, two involved federal declarations.

In January 1978, the Great Blizzard of 1978 closed homes and businesses 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 26, 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.

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 snow fall 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.

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.

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.

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.

Probability of Future Events

Map 2.4.a depicts National Climatic Data Center figures of Ohio's annual mean snow depth for the years 1994 to 2003. Southern portions of Ohio have mean snow depths of 12 to 24 inches and central Ohio has between 24 and 36 inches. However, the northeastern corner of the state has mean snow depths of 48 to more than 72 inches. In terms of probability, the snow depth with a 5% chance of being exceeded in any given year is between 50 and 60 inches in parts of Ohio. However, the vast majority of Ohio has the same chance of exceeding only 10 to 30 inches. 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 the Great Lakes.

Global climate change may have an impact on the probability of future events; however, it is unclear as to the extent of this impact.

LHMP Data

Cuyahoga County. The Countywide All Natural Hazards Mitigation Plan of October 2010 states that severe winter weather can pose consequences to Cuyahoga County in terms of power outages, impassible roadways, and safety concerns. As occurrences of severe winter weather are random in nature,

historic events were referenced to determine Cuyahoga County's susceptibility. According to the National Climatic Data Center website, between1993 - 2010, Cuyahoga County has been impacted by 81 severe winter weather events that have accounted for $254,160,000 in damages to affected areas throughout the State.

Lake County. The Lake County Hazard Risk Assessment of October 2010 indicates there have been 99 severe winter storms from 1950 to 2010. These types of storms are known to expend 15% of the snow removal budget and have left 185,000 customers without power. After extensive examination and spreadsheet calculations, loss estimates show $113,173,477 in structure damage d business functional loss of $4,351,419 for a total of $117,524,895.

Ashtabula County. The HIRA of the Ashtabula County Countywide All Natural Hazards Mitigation Plan of August 2012 examines subcategories of winter storms: blizzards, ice storms, lake effect snow on the southeastern Lake Erie Snow Belt and extreme cold. From 1993 to 2011, there were 105 severe winter events causing a total of over $200 million in property and crop damage. The frequency is the expectation of eight storms in any given year.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Considering all hazards identified in the local plans, winter storms ranked second in terms of frequency among the counties in the state (Chart 2.2.a). In terms of local magnitude, winter storms ranked the highest since most storms affect a large percentage of the land area within a given community when they occur. While ranking high for frequency and magnitude, winter storms ranked low for onset and property losses. Most winter storms are fairly predictable in terms of location and timing, which most likely resulted in low onset rankings. Also, property losses associated with these storms are fairly low compared to other hazards like flooding or tornadoes. According to records and data entered to date into vulnerability assessments, losses from winter storms are estimated at 428,792 residential structures ($14,487,090,117), 23,547 non-residential structures ($5,080,739,305) and 1,192 critical facilities ($2,034,278,248). These and additional HIRA data queried from SHARPP can be found in Appendix J.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

The 10-year winter storm losses (1994-2003) for each county provided the basis for estimating potential vulnerability and losses. To yield the per capita 10-year damage total for each county, the total damage for the decade was divided by the 2001 population. That figure divided by ten, resulted in the annual per capita damage figure for severe winter storms in each county (in raw dollar unadjusted for inflation). This is the figure that appears in the right column in Table 2.4.a.

Results

Using 2001 population estimates and winter storm loss data spanning a decade, the state can expect an annual winter storm loss of $13.07 per capita, which equates to a statewide winter storm loss of approximately $1,481,380,006 (see Table 2.4.a). The 10-Year loss includes all residential, commercial, governmental structures, as well as infrastructure and public facilities for each county.

Table 2.4.a

Estimate of Potential Losses to Winter Storms by Region

Region 1

County	2001 Pop.	10-Year Winter Storm Losses	Per-Capita Annual Winter Storm Losses
Allen	108,522	$1,375,000	$1.27
Auglaize	46,453	$15,651,000	$33.69
Champaign	39,210	$16,551,000	$42.21
Clark	143,969	$16,551,000	$11.50
Clinton	41,277	$17,536,000	$42.48
Crawford	46,695	$13,196,000	$28.26
Darke	53,178	$71,151,000	$133.80
Defiance	39,195	$6,250,000	$15.95
Erie	79,321	$19,598,000	$24.71
Fayette	28,387	$15,361,000	$54.11
Fulton	42,334	$12,367,000	$29.21
Hancock	71,745	$14,658,000	$20.43
Hardin	31,945	$1,405,000	$4.40
Henry	29,090	$1,812,000	$6.23
Huron	59,775	$15,986,000	$26.74
Logan	46,115	$1,875,000	$4.07
Lucas	454,029	$27,592,000	$6.08
Madison	40,158	$16,651,000	$41.46
Marion	65,639	$11,841,000	$18.04
Mercer	40,886	$15,651,000	$38.28
Miami	99,329	$16,551,000	$16.66
Morrow	32,319	$14,686,000	$45.44
Ottawa	41,036	$21,667,000	$52.80
Paulding	20,163	$1,425,000	$7.07
Preble	42,344	$16,556,000	$39.10
Putnam	34,741	$1,405,000	$4.04
Sandusky	61,653	$21,837,000	$35.42
Seneca	58,314	$18,071,000	$30.99
Shelby	48,233	$1,375,000	$2.85
Van Wert	29,432	$1,401,000	$4.76
Williams	39,200	$11,255,000	$28.71
Wood	121,680	$21,487,000	$17.66
Wyandot	22,956	$10,006,000	$43.59
TOTAL	**2,159,323**	**$470,780,000**	**$21.80**

Region 2

County	2001 Pop.	10-Year Winter Storm Losses	Per-Capita Annual Winter Storm Losses
Ashland	52,786	$19,821,000	$37.55
Ashtabula	102,729	$42,823,000	$41.69
Butler	335,992	$18,686,000	$5.56
Cuyahoga	1,384,252	$43,876,000	$3.17
Delaware	118,215	$16,951,000	$14.34
Fairfield	125,109	$19,961,000	$15.95
Franklin	1,081,784	$16,125,000	$1.49
Geauga	92,294	$47,743,000	$51.73
Greene	148,530	$16,551,000	$11.14
Hamilton	838,134	$17,886,000	$2.13
Knox	55,250	$17,726,000	$32.08
Lake	227,324	$46,870,000	$20.62
Licking	149,080	$16,711,000	$11.21
Lorain	285,798	$42,236,000	$14.78
Mahoning	254,810	$22,344,000	$8.77
Medina	154,718	$20,481,000	$13.24
Montgomery	553,579	$16,551,000	$2.99
Pickaway	52,840	$14,961,000	$28.31
Portage	153,056	$40,279,000	$26.32
Richland	128,549	$13,726,000	$10.68
Stark	378,098	$32,379,000	$8.56
Summitt	542,899	$47,981,000	$8.84
Trumbull	223,513	$42,459,000	$19.00
Warren	168,229	$17,986,000	$10.69
Wayne	112,274	$17,534,000	$15.62
TOTAL	**7,719,842**	**$670,647,000**	**$8.69**

Region 3

County	2001 Pop.	10-Year Winter Storm Losses	Per-Capita Annual Winter Storm Losses
Adams	27,225	$26,381,000	$96.90
Athens	62,792	$11,415,000	$18.18
Belmont	69,605	$838,000	$1.20
Brown	43,425	$27,860,000	$64.16
Carroll	29,011	$6,635,000	$22.87
Clermont	180,970	$17,891,000	$9.89
Columbiana	111,684	$1,435,000	$1.28
Coshocton	36,803	$5,395,000	$14.66
Gallia	30,929	$12,710,000	$41.09
Guernsey	40,899	$1,835,000	$4.49
Harrison	15,813	$895,000	$5.66
Highland	40,875	$17,000,006	$41.59
Hocking	28,241	$19,945,000	$70.62
Holmes	39,539	$21,714,000	$54.92
Jackson	32,743	$12,655,000	$38.65
Jefferson	72,705	$335,000	$0.46
Lawrence	62,017	$12,055,000	$19.44
Meigs	22,920	$12,660,000	$55.24
Monroe	15,141	$6,400,000	$42.27
Morgan	14,961	$5,057,000	$33.80
Muskingum	84,783	$6,395,000	$7.54
Noble	14,052	$6,340,000	$45.12
Perry	34,212	$6,130,000	$17.92
Pike	27,982	$26,900,000	$96.13
Ross	73,437	$22,016,000	$29.98
Scioto	78,428	$26,351,000	$33.60
Tuscarawas	91,521	$7,135,000	$7.80
Vinton	12,953	$6,410,000	$49.49
Washington	62,798	$11,165,000	$17.78
TOTAL	**1,458,464**	**$339,953,006**	**$23.31**

STATEWIDE TOTAL

Population	Losses	Per Capita
11,337,629	**$1,481,380,006**	**$13.07**

The total 10-year winter storm loss for Region 1 is $470,780,000 which is the second highest in the state. Within the region, Darke County historically has had the highest 10-year loss at a total of $71,151,000 affecting approximately 53,178 people (see Table 2.4.a). Allen and Shelby counties have historically had the lowest 10-year loss at $1,375,000 in each county affecting 108,522 people in Allen County and 48,233 in Shelby County (see Table 2.4.a).

Region 2 has the highest 10-year winter storm loss in the state at a total of $670,647,000. Within the region, Summit County has historically had the highest 10-year loss at a total of $47,981,000 affecting approximately 542,899 people (see Table 2.4.a). The second highest is Geauga County with a total loss of $47,743,000 affecting approximately 92,294 people (see Table 2.4.a). Richland County has historically had the lowest 10-year loss at $13,726,000 affecting 128,549 people (see Table 2.4.a).

Region 3 has historically had the lowest 10-year winter storm loss. In total there has been a loss of $339,953,006, which has affected a population of approximately 1,458,464 persons. Brown County has had experienced the highest 10-year loss at a total of $27,860,000 affecting approximately 42,425 people (see Table 2.4.a). Jefferson County has had the least 10-year loss to winter storms at $335,000, which affected approximately 72,705 persons (see Table 2.4.a).

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

Methodology

The methodology discussed above could not be used for state-owned and state-leased facilities as Ohio does not have attributed records of losses for each state-owned and leased facility. Additionally, winter storms are non-spatial in nature, which makes objective risk assessments difficult. Therefore, the methodology used here is based on state-owned and state-leased structure counts and dollars exposed within each snow depth level shown in Map 2.4.a. This information can help identify how many assets are at risk of experiencing high or moderately high snow amounts annually. Tables 2.4.b and 2.4.c show the results of the state facility counts in each depth area.

Also, the risk assessment for state facilities involved the GIS analysis of HSIP Gold 2011 data, which included electric transmission lines and power substations. These power facilities play crucial roles in the functionality of most state facilities, and if they are compromised by weather, associated state facilities would be affected as well. Since the HSIP Gold 2011 data have some inconsistencies in attributes and geocoding, the analysis here is general. However, it provides useful information with regards to risk and state facilities necessary for response and recovery. Map 2.4.b depicts the areas of high concentrations of electric lines and substations.

Results

Table 2.4.b

State-Owned and State-Leased Facility Counts at Mean Annual Snow Depths				
Mean Annual Snow Depth	**State-Owned Critical Facilities**	**State-Owned Non-Critical Facilities**	**State-Leased Critical Facilities**	**State-Leased Non-Critical Facilities**
<24"	716	818	11	100
24"-36"	1152	1007	13	116
36"-48"	316	150	4	41
48"-72"	148	97	2	9
>72"	11	42	0	1

Table 2.4.c

Dollars Exposed for State-Owned and State-Leased Facilities at Mean Annual Snow Depths				
Mean Annual Snow Depth	**State-Owned Critical Facilities**	**State-Owned Non-Critical Facilities**	**State-Leased Critical Facilities[1]**	**State-Leased Non-Critical Facilities[1]**
<24"	$802,660,700	$585,378,924	$2,484,137	$14,285,054
24"-36"	$1,470,560,693	$749,952,455	$5,999,040	$29,731,843
36"-48"	$446,389,712	$152,943,274	$47,048	$4,361,460
48"-72"	$57,267,696	$64,400,353	$442,566	$1,246,672
>72"	$2,080,475	$6,553,345	$0	$11,133

[1]The exposure for state-leased facilities is represented in the form of annual rental costs.

There are 53 state-owned facilities in the highest snow-depth region in the state (11 are critical), which represents over $8.5 million in exposure, nearly all of which are associated with the Department of Transportation or the Department of Natural Resources. However, transmission line and substation densities are relatively low in this area. The northwestern edge of the >72” region contains a few substations that could be at risk given a large winter storm event, but that density of substations is significantly less than those located in the 48”-72” region. There is only one state-leased facility in this area and it is non-critical to the state’s response and recovery efforts.

The region characterized by 48”-72” of snow annually contains 245 (148 are critical facilities) state-owned facilities with an exposure of more than $121 million. Again, the majority of these structures are associated with the Departments of Transportation or Natural Resources. This region of moderately high snow depth represents one of the highest population densities in the state, which corresponds to the high density of transmission lines and substations. Losses in this region are relatively high each year (Table 2.4.a), and these losses could be expected with state facilities as well.

Since it is the largest snow depth region in the state, it makes sense that nearly half of all state-owned and state-leased facilities are in the 24”-36” region. This also represents nearly half of the statewide exposure to winter storms. Since this is a low-to-moderate amount of snow per year, losses associated with winter storms should be much lower than those previously discussed. Electric line and substation densities correspond with this conclusion (Map 2.4.b).

It should be noted that while this risk assessment evaluates general locations of electric transmission lines and substations, these facilities are rarely compromised by winter storms. However, they do indicate where to expect higher densities of lower voltage lines that supply power to various types of structures, including critical and non-critical facilities. It is this association that makes this analysis beneficial in assessing risk for a non-spatial hazard.

Map 2.4.b

State of Ohio Annual Mean Snow Depth and Electric Transmission Lines

Voltage Class	Snow Depth
735 and Above	< 24"
500	24.1" - 36"
345	36.1" - 48"
100-161	48.1" - 72"
Under 100	> 72"
Step-Up	

In-Service Substations

The NOAA Storm Events Database contains data from the following sources: All Weather Events 1994 - 1995, as entered into Storm Data (No Latitude/Longitude); All Weather Events 1996 - 2003, as entered into Storm Data (including Latitude/Longitude).

Data shown on this map were developed from NOAA storm data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

2.5 LANDSLIDE

A landslide is the downward and outward movement of soil and rock material on slopes. There are three main types of landslides that occur in Ohio:

Figure 2.5.a

Major Components of a Rotational Slump.

Source: GeoFacts No. 8, ODNR, http://www.ohiodnr.com/geosurvey/geo_fact/geo_f08.htm

- *Rotational Slump*: the movement of a mass of weak rock or sediment as a block unit along a curved slip plane (Figure 2.5.a). In Ohio, these types of slides commonly involve hundreds of thousands of cubic yards of material and extend for hundreds of feet. The crown or head, located in the upper section of the ground surface, consists of one or more rupture zones (scarps) that form a stair-step pattern of displaced blocks. The surfaces of these blocks are commonly rotated backward (reverse slope) and form depressions along which water may accumulate, creating small ponds or swampy areas. Trees on these blocks may be inclined upslope, toward the top of the hill. The lower, downslope end (toe) of a rotational slump is a fan-shaped, bulging mass of material characterized by radial ridges and cracks. Trees on this portion of the landslide may be inclined at strange angles, giving rise to the descriptive terms "drunken" or "staggering" forest. Rotational slumps may develop comparatively slowly and commonly require several months or even years to reach stability; however, on occasion, they may move rapidly, achieving stability in only a few hours.
- *Earthflow:* involves rock, sediment, or weathered surface materials moving downslope in a mass. The most common form of earth movement in Ohio, earthflow involves a smaller area than a rotational slump and forms a hummocky topography of ridges and swales. Trees may be inclined at odd angles throughout the length of an earthflow. Earthflows are most common in weathered surface materials, do not necessarily indicate weak rock, and are also common in unconsolidated glacial sediments. The rate of movement of an earthflow is generally quite slow.
- *Rockfall:* an extremely rapid, potentially dangerous downslope movement of earth materials. Large blocks of massive bedrock suddenly become detached from a cliff or steep hillside and free fall in a rolling, bounding, or sliding manner downslope. Most rockfalls in Ohio involve massive beds of sandstone or limestone. Surface water seeps into joints or cracks in the rock, increasing its weight and causing expansion of joints in freezing temperatures, thus prying blocks of rock away from the main cliff. Weak

and easily eroded clay or shale beneath the massive bed is an important contributing factor to rockfall.

One or more of the following conditions contribute to the occurrence of landslide events:

- *Steep slope:* All landslides move downslope under the influence of gravity. Therefore, steep slopes, cliffs, or bluffs are a required element leading to a landslide, especially in conjunction with one or more of the conditions listed below.
- *Jointed rocks:* Fractures in rocks allow surface moisture to penetrate and weaken it. When the moisture freezes, it pries the rock masses apart at the joint.
- *Fine-grained, permeable rock or sediment:* Fine rock particles are particularly conducive to landslide development because large amounts of moisture can enter them easily, increasing the material's weight, reducing the bonding strength of individual grains, and dissolving grain-cementing materials.
- *Clay or shale units subject to lubrication*: Groundwater penetration of clay or shale can lead to a loss of binding strength between individual mineral grains and subsequent failure. Excess groundwater lubricates the contact between susceptible units and underlying materials and thus, promotes failure.
- *Large amounts of water*: Periods of heavy rainfall, excess snowmelt, or other events where water is accumulated saturate the zone above the normal water table and cause a landslide.

In addition to the conditions noted above, a landslide requires a triggering mechanism to initiate downslope movement. Several events or circumstances, many of them human-caused, can trigger landslides, including:

- *Vibrations* such as those from human-caused like blasting or the passing of a heavy truck or from natural events like earthquakes, although no such occurrence has been documented in Ohio.
- *Oversteepened slope* caused by undercutting by stream or wave erosion, by human construction activities, or by the addition of fill material to the upper portion of a slope, disturb the equilibrium of a stable slope and cause the angle of stability to be exceeded.
- *Increased weight on a slope* caused by the addition of large amounts of fill, the construction of a building or other structure, or an unusual increase in precipitation, either from heavy rains or from artificial alteration of drainage patterns.
- *Removal of vegetation and trees*, because of the loss of roots which tend to hold the rock or sediment in place and soak up excess moisture.

Areas in southern and eastern Ohio have several conditions that can lead to the occurrence of landslide events. Thick deposits of broken and weathered bedrock fragments called colluvium, and lake silts, create slopes that are vulnerable to failure (among other geological factors). In addition, redbeds, soft shales that weather rapidly and slip, slide, and flow to form gentle contours that are quickly grassed over, have long presented landslide conditions in the Appalachian Plateau.

RISK ASSESSMENT

Location

Region 1 primarily has a low landslide incidence. The most notable exception to this is Lucas County, which is reported to have a high landslide incidence. Several counties, Defiance, Paulding, Hardin, Mercer, Darke, Ottawa, Sandusky, Allen, Auglaize and Crawford have been identified as having a moderate susceptibility and low incidence (see Map 2.5.a).

In a similar fashion as Region 1, Region 2 also has a primary low landslide incidence. Within Region 2, Butler, Hamilton, Cuyahoga, and Summit are all identified as having a high landslide incidence, which does not reflect the regional trend. Additionally, Licking and Fairfield counties are identified as having a high susceptibility and low incidence (see Map 2.5.a).

Region 3 is identified as having the most area susceptible to landslide (*i.e.*, the Appalachian Plateau). The largest part of the region has a high susceptibility with a low or moderate incidence. However, most of Belmont and Monroe counties have a high landslide incidence with parts of Jefferson, Harrison, Washington, Athens, Meigs, Brown, and Clermont Counties having a high incidence as well (see Map 2.5.a).

LHMP Data

While Region 3 and parts of Region 2 have potential high susceptibility and incidence to landslide, Hamilton County and the City of Cincinnati has some of the highest cost per capita in the United States for historical landslide damages. According to the Hamilton County LHMP, landslides are considered to be their fourth area of concern for natural hazards, following flooding (number one), tornadoes, and severe storms. County officials based their decision on the lack of building regulations in areas deemed high hazard for landslides. Also, the removal of vegetation in riparian corridors can increase the landslide potential, and this is not regulated systematically. Finally, the lack of public education and awareness limits communities' understanding of such geophysical and regulatory relationships. Hamilton County's goal to mitigate landslide events involves identification of methodologies used by other, similar communities, and they want to increase public awareness through outreach initiatives.

Stark County. The Stark County Multi-Jurisdictional All-Hazard Mitigation Plan published in 2012 states that landslides have occurred primarily in the western and southern portion of the county, near the villages of Brewster, East Canton, Navarre, Waynesburg, and Wilmot and the cities of Canal Fulton, Magnolia, and Massillon. North Canton has also been reportedly plagued with numerous problems. Safety problems for travelers caused by landslides are a growing concern. There are several highways that could become damaged as a result of landslides in Stark County. US Routes 30 and 62, and State Routes 21, 43, 93, 172, 289, and 800 all are at risk. The county's vulnerability assessment estimates that landslides could cost over $ 500 million in damage.

Perry County. The 2012 Perry County Hazard Mitigation Plan mentions several abandoned underground mines in Perry County located near the Villages of Corning, Crooksville, Hemlock, New Straitsville, Rendville, and Shawnee. Safety problems for travelers caused by landslides initiated by abandoned underground mines are a growing concern. As a mitigation effort, the Ohio Department of Transportation (ODOT) developed an abandoned, underground mine inventory and risk assessment process. The process is intended to locate and assess the safety of mine sites underlying highways throughout Ohio. There are many State Routes located in the southeastern portion of the county that could be drastically impacted. The county's vulnerability assessment estimates that landslides could affect 4,625 structures and cause $ 147,346,000 in damage.

Scioto County. The Scioto County Hazard Mitigation Plan of 2013 identifies that the entire county is subject to landslides, with the major impact being the blockage of failure of roads. During periods of extreme rain, landslides are most prevalent as landslides are most likely in mined areas. These areas include most of the county, east of U.S. Route 23, or about half of the county. Numerous landslides have impacted infrastructure and roads in at least 12 presidential disaster declarations from 1991-2011. Hill slips onto roadways have been recorded for several county and state roadways when heavy rain events occur. The plan's vulnerability assessment estimates that landslides could affect 10,110 structures and cause $ 52,668,771 in damage.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Considering all hazards identified in the local plans, landslides ranked twelfth in terms of frequency among the counties classifying this hazard (Chart 2.2.a). In terms of onset, most local plans indicated a 12 – 24 hour warning associated with landslides in their communities. Landslides ranked very low among all of the other factors analyzed in SHARPP, which resulted in an overall ranking of 12th out of 15. While this hazard ranks low among the plans populated in the web portal, only one-third of those plans even listed landslides as a hazard. Additionally, the majority of the counties in Regions 1 and 2 did not identify this as a hazard. Once the HIRAs are fully populated in the portal, the above results may change to indicate a greater concern for landslides around the state. According to records and data entered to date into

vulnerability assessments, losses from landslides are estimated at 66,426 residential structures ($2,182,871,994), 3,778 non-residential structures ($768,593,901) and 113 critical facilities ($203,378,762). These and additional HIRA data queried from SHARPP can be found in Appendix J.

Past Occurrences

Ohio has had a long history of damage from landslides. Geologists at the University of Cincinnati report that the Cincinnati metropolitan area has one of the highest per capita costs of landslide damage of any metropolitan area in the United States. As shown by Figure 2.5.b, landslides in this area damage or destroy buildings, roads, and public utilities, and cost millions of dollars annually in lost productivity and repairs.

While landslides have been problematic in Cincinnati since the early to mid-1800s, documentation is limited. As the city began to expand and infrastructure was improved in the early 1900s, landslide hazards became better documented.

When large construction projects such as highway construction, began in the 1950s, geotechnical concerns received little consideration, and major landslides soon developed. In the 1960s and 1970s, landslides were so frequent that the area was included in a study of this hazard by the U. S. Geological Survey. The study found that landslide damages in Hamilton County, primarily due to public road construction, averaged more than $5 million each year between 1973 and 1978. Well-publicized landslides that occurred in the 1970s included those along Columbia Parkway, Hillside Avenue, Delhi Pike, and Huffman Court.

Map 2.5.a

State of Ohio Landslide Incidence and Susceptibility

- Low Incidence
- Moderate Susceptibility and Low Incidence
- Moderate Incidence
- High Susceptibility and Low Incidence
- High Susceptibility and Moderate Incidence
- High Susceptibility Incidence

These data represent a digital version of the U.S. Geological Survey Professional Paper 1183, Landslide Overview Map of the Conterminous United States. The map and digital data delineate areas in teh conterminous United States where large numbers of landslides have occurred and areas which are susceptible to landsliding. Due to the generalization of these data, they should only be used for broad planning purposes rather than site-specific applications.

Data shown on this map were developed from USGS landslide data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

Figure 2.5.b

Clifton Avenue Construction

Clifton Ave -- Construction of parking lot on top of old slide produced widespread failure. University of Cincinnati Landslide Gallery, http://homepages.uc.edu:8000/%7Emaynarjb/362/Images/CliftonAveParkLot.htm

In 1996, Hamilton County experienced a series of rotational slump slides in soil and shale. The damage exceeded $10 million, making it one of Ohio's most damaging recent slides.

Rockfalls have also caused dangerous conditions. The Ohio Department of Natural Resources reports that on Christmas Eve in 1986, an individual traveling in an automobile was killed by falling rock along U.S. Route 52 in Lawrence County in southern Ohio.

Landslides can be triggered by heavy rainfall and flooding, leading to multiple disasters in the same location. The most recent example is from January 2004 when the State received a disaster declaration due to the severe storms, flooding, mudslides, and landslides that struck the southeastern counties of Ohio. Individual assistance was made available in the counties of Franklin, Jefferson, Licking, Morgan, Ross, Tuscarawas, and Washington. Federal funding also was available to State and eligible local governments on a cost-sharing basis for the repair or replacement of public facilities damaged by the severe storms, flooding, mudslides, and landslides in the counties of Athens, Belmont, Guernsey, Harrison, Jefferson, Monroe, Morgan, Noble, Perry, Ross, Tuscarawas, and Washington.

Probability of Future Events

Region 1 and Region 2 probability of future occurrence is illustrated on Map 2.5.b. Because Ohio geologists do not calculate exceedance for landslides, FEMA's MHIRA document reports were used to determine the probability of future landslide incidences for Region 3, and it is identified as having the highest risk to the hazard. FEMA's MHIRA document reports that USGS studies confirm Ohio's landslide and debris flow potential. The MHIRA indicates that the hilly and mountainous terrain of the southern and southeastern portions of Ohio has high landslide potential and high landslide susceptibility (see Table 2.5.a).

Table 2.5.a

ODOT District No.	District Counties	Average Annual Slides
5	Coshocton, Fairfield, Guernsey, Knox, Licking, Muskingum, Perry	15
8	Butler, Clermont, Clinton, Greene, Hamilton, Preble, & Warren	15
9	Adams, Brown, Highland, Jackson, Lawrence, Pike, Ross, & Scioto	20
10	Athens, Gallia, Hocking, Meigs, Monroe, Morgan, Noble, Vinton & Washington	180-200
11	Belmont, Carroll, Columbiana, Harrison, Holmes, Jefferson & Tuscarawas	20

Source: ODOT (Div. of Engineering Policy)

Map 2.5.b

State of Ohio Potential Loss Estimates Based on Landslide Incidence and Susceptibility

- Low Potential Loss
- Medium Potential Loss
- High Potential Loss

These data represent a digital version of the U.S. Geological Survey Professional Paper 1183, Landslide Overview Map of the Conterminous United States. The map and digital data delineate areas in teh conterminous United States where large numbers of landslides have occurred and areas which are susceptible to landsliding. Due to the generalization of these data, they should only be used for broad planning purposes rather than site-specific applications.

Data shown on this map were developed from USGS landslide data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

The potential loss estimates, which do not include lifelines, are based upon high-level assumptions derived from the landslide history in each county. First, the counties were placed in three categories of potential loss, based upon landslide risk. The data come from the USGS's publication *Costly Landslide Events in the United* States. The highest risk level found anywhere in the county was applied to the whole county. For example, a county that is mostly low risk with a small amount of territory subject to high risk was designated as high risk. A county was designated as low risk only if the entire county was at a low risk for landslide. Next, since it's not possible to determine which individual structures are likely to be lost, the average structure value in each county was used to determine potential losses.

Results

The potential losses in a *High Potential for Loss* county equal the average structure value in the county times ten potentially lost structures. *Medium Potential for Losses* equals the average structure value in the county times one potentially lost structure. *Low Potential for Losses* equals the average structure value in the county times zero potentially lost structures (*i.e.,* low landslide potential results in potential losses due to landslides). Table 2.5.b depicts estimated losses based on landslide incidence and susceptibility.

Table 2.5.b

Estimate of Potential Losses to Landslide by Region

Region 1

County	Average Structure Value	Potential Loss	Estimated Loss
Allen	$89,013	Medium	$89,013
Auglaize	$103,509	Medium	$103,509
Champaign	$102,764	Low	$0
Clark	$115,714	Low	$0
Clinton	$105,185	Medium	$105,185
Crawford	$84,341	Medium	$84,341
Darke	$91,774	Medium	$91,774
Defiance	$88,758	Medium	$88,758
Erie	$138,957	Medium	$138,957
Fayette	$89,871	Low	$0
Fulton	$112,365	Medium	$112,365
Hancock	$103,815	Low	$0
Hardin	$74,821	Medium	$74,821
Henry	$93,482	Medium	$93,482
Huron	$101,618	Low	$0
Logan	$91,623	Low	$0
Lucas	$109,511	High	$1,095,106
Madison	$117,374	Low	$0
Marion	$91,612	Low	$0
Mercer	$92,577	Medium	$92,577
Miami	$118,581	Low	$0
Morrow	$98,524	Low	$0
Ottawa	$128,132	Medium	$128,132
Paulding	$71,783	Medium	$71,783
Preble	$99,686	Low	$0
Putnam	$96,294	Medium	$96,294
Sandusky	$100,864	Medium	$100,864
Seneca	$92,474	Low	$0
Shelby	$105,897	Low	$0
Union	$121,528	Low	$0
Van Wert	$81,137	Low	$0
Williams	$91,255	Medium	$91,255
Wood	$116,308	High	$1,163,085
Wyandot	$83,507	Low	$0
TOTAL	**$100,137**		**$3,821,301**

Region 2

County	Average Structure Value	Potential Loss	Estimated Loss
Ashland	$99,167	Low	$0
Ashtabula	$94,785	Medium	$94,785
Butler	$118,808	High	$1,188,077
Cuyahoga	$173,721	High	$1,737,211
Delaware	$178,692	Low	$0
Fairfield	$118,382	Medium	$118,382
Franklin	$129,404	Low	$0
Geauga	$175,189	Medium	$175,189
Greene	$130,079	Low	$0
Hamilton	$133,401	High	$1,334,012
Knox	$93,432	Low	$0
Lake	$153,500	Medium	$153,500
Licking	$111,871	Medium	$111,871
Lorain	$133,971	Low	$0
Mahoning	$89,778	Medium	$89,778
Medina	$148,346	Low	$0
Montgomery	$106,758	Low	$0
Pickaway	$114,886	Low	$0
Portage	$129,091	Medium	$129,091
Richland	$92,275	Medium	$92,275
Stark	$99,745	Medium	$99,745
Summit	$130,413	High	$1,304,129
Trumbull	$85,421	Medium	$85,421
Warren	$143,151	High	$1,431,505
Wayne	$107,620	Low	$0
TOTAL	**$123,675**		**$8,144,971**

Region 3

County	Average Structure Value	Potential Loss	Estimated Loss
Adams	$62,190	High	$621,901
Athens	$73,953	High	$739,530
Belmont	$64,053	High	$640,528
Brown	$85,457	High	$854,572
Carroll	$88,152	Medium	$88,152
Clermont	$116,673	High	$1,166,732
Columbiana	$83,399	High	$833,994
Coshocton	$81,179	Medium	$81,179
Gallia	$74,847	Medium	$74,847
Guernsey	$67,546	Medium	$67,546
Harrison	$59,105	High	$591,048
Highland	$84,108	Low	$0
Hocking	$79,877	Medium	$79,877
Holmes	$105,362	Low	$0
Jackson	$71,016	Medium	$71,016
Jefferson	$55,626	High	$556,255
Lawrence	$66,516	High	$665,162
Meigs	$60,499	High	$604,992
Monroe	$59,355	High	$593,546
Morgan	$71,635	Medium	$71,635
Muskingum	$82,973	Medium	$82,973
Noble	$65,029	High	$650,286
Perry	$69,858	Medium	$69,858
Pike	$83,147	Low	$0
Ross	$80,576	Low	$0
Scioto	$67,115	Low	$0
Tuscarawas	$93,030	Medium	$93,030
Vinton	$63,290	Medium	$63,290
Washington	$72,527	High	$725,271
TOTAL	**$75,451**		**$10,087,220**

Source: USGS & HAZUS-MH

Region 1 has a landslide vulnerability of approximately $3,821,301. Within this region, Wood County has the highest potential for losses at an estimated $1,163,085. Additionally, several counties within the Region have *Low Potential for Losses*, which equates to zero vulnerability (following our initial assumptions).

Region 2 has the second highest estimate of potential loss at a value of $8,144,971. Cuyahoga County has the highest estimate within the Region at a loss value of $1,737,211, and four other counties exhibit potential losses over $1 million.

Region 3 has the highest risk and vulnerability at a value of $10,087,220. Within this Region Clermont County has the highest estimated vulnerability of $1,166,732.

These results do not account for everything affected by landslide, especially roads. Landslides and mudslides affecting roads lead to costly repairs by state and local governments. In the six to seven year period leading up to 2002, repair, rehabilitation, and maintenance costs exceeded $34 million, at an average of $4.9 million per project. The massive floods of 1996-98 in eastern and southeastern Ohio counties each averaged $4.16 million in costs to the state, and landslides played roles in those disasters.

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

Methodology

The methodology employed to determine the vulnerability of state-owned and state-leased facilities to landslides is the same as described in the previous section. The *potential for loss* identified for each county is the same as used in the previous section as well (Map 2.5.b). It should be noted that the *potential for loss* estimates, which do not include lifelines, are based upon high-level assumptions derived from the landslide history in each county. Tables 2.5.b – 2.5.d list the results for the state-owned facilities in each county, and Tables 2.5.e – g list the results for the state-leased facilities in each county.

Results

Relatively low *potentials for loss* describe Region 1, with the exception of Lucas and Wood Counties, which collectively represent a significant percentage of the population in the entire Region. Lucas County losses could surpass $38 million for state-owned critical facilities and $12 million for state-owned non-critical facilities. Wood County losses would approach $3.5 million for critical and $950,000 for non-critical facilities (Table 2.5.b). These two counties would expect the greatest losses for state-leased facilities as well. Lucas County would expect to lose approximately $23,136 and Wood County would expect to lose over $590,000 for leased critical facilities. Concerning non-critical leases, Lucas

County losses are higher than Wood County losses, with $569,010 and $362,244, respectively (Table 2.5.e).

Region 2 has the lowest estimated critical facility loss when compared to Regions 1 and 3 ($44,081,817). The highest values for estimated losses belong to Summit and Warren Counties with nearly $9.7 million and $9.5 million, respectively. Butler ($5,677,384) and Hamilton ($4,955,507) Counties should also be mentioned as the next highest in Region 2, since these counties are in one of the highest development areas in the state. For state-owned non-critical facilities, Region 2 shows the highest estimated losses among the three regions with nearly $128 million, which is more than the other two regions combined (Table 2.5.c).

Summit and Hamilton Counties account for 94 percent of the estimated losses of state-leased critical facilities, with $481,956 and $40,224, respectively. The Region 2 total for estimated losses to state-leased facilities is more than double the losses in Regions 1 and 3 combined (Table 2.5.f).

As shown on Maps 2.5.a and 2.5.b, the greatest *potential for loss* to landslides is within Region 3. For state-owned critical facilities, Region 3 exhibits the greatest estimated losses among the three Regions, with losses nearing $58 million. Hotspots in this Region include Noble ($20,889,200) and Belmont ($13,025,580) Counties. For non-critical facilities, Region 2 has the second highest estimated losses from landslides, with the highest estimates coming from Brown ($16,869,649) and Athens ($12,525,127) Counties (Table 2.5.d).

State-leased facilities are relatively few in Region 3, which accounts for the lowest estimated losses among the three Regions. Even though Hocking County shows *medium potential for loss*, they do show the greatest estimated loss for leased critical facilities in the Region with $425,376. Non-critical losses are the greatest in Athens and Belmont Counties, with $494,856 and $362,712, respectively (Table 2.5.g).

Table 2.5.b

Estimate of Potential Losses to Landslide for Region 1 State-Owned Facilities						
County	**Potential for Loss**	**Average Critical Facility Value**	**Estimated Critical Facility Loss**	**Average Non-critical Facility Value**	**Estimated Non-Critical Facility Loss**	**Total Estimated Loss**
Allen	Medium	$1,490,165	$1,490,165	$344,899	$344,899	$1,835,064
Auglaize	Medium	$195,763	$195,763	$278,700	$278,700	$474,463
Champaign	Low	$174,017	$0	$55,093	$0	$0
Clark	Low	$161,092	$0	$149,879	$0	$0
Clinton	Medium	$458,011	$458,011	$122,400	$122,400	$580,411
Crawford	Medium	$229,100	$229,100	$0	$0	$229,100
Darke	Medium	$132,221	$132,221	$6,388	$6,388	$138,609
Defiance	Medium	$276,008	$276,008	$123,930	$123,930	$399,938
Erie	Medium	$217,205	$217,205	$2,035,206	$2,035,206	$2,252,412
Fayette	Low	$144,824	$0	$67,150	$0	$0
Fulton	Medium	$93,660	$93,660	$51,000	$51,000	$144,660
Hancock	Low	$415,642	$0	$168,938	$0	$0
Hardin	Medium	$112,438	$112,438	$5,500	$5,500	$117,938
Henry	Medium	$133,730	$133,730	$604,331	$604,331	$738,061
Huron	Low	$151,362	$0	$0	$0	$0
Logan	Low	$112,672	$0	$122,400	$0	$0
Lucas	High	$3,801,493	$38,014,931.43	$1,268,082	$12,680,819.80	$50,695,751
Madison	Low	$963,489	$0	$247,123	$0	$0
Marion	Low	$5,191,776	$0	$643,331	$0	$0
Mercer	Medium	$124,660	$124,660	$366,365	$366,365	$491,025
Miami	Low	$314,661	$0	$81,264	$0	$0
Morrow	Low	$73,281	$0	$149,662	$0	$0
Ottawa	Medium	$392,851	$392,851	$143,617	$143,617	$536,468
Paulding	Medium	$111,248	$111,248	$0	$0	$111,248
Preble	Low	$330,060	$0	$3,137,372	$0	$0
Putnam	Medium	$76,633	$76,633	$50,000	$50,000	$126,633
Sandusky	Medium	$118,746	$118,746	$520,833	$520,833	$639,579
Seneca	Low	$180,321	$0	$492,581	$0	$0
Shelby	Low	$421,620	$0	$153,000	$0	$0
Union	Low	$1,622,635	$0	$518,710	$0	$0
Van Wert	Low	$128,095	$0	$21,165	$0	$0
Williams	Medium	$197,298	$197,298	$130,399	$130,399	$327,697
Wood	High	$344,891	$3,448,910	$94,146	$941,462.67	$4,390,373
Wyandot	Low	$477,539	$0	$80,769	$0	$0
TOTAL	**--**	**--**	**$45,823,579**	**--**	**$18,405,850**	**$64,229,430**

Table 2.5.c

Estimate of Potential Losses to Landslide for Region 2 State-Owned Facilities						
County	**Potential for Loss**	**Average Critical Facility Value**	**Estimated Critical Facility Loss**	**Average Non-critical Facility Value**	**Estimated Non-Critical Facility Loss**	**Total Estimated Loss**
Ashland	Low	$1,105,718	$0	$512,499	$0	$0
Ashtabula	Medium	$539,297	$539,297	$191,300	$191,300	$730,597
Butler	High	$946,231	$5,677,384*	$700,000	$1,400,000*	$7,077,384
Cuyahoga	High	$388,543	$3,885,430	$1,464,145	$14,641,450	$18,526,880
Delaware	Low	$369,945	$0	$850,354	$0	$0
Fairfield	Medium	$568,044	$568,044	$502,829	$502,829	$1,070,873
Franklin	Low	$6,823,324	$0	$2,379,300	$0	$0
Geauga	Medium	$249,991	$249,991	$153,151	$153,151	$403,142
Greene	Low	$274,602	$0	$661,465	$0	$0
Hamilton	High	$619,438	$4,955,507*	$6,669,899	$66,698,990	$71,654,497
Knox	Low	$210,052	$0	$876,860	$0	$0
Lake	Medium	$210,027	$210,027	$125,767	$125,767	$335,794
Licking	Medium	$1,149,844	$1,149,844	$153,044	$153,044	$1,302,888
Lorain	Low	$3,282,278	$0	$141,828	$0	$0
Mahoning	Medium	$1,830,644	$1,830,644	$945,053	$945,053	$2,775,696
Medina	Low	$248,007	$0	$31,212	$0	$0
Montgomery	Low	$544,346	$0	$1,314,846	$0	$0
Pickaway	Low	$2,407,465	$0	$515,384	$0	$0
Portage	Medium	$249,064	$249,064	$174,102	$174,102	$423,166
Richland	Medium	$4,546,767	$4,546,767	$621,740	$621,740	$5,168,507
Stark	Medium	$447,608	$447,608	$5,710,551	$5,710,551	$6,158,159
Summit	High	$966,046	$9,660,460	$3,208,745	$32,087,450	$41,747,910
Trumbull	Medium	$624,492	$624,492	$546,919	$546,919	$1,171,411
Warren	High	$948,726	$9,487,260	$401,223	$4,012,230	$13,499,490
Wayne	Low	$178,430	$0	$1,487,855	$0	$0
TOTAL	**--**	**--**	**$44,081,817**	**--**	**$127,964,577**	**$172,046,394**

*10 X Average Structure Value for High Potential for Loss results in value greater than total building stock, so the value represents the total building stock.

Table 2.5.d

Estimate of Potential Losses to Landslide for Region 3 State-Owned Facilities						
County	**Potential for Loss**	**Average Critical Facility Value**	**Estimated Critical Facility Loss**	**Average Non-critical Facility Value**	**Estimated Non-Critical Facility Loss**	**Total Estimated Loss**
Adams	High	$100,294	$1,002,940	$765	$765*	$1,003,705
Athens	High	$698,343	$6,983,430	$1,252,513	$12,525,127*	$19,508,557
Belmont	High	$1,302,558	$13,025,580	$935,099	$4,675,493*	$17,701,073
Brown	High	$207,651	$2,076,510	$4,217,412	$16,869,649*	$18,946,159
Carroll	Medium	$78,163	$78,163	$387,033	$387,033	$465,196
Clermont	High	$195,381	$976,905*	$496,072	$4,960,720	$5,937,625
Columbiana	High	$133,526	$1,335,260	$401,570	$2,007,850*	$3,343,110
Coshocton	Medium	$153,553	$153,553	$119,571	$119,571	$273,124
Gallia	Medium	$323,234	$323,234	$506,423	$506,423	$829,657
Guernsey	Medium	$272,291	$272,291	$711,715	$711,715	$984,006
Harrison	High	$103,221	$1,032,210	$11,348	$22,695*	$1,054,905
Highland	Low	$143,022	$0	$149,792	$0	$0
Hocking	Medium	$905,950	$905,950	$130,871	$130,871	$1,036,821
Holmes	Low	$72,348	$0	$0	$0	$0
Jackson	Medium	$335,432	$335,432	$68,850	$68,850	$404,282
Jefferson	High	$119,652	$1,196,520	$510,000	$510,000*	$1,706,520
Lawrence	High	$101,976	$1,019,760	$0	$0	$1,019,760
Meigs	High	$147,159	$1,471,590	$72,930	$145,860*	$1,617,450
Monroe	High	$141,070	$1,269,631*	$0	$0	$1,269,631
Morgan	Medium	$99,426	$99,426	$162,431	$162,431	$261,857
Muskingum	Medium	$110,331	$110,331	$128,896	$128,896	$239,227
Noble	High	$2,088,920	$20,889,200	$1,267,867	$6,339,333*	$27,228,533
Perry	Medium	$153,680	$153,680	$270,965	$270,965	$424,645
Pike	Low	$110,267	$0	$71,874	$0	$0
Ross	Low	$2,287,335	$0	$533,506	$0	$0
Scioto	Low	$2,584,665	$0	$398,548	$0	$0
Tuscarawas	Medium	$453,658	$453,658	$116,670	$116,670	$570,328
Vinton	Medium	$136,427	$136,427	$130,317	$130,317	$266,744
Washington	High	$255,058	$2,550,580	$428,808	$4,288,080	$6,838,660
TOTAL	**--**	**--**	**$57,852,261**	**--**	**$55,079,314**	**$112,931,575**

*10 X Average Structure Value for High Potential for Loss results in value greater than total building stock, so the value represents the total building stock.

Table 2.5.e

Estimate of Potential Losses to Landslide for Region 1 State-Leased Facilities						
County	**Potential for Loss**	**Average Critical Facility Value**	**Estimated Critical Facility Loss**	**Average Non-critical Facility Value**	**Estimated Non-Critical Facility Loss**	**Total Estimated Loss**
Allen	Medium	$0	$0	$146,244	$146,244	$146,244
Auglaize	Medium	$0	$0	$10,194	$10,194	$10,194
Champaign	Low	$0	$0	$3,096	$0	$0
Clark	Low	$0	$0	$157,872	$0	$0
Clinton	Medium	$0	$0	$0	$0	$0
Crawford	Medium	$0	$0	$0	$0	$0
Darke	Medium	$0	$0	$0	$0	$0
Defiance	Medium	$0	$0	$41,644	$41,644	$41,644
Erie	Medium	$0	$0	$56,671	$56,671	$56,671
Fayette	Low	$0	$0	$0	$0	$0
Fulton	Medium	$0	$0	$0	$0	$0
Hancock	Low	$40,788	$0	$72,000	$0	$0
Hardin	Medium	$0	$0	$0	$0	$0
Henry	Medium	$0	$0	$0	$0	$0
Huron	Low	$0	$0	$12,768	$0	$0
Logan	Low	$0	$0	$0	$0	$0
Lucas	High	$23,136	$23,136*	$142,253	$569,010.00*	$592,146
Madison	Low	$0	$0	$30,000	$0	$0
Marion	Low	$0	$0	$0	$0	$0
Mercer	Medium	$0	$0	$0	$0	$0
Miami	Low	$0	$0	$19,932	$0	$0
Morrow	Low	$0	$0	$0	$0	$0
Ottawa	Medium	$0	$0	$504	$504	$504
Paulding	Medium	$0	$0	$0	$0	$0
Preble	Low	$0	$0	$0	$0	$0
Putnam	Medium	$0	$0	$12,384	$12,384	$12,384
Sandusky	Medium	$0	$0	$54,828	$54,828	$54,828
Seneca	Low	$0	$0	$67,940	$0	$0
Shelby	Low	$0	$0	$123,684	$0	$0
Union	Low	$0	$0	$14,760	$0	$0
Van Wert	Low	$0	$0	$2,292	$0	$0
Williams	Medium	$0	$0	$0	$0	$0
Wood	High	$590,604	$590,604*	$120,748	$362,244.00*	$952,848
Wyandot	Low	$0	$0	$0	$0	$0
TOTAL	**--**	**--**	**$613,740**	**--**	**$1,253,723**	**$1,867,463**

*10 X Average Structure Value for High Potential for Loss results in value greater than total building stock, so the value represents the total building stock.

Table 2.5.f

Estimate of Potential Losses to Landslide for Region 2 State-Leased Facilities						
County	**Potential for Loss**	**Average Critical Facility Value**	**Estimated Critical Facility Loss**	**Average Non-critical Facility Value**	**Estimated Non-Critical Facility Loss**	**Total Estimated Loss**
Ashland	Low	$0	$0	$0	$0	$0
Ashtabula	Medium	$0	$0	$23,616	$23,616	$23,616
Butler	High	$0	$0	$154,719	$618,876*	$618,876
Cuyahoga	High	$0	$0	$156,840	$1,568,400	$1,568,400
Delaware	Low	$0	$0	$0	$0	$0
Fairfield	Medium	$0	$0	$199,887	$199,887	$199,887
Franklin	Low	$465,141	$0	$423,456	$0	$0
Geauga	Medium	$0	$0	$11,400	$11,400	$11,400
Greene	Low	$0	$0	$48,912	$0	$0
Hamilton	High	$40,224	$40,224*	$221,211	$2,212,110	$2,252,334
Knox	Low	$0	$0	$2,364	$0	$0
Lake	Medium	$0	$0	$58,892	$58,892	$58,892
Licking	Medium	$0	$0	$0	$0	$0
Lorain	Low	$0	$0	$111,230	$0	$0
Mahoning	Medium	$20,260	$20,260	$122,029	$122,029	$142,289
Medina	Low	$0	$0	$22,356	$0	$0
Montgomery	Low	$189,011	$0	$134,231	$0	$0
Pickaway	Low	$0	$0	$0	$0	$0
Portage	Medium	$0	$0	$0	$0	$0
Richland	Medium	$0	$0	$165,451	$165,451	$165,451
Stark	Medium	$0	$0	$225,943	$225,943	$225,943
Summit	High	$240,978	$481,956*	$41,204	$206,022*	$687,978
Trumbull	Medium	$10,716	$10,716	$16,384	$16,384	$27,100
Warren	High	$0	$0	$14,487	$28,974*	$28,974
Wayne	Low	$0	$0	$23,676	$0	$0
TOTAL	**--**	**--**	**$553,156**	**--**	**$5,457,984**	**$6,011,140**

*10 X Average Structure Value for High Potential for Loss results in value greater than total building stock, so the value represents the total building stock.

Table 2.5.g

Estimate of Potential Losses to Landslide for Region 3 State-Leased Facilities						
County	**Potential for Loss**	**Average Critical Facility Value**	**Estimated Critical Facility Loss**	**Average Non-critical Facility Value**	**Estimated Non-Critical Facility Loss**	**Total Estimated Loss**
Adams	High	$0	$0	$0	$0	$0
Athens	High	$0	$0	$70,694	$494,856*	$494,856
Belmont	High	$0	$0	$60,452	$362,712*	$362,712
Brown	High	$0	$0	$1,308	$1,308*	$1,308
Carroll	Medium	$0	$0	$0	$0	$0
Clermont	High	$0	$0	$0	$0	$0
Columbiana	High	$3,600	$3,600*	$0	$0	$3,600
Coshocton	Medium	$0	$0	$0	$0	$0
Gallia	Medium	$0	$0	$0	$0	$0
Guernsey	Medium	$47,856	$47,856	$63,992	$63,992	$111,848
Harrison	High	$0	$0	$0	$0	$0
Highland	Low	$0	$0	$21,582	$0	$0
Hocking	Medium	$425,376	$425,376	$80,088	$80,088	$505,464
Holmes	Low	$0	$0	$0	$0	$0
Jackson	Medium	$0	$0	$46,524	$46,524	$46,524
Jefferson	High	$0	$0	$21,894	$21,894*	$21,894
Lawrence	High	$0	$0	$29,856	$89,568*	$89,568
Meigs	High	$0	$0	$0	$0	$0
Monroe	High	$0	$0	$0	$0	$0
Morgan	Medium	$0	$0	$0	$0	$0
Muskingum	Medium	$0	$0	$28,990	$28,990	$28,990
Noble	High	$0	$0	$0	$0	$0
Perry	Medium	$0	$0	$0	$0	$0
Pike	Low	$0	$0	$5,586	$0	$0
Ross	Low	$0	$0	$56,131	$0	$0
Scioto	Low	$0	$0	$133,461	$0	$0
Tuscarawas	Medium	$0	$0	$28,656	$28,656	$28,656
Vinton	Medium	$0	$0	$0	$0	$0
Washington	High	$0	$0	$21,216	$106,080*	$106,080
TOTAL	--	--	**$476,832**	--	**$1,324,668**	**$1,801,500**

*10 X Average Structure Value for High Potential for Loss results in value greater than total building stock, so the value represents the total building stock.

2.6 DAM/LEVEE FAILURE

Dam Failure

A dam is defined as an artificial barrier that is usually constructed across a stream channel to impound water. A dam failure is defined as an uncontrolled release of that impounded water. The causes of dam failures can be divided into three groups: dam overtopping, excessive seepage, and structural failure of a component. Despite efforts to provide sufficient structural integrity and to perform inspection and maintenance, problems can develop that can lead to failure. While most dams have storage volumes small enough that failures would have little or no consequences, dams with large storage amounts could cause significant flooding downstream.

Dam failures can result from any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity, resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments, or maintain gates, valves, and other operational components;
- Improper design, including the use of improper construction materials and construction practices;
- Improper operation, including the failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway that release water to a downstream dam;
- Earthquakes, which typically cause longitudinal cracks at the tops of the embankments that can weaken entire structures.

In terms of emergency management, dam failures are categorized as either *sunny day failures* or *rainy day failures*. *Sunny day failures* occur during a non-flooding situation with the reservoir near normal pool level. *Rainy day failures* usually involve periods of rainfall and flooding, and can exacerbate inadequate spillway capacity. Improper design of a spillway or operation of gates during high flows can lead to excessive water pressure and subsequent failure as well. Even though both types of failures can be disastrous, it can be assumed that a *sunny day failure* would be more catastrophic due to its unanticipated occurrence and the lack of time to warn residents downstream.

Dams are complicated structures, and it can be difficult to predict how a structure will respond to distress. "… the modes and causes of failure are varied, multiple, and often complex and interrelated, *i.e.*, often the triggering cause may not truly have resulted in failure had the dam not had a secondary weakness. These

causes illustrate the need for careful, critical review of all facets of a dam" (*Safety of Existing Dams*, 1983).

Levee Failure

A levee is any artificial barrier together with appurtenant works that will divert or restrain the flow of a stream or other body of water for the purpose of protecting an area from inundation by flood waters. Generally, a levee is subjected to water loading during a few days or weeks in a given year; unlike a dam that is retaining water most days in the same year.

A levee breach results when a portion of the levee breaks away, providing an opening for water to flood the landward side of the structure. Such breaches can be caused by surface erosion due to water velocities, or they can be the result of subsurface actions. Subsurface actions usually involve sand boils whereby the upward pressure of water flowing through porous soil under the levee exceeds the static pressure of the soil weight above it (*i.e.*, underseepage). These boils can indicate instability of the levee foundation given the liquefied substrate below it, leading way to breaching. Levee overtopping is similar to dam overtopping in that the flood waters simply exceed the design capacity of the structure, thus flowing over the lowest crest of the system. Such overtopping can lead to erosion on the landward side which, subsequently, can lead to breaching. In order to prevent this type landward erosion, many levees are reinforced or armored with rocks or concrete.

Authority and Responsibility

The Ohio Department of Natural Resources, Division of Soil and Water Resources - Dam Safety Program (DSP) has the responsibility to ensure that human life, health and property are protected from dam and levee failures. The program achieves its core purpose by performing five main functions:

- *Emergency response* – Assessing the conditions of dams during severe floods and emergency's, taking action to correct dams that pose an immediate threat to public safety, providing timely and best-available information to other agencies and the public during disasters, and supporting mandate Ohio Revised Code (ORC) Section 1521.062;
- *Construction permits* – Ensuring that dams and levees are designed and constructed in accordance with proper engineering standards and OAC rules, reviewing construction plans and specifications, performing calculations and investigations, issuing permits, and monitoring/approving construction;
- *Repairs and modifications* -- Ensuring that dams and levees are repaired in accordance with proper engineering standards and OAC rules, reviewing construction plans and specifications, performing calculations and investigations, issuing permits, and monitoring/approving construction, and supporting mandate ORC Section 1521.062;

- *Periodic safety inspections* –Inspecting Class I-III dams once every five years, monitoring the overall condition of Ohio's dams, providing data for the National Performance of Dams Program (NPDP), and supporting mandate ORC Section 1521.062; *Enforcement* – Requiring dam and levee owners to improve safety when efforts for voluntary compliance have been unsuccessful and focusing on Class I dams with dense populations downstream; and
- *Public information* – Providing data security for Ohio EMA, US Army Corps of Engineers (USACE), the National Guard, Ohio EPA, as well as the state and federal legislatures, providing dam and levee owners and engineers with technical information and access to division files, educating the public about dam safety and providing quality data, and giving presentations for EPA, Water Management Association of Ohio (WMAO), and the Ohio Legislative Correspondents Association (OLCA).

The ORC provides the authority for the program to regulate dam and levee safety and dictates the responsibilities of the program as well as the responsibilities of the dam and levee owners. The program has jurisdiction over approximately 2,550 dams in Ohio, of which 365 are Class I (highest hazard); DSP does not have jurisdiction over Federal dams. USACE presides over most of those Federal dams, and ensures they are operated and maintained properly.

Many levees in Ohio are owned and maintained by local communities, with a few levees being owned and maintained by the USACE. While a federal inventory of levees is complete, the methodology for evaluating the effects of levees on flood hazards is in flux. This will be discussed later in this section.

RISK ASSESSMENT

Dams—Location

In Ohio there are 5,786 known structures that retain or detain water, and these are included in ODNR's inventory of dams (DSP data, September, 2010). The volume of water impounded, and the density, type, and value of development downstream determine the potential severity and potential classification of dam. The 2008 Update analyzed data from USACE's National Inventory of Dams (NID). However, these data only represented a portion of the dams regulated by the State of Ohio. Therefore, a more complete list was obtained from ODNR's inventory for this 2011 Update, and these data are dated September, 2010.

The ODNR DSP classifies dams as Class I, Class II, Class III, and Class IV dams, with Class I being the highest and Class IV the lowest (see Table 2.6.a). The classification of a dam is based on three factors: the dam's height, storage capacity, and potential downstream hazard. The height of the dam is the vertical distance from the crest to the downstream toe. The storage capacity is the volume of water that the dam can impound at the top of dam (crest) elevation. The downstream hazard consists of roads, buildings, homes, and other structures that would be damaged in the event of a dam failure. Potential for loss

of life is also evaluated. Various dam failure scenarios must be considered, and they include failures when the dam is at normal pool level (*sunny day*) and failures during significant flood events (*rainy day*). Each of the three factors is evaluated, and the final classification of the dam is based on the highest individual factor. The classification of a dam can change based on future development along the downstream channel. It is important to note all classes are required to have EAPs and Class I's are required to include dam failure inundation mapping.

The 2008 Plan Update evaluated the dams throughout the State by their corresponding Federal Classification (Table 2.6.a). However, dam data are provided to county EMA directors by DSP and are classified using the Ohio Classification System. Therefore, the 2011 Update will evaluate the most current DSP data (September, 2010) and will maintain the Ohio Classification so as to limit confusion for local EMA directors.

Table 2.6.a

Ohio and Federal Dam Classification Systems		
Ohio Dam Classification	**Description**	**Corresponding Federal Classification**
Class I	Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, major public utilities)	High
Class II	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas	Significant
Class III	Damage to low value non- residential structures, local roads, agricultural crops and livestock	Significant
Class IV	Losses restricted mainly to the dam	Low

Source: http://www.dnr.state.oh.us/tabid/3342/Default.aspx

This Update will focus on Class I dams as they are deemed as having the most potential for loss of life, greatest hazards to health, and causing the most structural damage should any of them fail. Classes II and III also will be evaluated to a slight degree since their failure would most likely result in damages to homes, businesses, infrastructure, but no loss of life is likely.

As mentioned above, there are 416 Class I dams, 1,260 Class II and III, and 1,273 Class IV dams in Ohio. Also, there are approximately 3,085 structures throughout the state that are unclassified, exempt from ORC regulations, or are abandoned, and they are categorized as *Other* (Table 2.6.b).

Table 2.6.b

Dam Inventory by County and Dam Classification											
Region 1											
County	**I**	**II+III**	**IV**	**Other**	**Total**	**County**	**I**	**II+III**	**IV**	**Other**	**Total**
Allen	4	9	10	19	42	**Madison**	1	3	1	3	8
Auglaize	1	2	3	6	12	**Marion**	0	2	5	4	11
Champaign	1	8	7	11	27	**Mercer**	1	5	1	1	8
Clark	2	5	6	9	22	**Miami**	3	10	8	20	41
Clinton	9	13	13	16	51	**Morrow**	3	14	17	28	62
Crawford	6	7	12	15	40	**Ottawa**	0	2	3	5	10
Darke	0	5	7	25	37	**Paulding**	1	1	6	9	17
Defiance	2	7	6	12	27	**Preble**	6	11	15	36	68
Erie	0	4	3	11	18	**Putnam**	1	2	3	9	15
Fayette	1	3	1	6	11	**Sandusky**	2	0	2	5	9
Fulton	5	5	0	3	13	**Seneca**	2	5	4	9	20
Hancock	8	6	0	11	25	**Shelby**	2	4	10	22	38
Hardin	0	3	6	10	19	**Union**	0	4	5	20	29
Henry	0	1	1	11	13	**Van Wert**	3	0	1	5	9
Huron	10	15	10	21	56	**Williams**	1	7	14	25	47
Logan	3	11	12	19	45	**Wood**	4	4	0	9	17
Lucas	1	4	0	15	20	**Wyandot**	1	9	7	17	34
TOTALS	**I: 84**		**II+III: 191**			**IV: 199**			**Other: 447**		
Region 2											
County	**I**	**II+III**	**IV**	**Other**	**Total**	**County**	**I**	**II+III**	**IV**	**Other**	**Total**
Ashland	5	21	18	42	86	**Lorain**	5	25	20	95	145
Ashtabula	5	32	23	68	128	**Mahoning**	5	20	13	54	92
Butler	8	22	22	68	120	**Medina**	14	53	64	128	259
Cuyahoga	9	12	5	38	64	**Montgomery**	6	9	6	32	53
Delaware	14	16	24	33	87	**Pickaway**	2	15	11	15	43
Fairfield	13	34	15	35	97	**Portage**	8	22	27	145	202
Franklin	4	17	11	37	69	**Richland**	3	12	11	28	54
Geauga	7	30	23	61	121	**Stark**	4	31	27	93	155
Greene	6	8	15	26	55	**Summit**	17	36	23	110	186
Hamilton	10	33	13	72	128	**Trumbull**	3	19	14	88	124
Knox	3	15	10	30	58	**Warren**	11	41	45	68	165
Lake	2	12	4	18	36	**Wayne**	3	18	10	44	75
Licking	1	21	39	57	118						
TOTALS	**I: 168**		**II+III: 574**			**IV: 493**			**Other: 1,485**		
Region 3											

County	I	II+III	IV	Other	Total	County	I	II+III	IV	Other	Total
Adams	3	9	10	36	58	**Jefferson**	8	22	16	41	87
Athens	7	6	10	39	62	**Lawrence**	5	9	3	35	52
Belmont	10	10	26	53	99	**Meigs**	3	8	7	21	39
Brown	3	20	14	39	76	**Monroe**	2	10	8	26	46
Carroll	2	22	26	44	94	**Morgan**	7	24	8	28	67
Clermont	9	38	20	55	122	**Muskingum**	5	49	22	55	131
Columbiana	5	38	21	74	138	**Noble**	3	9	4	20	36
Coshocton	3	16	13	22	54	**Perry**	11	23	8	38	80
Gallia	4	12	4	33	53	**Pike**	8	6	3	39	56
Guernsey	5	29	12	22	68	**Ross**	9	15	7	27	58
Harrison	11	26	13	61	111	**Scioto**	8	10	4	57	79
Highland	3	8	9	28	48	**Tuscarawas**	7	24	13	56	100
Hocking	6	12	10	77	105	**Vinton**	3	8	8	18	37
Holmes	2	3	11	12	28	**Washington**	6	15	11	7	39
Jackson	6	14	12	90	122						
TOTALS	**I: 164**		**II+III: 495**			**IV: 333**			**Other: 1,153**		

Source: DSP Dam Inventory, September 2010

There are a total of 474 Class I-IV dams within Region 1, which is the least number of dams among the three Regions. Out of those there are 84 Class I and 191 Class II and III dams. Within Region 1, Huron County has the highest, combined number of Class I-III dams (25).

There are a total of 1,235 dams within Region 2 that are Class I-IV. Out of those, there are 168 Class I dams and 574 Class II and III dams. The largest concentration of dams and water retention structures within Region 2 is in Medina County (259), as they have the highest combined number of Class I-III dams in the Region.

Region 3 has the second highest number of dams as recognized by DSP's data, with a total of 992 structures. Of these, 164 are Class I and 495 are Class II and III dams. Within Region 3 Muskingum County has the highest combined number of Class I-III dams in the Region (54). However, Perry and Harrison Counties exhibit the highest number of Class I dams in the Region with 11 structures each.

Levees—Location

The inventory of levees in the State of Ohio is nearly complete, with the USACE National Levee Database housing most of the data. While the database is dynamic in nature, it does provide much static information regarding levee location and attributes, which can aid in decision making and better flood risk management. This database was recently released to the public so individuals would have the ability to conduct custom queries and get information pertinent to their situation and their community. However, there remain gaps in some qualitative and quantitative data for levees, which will affect a community's ability

to gauge risk and implement successful risk communication. Such data gaps exacerbate existing state- and community-specific levee safety issues; estimating levee maintenance costs, which affect future funding priorities; and completing accurate risk assessments among the various counties containing such structures in their jurisdictions.

Additionally, the methodologies that are used for assessing flood risk behind levees (*i.e.*, floodplain mapping) are in deliberation at the national level. There are many variables associated with such processes, and it is imperative that each one be considered and weighted appropriately when estimating risk landward of a levee or floodwall system. Until those levee data gaps are bridged and these methodologies are finalized, this plan will utilize NFIP levee information as collected during FEMA's various flood and risk mapping initiatives (2003 to present), and those data maintained by DSP. Some data will be used from the USACE database, but will be identified as such when used.

The ODNR DSP classifies the hazard potential for levees as Class I, Class II, Class III, and Class IV levees (Table 2.6.c), depending on what is identified as the landward risk.

Table 2.6.c

Ohio Levee Classification Systems	
Hazard Classification	**Description**
Class I	Probable loss of human life, structural collapse of at least one residence or one commercial or industrial business
Class II	Disruption of a public water supply or wastewater treatment facility, or other health hazards; flooding of residential, commercial, industrial, or publicly owned structures; flooding of high-value property; damage or disruption to major roads including but not limited to interstate and state highways, and the only access to residential or other critical areas such as hospitals, nursing homes, or correctional facilities as determined by the chief; damage or disruption to railroads or public utilities
Class III	Property losses including but not limited to rural buildings not otherwise described in this rule; damage or disruption to local roads including but not limited to roads not otherwise listed as major roads in this rule
Class IV	Levee having a height of not more than three feet; losses restricted mainly to the levee, owner's property and rural lands

Source: http://www.dnr.state.oh.us/tabid/3344/Default.aspx

In Ohio, there are 73 levees that have been identified throughout the state and are providing some level of protection to agricultural resources or urban/suburban environments (Map 2.6.a and Table 2.6.d). Of that total, there are 22 Class I levees in Region 1, with 12 providing agricultural protection in Ottawa County. For Region 2, there are 29 Class I levees and 6 Class II, and 26 of those are protecting urban settings. Twelve of the levees in Region 2 are located in Butler County, mostly protecting urban and suburban areas. Lastly, 13 Class I levees have been counted in Region 3, while only three Class II structures are inventoried. Nearly half of the levees identified in Region 3 protect waste water treatment plants from riverine flooding.

Past Occurrences

The 2008 State Hazard Mitigation Plan Update referenced "The National Performance of Dams Partnership," a cooperative effort of engineers and dam safety professionals in the U.S. who retrieve, archive, and disseminate information on dam performance in order to list dam incidents and failures throughout the state. According to the Dam Incident Query database, Ohio experienced 320 dam incidents from 1800 to 2014. Seventeen incidents resulted in dam failure, ten of those incidents were caused by in-flow flooding and four incidents occurred during DR-1164. Because dam classification can be dynamic, a more complete database was developed by DSP for a span of years ranging from 1852 to 2009. (Please note the DSP data list incidents/failures dating back to 1852, However, the DSP was not created until 1963. Therefore, not all data provided to Ohio EMA were collected by DSP.) Table 2.6.e lists the dam failures and incidents for Class I and II dams throughout the state.

There has been little property damage that has resulted from a dam failure alone, as dam failures are few in Ohio. However, there has been property damage that was a combination of downstream flooding due to excessive precipitation and dam failure. Unfortunately, it is difficult to assess which property damage was a direct result of the dam failure and which damage was a result of downstream flooding due to excessive precipitation. There has been some infrastructure loss in terms of roads washing away, but there has been no loss of critical facilities due to dam failure to date. It should be noted that DSP does not have much data showing property damages and losses; such data are generally unavailable as there has not been a large, Ohio dam failure in many years. The comments associated with each incident or failure in Table 2.6.e rarely contains such loss information.

There are no documented instances of levee breaches whereby structures or properties were damaged in Ohio as such data are generally unavailable and undocumented. This does not mean there is minimal risk behind these levees; it means more effort needs to be exerted in the collection of such data. However, according to DSP records, in 1997 the Green Acres Levee (Pike County) was overtopped by a flood estimated to be a 100-year event. Several homes were flooded as a result, but no specific damage data could be found for this update.

Map 2.6.a

Levees and Floodwalls Inventoried in Ohio

Levees and Floodwalls

Rivers

Region 1

Region 2

Region 3

There are 73 levees inventoried by FEMA, USACE, and ODNR in Ohio.

0 20 40 80 Miles

N W E S

This map depicts data not created or maintained by Ohio EMA, and, as such, Ohio EMA does not guarantee their accuracy.

Map Creator: Ohio EMA
Data Source: FEMA and ODNR (2010)

Table 2.6.d

Ohio Levee Inventory, Proposed Levels of Protection, and Hazard Classification						
Region 1						
County	Levee/Community Name	Flooding Source	Proposed Level of Protection	Class	Federal/State/ Local/Private	Type
Erie	Whites Landing	Lake Erie Shoreline	100-500-year flood	I	Federal	Agriculture
Lucas	Toledo	Swan Creek	100-500-year flood	I	Federal	Urban
Lucas	Toledo	Ottawa River	100-500-year flood	I	Federal	Urban
Lucas	Jerusalem Township	Lake Erie Shoreline	100-500-year flood	I	Federal	Agriculture
Lucas	Jerusalem Township	Wards Canal	100-500-year flood	I	Federal	Agriculture
Miami	Tipp City	Great Miami River	100-Year Flood	I	Local	Urban
Miami	Piqua	Miami River	100-Year Flood	I	Local	Urban
Miami	Troy, Miami County, Unincorporated Areas	Great Miami River	100-Year Flood	I	Local	Urban
Ottawa	Ottawa County, Unincorporated Areas	Toussaint River Tributary	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Lacarpe Creek	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Unnamed	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Lake Erie Shoreline	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Turtle Creek Bay	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Turtle Creek	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Packer Creek	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Little Portage River	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Toussaint River (Ring Levee)	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Muddy Creek	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Rusha Creek	100-Year Flood	I	Private	Agriculture
Ottawa	Ottawa County, Unincorporated Areas	Toussaint River	100-Year Flood	I	Private	Agriculture
Sandusky	Fremont	Sandusky River	100-Year Flood	I	Federal	Urban
Sandusky	Fremont	Sandusky River	100-Year Flood	I	Federal	Urban

Region 2						
County	**Levee/Community Name**	**Flooding Source**	**Proposed Level of Protection**	**Class**	**Federal/State/ Local/Private**	**Type**
Butler	Butler County, Unincorporated Areas	Great Miami River	100-Year Flood	I	Local	Urban
Butler	Butler County, Unincorporated Areas	Great Miami River/Dicks River	100-Year Flood	I	Local	Urban
Butler	Middletown	Great Miami River	100-Year Flood	I	Local	Urban
Butler	Hamilton	Great Miami River	100-Year Flood	I	Local	Urban
Butler	Hamilton South Water Treatment Levee	Pleasant Run	100-500-year flood	II	Local	WWTP
Butler	Fairfield	Pleasant Run	100-Year Flood	I	Local	Urban
Butler	Butler County, Unincorporated Areas	Great Miami River	100-Year Flood	I	Local	Urban
Butler	Monroe	Millers Creek	100-Year Flood	I	Local	Urban
Butler	Middletown	Great Miami River	100-Year Flood	I	Local	Urban
Butler	Hamilton	Great Miami River	100-Year Flood	I	Local	Urban
Butler	Fairfield	Pleasant Run Branch #3	100-Year Flood	I	Local	Urban
Cuyahoga	Cleveland	Euclid Creek	50-99-year flood	I	Federal	Urban
Fairfield	Bremen/Franklin County, Unincorporated Areas	Little Rush Creek/Raccoon Run	100-Year Flood	I	Federal	Urban
Franklin	Agg Rock Reach Levee	Scioto Big Run	100-Year Flood	I	Private	Industrial
Franklin	Columbus	Dry Run	100-500-year flood	I	Federal	Urban
Franklin	King Avenue Levee	Olentangy River	100-500-year flood	II	Local	WWTP
Hamilton	Cincinnati	Ohio River	100-500-year flood	I	Federal	Urban
Hamilton	Cincinnati	Ohio River/Little Miami River	100-Year Flood	I	Local	Urban
Hamilton	Little Miami WWTP Levee	Ohio River	100-500-year flood	II	Local	WWTP
Hamilton	Muddy Creek WWTP Levee	Ohio River	100-Year Flood	I	Local	WWTP
Hamilton	Sycamore Creek WWTP Levee	Sycamore Creek	100-500-year flood	II	Local	WWTP
Knox	Mount Vernon	Kokosing River/Dry Creek	100-Year Flood	I	Local	Urban
Licking	Heath WWTP Flood Protection Levee	South Fork of Licking River	100-500-year flood	II	Local	WWTP

Licking	Newark	South Fork of Licking River	50-99-year flood	I	Federal	Urban
Licking	Utica	Licking River	50-99-year flood	I	Federal	Urban
Montgomery	Dayton	Wolf Creek	100-Year Flood	I	Local	Urban
Montgomery	Dayton/Miamisburg/West Carrollton	Great Miami River/Stillwater River/Mad River	100-Year Flood	I	Local	Urban
Montgomery	Dayton	Great Miami River	100-Year Flood	I	Local	Urban
Montgomery	Huber Heights	Great Miami River	100-Year Flood	I	Local	Urban
Montgomery	Moraine Levee and Floodwall	Great Miami River	100-Year Flood	I	Local	Urban
Richland	Mansfield	Rocky Fork	100-Year Flood	I	Local	Urban
Stark	Massillon	Tuscarawas River	100-500-year flood	I	Federal	Urban
Stark	Brewster	Sugar Creek/Elm Run	100-Year Flood	I	Local	Urban
Warren	Franklin	Great Miami River	100-Year Flood	I	Local	Urban
Wayne	Wooster Levee Relocation	Killbuck Creek	100-500-year flood	II	Local	WWTP
Region 3						
County	**Levee/Community Name**	**Flooding Source**	**Proposed Level of Protection**	**Class**	**Federal/State/ Local/Private**	**Type**
Belmont	Shadyside WWTP Levee	Ohio River	100-500-year flood	II	Local	WWTP
Carroll	Magnolia	Beaver Canal	100-Year Flood	I	Local	Urban
Columbiana	Wellsville	Ohio River/Little Yellow Creek	Greater than 500-year flood	I	Federal	Urban
Gallia	Kyger Creek Levee	Kyger Creek	10-Year Flood	II	State	Urban
Guernsey	Southgate Dike	Wills Creek	500-Year Flood	I	Local	WWTP
Hocking	Laurelville	Laurel Run	100-Year Flood	I	Local	Urban
Hocking	Logan WWTP Levee	Hocking River	100-500-year flood	II	Local	WWTP
Lawrence	Ironton	Ohio River	Greater than 500-year flood	I	Federal	Urban
Lawrence	Ironton/Lawrence County Unincorporated	Storm Creek/Rocky Fork	100-Year Flood	I	Local	Urban
Muskingum/ Perry	Roseville	Moxahala Creek	100-500-year flood	I	Federal	Urban

Pike	Green Acres Levee	Crooked Creek	100-Year Flood	I	Local	Urban
Pike	Mills Pride Levee	Scioto River	100-Year Flood	I	Private	Industrial
Pike	Waverly WWTP Levee	Scioto River	100-Year Flood	I	Local	WWTP
Ross	Chillicothe	Scioto River	100-500-year flood	I	Federal	Urban
Scioto	New Boston	Ohio River	Greater than 500-year flood	I	Federal	Urban
Scioto	Portsmouth	Ohio River	Greater than 500-year flood	I	Federal	Urban

Source: FEMA Region V Levee Database (2009) and DSP Levee Database (2010)

LHMP Data

Stark County. The county Multi-Jurisdiction All-Hazard Mitigation Plan of 2012 indicates there are 17 dams in the county. Of those, five are Class I dams and, 12 are Class II dams. According to flood studies on file with the Stark County EMA, many communities in the county could be affected by a dam failure event. Flood studies done in the mid-1980s indicate that failure of several dams in and around Stark County could significantly affect many Stark County communities. In an event where the Dover and Bolivar dams were at the emergency spillway, back up flooding along the Tuscarawas River through Stark County would significantly impact the Village of Navarre, as well as affect the Cities of Massillon and Canal Fulton. Flooding in Navarre would far surpass 500-year flood levels, placing much of the village's downtown under water. Similar studies for Atwood Lake and the Beach City Dam, on file with the county EMA, indicate similar concerns. After an extensive examination of spreadsheet calculations, vulnerability assessments show that 28,288 structures could be damaged with an estimated loss of $1,019,132,000.

Lake County. The county Multi-Jurisdiction All-Hazard Mitigation Plan Update of 2010 states out of the ten dams in the county, two are Class I dams (Mentor and Brightwood Lake) and two are Class II dams (Clover Lake and Little Mountain Dam "A"). Both Class I dams are located on Kellogg Creek and are classified as "high." While the Brightwood Lake Dam is located farther upstream, (3.8 miles), the Mentor Dam is located only one-tenth of a mile from the city of Mentor. The Class II dams are found on two other watersheds, however, both affect the City of Painesville. Clover lake Dam is situated on a tributary to Big Creek 1.3 miles from Painesville, while Little Mountain Dam "A" is located 4.2 miles from the city. The Lake County Mitigation Plan estimates that a total of 12,947 structures could be damaged with an estimated loss of $821,889,527.

Delaware County. Dam failure is a significant concern for Delaware County as there are thirty-nine earthen dams and reservoirs located within the county that could result in significant losses if they were to fail or become inundated. These dams are Delaware, Alum Creek, O'Shaughnessy, Westerville, Whispering Pines, Lexington Glen, seven unnamed dams owned by Del-Co Water, and two Sunbury Reservoirs. The Hoover Dam structure is located within Blendon Township in Franklin County, but a significant portion of its reservoir exists within Delaware County and should be considered a potential hazard to Delaware County residents (see flood section). The Dams located within Delaware County are regulated by the U.S. Army Corp of Engineers (USACE), Ohio Department of Natural Resources (Division of Water) (ODNR) and Federal Energy Regulatory Commission (FERC).

Local GIS inundation maps for all of the dams, except for the Sunbury and Ashley reservoirs, were overlaid onto the Auditor's parcel data and this determined the number of structures at-risk within each jurisdiction. Delaware, Powell, Shawnee Hills are the only cities or villages that contain at-risk populations or structures due to their proximity to crucial rivers and reservoirs.

Delaware City contains a staggering 1,458 vulnerable structures valued at over $300 million because the densely populated city lies directly south of the dam in the direct pathway of the water's direction. In addition, there are over 2,000 vulnerable structures that lie outside of the county's municipalities, particularly since the majority of the dams and reservoirs are a sizeable distance from them. The 2013 Delaware County Multi- Hazard Mitigation Plan estimates that a total of 3,734 structures could be damaged with an estimated loss of $909,122,500.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Considering all hazards identified in the local plans, dam/levee failure ranked last in terms of frequency, as these have occurred in minimal numbers around the state (Chart 2.2.a). However, this hazard ranked relatively high for the response factor, whereby local plans indicated an average of one day – one week for response duration. Also, dam/levee failure ranked near the top of the list for potential business and human impacts. Overall, this hazard ranked fifth out of 15 hazards evaluated in SHARPP, which indicates dam/levee failures are considered to be a potential threat throughout the state. According to records and data entered to date into vulnerability assessments, losses from dam failure are estimated at 75,968 residential structures ($1,432,009,144), 11,963 non-residential structures ($500,272,497) and 175 critical facilities ($216,278,716). These and additional HIRA data queried from SHARPP can be found in Appendix J.

Table 2.6.e

Ohio High Hazard Dam Incidents/Failures From 1852 to 2014					
Region	**County**	**DSP Class**	**Dam Name**	**Incident Year**	**Incident Description***
Region 1	Huron	I	NORWALK LOWER RESERVOIR	1969	Dam failed; no damage downstream noted. Dam was rebuilt with berm and drainage.
	Huron	I	GREENWICH RESERVOIR DAM	1969	Dam partially failed; no damage downstream noted.
	Huron	I	HOLIDAY LAKE DAM	1982 2007	Left sidewall failed in 1882. A shallow slide was noted in 2007.
	Morrow	I	CANDLEWOOD LAKE DAM	1998	Approximately 3-4' noted in the emergency spillway.
	Sandusky	I	BALLVILLE DAM	1913	Dam failed with 1913 flood; no damage downstream reported.
	Williams	I	LAKE SENECA DAM	1973 1996	Overflow spillway failed in 1973 and 1996; no damage downstream reported.
	Wyandot	I	KILLDEER UPGROUND RESERVOIR	1979 2004	Leak and slide indicated in 1979, and multiple slides indicated in 2004.
	Defiance	II	INDEPENDENCE DAM	1982	Left abutment was overtopped and damaged.
	Lucas	II	SWANTON UPGROUND RESERVOIR	1970	Dam failure in 1970, but was repaired.
	Seneca	II	MOHAWK LAKE DAM	1910 1963	Dam failure in 1910 resulted in replacement; dam failure in 1963 resulted in repairs. No damage downstream reported.
Region 2	Ashtabula	II	GERLAT LAKE DAM	2011	Spillway failed. ODNR issued an order for the dam to be repaired or breached. The dam was breached.
	Cuyahoga	I	BRIAR HILL LAKE DAM	2006	Dam possibly overtopped; no damage downstream noted.

Ohio High Hazard Dam Incidents/Failures From 1852 to 2014					
Region	**County**	**DSP Class**	**Dam Name**	**Incident Year**	**Incident Description***
	Delaware	I	LEXINGTON GLEN DAM	1987	Dam failed due to erosion on the emergency spillway and four erosion rills on the downstream slope.
	Delaware	I	SUNBURY UPGROUND RESERVOIR NO. 1	1960s	Dam overtopped; no downstream damage noted.
	Fairfield	I	RUSH CREEK STRUCTURE NO. VI-A	1982	An abutment leakage was noted and repaired.
	Fairfield	I	PINE LAKE ESTATES DAM	2013	Spillway failure
	Geauga	II	KENSTON LAKE DAM	2010	Spillway clogged and the dam overtopped. ODNR issued an order for the dam to be repaired or breached. The dam was breached. Pipe jacked and bored through the dam, eliminating the reservoir and making the dam a roadway embankment.
	Geauga	I	MONT-MERE LAKE DAM	2006	Water was 1-1.5' below top of dam; dam never overtopped.
	Geauga	I	TANGLEWOOD LAKE DAM	1981	Spillway partially failed, but was repaired; no damage downstream noted.
	Knox	I	KNOX LAKE DAM	1950	Seepage was noted and spillway failed.
	Lake	I	HOOSE ROAD RETENTION DAM	2006	Water was 1-2' above emergency spillway elevation.
	Lake	I	BRIGHTWOOD LAKE DAM	1985	A resident near the emergency spillway stated the dam overtopped; no damage downstream reported.
	Lorain	II	BRENTWOOD LAKE DAM	2009	Spillway failed. ODNR issued an order for the dam to be repaired or breached. The dam was breached.

Ohio High Hazard Dam Incidents/Failures From 1852 to 2014					
Region	**County**	**DSP Class**	**Dam Name**	**Incident Year**	**Incident Description***
	Medina	I	PISCHIERI POND DAM	1999	Dam was breached in controlled manner due to detection of void in dam; no damage downstream.
	Medina	I	RAVENSWOOD LAKE DAM	1973	Original dam failed and was rebuilt in 1973.
	Medina	I	RUSTIC HILLS LAKE DAM	1980 2003	Dam failed in 1980, and emergency spillway failed in 2003 which caused overtopping; no damage downstream reported.
	Portage	I	BRIMFIELD LAKE DAM	1979	Dam nearly failed due to overtopping; no damage downstream reported.
	Richland	I	SHELBY UPGROUND RESERVOIR NO. 2	2001	Seepage was noted through reservoir due to field tile; repairs were made accordingly.
	Summit	II	THE MEADOWS DAM	2012	Spillway failed. ODNR issued an order for the dam to be repaired or breached. The dam was breached.
	Summit	I	LAKE LITCHFIELD DAM	1973	Embankment failed during construction.
	Warren	I	PINE HILL LAKE DAM	2001	Emergency spillway flowed; no damage downstream reported.
	Wayne	I	CHIPPEWA CREEK STRUCTURE VII-C	1973	Foundation failure during construction; no damage indicated downstream.
	Ashtabula	II	ELKEM FLUID WASTE POND 3A	1980	Slide was noted in the downstream slope, and was fixed.
	Cuyahoga	II	MARSHFIELD LAKE DAM	1973	Dam breached under order; no damages reported; rebuilt in 1977.
	Franklin	II	TIMBERLAKE NO. 1 DAM	1984	Drain pipe failed, but was repaired.
	Geauga	II	BURTON LAKE DAM	1970s 1997	Dam breached in the 1970s, and seepage boils were noted in 1997.

Ohio High Hazard Dam Incidents/Failures From 1852 to 2014					
Region	**County**	**DSP Class**	**Dam Name**	**Incident Year**	**Incident Description***
	Geauga	II	PAW PAW LAKE DAM	1941	Dam failed and was rebuilt in 1941; no damage downstream was reported.
	Geauga	II	KENSTON LAKE DAM	1970s	Downstream face slipped.
	Hamilton	II	HERMITAGE CLUB LAKE DAM	1982	Intense storm resulted in dam overtopping; no damage downstream reported.
	Licking	II	GOSS LAKE DAM	1990	Floodwaters caused partial failure of principal spillway; no damage downstream noted.
	Licking	II	NEWARK LOW HEAD DAM	1959	Dam washed out in 1959, but was rebuilt.
	Medina	II	RPM LAKE DAM	1998	Principal spillway failure; repairs made in 1998.
	Portage	II	AURORA POND DAM	1985	Dam failed and was rebuilt around 1985.
	Stark	II	MORELLI POND DAM	2003	Causeway breached due to a compromise in left end of dam; no damage downstream reported.
	Stark	II	WILLOWDALE LAKE DAM	1923	Original dam failed and was rebuilt in 1924, with multiple repairs through the present.
	Summit	II	VIRGINIA KENDALL PARK DAM	2003	Dam failure in late 1970s, and was overtopped in 2003; no damage downstream noted.
	Summit	II	CAMP JULIA CROWELL LAKE DAM	2006	Severe erosion was noted on the left side of the emergency spillway.
	Summit	II	LAKE FOREST DAM	2003	Dam experienced a flood of record in 2003; no damage downstream reported.
	Summit	II	CITY OF HUDSON UPPER LAKE DAM	2003	Dam overtopped; no downstream damage noted.
	Summit	II	CITY OF HUDSON LOWER LAKE DAM	2003	Dam overtopped; no downstream damage noted.

Ohio High Hazard Dam Incidents/Failures From 1852 to 2014					
Region	**County**	**DSP Class**	**Dam Name**	**Incident Year**	**Incident Description***
	Trumbull	II	NEWTON FALLS LOW HEAD DAM	1988	Hole was noted in spillway.
	Warren	II	WATER'S EDGE DAM	1993	Dam was rebuilt in 1993 after failure.
Region 3	Athens	I	ATHENS FISH AND GAME CLUB LAKE DAM	1975	Dam was deemed unsafe due to seepage and a slide and was breeched; no downstream damage reported. It was reconstructed in 1978.
	Belmont	I	ST. CLAIRSVILLE RESERVOIR NO. 2 DAM	1980	A sinkhole was noted in the upstream slope.
	Belmont	I	BARNESVILLE LAKE DAM	2005	A shallow slide was noted on the downstream slope.
	Belmont	I	MEIGS-PHILLIPS I NO. 1 DAM	2004	Severe erosion was noted in the emergency spillway.
	Brown	I	RUSSELLVILLE RESERVOIR DAM	1997	Dam was overtopped; no damage noted downstream.
	Columbiana	I	GUILFORD LAKE DAM	1852	Dam breached; no downstream damage noted.
	Guernsey	I	LUBURGH LAKE DAM	1979	A downstream slope slide was noted and repaired.
	Guernsey	I	SALT FORK LAKE DAM	1998	Dam overtopped; no downstream damage noted.
	Hocking	I	LAKE LOGAN DAM	1950	Dam was breached upon initial filling; no damage downstream noted. Dam was redesigned in 1952 and rebuilt in 1954.
	Hocking	I	LAKE OF THE FOUR SEASONS DAM	2013	Upstream slope earth slide.
	Jackson	I	WELLSTON RESERVOIR DAM	1937	A slide was noted.

Ohio High Hazard Dam Incidents/Failures From 1852 to 2014					
Region	**County**	**DSP Class**	**Dam Name**	**Incident Year**	**Incident Description***
	Jackson	I	OAK HILL UPGROUND RESERVOIR	1986	Multiple slides were noted.
	Jefferson	I	JEFFERSON LAKE DAM	2004	Dam was within 0.5' of overtopping two times in one year.
	Jefferson	I	WILLIAMS LAKE DAM	2004	Dam overtopped twice in same year; no damage downstream reported.
	Morgan	I	CROOKSVILLE RESERVOIR NO. 1 DAM	1950	Dam noted as probably overtopping; no damage downstream indicated.
	Morgan	I	CROOKSVILLE RESERVOIR NO. 2 DAM	1984	Slide was noted in the downstream slope, and was fixed.
	Perry	I	SHELTON LAKE DAM	1990	Dam overtopped; no downstream damage noted.
	Perry	I	ALTIERS LAKE DAM	2004	Flood event resulted in pool being 3-4' above normal; dam did not overtop.
	Pike	I	LAKE WHITE DAM	1964 1994	Dam overtopped in 1964 and 1994; no damage downstream reported.
	Ross	I	CALDWELL LAKE DAM	1994	Sink hole was noted and repaired.
	Ross	I	KNOLES POND DAM	1979	Lake was drained for repairs.
	Scioto	I	ROOSEVELT LAKE DAM	1997	Dam overtopped; no downstream damage noted.
	Athens	II	RAINBOW LAKE DAM	1979	Slide was noted in the downstream slope near right abutment, and was fixed.
	Carroll	II	ROHR DAM	1975	Failure indicated at right end of dam; no damage downstream reported.
	Carroll	II	BOY SCOUT DAM	1984	Upstream slope failed during construction.
	Clermont	II	BECKJORD ASH POND C DAM	1999	Elbow of pipe and riser collapsed.

Ohio High Hazard Dam Incidents/Failures From 1852 to 2014					
Region	**County**	**DSP Class**	**Dam Name**	**Incident Year**	**Incident Description***
	Columbiana	II	WESTVILLE LAKE DAM	1980 1982 1994	Breach in the south dike indicated in 1980; another breach indicated in 1982; portion of replacement spillway washed out during construction in 1994. No damage downstream was reported.
	Columbiana	II	SEVAKEEN COUNTRY CLUB LAKE DAM	1930s	Dam breached and rebuilt; no downstream damage noted.
	Columbiana	II	SLATES LAKE DAM	1965	Dam failed during initial filling of lake due to seepage around spillway pipe; no damage downstream indicated.
	Columbiana	II	WOODLAND LAKE DAM	2003	Dam overtopped; no downstream damage noted.
	Columbiana	I	Buckeye Water District Reservoir	2008	
	Harrison	II	SELESKI LAKE NO. 2 DAM	1989	Dam overtopped at left end; no damage downstream reported.
	Jefferson	II	LAKE HENRY DAM	1993	Original principal spillway was blocked.
	Lawrence	II	SMITH HOLLOW DAM	1989	Spillway failed; no damage downstream reported.
	Morgan	II	MUSKINGUM RIVER LOCK AND DAM NO. 7	1959	Dam failed in 1959; no damage downstream reported.
	Muskingum	II	MUSKINGUM RIVER LOCK AND DAM NO. 10	1951	Dam failed in 1951; no damage downstream reported.
	Perry	II	MERKLE DAM	1972	Dam washed out but was rebuilt in 1972.
	Perry	II	TECUMSEH LAKE DAM	1990	Dam was overtopped by 1-2'; no damage downstream was reported.
	Scioto	II	ELKS COUNTRY CLUB LAKE DAM	1980	33' long slide on the downstream slope; repaired, but slipped again.

Ohio High Hazard Dam Incidents/Failures From 1852 to 2014					
Region	**County**	**DSP Class**	**Dam Name**	**Incident Year**	**Incident Description***
	Scioto	II	LAKE MARGARET DAM	1997	Dam overtopped in 1997, but repaired in 2002. No damage downstream noted.
	Tuscarawas	I	SUGAR CREEK SPORTSMAN CLUB Dam	2010	Seepage.
	Washington	II	CHOPPER'S LAKE DAM	1994	Dam breached due to heavy rainfall with erosion of earth adjacent to spillway; no downstream damage noted.

**Source: ODNR—Division of Soil and Water Resources, Dam Safety Program, Dam Inventory Data, September 2010; ODNR is not responsible for collecting or maintaining data about damages experienced downstream due to incidents or failures. As such, these data only indicate that no damage was reported to ODNR; dam owners or communities may have additional records that show damages for any of these incidents or failures. Such records were not sought for this plan update.*

Probability of Occurrence

For reasons previously mentioned, and some of which are uncontrollable by humans, it is possible a dam or levee can fail at any time, given the right circumstances. However, the probability of future occurrence is reduced due to proactive preventative action on the part of ODNR – DSP and individual dam and levee owners. As previously discussed in this section, the DSP provides oversight to dam/levee repairs, oversees and issues construction permits, enforces safety standards and mandates, conducts periodic safety inspections, and provides public information to levee owners, engineers, and the general public. This proactive approach to managing dam and levee safety in Ohio reduces the number of losses to property and life as a result of dam or levee failures or near failures.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Dams—Methodology

Assessing the hazard that a dam poses to downstream areas can be divided into three analyses: (1) analysis of an uncontrolled release of the reservoir, (2) analysis of the inundation from the uncontrolled release, and (3) analysis of the consequence of the release. In other words, a dam fails, the failure causes flooding downstream, and the flooding has negative impacts on people or property. Each of these analyses includes substantial uncertainty. Legitimate estimates of discharge from a breach can differ by over 200%. Discharge from a dam breach is usually several times the one-percent-annual-chance flood, and, therefore, typical flood studies are of limited use in estimating the extent of flooding. Dam failure inundation studies require specialized hydraulic modeling software and experience. Determining the impact of flooding is also difficult to accomplish, especially for estimating loss of life. Loss of life is a function of the time of day, warning time, awareness of those affected, and particular failure scenario. Many dam safety agencies have used “population at risk” (PAR), a more quantifiable measurement of the impact to human life, rather than “loss of life.” PAR is the number of people in structures within the inundation area that would be subject to significant, personal danger, if they took no action to evacuate.

As mentioned at the beginning of this section, emergency managers usually categorize dam failures as either *sunny day failures* or *rainy day failures*. *Sunny day failures* occur during a non-flooding situation with the reservoir near normal pool level. *Rainy day failures* usually involve periods of rainfall and flooding, and can exacerbate inadequate spillway capacity. Improper design of a spillway or careless operation of gates during high flows can lead to excessive water pressure and subsequent failure as well. Even though both types of failures can be disastrous, it can be assumed that a *sunny day failure* would be more catastrophic due to its unanticipated occurrence and the lack of time to warn residents downstream.

The impacts of a dam failure are contingent on many factors and, therefore, cannot be concisely described. The assessments in Table 2.6.f are rough estimates based on experience with flood modeling, other inundation studies, best available information, and site inspections by the DSP. The table shows estimated damage levels and PAR values for both the *sunny day* and *rainy day failure* scenarios.

Dams—Results

These results focus on the High Hazard potential dams, and they are considered by ODNR as "high priority," as failure of any one would presumably result in a loss of at least 50 human lives. Table 2.6.f lists the High Hazard dams with this characteristic by region, and Map 2.6.b displays the *Rainy Day* PAR.

Table 2.6.f

Priority Dam Inventory, Expected Downstream Damage Level, and Minimum Level Population At-Risk (PAR) by County					
Region 1					
County	**Dam**	**Sunny Day Damage Level**	**Sunny Day PAR Level**	**Rainy Day Damage Level**	**Rainy Day PAR Level**
Allen	Ferguson Upground Reservoir	High	Medium	Very High	Medium
Allen	Metzger Upground Reservoir	Medium	Medium	Very High	Medium
Allen	Lost Creek Upground Reservoir	Medium	Low	Medium	Low
Clinton	Wilmington Upground Reservoir No. 2	Medium	Low	Medium	Low
Crawford	Bucyrus Reservoir No. 1 Dam	Medium	Low	Medium	Low
Hancock	Veterans Memorial Reservoir	Medium	Low	Medium	Low
Huron	Willard City Upground Reservoir	Medium	Low	Medium	Low
Huron	Norwalk Memorial Reservoir	High	Low	High	Low
Huron	Norwalk Upper Reservoir	High	Low	High	Low
Huron	Norwalk Lower Reservoir	High	Low	High	Low
Shelby	Lockington Dam	--	Low	Very High	Medium
Shelby	Lake Loramie Dam	Medium	Low	Medium	Low
Region 2					
County	**Dam**	**Sunny Day Damage Level**	**Sunny Day PAR Level**	**Rainy Day Damage Level**	**Rainy Day PAR Level**
Ashtabula	Roaming Rock Shores Lake Dam	High	Medium	High	Medium
Butler	Fairfield Detention "A" Dam	--	Low	Medium	Low
Butler	Fairfield Detention "C" Dam	--	Low	Medium	Low
Butler	Acton Lake Dam	High	Low	High	Low
Cuyahoga	Lakeview Cemetery Flood Control Dam	--	Low	High	Medium
Delaware	Alum Creek Upground Reservoir	High	Low	High	Low
Delaware	O'Shaughnessy Reservoir Dam	Very High	Low	Very High	Low
Franklin	Hoover Dam	Very High	High	Very High	High
Franklin	Julian Griggs Dam	High	Low	High	Low

Geauga	Bridge Creek Dam	Very High	Medium	Very High	Medium
Greene	Huffman Dam	--	Low	Very High	Medium
Knox	Apple Valley Lake Dam	High	Low	High	Low
Licking	Buckeye Lake Dam	Very High	High	Very High	Medium
Mahoning	Evans Lake Dam	High	Medium	Very High	Medium
Mahoning	McKelvey Lake Dam	High	Medium	High	Medium
Mahoning	Lake Hamilton Dam	Medium	Low	High	Low
Mahoning	Lake Milton Dam	Very High	High	Very High	High
Montgomery	Germantown Dam	--	Low	Very High	Medium
Montgomery	Taylorsville Dam	--	Low	Very High	Medium
Montgomery	Englewood Dam	--	Low	Very High	High
Portage	Mogadore Reservoir Dam	High	Medium	High	Medium
Portage	Lake Rockwell Dam	High	Medium	Very High	Medium
Richland	Clear Fork Reservoir Dam	Medium	Low	High	Medium
Summit	West Reservoir Dam	High	Low	High	Low
Summit	Wolf Creek Dam	Very High	High	Very High	High
Summit	Tuscarawas River Diversion Dam	Medium	Low	High	Low
Summit	North Reservoir Dam	Medium	Low	Medium	Low
Summit	East Reservoir Dam	Medium	Low	Medium	Low
Summit	Lake Dorothy Dam	Medium	Low	High	Low
Trumbull	Mineral Ridge Dam	Very High	High	Very High	High
Region 3					
County	**Dam**	**Sunny Day Damage Level**	**Sunny Day PAR Level**	**Rainy Day Damage Level**	**Rainy Day PAR Level**
Belmont	Belmont Lake Dam	Medium	Low	High	Medium
Clermont	Stonelick Lake Dam	High	Medium	Medium	Low
Columbiana	Guilford Lake Dam	High	Medium	Medium	Low
Gallia	Gavin Bottom Ash Pond	Medium	Low	Medium	Low
Gallia	Stingy Run Fly Ash Dam	Very High	Medium	Very High	High
Guernsey	Salt Fork Lake Dam	Very High	Medium	Very High	Medium
Highland	Rocky Fork Lake Dam	Very High	High	Very High	High
Holmes	Lake Buckhorn Dam	Medium	Low	Medium	Low
Jefferson	Cardinal Fly Ash No. 2 Dam	Very High	Low	Very High	Low
Jefferson	Lake Austin Dam	High	Low	High	Low
Noble	Wolf Run Lake Dam	Very High	Medium	Very High	Medium
Noble	Caldwell Lake Dam	High	Medium	High	Medium
Scioto	Turkey Creek Lake Dam	High	Medium	Medium	Low
Washington	Eramet Waste Retention Dam	High	Medium	High	Medium

Map 2.6.b

"High Priority" Dams in Ohio

Rainy Day PAR

- Low
- Medium
- High

- Region 1
- Region 2
- Region 3

There are 56 "High Priority" dams identified by ODNR throughout Ohio.

0 20 40 80 Miles

N W E S

This map depicts data not created or maintained by Ohio EMA, and, as such, Ohio EMA does not guarantee their accuracy.

Map Creator: Ohio EMA
Data Source: ODNR (2010)

Of the 56 “high priority” dams, 41 are categorized as *large* since they have more than 5,000 acre-feet of storage, or they have more than 100 acres of surface area at the dams’ normal pools. The remaining 15 dams have less storage, but still represent a real risk to more than 50 people per dam.

Region 1 includes 12 “high priority” dams, seven of which reside in Allen (3) and Huron (4) Counties combined. Even though no dams in this Region have a *High* PAR level, three of the dams exhibit a *Medium* PAR level. Two of the dams in Allen County (Ferguson Upground Reservoir and Metzger Upground Reservoir) do not have approved EAPs. A failure of these structures could prove to be even more catastrophic than represented in Table 2.6.f since the proper preparedness has not been accomplished. However, both have draft inundation mapping, which could aid local officials in outreach initiatives for the public.

In terms of damages, the dams upstream of larger populations exhibit higher estimated damages with both the *sunny day* and *rainy day* scenarios. For instance, Lockington Dam (Shelby County) shows no evidence of downstream damage during a *sunny day* failure, as the dam does not impound any pool—flood control dam. *Very High* damage estimates should be expected during a large storm event as the channel would most likely be overwhelmed.

Considering the relationship between Table 2.6.e and 2.6.f, it should be noted that Norwalk Lower Reservoir (Huron County) had a documented failure in 1969 and is listed as a “high priority” by the State, as it exhibits *High* expected damage levels for both *sunny day* and *rainy day* scenarios. However, the failure resulted in a rebuild that included a berm and updated drainage, and an EAP was developed. Any future incidents should be managed by this plan.

Also, there is only one Class I dam in Region 1 that has had a documented incident or failure but lacks an EAP—Greenwich Reservoir Dam (Huron County). An EAP would provide the added preparedness to reduce future losses; this should be considered by the dam owner.

Region 2 is distinguished as having the most “high priority” dams among the State’s regions with 30 dams. Six dams in the Region exhibit *High* PAR levels when considering both scenarios, including Lake Milton Dam (Trumbull County), which does not have an approved EAP. A failure of this structure could prove to be even more catastrophic than represented in Table 2.6.f since the proper preparedness has not been accomplished. Additionally, Buckeye Lake Dam (Licking County) does not have an approved EAP, but draft inundation mapping is available for outreach to people within the community.

Considering potential damage levels given a dam failure in this Region (Table 2.6.f), the dams exhibiting *High* or *Very High* damage estimates during a *sunny day* failure should be points of interest, especially those without EAPs. An example of this would be Lake Rockwell Dam (Portage County) whereby the *sunny day* scenario is projected to result in *High* damage levels downstream of the failure. Without an EAP, there may not be adequate preparedness to handle such an event in an efficient and effective manner.

Currently, there are seven Class I dams in Region 1 that have had documented incidents or failures (Table 2.6.e) but lack EAPs. In Delaware County, the Sunbury Upground Reservoir Number 1 overtopped in the 1960s, but there were no damages reported. Additional dams in Geauga (Mont-Mere Lake Dam), Medina (Pischieri Pond Dam), Portage (Brimfield Lake Dam), Summit (Lake Litchfield Dam), Warren (Pine Hill Lake Dam), and Wayne Counties (Chippewa Creek Structure VII-C) have experienced incidents via high flows or have experienced failures during construction. Without EAPs, losses could be devastating given uninformed citizens and/or local officials in each of these communities.

Region 3 is noted as having the second most "high priority" dams among the State's Regions with 14 dams (Table 2.6.f). Two dams in this Region exhibit the *High* PAR level for the *rainy day* scenario, Stingy Run Fly Ash Dam (Gallia County) and Rocky Fork Lake Dam (Highland County). Neither of these dams has approved EAPs, but draft inundation mapping is available for Stingy Run Fly Ash Dam. This could prove beneficial should outreach be conducted to communicate the risk to those citizens located in or near the inundation area.

Considering potential damage levels given a dam failure in this Region (Table 2.6.f), the dams exhibiting *High* or *Very High* damage estimates during a *sunny day* failure should be points of interest, especially those without EAPs. Both "high priority" dams in Noble County are lacking EAPs (Wolf Run Lake Dam and Caldwell Lake Dam), and both have *Medium* PARs. Without an approved EAP, there may not be adequate preparedness to handle such an event in an efficient and effective manner. It should be noted that both of these dams have draft inundation mapping available that could be used for community outreach and increased risk communication.

Currently, there are two "high priority" Class I dams in Region 3 that have had documented incidents or failures (Table 2.6.e)—Guilford Lake Dam (Columbiana County) and Salt Fork Lake Dam (Guernsey County). In Columbiana County, Guilford Lake Dam failed in 1852, and they do not have an approved EAP available. An Emergency Preparedness Plan (EPP) has been developed and should better prepare the community for a failure; however, inundation mapping is unavailable to date. On February 15, 2005, a drain system for Salt Fork Dam failed, jeopardizing the overall safety of the dam. Repair of the dam began in December 2005 and finished in spring 2006. An EAP and inundation mapping exist for the Salt Fork Dam, which should reduce vulnerability for future incidents or failures.

Levees—Methodology

As mentioned above, the methodology for mapping risk behind levees is being redeveloped at the national level. Additionally, there are gaps in some of the qualitative and quantitative data available for levees throughout the state. As these methodologies are finalized and the attributed data become available, the results will be incorporated into this plan. Such analyses will include evaluating

vulnerability considering the *with levee* and *without levee* scenarios. More information on these scenarios can be found in FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix H*.

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

METHODOLOGY

As discussed in Section 2.1, the Department of Administrative Services maintains a database of all state-owned and state-leased facilities. These data were obtained for this enhanced plan update, and facilities were categorized based on their critical and non-critical nature (per the definition provided in Section 2.1). For dam failures, inundation mapping is available for many Class I dams throughout the state. This mapping can be coupled with the georeferenced state-owned and state-leased facilities to determine which state holdings are at risk given a dam failure that matches the assumptions made during the inundation analyses.

This methodology was used for assessing state-owned and state-leased facilities vulnerable to Class I dams owned and operated by the USACE. Specifically, 26 dams were analyzed, including 20 within the Huntington District, four within the Louisville District, and two within the Pittsburgh District. The inundation area that was analyzed for each dam was specific to the spillway design flood <u>with</u> dam failure. While such an event is extremely remote in nature, it is within the realm of possibility given the right conditions.

It should be noted the majority of dams throughout the state do not possess inundation mapping, many of which are Class I. However, a portion of these *high hazard* dams have draft or final inundation mapping available through the ODNR-DSP. Future updates to this plan will include analysis of these maps in coordination with the ODNR using the same methodology described previously.

As mentioned above, the methodology for mapping risk behind levees is being redeveloped at the national level. Additionally, there are gaps in some of the qualitative and quantitative data available for levees throughout the state. As these methodologies are finalized and the attributed data become available, the results will be incorporated into this plan. Such analyses will include evaluating vulnerability considering the *with levee* and *without levee* scenarios for all state-owned and state-leased facilities. More information on these scenarios can be found in FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix H*. Until then, this plan will reference the Regional and statewide replacement and rental totals for all state-owned and state-leased facilities in Section 2.1 and Appendix C.

Results

Table 2.6.f shows the numbers of state-owned and state-leased facilities potentially affected by an event equivalent to the spillway design flood with dam failure. It should be noted that there were numerous instances where the same

facility would be impacted by more than one dam failure. Therefore, the columns in Table 2.6.f were not totaled, as this would overestimate the vulnerability for each type of facility. (These results are not in any way intended to reflect upon the integrity of any dams listed in Table 2.6.f. These analyses were completed to gain a better understanding of the state's vulnerability below *high hazard* dams.)

Region 1 is characterized by the lowest number of USACE owned and operated dams with two. For state-owned critical facilities, CJ Brown Dam (Clark County) failure results in the highest potential loss in the Region with 22 facilities worth more than $2.8 million. No state-leased properties were determined to be affected by failure of Caesar's Creek or CJ Brown Dams.

Ten USACE dams comprise Region 2, which ranks second among the Regions in the state. The highest potential vulnerability is associated with failure of Delaware Lake Dam (Delaware County), as it could affect 27 state-owned critical facilities worth almost $107 million. For state-leased critical facilities, Alum Creek Lake Dam (Delaware County) failure would result in potential losses of two facilities worth $330,000 annually. For state-owned non-critical facilities, three dams exhibited similar losses (43 facilities): Charles Mill Lake Dam, Mohicanville Dam, and Pleasant Hill Reservoir. All three of these dams are in the Richland/Ashland County area, which explains the similarity in results, as they are each located on different forks of the Mohican River.

Region 3 contains the most USACE dams in the state with 14, and these dams showed the highest collective losses for state-owned critical and non-critical facilities. Dover and Beach City Dams' (Tuscarawas County) failures could result in losses of 65 and 62 state-owned critical facilities, respectively. These facility numbers equate to $23.8 million and $24.2 million in losses, respectively. For state-owned non-critical facilities, the greatest number (61) of structures at risk is downstream of Paint Creek Dam (Highland County). The highest non-critical vulnerability is downstream of Senecaville Dam (Guernsey and Noble Counties), and is estimated at almost $38 million.

Table 2.6.f

Estimated Losses from Seiche/Coastal Flooding for State-Owned and State-Leased Facilities									
Region	**Dam**	**State-Owned Critical Facility Count**	**State-Owned Critical Facility Value**	**State-Leased Critical Facility Count**	**State-Leased Critical Facility Count**	**State-Owned Non-Critical Facility Count**	**State-Owned Non-Critical Facility Value**	**State-Leased Non-Critical Facility Count**	**State-Leased Non-Critical Facility Rent**
Region 1	Caesar's Creek	1	$41,540	0	$0	2	$357,000	0	$0
	CJ Brown	22	$2,869,081	0	$0	0	$0	0	$0
Region 2	Alum Creek	1	$9,799,344	2	$330,000	6	$6,460,549	4	$1,165,572
	Berlin	13	$23,116,280	0	$0	20	$11,220,910	1	$6,360
	Charles Mill	5	$347,956	0	$0	43	$24,409,801	0	$0
	Deer Creek	0	$0	0	$0	27	$9,646,805	2	$11,172
	Delaware	27	$106,989,775	1	$15,432	11	$24,465,516	1	$90,060
	Mohicanville	0	$0	0	$0	43	$24,409,801	0	$0
	Mosquito Creek	1	$60,543	0	$0	0	$0	0	$0
	North Branch Kokosing River	1	$345,091	0	$0	0	$0	0	$0
	Pleasant Hill	5	$347,956	0	$0	43	$24,409,801	0	$0
	West Fork	1	$1,501,328	0	$0	0	$0	1	$163,866

Region	Dam	State-Owned Critical Facility Count	State-Owned Critical Facility Value	State-Leased Critical Facility Count	State-Leased Critical Facility Count	State-Owned Non-Critical Facility Count	State-Owned Non-Critical Facility Value	State-Leased Non-Critical Facility Count	State-Leased Non-Critical Facility Rent
Region 3	Atwood	38	$18,053,058	0	$0	8	$1,285,579	1	$21,624
	Beach City	62	$24,203,417	0	$0	8	$1,333,927	6	$154,476
	Bolivar	54	$23,437,507	0	$0	38	$7,607,281	7	$166,476
	Clendening	0	$0	0	$0	0	$0	0	$0
	Dillon	18	$738,103	0	$0	13	$1,787,168	8	$214,932
	Dover	65	$23,841,610	0	$0	30	$5,489,093	8	$224,556
	East Fork	1	$41,540	0	$0	0	$0	0	$0
	Leesville	37	$1,952,357	0	$0	23	$3,929,981	1	$21,624
	Mohawk	20	$2,546,110	0	$0	11	$2,759,300	9	$234,936
	Paint Creek	7	$5,102,023	0	$0	61	$5,018,676	6	$161,820
	Piedmont	36	$1,711,302	0	$0	2	$265,579	0	$0
	Senecaville	7	$4,725,476	0	$0	2	$37,953,058	3	$57,180
	Tappan	0	$0	0	$0	0	$0	0	$0
	Wills Creek	24	$5,599,043	0	$0	2	$150,348	6	$122,268

2.7 WILDFIRE

Each year in Ohio, an average of 800 wildfires burn 4,000 to 5,000 acres of forest and grassland within ODNR Division of Forestry's Wildfire Protection Area (Map 2.7.a). The protection area includes all 185,000 acres of Ohio's 20 State Forests, as well as all privately owned lands within the district boundaries. The forest fire protection district corresponds mostly to the state's unglaciated hill country (southern and eastern Ohio), and also encompasses a section of northwest Ohio (Maumee State Forest area). Ohio's wildfire seasons occur primarily in the spring (March, April and May) before vegetation has "greened-up", and the fall (October and November) when leaf drop occurs. During these times, and especially when weather conditions are warm, windy and with low humidity, cured vegetation is particularly susceptible to burning. When combined, fuel (vegetation, woody debris), weather (wind, temperature, humidity) and topography (hills and valleys) present an unpredictable danger to unwary citizens and firefighters in the path of a wildfire.

While Ohio government agencies and local fire departments are accustomed to handling seasonal wildfires, occasional extreme events can make conditions dangerous and disruptive. Heavy fuel accumulations oftentimes make wildfire suppression extremely difficult due to more intense blazes. Occasionally, heavy fuel loadings and topography create problems in limiting access to fires, and lead to heavy equipment use for suppression. Prolonged drought may cause an exceptionally long or active wildfire season, as well as contribute to extreme wildfire behavior or burning conditions. Multiple concurrent fires can tax resources and quickly create a lack of manpower and other resources and retard the ability to suppress fires rapidly and safely.

Wildland Urban Interface (WUI) conditions may create a serious issue of concern in Ohio, as well. WUI is defined as the situation where homes, residences, and structures are in close proximity to forested lands and grasslands prone to wildfire. This creates a situation where, in the event of a wildfire, personal and property safety are put in jeopardy. Additionally, WUI situations force fire departments to shift focus from fire suppression to structure protection, consequently increasing exposure time and risk. WUI situations are most effectively addressed prior to wildfire occurrence by individual homeowners. Mitigation strategies include reducing flammable vegetation and debris within 30 feet of the structure, choosing less flammable landscape species, using fire resistant building materials, and practicing safe open burning techniques. Currently in Ohio, there are no building codes that require wildfire safety considerations in construction, nor do insurance companies offer premium breaks for homeowners who do include wildfire safety measures around their homes.

In the fall of 2003, ODNR Division of Forestry implemented Firewise Ohio, a statewide WUI safety initiative, in response to the growing WUI situation in Ohio. Firewise Ohio is focused on cooperating with local fire departments to create effective WUI and wildfire prevention and safety programs at the community level. To this point, Firewise Ohio has been very successful, and many fire

departments from high-hazard areas are taking advantage of proactive Firewise Ohio opportunities including grants, prevention materials, and pre-planning efforts. Additionally, two communities at risk to wildfire in Ohio (Maynard, Belmont County and Washington Township, Scioto County) have attained national Firewise Communities USA status in recognition of their outstanding work in community wildfire prevention and safety.

Open burning (burning of yard waste or debris) is regulated by state laws and local burning ordinances, which may vary from one jurisdiction to another. ORC 1503.18 addresses kindled fires regulations, and states that outside municipal limits, open burning is prohibited from 6 am to 6 pm during the months of March, April, May, October and November. It is during these times of the year and days that wildfires are most likely to occur and are the most difficult to control. Additionally, the Ohio EPA enforces OAC 3745-19, which regulates materials that may or may not be incinerated through open burning. Prohibited substances include petroleum based materials, food waste, and animal carcasses. For a complete list of materials and regulations, contact the Ohio EPA Division of Air Pollution Control. To ensure compliance with all regulations, residents should contact their local fire official with jurisdiction for the applicable laws.

RISK ASSESSMENT

Location

Wildfires in Ohio occur most frequently in the southern, southeastern, and eastern parts of the state. This area is predominantly unglaciated, hilly country, and varies in land cover type, including abundant forests and grasslands. The ODNR Division of Forestry is responsible for wildland fire protection on all state and private lands within this area. Additionally, ODNR Division of Forestry has wildfire protection responsibility in a disjoined area in northwest Ohio surrounding Maumee State Forest. Local and volunteer fire departments across these parts of Ohio typically provide initial response wildfire suppression service within their respective jurisdictions. Following response to a wildfire event, local fire departments within the ODNR Division of Forestry wildfire protection area are encouraged to file a wildfire report to ODNR Division of Forestry. Wildfire reports contain information such as date, time, location, size, etc. Filing wildfire reports to ODNR Division of Forestry is not mandatory, only encouraged.

State Of Ohio
Wildfire Hazard Assessment
ODNR Division of Forestry
Wildfire Protection Area
Boundary
Legend
EMA Region Boundaries
Wildfire Protection Area
1
2
2
3
0 15 30 60
Miles
Map 2.7.a

Counties that lie outside of the ODNR Division of Forestry wildfire protection area typically do not experience many wildfire events due to land use and land cover type (agricultural, developed urban/suburban). Fire departments from these counties do not file any wildfire reports; therefore ODNR Division of Forestry does not have a dataset for wildfire occurrence in these areas.

Region 1 ODNR Division of Forestry collects wildfire data from fire departments in Lucas, Henry, and Fulton Counties in Region 1, as these counties contain parts of Maumee State Forest. ODNR Division of Forestry does not collect wildfire report data in the remainder of Region 1 counties. Land cover type in Region 1 is predominantly agricultural land, and generally unforested; therefore, wildfire occurrence and risk are not as great. From 1/1/1997 – 11/20/2007, 227 wildfires burning 679 acres were reported in Lucas, Henry, and Fulton Counties.

Region 2 The majority of Region 2 lies outside of the ODNR Division of Forestry wildfire protection area – six counties straddle the wildfire protection area boundary. Ashland County contains Mohican State Forest, which is located completely within Region 2. Ashland and neighboring Richland Counties reported 57 wildfires burning 172 acres from 1/1/1997 – 11/20/2007. Additional portions of Region 2 counties that report wildfires to ODNR Division of Forestry include southeastern Fairfield, western Licking, western Knox, and southern Stark. Region 2 contains Ohio's most developed metropolitan hubs, as well as areas of highest population density. Wildland fuel types (woodland, grasslands) are not as abundant; accordingly, wildfire risk and occurrence are not as great. One notable location for potential large scale and damaging wildfire in Region 2 is the Mentor Marsh in Lake County, east of Cleveland. Mentor Marsh is a 691-acre nature preserve that has converted to nearly a monoculture of 8-12 foot high non-native Phragmites grass. This area is highly flammable, especially in spring with high winds coming off Lake Erie. Mentor Marsh has experienced 10 wildfire events since 1979, four of these being extremely noteworthy: May 1982 – 200 acres, May 1987 – 120 acres, May 1992 – 400 acres, April 2003 – 375 acres. All of these large-scale events were determined to be arson caused. Many homes, businesses, and high valued property are at risk from wildfire events in Mentor Marsh.

Region 3 Counties within Region 3 represent areas of highest wildfire risk and hazard in the State of Ohio. The vast majority of wildfires in Ohio occur in Region 3 due in part to abundant forested lands and grasslands. Population distribution and regional socio-cultural aspects contribute to higher wildfire occurrence, as well. Topography in Region 3 has more variety with numerous ridges and hollows, as opposed to flatter areas in western and central Ohio, which contributes to more complex wildfire behavior. ODNR Division of Forestry has identified 101 communities at risk (CAR) to wildfire in Ohio through GIS analysis, and all 101 CAR lie within Region 3 (see Map 2.7.b). ODNR Division of Forestry collects wildfire data from fire departments in all counties of Region 3, with the exception of Brown and Clermont Counties.

Map 2.3.b

State of Ohio Wildfire Hazard Assessment

Communities at Risk

These data were compiled by the ODNR Division of Forestry in conjunction with this planning effort. Wildfire risk is assigned at the township level because rural fire departments are typically organized at this level. Evaluating wildfire hazard at the township level better illustrates the areas that need to increase fire prevention and awareness programs.

Data shown on this map were developed from ODNR wildfire data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

Past Occurrences

Ohio has experienced 8,235 wildfires that have burned 42,622 acres between 1/1/1997 and 11/20/2007. These statistics were taken from wildfire reports filed by local and volunteer fire departments in southern, southeastern, eastern, as well as the disjoined northwestern Ohio section within the ODNR Division of Forestry Wildfire Protection Area. Wildfires that have occurred on federal lands in Ohio are not included in these data. It can be safely assumed that less than 100% of all wildfires on state and public land are reported; consequently, actual total occurrence and acres burned are suspected to be higher than data indicate.

Weather is the primary factor that determines the severity of fall and spring wildfire seasons in Ohio. Drought condition, combined with windy days create red flag, or extremely high fire danger. Consequently, the past fire occurrence record can be closely linked to historical weather data. Weather conditions leading up to and in 1930 resulted in the worst year to date for wildfires in Ohio, as 15,400 acres were recorded as burning over the course of the year. Extreme drought in 1950 that continued for the next several years provided for very active wildfire seasons. March 27, 1950 is considered the worst day in Ohio fire control history – 65 fires burned a total of 5,900 acres. In 1952, continued summer drought spurred a record fall fire season in Ohio and neighboring states. ODNR Division of Parks and Division of Wildlife employees assisted in suppression efforts, and the Ohio National Guard also provided assistance. A total of 680 wildfires burned 22,445 acres in the fall of 1952. Drought conditions in 1963 required placing on alert the ODNR Division of Forestry's pilots, 2000 fire wardens, 150 ODNR Division of Forestry employees, as well as several thousand volunteer firefighters and the Ohio National Guard. One or more fires were reported every day from September 17 through November 29, and October showed a record number of fires for that month. 1988 was another severe wildfire year, as drought conditions required that Civilian Conservation Corps crews be mobilized, as well as all other trained Division employees. More recently, 1999 proved to be a busy year for wildfire in Ohio, as an above average 7,836 acres were burned by nearly 1,500 wildfires.

Table 2.7.a: Wildfire occurrence and acres burned for selected counties in Ohio – top ten counties in terms of acres burned (1/1/1997 – 11/20/2007)

County	# of fires	Total acres burned	County	# of fires	Total acres
Lawrence	*1,649*	*11,865*	**Jackson**	*294*	*1,181*
Scioto	*564*	*6,945*	**Ross**	*284*	*975*
Gallia	*565*	*5,609*	**Belmont**	*232*	*970*
Pike	*427*	*2,316*	**Athens**	*183*	*800*
Adams	*353*	*1,203*	**Tuscarawas**	*244*	*680*

**Note: All counties in this table are located in Ohio EMA Region 3*

Over the past ten years, average fire size in Ohio calculated from wildfire report data is 5.17 acres. The smallest reported wildfire was <0.10 acres (multiple

counties and dates), while the largest reported fire was 1,016 acres (Scioto County, 4/14/2003).

Table 2.7.b: Wildfire occurrence by class size (1/1/1997 – 11/20/2007)

Class	Description	# of fires	Total acres burned
N/A	Not calculated	119	126.02
A	< .25 acres	1,703	271.62
B	.26 acres – 9.9 acres	5,477	11,098.88
C	10 acres – 99.9 acres	887	20,824.51
D	100 acres – 299.9 acres	41	6,075
E	300 acres – 999.9 acres	7	3,210
F	1,000 acres – 4,999.9 acres	1	1,016

Over 99.9% of wildfires in Ohio are caused by human action or accident. Due to the nature of these ignitions, many wildfires in Ohio burn into close proximity of homes and structures. Since human behavior is to blame for the vast majority of wildfire starts in Ohio, an opportunity exists to influence behavior change and subsequently decrease wildfire occurrence. Many proactive steps have been taken by ODNR Division of Forestry and local fire departments to educate Ohio citizens about wildfire and home safety, and efforts will continue in the future.

Table 2.7.c: Causes of wildfires in Ohio (1/1/1997 – 11/20/2007)

Cause	# of fires	Total acres burned
Debris burning	3,395	13,754.3
Incendiary (arson)	1,174	9,217.02
Equipment	224	694.13
Smoking	177	691.83
Campfires	128	572.93
Children (playing with matches)	87	188.96
Lightning	56	76.52
Railroad	22	35.16
Other/Unknown	2,972	17,391.22

**Note: Other/Unknown indicates wildfire was not investigated to the point of confidently determining cause of ignition*

LHMP Data

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Considering all hazards identified in the local plans, wildfire ranked 12th in terms of frequency, as large instances have occurred in minimal numbers around the state (Chart 2.2.a). However, this hazard ranked relatively high for the onset factor, whereby local plans indicated an average of 6-12 hours of warning time prior to an event. Overall, this hazard ranked near the bottom of the list for each factor (except onset), which resulted in

an overall ranking of 11 out of 15. These and additional HIRA data queried from SHARPP can be found in Appendix J.

Probability of Future Events

According to research and historical record, wildfires have occurred every spring and fall in the hardwood forests and grasslands of southern, southeastern, and eastern Ohio for hundreds of years, and will continue to do so. The number of occurrences, size of wildfires, and severity of burn fluctuate annually in response to a variety of factors including:

- Weather – daily, monthly, seasonal, annual, and long-term trends in:
  - Precipitation
  - Relative Humidity
  - Temperature
  - Wind
- Fuels – condition of 1, 10, 100, 1000 hour fuels in terms of:
  - Moisture content
  - Arrangement
  - Accumulation level
  - Availability
- Ignitions – presence or absence of wildfire starts:
  - Human caused
    - Debris burning – compliance with ORC 1503.18, and safe debris burning techniques
    - Incendiary – arsonists at large
    - Wildfire prevention and awareness efforts
- Suppression Response – Capability and timeliness of initial attack:
  - Quickness of response to the incident
  - Local / Volunteer fire department capability
  - Availability of state and local resources
    - Number of concurrent wildfires

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

In order to accurately and quantitatively determine statewide wildfire risk, ODNR Division of Forestry combined several available datasets, using GIS tools and extensions, to complete a wildfire hazard assessment. Datasets integrated in the wildfire assessment include historic wildfire occurrence (all available wildfire reports submitted to ODNR Division of Forestry from Ohio fire departments), land use / land cover (LULC) data (1994 Landsat TM coverage data), and statewide population density. These three datasets were chosen to represent a risk (wildfire occurrence), hazard (land cover/fuel type), and value (population/homes). The township level was chosen to assign wildfire risk because rural fire departments in Ohio are typically organized at the township level. Evaluating wildfire hazard at the township level better illustrates the areas

that need to increase wildfire prevention and awareness programs. It also indicates the local fire departments that are responsible for particular high-risk jurisdictions.

Each of these respective datasets was converted to a raster format, and categorical values were reclassified accordingly. For example, hardwood LULC type was given a value of 8 while urban cover type was given a value of 0 (to indicate flammability), “0 – 10” wildfires was valued at 1 while “500 – 650” wildfires was valued at 10 (to indicate occurrence risk), etc. A weighted calculation was then performed using the ArcGIS raster calculator function, whereby a total wildfire hazard value was computed from the reclassified values as such: historic reported wildfire occurrence 50%, LULC 37.50%, population density 12.50%. The calculation resulted in a new raster. The calculated wildfire hazard value was broken into four categories and labeled low, moderate, high, and very high. Factors pertinent to overall wildfire hazard level not incorporated into the calculation include fire department capability and water availability. The ODNR Division of Forestry wildfire hazard assessment was most recently updated on December 15, 2006.

Results

The product of this project, the Ohio wildfire hazard assessment map, accurately indicates wildfire hazard level for all townships in Ohio (see map 2.7.c). Communities at risk to wildfire in Ohio are those townships that were attributed with a calculated wildfire hazard value equal to *High* or *Very High*.

Region 1 and Region 2 are assessed as having generally low wildfire hazard, with several pockets of moderate risk of wildfire. Region 3 is assessed as having generally moderate risk of wildfire, with a sizeable section of southern Ohio having high or very high wildfire risk (Gallia, Lawrence, Scioto, Adams, Pike, and southern Ross Counties). Southeastern and eastern Ohio were assessed as having an additional 29 communities rated as having high wildfire hazard. Particular high-risk groups in southeastern and eastern Ohio occur in southern Athens and Meigs Counties, as well as in Belmont and southern Jefferson Counties.

High valued personal property, including homes, machinery, agricultural crops, and tree plantations in areas of high or very high wildfire hazard are more vulnerable to damage by wildfire. Fire engines belonging to local fire departments are occasionally damaged while suppressing wildfires. A great amount of personal property has been saved by fire departments through effective and safe wildfire suppression

Map 2.7.c

State of Ohio Wildfire Hazard Assessment

Wildfire Risk

- None
- Low
- Moderate
- High
- Very High

These data were compiled by the ODNR Division of Forestry in conjunction with this planning effort. Wildfire risk is assigned at the township level because rural fire departments are typically organized at this level. Evaluating wildfire hazard at the township level better illustrates the areas that need to increase fire prevention and awareness programs.

Data shown on this map were developed from ODNR wildfire data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

Table 2.7.d

Estimate of Potential Losses to Wildfire by Region - 1/1/1997 - 11/20/2007

Region 1

County	Events	Acres	Damage	Loss Avoided
Allen	0	0.00	$0	$0.00
Auglaize	0	0.00	$0	$0.00
Champaign	0	0.00	$0	$0.00
Clark	0	0.00	$0	$0.00
Clinton	0	0.00	$0	$0.00
Crawford	0	0.00	$0	$0.00
Darke	0	0.00	$0	$0.00
Defiance	0	0.00	$0	$0.00
Erie	0	0.00	$0	$0.00
Fayette	0	0.00	$0	$0.00
Fulton	53	72.97	$29,702	$1,853.00
Hancock	0	0.00	$0	$0.00
Hardin	0	0.00	$0	$0.00
Henry	9	32.61	$0	$0.00
Huron	0	0.00	$0	$0.00
Logan	0	0.00	$0	$0.00
Lucas	165	727.71	$40,100	$222,000.00
Madison	0	0.00	$0	$0.00
Marion	0	0.00	$0	$0.00
Mercer	0	0.00	$0	$0.00
Miami	0	0.00	$0	$0.00
Morrow	0	0.00	$0	$0.00
Ottawa	0	0.00	$0	$0.00
Paulding	0	0.00	$0	$0.00
Preble	0	0.00	$0	$0.00
Putnam	0	0.00	$0	$0.00
Sandusky	0	0.00	$0	$0.00
Seneca	0	0.00	$0	$0.00
Shelby	0	0.00	$0	$0.00
Van Wert	0	0.00	$0	$0.00
Williams	0	0.00	$0	$0.00
Wood	0	0.00	$0	$0.00
Wyandot	0	0.00	$0	$0.00
TOTAL	**227**	**833.29**	**$69,802**	**$223,853**

Region 2

County	Events	Acres	Damage	Loss Avoided
Ashland	19	12.28	$200	$325,000.00
Ashtabula	0	0.00	$0	$0.00
Butler	0	0.00	$0	$0.00
Cuyahoga	0	0.00	$0	$0.00
Delaware	0	0.00	$0	$0.00
Fairfield	33	70.31	$250	$155,000.00
Franklin	0	0.00	$0	$0.00
Geauga	2	0.30	$0	$0.00
Greene	0	0.00	$0	$0.00
Hamilton	0	0.00	$0	$0.00
Knox	122	230.11	$1,200	$1,530,000.00
Lake	2	775.00	$11,000	$50,000.00
Licking	126	302.77	$26,400	$120,000.00
Lorain	0	0.00	$0	$0.00
Mahoning	0	0.00	$0	$0.00
Medina	0	0.00	$0	$0.00
Montgomery	0	0.00	$0	$0.00
Pickaway	7	34.25	$0	$0.00
Portage	0	0.00	$0	$0.00
Richland	39	159.45	$16,450	$575,000.00
Stark	52	222.87	$100	$0.00
Summitt	0	0.00	$0	$0.00
Trumbull	0	0.00	$0	$0.00
Warren	0	0.00	$0	$0.00
Wayne	0	0.00	$0	$0.00
TOTAL	**402**	**1807.34**	**$55,600**	**$2,755,000**

Region 3

County	Events	Acres	Damage	Loss Avoided
Adams	354	1202.90	$36,278	$1,456,757.00
Athens	183	800.31	$26,550	$150.00
Belmont	232	969.09	$3,340	$846,800.00
Brown	0	0.00	$0	$0.00
Carroll	209	472.12	$19,485	$1,623,200.00
Clermont	0	0.00	$0	$0.00
Columbiana	239	748.40	$3,440	$846,800.00
Coshocton	226	553.45	$36,300	$873,060.00
Gallia	565	5608.52	$3,084	$191,129.00
Guernsey	240	663.18	$7,480	$700.00
Harrison	163	611.78	$1,909	$965,000.00
Highland	46	230.35	$0	$230.00
Hocking	135	621.69	$3,000	$1,271,225.00
Holmes	126	321.96	$1,800	$1,320,300.00
Jackson	295	1182.68	$8,210	$226,904.00
Jefferson	174	635.61	$4,320	$565,500.00
Lawrence	1,652	11876.50	$34,559	$1,118,920.00
Meigs	272	613.24	$32,560	$6,400.00
Monroe	120	341.94	$23,960	$48,800.00
Morgan	104	272.27	$0	$17,550.00
Muskingum	261	608.25	$35,540	$2,800.00
Noble	77	312.85	$30,300	$0.00
Perry	132	263.85	$435	$170.00
Pike	427	2316.09	$89,160	$675,000.00
Ross	284	974.81	$80,100	$697,551.00
Scioto	570	7072.85	$96,467	$5,671,868.00
Tuscarawas	245	679.50	$65,955	$2,734,000.00
Vinton	126	638.62	$60,000	$0.00
Washington	153	592.88	$78,250	$263,500.00
TOTAL	**7,610**	**41185.69**	**$782,482**	**$21,424,314**

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

Using the *high* and *very high* risk areas shown in Map 2.7.c, state-owned and state-leased facilities were analyzed in a GIS environment. Because of the limited attributes associated with the facility data, the assumptions used in this assessment had to be broad. Therefore, the estimated losses are based on an entire facility loss if it was located in one of those high-wildfire-risk areas. The results are listed in Table 2.7.e.

The *high* and *very high risk* areas only fall within Region 3, which is the most undeveloped and heavily forested Region in the state. In terms of state-owned critical facilities, the highest number is in Scioto County, which represents over $59 million in assets at risk. The second highest value is in Athens County, which includes only one structure valued at $8.9 million. There are no state-leased critical facilities located within the high risk areas.

Concerning non-critical facilities, 82 state-owned facilities in Scioto County are located in *high* or *very high* risk areas, worth over $34 million. The second highest amount is in Gallia County, with 43 structures worth nearly $22 million. While there are only 14 state-leased non-critical facilities in CARs, Belmont and Scioto Counties contain the majority, with five and four, respectively.

Evaluating all state-owned facilities in the CARs, there are 293 facilities at risk, with a total estimated replacement cost of $143 million.

Table 2.7.e

Estimate of Potential Losses to Wildfires for State Facilities in CARs						
County	**State-Owned Critical Facility Count**	**State-Owned Critical Facility Value**	**State-Owned Non-Critical Facility Count**	**State-Owned Non-Critical Facility Value**	**State-Leased Non-Critical Facility Count**	**State-Leased Non-Critical Facility Rent**
Adams	11	$1,103,231	1	$765	0	$0
Athens	1	$8,935,387	0	$0	0	$0
Belmont	20	$2,168,633	1	$25,500	5	$359,412
Brown	0	$0	0	$0	0	$0
Carroll	2	$27,323	0	$0	0	$0
Clermont	0	$0	0	$0	0	$0
Columbiana	4	$255,759	3	$408,000	0	$0
Coshocton	0	$0	0	$0	0	$0
Gallia	7	$2,262,639	43	$21,776,188	0	$0
Guernsey	7	$363,177	0	$0	0	$0
Harrison	0	$0	0	$0	0	$0
Highland	0	$0	2	$61,200	0	$0
Hocking	0	$0	7	$4,826,812	0	$0
Holmes	0	$0	0	$0	0	$0
Jackson	0	$0	3	$219,300	0	$0
Jefferson	3	$196,102	1	$510,000	0	$0
Lawrence	19	$1,937,552	0	$0	3	$89,568
Meigs	12	$979,028	2	$145,860	0	$0
Monroe	0	$0	0	$0	0	$0
Morgan	0	$0	0	$0	0	$0
Muskingum	0	$0	0	$0	0	$0
Noble	0	$0	0	$0	0	$0
Perry	0	$0	0	$0	0	$0
Pike	8	$882,134	28	$2,012,460	2	$11,172
Ross	0	$0	3	$295,392	0	$0
Scioto	23	$59,447,289	82	$34,214,691	4	$533,843
Tuscarawas	0	$0	0	$0	0	$0
Vinton	0	$0	0	$0	0	$0
Washington	0	$0	0	$0	0	$0
TOTAL	**117**	**$78,558,254**	**176**	**$64,496,168**	**14**	**$993,995**

2.8 SEICHE / COASTAL FLOODING

Seiche can be defined as a standing wave in an enclosed or partially enclosed body of water which can result in coastal flooding. The most common cause of seiches in Ohio is a strong, constant wind blowing over the surface of the water forcing it to accumulate at the down-wind shore. When the wind diminishes the water level will begin to return to its original equilibrium though a series of broad oscillations across the entire body. Often referred to as the bathtub effect, seiches cause the water levels to rise and fall along the shorelines repeatedly until equilibrium is restored. Other causes of seiches include earthquakes, changes in barometric pressure or any of a variety of atmospheric changes.

The magnitude of seiche events is dependent on a number of factors. Wind velocity and barometric pressure are the most obvious contributors to the size of an event. What is not immediately apparent is how the configuration of the water body factors into the event. The larger and shallower the water body is translates into an increase in the magnitude of the seiche. This can have significant effects on artificial bodies of water such as reservoirs.

The United States Army Corps of Engineers office in Detroit Michigan developed a profile of seiche as part of a larger work analyzing water levels for the Great Lakes. Figure 2.8.a displays the static impact seiche has on a body of water with water levels rising on the downwind shore and falling along the upwind shore.

Figure 2.8.a

Lake Profile Showing Wind Set-Up

Figure 2.8.b provides a detailed description of the combined effect of wind and wave actions. The base water level for the lake is marked as the SWL, or still water level. The position marked R represents the new increased water level at the shoreline. When winds are generated by severe storms the potential for wave action increases greatly.

Figure 2.8.b

RISK ASSESSMENT

Location

Lake Erie is most notable water body impacted by seiches in Ohio. Although Lake Erie has 9,940 square miles of surface area implying a large body of water, it is relatively shallow with an average depth of 62 feet. Broken into what is generally referred to as the eastern, central and western basins, Lake Erie's susceptibility to seiches varies greatly. The central basin, encompassing the area from Ohio's eastern border to Lorain, ranges from 15 to 24 feet deep with a shoreline ranging from sandy beaches to small cliffs. The western basin is much shallower with depths ranging from 10 to 15 feet along with a shoreline of wetlands and estuaries.

The seiche / coastal flooding hazard exposure is limited to counties adjacent to the south shore of Lake Erie. Region 1 counties impacted by seiche include: Lucas, Ottawa, Sandusky and Erie. Region 2 counties impacted by seiche include: Lorain, Cuyahoga, Lake and Ashtabula. No counties in Region 3 border the lake, as described in Section 1.

Past Occurrences

The NCDC history of hazardous weather events currently lists only one seiche event which occurred in 1998 impacting Erie, Lorain, Lucas and Ottawa counties. The event consisted of southwest storm force winds gusting to 69 miles per hour that pushed water away from the western end of Lake Erie towards the state of New York and Ontario Canada. As the water level fell to four feet below normal, boats and ferries were left stranded in the mud in marinas from the Maumee River east to the lagoons in Vermilion, while freighters were forced to drop anchor outside Sandusky Bay near Port Clinton. There were no estimates provided for property or other economic losses, but it is common for boats to be suctioned to the lake bottom muck and be covered when water returns thus rendering the vessels to remain sunk unless raised by salvage vessels.

The earliest recorded seiche wave in Ohio history occurred on the morning of June 23, 1882 when an eight-foot wall of water suddenly crashed into the 9th Street Pier in Cleveland. This wave damaged or destroyed several boats and created a novel fishing experience as it propelled hundreds of fish farther inland from the docks. One fatality resulted from this event as a homeless person was sleeping near the shore and drowned.

Other events occurred in May 1942, 1944 and 1948 with waves being recorded anywhere from six to 20 feet high and lengths from 15 to 100 miles. Seiche waves continued to oscillate from several hours to days.

In addition to the seiche listed by the NCDC are six events classified as storm surge. Reviewing the descriptions provided it was deduced these events were associated with severe summer or winter storms and are clear examples of coastal flooding.

March 13, 1997 Storm Surge - Gale force east winds to 35 knots caused the water level at the west end of Lake Erie to rise to 79 inches above low water datum, around 35 inches above the recent average lake level. Flooding and considerable beach erosion occurred along the lakeshores of Lucas, Ottawa, Sandusky and Erie Counties. In Toledo (Lucas County), roads and a parking lot were inundated, including Monroe and Second Streets, and at Point Place on Maumee Bay. Water also overtopped a road in Jerusalem Township. In Ottawa County, roads were flooded in Port Clinton and sandbagging was performed at some local businesses. Also, on Catawba Island, waves were recorded as overtopping at least one road. At Bayview (Sandusky County), County Road 259 was flooded. Losses approached $50,000 from this coastal event.

June 1, 1997 Storm Surge - Businesses and homes were flooded when strong northeasterly winds and near record high lake levels produced waves of six to eight feet, aggravating shoreline erosion and slowing discharge of stream outflow into Lake Erie. In Erie County, 75 – 100 families evacuated near the Vermilion and Huron Rivers, while those on Mudbrook Road moved to their second floors to escape the flood waters. Also in Erie County, Riverside Avenue residents were evacuated as well as those in Franklin Flats, Rye Beach and White's Landing. Roads along the shoreline were flooded and covered with so much sand and debris that they had to be cleared with snow plows in Port Clinton and Marblehead. On Catawba Island, rising water flooded buildings and cars were submerged. Charter services cancelled trips and hundreds of travelers were stranded on South Bass Island when most ferry trips were also cancelled. In Erie County, the north end of Jackson Pier collapsed. As the water receded, a large number of fish were left behind in people's yards. Losses were estimated at $525,000 from the event which encompassed Erie, Lorain, Lucas, Ottawa and Sandusky Counties.

February 4, 1998 Storm Surge - Northeast winds up to 35 miles per hour caused flooding of the immediate lakeshore and beach erosion in Lucas, Erie, and Ottawa Counties. Losses were estimated at $75,000 from the event.

February 17, 1998 Storm Surge - Northeast winds up to 40 miles per hour increased the water level at the Toledo Coast Guard Station (Lucas County) to around seven feet above low water datum. Waves of seven to ten feet caused major flooding and beach erosion along the western shoreline of Lake Erie, particularly at Crystal Rock and Whites Landing (Erie County), where homes and yards were flooded. Losses were estimated at $700,000 from the event which impacted Erie, Lucas and Ottawa Counties.

March 20, 1998 Storm Surge - North to northeast gales of 35 knots, with higher gusts, produced 11 to 14 foot waves on Lake Erie. Also, the water level at Toledo (Lucas County) was seven feet above low water datum. This combination resulted in major flooding and beach erosion. Many streets were flooded around Sandusky Bay (Ottawa, Sandusky, and Erie Counties) and Maumee Bay (Lucas County) and flooding had progressed further inland in some areas. In Sandusky and Huron (Erie County), several streets were flooded. At Beachwood Cove in Huron, the 30 foot high breakwall was destroyed and just a few feet of land separated the homes from the lake. Losses were estimated at $400,000 from the event which impacted Sandusky, Lorain, Ottawa, Erie and Lucas counties.

November 11, 1998 Storm Surge - Northeast gales of 35 knots and water levels that peaked just below 100 inches above low water datum produced 10 to 14 foot waves which caused major damage along the lakeshore. Many lakeshore roads were not only flooded, but also covered with rocks and other debris that, in some places, had to be removed by bulldozers. In Ottawa County, ten houses were destroyed and over 200 others were damaged, streets in downtown Port Clinton were flooded and the dike system and gravel roads in the Ottawa National Wildlife Refuge were badly damaged. Some evacuations took place at Whites Landing in Erie and Sandusky Counties and also at Wightmans Grove and Memory Marina in Sandusky County. A State of Emergency was declared and standing flood water persisted for several days in some areas. Losses were estimated at $3,700,000 from the event which impacted Erie, Ottawa, Lucas and Sandusky Counties.

October 17 to 21, 2011 Seiche Wave - The graph below traces a recent Lake Erie seiche. From October 17 to 21, 2011, the wind shifted widely, from out of the west to out of the northeast, and to eventually out of the west again. The lines on the graph show the response of the water levels at Buffalo (red) and Toledo (blue) to these shifts. The greatest difference in water level was about 7 feet, and as the up-and-down swings of the lines show, the lake never settled to an equilibrium state over these several days.

Source: Ohio Dept. of Natural Resources, Division of Geological Survey

There are two observations which can be made reviewing the NCDC data. First, none of the events impacted Region 2 counties. This could be due to size of the area impacted by the wind or due to the type of shoreline for those counties. Second, the only seiche event noted depicts a westerly wind lowering the water level in the western basin. It can be speculated that the displaced water was moved to the eastern basin which is beyond the Ohio and Pennsylvania border. This could be an additional factor resulting in Region 2 counties having no record of seiche or storm surge impacts.

Probability of Future Events

It is clear seiche and storm surge coastal flooding have a significant impact in Ohio. Based on the event profiles, it is possible for these events to occur between two and five times in a given year. Based on eleven events over 132 years, there is an 8.34% chance of a seiche wave to happen on any given day. The only seasonal limitation to events on Lake Erie would be during the height of winter when portions of the water surface can be covered by ice. It should be noted that ice coverage on Lake Erie varies from year to year, making it impossible to indicate any definitive time period when events cannot occur.

LHMP Data.

Cuyahoga County – Seiche. The Countywide All Natural Hazards Mitigation Plan states their northern coastline has a high frequency of seiche with a moderate vulnerability. The roads and highways along the coast can become flooded due to seiche waves. Most damage caused by seiche involves boat docks, low-lying areas along the lake shore, and river inlets to Lake Erie. The most severe seiche that hit the Cleveland area was an eight-foot seiche in the early 1990s.

Lucas County – Coastal Flooding. The Plan states that lake surges (also referred to as storm surges) are associated with extreme weather events and are responsible for coastal flooding and erosion (along Lake Erie within Lucas County.) The storms that generate large waves and lake surges can develop year-round, however within Lucas County, these events have typically occurred in the early spring and late fall months. Storm surges inundate coastal floodplains by dune over wash, the rise in water levels in inland bays and harbors, and backwater flooding through river mouths. Storm systems also generate large waves that run up and flood coastal beaches. The problem of lake surges and associated inland flooding is compounded by adjacent low-lying floodplains. The Plan's history provides information that lake surges cause coastal flooding in the cities of Toledo, Oregon, the Village of Harbor View and the unincorporated Jerusalem Township. The total damages attributed to lake surges are $665,981.92, which equates to approximately $110,996.99 per event. There are limited data to calculate the probability of occurrence; however, records indicate multiple occurrences during the early spring and late fall months. It is fair to assume that future events would likely result in localized property damage to only specific areas within Lucas County, and that there is only a small potential for future events to result in injuries or deaths.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. There are limited data to evaluate in SHARPP concerning this hazard since not all coastal counties have their HIRA populated. For those coastal counties reporting HIRA data, a couple incorporated seiche into their flood hazard identification and risk assessment. However, for those responding specifically to this hazard, seiche/coastal flooding ranked very low for all factors evaluated. This could be related to the difficulty in differentiating between riverine and coastal flooding given large events impacting these counties. These and additional HIRA data queried from SHARPP can be found in Appendix J.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

Loss estimates for Ohio's seiche hazard were developed using FEMA's hazard analysis and loss estimation software HAZUS-MH MR3 coastal flooding application within the flood module. This application was updated in HAZUS-MH MR3 to reflect the unique issues associated with the Great Lakes. Still water lake elevations for each county were taken from the US Army Corps of Engineers report *Revised Report on Great Lakes Open-Coast Flood Levels* published April 1988.

HAZUS-MH MR3 analysis was run for each county bordering Lake Erie based on a 100-year return event. Each run was specifically adjusted to take into consideration the type of shoreline associated with each county. Sandusky County could not be analyzed due to the software failing to recognize any coastal

exposure. Upon closer review, the exposure which does exist within the county was assessed as part of the two neighboring county evaluations.

Results

Region 1 exposure to seiche is limited to the coastal counties of Erie, Lucas, Ottawa and Sandusky. The total building exposure is estimated at $8,743,489,700. The numbers of impacted structures by percent of the structure damaged are estimated to be: 1 to 10 percent damaged at 455, 11 to 20 percent damaged at 2,184, 21 to 30 percent damaged at 1,476, 31 to 40 percent damaged at 1,059, 41 to 50 percent damaged at 309 and substantially damaged at 914. There are an estimated 4 essential facilities, which will experience at least moderate damage. According to Table 2.8.a, estimates for business interruption and building losses are $8,560,000 and $974,880,000, respectively.

Table 2.8.a

Estimate of Potential Losses to Seiche / Coastal Flooding Region 1											
County	Population	Building Exposure Value	1-10% Damage Count	11-20 % Damage Count	21-30% Damage Count	31-40% Damage Count	41-50% Damage Count	Substantial Damage Count	Essential Facilities Count	Estimated Business Interup	Estimated Property Loss
Erie	79,321	$4,150,287,000	159	372	175	28	5	40	1	$2,070,000	$132,210,000
Lucas	454,029	$2,545,448,000	113	395	840	932	227	189	3	$3,260,000	$548,900,000
Ottaw a	41,036	$2,047,754,700	183	1,417	461	99	77	685	0	$3,230,000	$293,770,000
TOTAL	**574,386**	**$8,743,489,700**	**455**	**2,184**	**1,476**	**1,059**	**309**	**914**	**4**	**$8,560,000**	**$974,880,000**

The majority of building loss is associated with Lucas County as a result of inland backup of the Maumee River. HAZUS-MH MR3 profiles for the remaining counties do not indicate riverine backup to a significant extent.

Region 2 exposure to seiche is limited to the coastal counties of Ashtabula, Cuyahoga, Lake and Lorain. The total building exposure is estimated at $2,396,004,000. The numbers of impacted structures by percent of the structure damaged are estimated to be: 1 to 10 percent damaged at 85, 11 to 20 percent damaged at 272, 21 to 30 percent damaged at 286, 31 to 40 percent damaged at 92, 41 to 50 percent damaged at 20 and substantially damaged at 13. There are no essential facilities estimated as impacted. Estimates for business interruption and building loss are $580,000 and $88,240,000 respectively (see Table 2.8.b).

Table 2.8.b

Estimate of Potential Losses to Seiche / Coastal Flooding Region 2											
County	Population	Building Exposure Value	1-10% Damage Count	11-20 % Damage Count	21-30% Damage Count	31-40% Damage Count	41-50% Damage Count	Substantial Damage Count	Essential Facilities Count	Estimated Business Interup	Estimated Property Loss
Ashtabula	102,729	$240,029,000	3	12	8	1	0	1	0	$80,000	$5,280,000
Cuyahoga	1,384,252	$1,033,868,000	2	19	16	0	2	0	0	$110,000	$10,410,000
Lake	227,324	$671,888,000	55	159	206	89	12	12	0	$240,000	$43,840,000
Lorain	285,798	$450,219,000	25	82	56	2	6	0	0	$150,000	$28,710,000
TOTAL	**1,897,374**	**$2,396,004,000**	**85**	**272**	**286**	**92**	**20**	**13**	**0**	**$580,000**	**$88,240,000**

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

Using HAZUS-MH MR3 results and the FIRMs for the coastal counties, state-owned and state-leased facilities were evaluated for their involvement with seiche/coastal hazards. While all eight coastal counties were evaluated, only three of those contained facilities that could be at risk of flooding via seiche or coastal flooding, and all three are in Region 1. Table 2.8.c lists the results of this analysis.

One state-owned critical facility was located in the hazard area in Lucas County, which represents $153,000 at risk. While this facility is operated by the ODNR, it is a watercraft office that would be crucial to immediate response and rescue necessities. In terms of non-critical facilities, over 90 percent of those identified are located in Lucas County, and the majority of those involve state park facilities. Only one state-leased non-critical facility was noted to be at risk, and it is located in the City of Sandusky, Erie County, representing over $80,000 in annual rent at risk. It should be noted that no state-leased critical facilities were determined to be at risk to this hazard.

Table 2.8.c

Estimated Losses from Seiche/Coastal Flooding for State-Owned and State-Leased Facilities

County	State-Owned Critical Facility Count	State-Owned Critical Facility Value	State-Owned Non-Critical Facility Count	State-Owned Non-Critical Facility Value	State-Leased Non-Critical Facility Count	State-Leased Non-Critical Facility Rent
Erie	0	$0	5	$674,495	1	$82,131
Lucas	1	$153,000	33	$24,256,560	0	$0
Ottawa	0	$0	0	$0	0	$0
Sandusky	0	$0	6	$799,680	0	$0
TOTAL	**1**	**$153,000**	**44**	**$25,730,735**	**1**	**$82,131**

2.9 EARTHQUAKE

Earthquakes occur as a result of the constant motion of the earth. Current science describes the earth in three major regions: the core, mantle and crust. Figure 2.9.a provides a three dimensional representation of the earth's regions.

Figure 2.9.a

Interior zones of the Earth (figure modified from Washington Division of Geology and Earth Resources, Information Circular No. 85, 1988). The Earth's crust consists of great plates that slowly move across the surface of the Earth in response to convection cells in the mantle. Most earthquakes occur where plates meet, such as at spreading or convergent boundaries.

Source: Educational Leaflet No. 9 Revised Edition 2007 Division of Geological Survey

The core is hot and consists of two subsections. The very center of the planet's core is hottest and solid. Surrounding the solid center is a liquid (i.e. molten material / magma) layer.

The mantle is cooler than the core and although solid, circulates with the consistency of malleable plastic. Through convection, the portion of the mantle closest to the core heats and subsequently rises in the same manner as the air in the earth's atmosphere. Conversely, the upper portion of the mantle transfers its heat to the crust, cools and descends back toward the core.

The crust is also solid; however, unlike the mantle it is rigid and brittle. The crust consists of a number of individual plates, each in constant motion, resting on the mantle. The boundaries where plates meet are the locations where new crust develops (spreading boundary) and alternately existing crust material returns to the mantle (convergent boundary.)

Understanding the composition of the earth is crucial because earthquakes are often associated with boundaries where the plates slide against, rise over or sink under each other. The movement at many of the plate boundaries is not smooth and consistent, but rather grinds and jerks. As entire plates move the boundaries become locked together and enormous amounts of tension build until a sudden release occurs, realigning the plate edges and creating the observed earthquake.

The locations where the crust is fractured and sliding are called faults. California has several famous faults (*e.g.* the San Andreas Fault), which can be clearly observed though aerial photography. In cases where the crust is pulling apart, the location is called a rift. The Reelfoot Rift and associated rift valley located in Missouri is one of the largest in North America. Ohio geologically contains both fault and rift zones.

Figure 2.9.b

Source: West Publishing Company

Another significant source of earthquakes is associated with large bodies of magma, which are located near the earth's crust. The Hawaiian archipelago and Yellowstone National Park are examples where magma deposits are altering the crust and generating both volcanic activity and earthquakes.

Earthquake locations are recorded based on the latitude and longitude of the occurrence, called the epicenter, and the associated depth underneath the earth's surface. The energy released in earthquakes travels from the epicenter in seismic waves through the earth. The four major types of waves are often referred to as primary, secondary (body waves), Rayleigh and Love (surface waves) (Figure 2.9.b). Primary waves compress the earth's surface in front of it as they travel. Secondary waves cause the earth's surface to rise and fall perpendicular to its line of travel. Rayleigh waves travel in a circulating pattern similar to those in an ocean wave. Finally, Love waves cause the earth's surface to oscillate from side to side perpendicular to its line of travel. The primary and secondary waves travel faster than the Rayleigh and Love waves providing the initial evidence of an event.

Each wave affects structures differently. For example, secondary waves have much greater impact in tall structures. Additionally, each wave has unique characteristics. The secondary wave, for example, cannot travel through fluids, including the molten outer core.

Location of earthquake events has the added dimension of land / crust composition. Within the United States, areas like southern California are primarily young, hot rock that is broken by mountain ranges. Under these conditions seismic waves are somewhat limited in their ability to travel (attenuation) reducing the overall area of impact. Conversely, seismic zones in the central and eastern United States have flat-lying, cold, brittle rocks with much thicker deposits of soil and sediments. Loosely consolidated materials such as sand and soil cause seismic waves to amplify ground motion.

When seismic waves travel through unconsolidated materials it can have the effect of turning solid land into quicksand. When this phenomenon, called liquefaction, occurs, any object located in the affected area may slide over or sink into the soil. Entire buildings, roadways and bridges may be significantly damaged.

Figure 2.9.c

Modified Mercalli Intensity Scale		Magnitude Scale
I	Detected only by sensitive instruments	1.5
II	Felt by few persons at rest, especially on upper floors; delicately suspended objects may swing	2
III	Felt noticeably indoors, but not always recognized as earthquake; standing autos rock slightly, vibrations like passing truck	2.5
IV	Felt indoors by many, outdoors by few, at night some awaken; dishes, windows, doors disturbed; standing autos rock noticeably	3
V	Felt by most people; some breakage of dishes, windows, and plaster; disturbance of tall objects	3.5
VI	Felt by all, many frightened and run outdoors; falling plaster and chimneys, damage small	4
VII	Everybody runs outdoors; damage to buildings varies depending on quality of construction; noticed by drivers of autos	4.5
VIII	Panel walls thrown out of frames; walls, monuments, chimneys fall; sand and mud ejected; drivers of autos disturbed	5
IX	Buildings shifted off foundations, cracked, thrown out of plumb; ground cracked; underground pipes broken	5.5
X	Most masonry and frame structures destroyed; ground cracked, rails bent, landslides	6
XI	Few structures remain standing; bridges destroyed, fissures in ground, pipes broken, landslides, rails bent	6.5
XII	Damage total; waves seen on ground surface, lines of sight and level distorted, objects thrown up into air	7
		7.5
		8

General relationship between epicentral Modified Mercalli intensities and magnitude. Intensities can be highly variable, depending on local geologic conditions. (Modified from D. W. Steeples, 1978, Earthquakes: Kansas Geological Survey pamphlet.)

Source: Educational Leaflet No. 9 Revised Edition 2007 Division of Geological Survey

One factor which greatly determines the extent of damage from an event is duration. Events can last anywhere from a few seconds to minutes. The longer the event is promulgating seismic waves the greater the opportunity for damage.

Earthquake forces are generally measured using an instrumental scale developed initially in 1935 by Charles Richter. The scale is open ended but

generally ranges to 9+ (severe damage and ground deformation). The scale is logarithmic which can be confusing. For example, an earthquake of magnitude 2.0 is 30 times more powerful, in terms of energy released, than one rated 1.0.

Another method of measuring an earthquake event is by describing its intensity. Italian volcanologist Giuseppi Mercalli developed a widely used scale in 1902 based on the previous Rossi-Forel scale. Over time experts have altered the original scale creating the currently used version named the Modified Mercalli Intensity Scale (MMI).

Looking at Figure 2.9.c the exponential increases in damage for each single digit increase in the intensity scale is apparent. For example, MMI IX discusses shifted and damaged building while X describes mass destruction of masonry (brick) and frame (wood) buildings.

Locations of felt earthquakes or those with magnitudes of 2.0 or greater in Ohio and its border area. Locations and magnitudes of historic earthquakes are represented by symbols corresponding to felt area or maximum epicentral Modified Mercalli intensities. Noninstrumental locations may be in error by a considerable distance, especially for early events.

Source: Educational Leaflet No. 9 Revised Edition 2007. ODNR - Division of Geological Survey

Map 2.9.a

RISK ASSESSMENT

Location

Earthquakes in Ohio are primarily located the northeast and far west-central portions of the state and historically have not exceed 5.4 magnitude (Map 2.9.a). The map of historical epicenters lists all the events with magnitudes greater than 2.0. The size of the location marker increases with the magnitude of the event. Red circles represent instrumentally recorded events. Blue circles represent non-instrument recorded.

The epicenter map clearly identifies the northeast Ohio counties of Ashtabula, Geauga and Lake in Region 1 as one of the most earthquake-prone areas. Similarly, another earthquake-prone area is located in the west-central Counties of Auglaize, Champaign, Logan, Mercer, and

Shelby (Region 3). Although there are clear clusters of activity, a limited number of events have occurred and are spread over a large portion of the state.

According to information published by the ODNR Division of Geological Survey, the origins of Ohio earthquakes, as with earthquakes throughout the eastern United States, are poorly understood at this time. Those in Ohio appear to be associated with ancient zones of weakness in the Earth's crust that formed during continental collision and mountain-building events about one billion years ago. These zones are characterized by deeply buried and poorly known faults, some of which serve as the sites for periodic release of strain that is constantly building up in the North American continental plate due to continuous movement of the tectonic plates that make up the Earth's crust.

Map 2.9.b

Basement structures in Ohio (modified from Division of Geological Survey Map PG-23, 2002). This map portrays a number of deep faults and other structures that have been identified by a variety of geologic studies. Some faults are well known, whereas others are speculative. Very few of them are visible at the surface. The Fort Wayne (Anna) rift in western Ohio is the site of numerous historic earthquakes.

The Division of Geological Survey has developed a map of geologic features, referred to as basement structures, which lie far below the earth's surface (see Map 2.9.b). The Region 1 active zone corresponds to the structure called the Akron Magnetic Boundary. Several geologists have speculated the boundary is a fracture zone in crystalline rocks lying more than 6,000 feet below the surface. The active area of Region 2 matches to better understood features. The Fort Wayne Rift along with the Anna-Champaign, Logan and Auglaize faults, though still poorly understood, can be evaluated using the existing understanding of how these structures behave.

LHMP Data

As indicated in the vulnerability analysis below, Hamilton County and Shelby County are the most likely counties in Ohio to be affected by a significant

earthquake (Hamilton County's issues are compounded by the county's susceptibility to landslide and soil liquefaction). Both the Hamilton County and the Shelby County LHMP considers earthquakes, ranked fifth and sixth, respectively, to be a high ranking hazard for them. They acknowledge that an earthquake is a low probability, high consequence event. The lack of public awareness, building standards, and aging infrastructure were the reasons cited by Hamilton County for ranking earthquakes within their top five concerns. Shelby County, considered to be one of the most active seismic zones within the state, experiencing more than 40 since 1875, ranked earthquakes sixth based on its history of earthquakes, which includes the most damaging earthquake to strike the state.

Auglaize County. The Auglaize County Hazards Mitigation Plan mentions an earthquake of a 4.5 magnitude wave was felt in Auglaize County on July 12, 1986. This quake occurred near the City of St. Marys and caused minor damage. It occurred on the Anna-Champaign fault which runs from Champaign County through Shelby, Auglaize, and Mercer Counties. Broken windows in the nearby Town of Moulton and medications falling off shelves at the Joint Township District Memorial Hospital were among the damages that occurred. These analyses projected 5,213 residential structures at risk at a value of $215,567,580, an estimated 171 non-residential structures valued at $22,564,664 and eight critical facilities valued at $7,177,728.

Shelby County. The Shelby County Hazards Mitigation Plan provides a worst-case scenario by simulating a 5.4 magnitude wave earthquake with an epicenter in Anna, Ohio with no depth. Using a combination of HAZUS-MH and conversion charts, it was determined that such an event would yield an estimated 1,727 residential structures at risk at a value of $293,222,603, an estimated 2,002 non-residential structures valued at $341,732,742 and 35 critical facilities valued at $5,974,349.

Lake County. The Lake County Multi-Jurisdictional Hazards Mitigation Plan updated in 2010 states that the county's largest earthquake occurred in 1986 in the central part of the county registering 5.0 – 5.4 instrumental magnitude. An earthquake of this size is classified as intermediate to severe on the Richter Scale. Lake County has experienced 15 quakes between 1858 and the present, with an approximate 9.7 percent chance of an event occurring in any given year with an estimate of 37,031 structures at risk valued at a loss of $2,383,971,440.

Medina County. The Medina County All Hazard and Flood Mitigation Plan updated in 2011 states that the strongest quake was felt on January 31, 1986, where the magnitude wave reading was 5.0. There was only moderate to minor damage such as broken windows and cracked plaster. There have been a few instances that seismic activity has been felt and caused damage. An earthquake scenario estimates 6,089 residential structures at risk at a value of $1,198,565,176.68 an estimated 1,846 non-residential structures valued at $560,602,287.17 and 92 critical facilities valued at $27,939,008.89.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Considering all hazards identified in the local plans, earthquakes ranked nearly last in terms of frequency, as large instances have occurred in minimal numbers around the state (Chart 2.2.a). However, this hazard ranked the highest for onset, or warning time, whereby local plans indicated little to no warning. Also, dam/levee failure ranked at or near the top of the list for potential business, human (*i.e.*, loss of life), and property impacts. Overall, this hazard ranked fourth out of 15 hazards evaluated in SHARPP, which indicates earthquakes are considered to be a potential threat throughout the state. According to records and data entered to date into vulnerability assessments, potential losses from earthquakes are estimated at 386,095 residential structures ($11,619,647,525), 39,228 non-residential structures ($2,775,420,583) and 1,049 critical facilities ($2,058,194,796). These and additional HIRA data queried from SHARPP can be found in Appendix J.

National Level Exercise, 2011 (NLE-11)

In September 2010, Ohio EMA's Mitigation Section was consulted to provide HAZUS runs for an earthquake tabletop exercise scenario. The scenario was designed for selected counties in southwest Ohio in preparation for NLE-11 (National Level Exercise 2011). The purpose is to test critical resource logistics and catastrophic planning in conjunction with FEMA Region V and participating States. HAZUS runs were produced for Hamilton, Butler, Clermont, Darke, Scioto and Warren Counties with a 5.7 moment magnitude scale epicenter in downtown Cincinnati to a depth of 10 kilometers.

The aggregate HAZUS runs resulted in 79,070 buildings with moderate damage and 4,418 buildings beyond repair. 487 essential facilities would be less than 50% functional. 1,468 transportation systems and 201 utility systems would be damaged. Destruction is projected to produce 3.513 million tons of debris and 93 fire ignitions resulting 13,490 people displaced from their residences with $1,248,000,000 in damage. The social impact estimates 179 fatalities, 123 people with life-threatening injuries, 901 people would have to be hospitalized and 3,871 would have to be treated with first aid or at an aid station. 8,806 people would seek temporary shelter. The economic impact is projected to result in $10,828,490,000 in lost income and, $2,050,500,000 in capital stock loss. It is estimated to take 15 years for economic recovery from this event.

Past Occurrences

Earthquakes are a continuously occurring hazard in Ohio. Eleven events were recorded by the Division of Geological Survey for the first 11 months of 2007. Data are available for events dating back over 200 years.

Most of Ohio's earthquake events are small, registering between 2 and 4 magnitudes. Significant events are discussed in Geological Survey document *Educational Leaflet No. 9*, which follows.

Summer 1776: The earliest Ohio earthquake to be noted occurred at 8 a.m. sometime in the summer of 1776 and was chronicled by John Heckewelder, a

Moravian missionary, who reported that "the southwest side of the house was raised with such violence that the furniture of the room was nearly overturned." Heckewelder spent the summer of 1776 at the Moravian mission of Lichtenau, which was in present-day Coshocton County. Because his report is the only account of this event, it is impossible to determine an epicentral location with any certainty. It should be noted the epicenter of this earthquake may not have been in Ohio.

1811 and 1812: On December 16, 1811, and January 23 and February 7, 1812, the largest earthquakes ever to strike the continental United States occurred at New Madrid, Missouri. These events were felt throughout an area of about 2 million square miles, including all of Ohio. In Ohio, some chimneys were toppled in the Cincinnati area, which experienced the strongest shaking from these events. Should earthquakes of this intensity be repeated at New Madrid, they would probably cause considerable damage in southwestern Ohio.

June 18, 1875: This earthquake was felt throughout an area of at least 40,000 square miles and was most intense at Sidney (Shelby County) and Urbana (Champaign County), where masonry walls were cracked and chimneys toppled. It has been interpreted to have had an MMI of VII.

September 19, 1884: An earthquake in the vicinity of Lima (Allen County) had an epicentral MMI of VI. There were reports of fallen ceiling plaster as far away as Zanesville (Muskingum County) and Parkersburg, West Virginia. On the basis of area feeling the earthquake (140,000 square miles), it is estimated to have had a magnitude of 4.8. Workmen on top of the Washington Monument in Washington, D.C., reported feeling this earthquake.

May 17, 1901: During this earthquake, bricks were dislodged from chimneys and some windows were cracked in Portsmouth (Scioto County) and chimneys were damaged in Sciotoville. Modified Mercalli intensities of VI were generated in the epicentral area. Based on felt area, this earthquake was assigned a magnitude of 4.3.

November 5, 1926: This earthquake was centered near Pomeroy and Keno, in Meigs County, where chimneys were toppled. A stove was over turned at Chester. Modified Mercalli intensities of VII were generated in the epicentral area, but the earthquake was felt only in portions of Meigs County and adjacent parts of West Virginia. On the basis of this small felt area, this event has been assigned a magnitude of 3.6. Explosive earth sounds were reported to have accompanied this earthquake.

September 30, 1930: This earthquake cracked plaster and toppled a chimney in Anna (Shelby County). An epicentral MMI of VII and a magnitude of 4.2 have been assigned to this event.

September 20, 1931: In this event, Anna and Sidney in Shelby County experienced toppled chimneys and cracked plaster. Store merchandise and crockery were knocked off shelves, and stones were jarred loose from the foundation of the Lutheran church in Anna. A ceiling collapsed in a school at

Botkins, north of Anna. An MMI of VII and a magnitude of 4.7 have been assigned to this earthquake.

March 2 and 9, 1937: These two earthquakes are the most damaging to have struck Ohio. Maximum intensities were experienced at Anna (Shelby County), where an MMI of VII was associated with the March 2 event and an MMI of VIII with the March 9 event. In Anna, chimneys were toppled, organ pipes were twisted in the Lutheran church, the masonry school building was so badly cracked that it was razed, water wells were disturbed, and cemetery monuments were rotated. Both earthquakes were felt throughout a multi-state area—plaster was cracked as far away as Fort Wayne, Indiana. The March 9th event was felt throughout an area of about 150,000 square miles. Analysis of seismograms from these earthquakes by the U.S. Geological Survey (Stover and Coffman, 1993) assigned magnitudes of 4.7 and 4.9, respectively, to these events. On the basis of felt area, these earthquakes have been assigned magnitudes of 4.9 and 5.4, respectively.

January 31, 1986: This earthquake, which had a magnitude of 5.0 and an MMI in the high VI range, occurred in Lake County, east of Cleveland, in the general vicinity of a 1943 event with 4.5 magnitude. The 1986 earthquake cracked plaster and masonry, broke windows, and caused changes in water wells. The epicenter was only a few miles from the Perry nuclear power plant. It is the most intensively studied earthquake in Ohio and was the subject of several scientific reports (*i.e.*, Nicholson and others, 1988).

July 12, 1986: Minor damage, consisting primarily of cracked windows and plaster and fallen bricks from chimneys, was reported from this MMI VI earthquake centered northwest of Anna, near St. Mary's, in Auglaize County. It had a magnitude of 4.5.

January 25, 2001: The city of Ashtabula was struck by a 4.5-magnitude earthquake that caused minor damage to about 50 homes and businesses. This earthquake was the largest in a series of shallow earthquakes that began in 1987 and were attributed to fluids from a Class I deep-injection well. Nearly 40 earthquakes above a magnitude of 2.0 were recorded at Ashtabula through 2001. Prior to 1987, no earthquakes had been noted in the area.

June 3, 2001: Residents of Ashtabula and nearby areas were shaken by another earthquake on June 3, 2001, at 6:36 p.m. This event had a magnitude of 3.2, as determined by the Ohio Seismic Network. No damage was reported, although more than 90 felt reports were received by the Ashtabula County Emergency Management Agency. A 2.3-magnitude aftershock was recorded at 4:27 a.m. on June 5. One person reported feeling it. The epicenter location is east of Ashtabula.

May 6, 2002: On Monday, May 6, 2002, a small earthquake occurred at 6:26 p.m. Eastern Daylight Time near the Ohio River in Meigs County, in the general vicinity of the communities of Racine and Antiquity. No felt reports were immediately received by the Ohio Seismic Network. The event was originally

noted and located by the Virginia Tech Seismological Observatory in Blacksburg, VA.

June 30, 2003: The Ohio Seismic Network recorded a small earthquake beneath Lake Erie, offshore from Lake County, on June 30 at 3:21 p.m.. The 3.5-magnitude earthquake was widely felt in Lake, Ashtabula, and Geauga Counties. There were no reports of injuries or damage, which would not be expected from an earthquake of this size.

June 30, 2004: A small 3.3 magitude earthquake occurred at 12:03 a.m. EDT 9 miles ENE of Painesville, Lake County, Ohio. It was strongly felt at Painesville, Madison, and Perry, Ohio. No damages were reported. Many residents reported a loud boom followed by a sharp jolt and brief, but intense shaking. This is the second earthquake this year in the general area of Painesville. On March 14, 2004 a 2.4 magnitude earthquake was centered near Fairport Harbor.

Filtered seismogram recorded at OhioSeis station CLEO (Cleveland Museum of Natural History).

March 11, 2006: A small, but widely felt, earthquake occurred on Saturday, March 11 at 7:27 a.m. Eastern Standard Time beneath Lake Erie about three miles offshore from Mentor and Mentor-on-the-Lake, Lake County. More than 300 felt reports were submitted to the Community Internet Intensity Web site from individuals in communities as far west as Euclid and as far east as Painesville. Most reports came from Mentor and Mentor-on-the-Lake and Eastlake but a significant number came from Willoughby and Willowick. Maximum Modified Mercalli Intensity was III. No damage was reported. Many residents reported a boom or jolt followed by a brief period of high-frequency shaking. Commonly, a first reaction was that a vehicle or tree limb had hit the house or that the furnace exploded. If you felt this earthquake and have not submitted a report, please follow the link below and fill out a short form. Collectively, this information is of great value to the Ohio Seismic Network in understanding how sediments respond to earthquakes. Such information will assist in future preparation of maps depicting seismic risk in various areas.

May 12, 2006: A small earthquake struck the east side of Lima on May 11 at 9:51 p.m. EDT (01:51 May 12 UTC). No damage was reported from the 2.8-magnitude event but many residents of Lima, particularly on the east side of town, reported a booming sound followed by a brief period of shaking. Many thought that the refinery exploded. Approximately 40 felt reports were submitted through the Internet. Most were from the east side of Lima, but reports were received from Ada, Beaver Dam, Elida, Harrod, and Ottoville. Modified Mercalli intensity was III. The event was recorded at Ohio Seismic Network stations throughout western and central Ohio.

June 20, 2006: A small earthquake occurred beneath Lake Erie about 10 km northeast of Painesville at 4:11 p.m. EDT. Many people from Eastlake to Ashtabula felt this event as a sharp shaking and some reported a booming sound. No damage was reported and would not be expected with an earthquake of this size. A number of small earthquakes, dating back to at least 1988 have occurred at this general location, including a 3.4-magnitude event on June 30, 2003. A small aftershock occurred at 4:57 p.m. No felt reports were received for this 2.2-magnitude earthquake.

March 12, 2007: A small, but strongly felt earthquake struck a several-county area of northeastern Ohio on Monday, March 12 at 7:18 Eastern Daylight Time. No damage was reported although many people were alarmed by the earthquake. The event was felt throughout an area of about 3,000 square miles as defined by contiguous zip codes from which felt reports were received. Maximum intensities (IV) were recorded at Aurora, Northfield, and Twinsburg.

Seismogram of the March 12, 2007 earthquake (3.3 mbLg) near Twinsburg as recorded at OhioSeis station ACSO at Alum Creek State Park, about 111 miles southwest of the epicenter. Arrival times of the P and S waves are noted.

October 10, 2007: A small earthquake occurred beneath Lake Erie about four miles northwest of Mentor-on-the-Lake and was widely felt along the Lake Erie shore area east of Cleveland. The 3.2 magnitude earthquake occurred at 4:04 p.m. EDT and caused much alarm among residents of Mentor, Willoughby,

Eastlake, and other communities and resulted in numerous calls to local law enforcement agencies, news media, and the Lake County Emergency Management Agency. Many described a booming sound and a sharp jolt. There have been several small earthquakes in this general area in recent years. No reports of damage were received.

September 18, 2008: A small earthquake occurred beneath Lake Erie about seven miles NNW of Mentor at 9:04 p.m. EDT. A number of small earthquakes have occurred in this general location, beginning in 2006. Felt reports were mostly from Mentor but individuals in Willoughby and Eastlake also reported feeling the event. There were no damages.

September 30, 2008: A small earthquake centered in northwestern Shelby County, north of Lake Loramie, was felt by residents in Shelby and surrounding counties at 9:06 p.m., September 29, 2008 EDT. This event was in the Anna Seismic Zone, which has traditionally been one of the most active seismic zones in Ohio. The epicenter of the earthquake is very close to the northwest-trending Anna-Champaign fault.

April 24, 2009: A small earthquake occurred about six miles WNW of Gallipolis, Gallia County, Ohio, at 9:42 a.m. EDT. The earthquake was felt over a several county area, including parts of West Virginia and Kentucky. There were no damage reports, which is consistent with an earthquake of this magnitude.

April 25, 2010: A small earthquake occurred in eastern Lake County between Perry and Madison on April 24, 2010, at 10:00 p.m. EDT. Many residents of both communities reported feeling the event. A 2.3 magnitude earthquake occurred very near this location on February 1, 2005 and a 3.3 earthquake occurred here on June 30, 2004. No damages were reported.

October 24, 2010: A small earthquake occurred at 4:12 a.m. EDT about 5 miles ENE of Marietta, Washington County, Ohio. It awakened residents in Marietta and Reno who described a loud boom and brief shaking that rattled glassware in cabinets. Many thought that their furnace had exploded or a car had hit the building. No damages were reported. There has been no previous record of earthquake activity in historic times in the Marietta area.

June 5, 2011: A small earthquake centered in southwest Medina County was felt by many residents in Medina and neighboring counties at 11:35 a.m. EDT. No damages were reported. Most felt reports were from Lodi, West Salem, and Creston but also came from Burbank, Litchfield, Medina, Spencer, Seville, and Wellington.

August 31, 2011: A small earthquake was felt in the Marietta, Ohio area at 05:35 a.m. EDT. An aftershock occurred at 01:36 p.m. EDT and was felt as well. Data are preliminary at this point and may be revised based on further analysis. No damages were reported from either event.

A second earthquake struck the Marietta, Ohio area at 1:36 p.m. EDT and was widely felt in Marietta and neighboring communities. No damages were reported for either event but many residents described a loud boom and brief shaking. Some residents thought that the afternoon event felt larger than the one in the early morning.

December 31, 2011: A 4.0 magnitude earthquake centered at Youngstown rocked northeastern Ohio just before 3:05 p.m. EST on New Year's Eve. This was the 11th earthquake in a sequence that began on March 17, 2011 at Youngstown. The December 31 earthquake was felt throughout northeastern Ohio, adjacent areas in western Pennsylvania, and in Ontario, Canada. Media reports indicate that damage was minor from this event with a few reports of cracked plaster and glassware falling from shelves. Earthquakes in the low 4 magnitude range would not be expected to cause major damage. More than 4,700 felt reports have been submitted by individuals to the U.S. Geological Survey's Did You Feel It Web site. This event was the strongest quake felt in the area as Youngstown had experienced eleven more events between March 17, 2011 and January 13, 2012 registering from 2.2 to 4.0 magnitude wave.

July 1, 2013: A small earthquake occurred at 03:48 a.m. EDT offshore, north of Fairport Harbor, Lake County. A number of small earthquakes have occurred in this general area in recent years. Felt reports were received from Fairport Harbor, Mentor, and Painesville.

Other earthquakes between March 2011 and March 2013 have occurred in northeast Ohio communities such as Lodi, Ohio (Medina County) and Rock Creek (southern Ashtabula County). Four earthquakes have occurred offshore with epicenters in Lake Erie. Two quakes occurred offshore of Lake County, one offshore of Cuyahoga County and one quake originated in the middle of the lake

along the Ohio-Ontario Canada border. In southeastern Ohio, five earthquakes occurred near Marietta (Washington County) and others have occurred in Gallia and Meigs Counties.

PROBABILITY OF FUTURE EVENTS

Map 2.9.c

Source: USGS http://pubs.usgs.gov/of/2002/ofr-02-420/USpga500v3-508.pdf

Earthquakes have affected Ohio as early in history as written and oral records exist. There is clear precedence set to expect Ohio will continue to experience seismic events for the foreseeable future. Probabilities of future events have been developed and mapped by the USGS (Map 2.9.c). The measurement used in this estimation is based on the chance of ground shaking (*e.g.* peak ground acceleration) as a percentage of the natural force of gravity over time. In this analysis the extreme southwestern portion of Ohio has one in ten chance of experiencing an earthquake equal in force to three percent of the earth's gravity in the next 50 years due to its proximity to the New Madrid seismic zone.

Although future earthquake events are highly likely to occur in Ohio, fortunately the state has not experienced any loss of life due to earthquakes. Damages are commonly limited to poorly built structures.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

Loss estimates for Ohio's earthquake hazard were developed using FEMA's hazard analysis and loss estimation software HAZUS-MH and its extensive inventory of historical events. HAZUS has been used successfully for over a decade in California's earthquake preparation and response efforts. For the purpose of this initial effort, level one analyses were completed using the program; unmanipulated, census-tract-level data were used. It is important to interpret HAZUS-MH MR4 (second release) results with the understanding that they are estimates and cannot be considered precise losses.

For the northeast Ohio analysis, the historical event of January 31, 1986 was used, which had a magnitude of 5.0 and was felt in 10 other states and southern

Canada. Estimates for the west-central portion of the state were based on the event of March 2, 1937 with an estimated magnitude of 5.4 and an eight kilometer depth. Analysis for the 1811/1812 New Madrid event could not be performed due to constraints within the software.

Beginning with the county where the epicenter was located, HAZUS-MH MR4 runs were performed on each contiguous county expanding outward, until loss estimates became negligible.

Results

Region 1 counties with notable losses included: Allen, Auglaize, Darke, Hardin, Logan, Mercer and Shelby, (see table 2.9.a). Results indicated very minimal losses of utility, transportation and critical facilities. The categories which reflected the greatest impact are associated with the building inventory and are the focus of the loss estimation. The only other category with any loss is wastewater treatment, and those were negligible by comparison.

Figure 2.9.d

The total population for the impacted area is 375,177 with a total building value of $27,875,000,000. Impacts are reported in terms of damage degree, income losses and property damage. The HAZUS-MH MR4 User's Manual provides a basic diagram to depict the degrees of damage, (see Figure 2.9.d).

Using the building category "Wood, Light Frame" as an example, the following descriptions are provided in the User's Manual to clarify the degrees of damage.

> **Slight**: Small plaster or gypsum board cracks at corners of door and window openings and wall ceiling intersections; small cracks in masonry chimneys and masonry veneer.
>
> **Moderate**: Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.
>
> **Extensive**: Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations; small foundations cracks.
>
> **Complete**: Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple wall failure or

the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

HAZUS results for building counts indicate 13,700 slight, 5,257 moderate, 997 extensive and 157 completely impacted structures. The total loss of income is estimated at $85,430,000, and total property losses are estimated at $512,130,000. This represents approximately a 2.1 percent overall loss ratio.

Table 2.9.a

Estimate of Potential Losses to Earthquake								
Region 1								
County	**2009 Pop.**	**Total Building Value**	**Slight Damage Count**	**Moderate Damage Count**	**Extensive Damage Count**	**Complete Damage Count**	**Income Loss**	**Property Loss**
Allen	108,473	$8,276,000,000	2,147	662	96	10	$12,080,000	$54,690,000
Auglaize	46,611	$3,493,000,000	2,751	1,020	194	29	$15,210,000	$103,640,000
Darke	31,945	$3,766,000,000	840	254	36	4	$3,340,000	$15,810,000
Hardin	53,309	$2,110,000,000	430	129	16	1	$5,990,000	$1,500,000
Logan	46,005	$3,496,000,000	2,000	709	105	12	$6,890,000	$40,410,000
Mercer	40,924	$2,933,000,000	966	309	45	5	$4,420,000	$22,140,000
Shelby	47,910	$3,801,000,000	4,566	2,174	505	96	$37,500,000	$273,940,000
TOTAL	**375,177**	**$27,875,000,000**	**13,700**	**5,257**	**997**	**157**	**$85,430,000**	**$512,130,000**

Region 2 counties with notable losses included: Ashtabula, Cuyahoga, Geauga, Lake and Trumbull (see Table 2.9.b). Again the notable losses are associated with building stock in addition to negligible losses to wastewater treatment facilities. The total population for the impacted area is 2,040,228 with a total building value of $179,111,000,000. HAZUS results for building counts indicate 13,729 slight, 4,170 moderate, 612 extensive and 67 completely impacted structures. The total loss of income is estimated at $79,860,000 and total property losses are estimated at $615,970,000. This represents approximately a 0.4 percent overall loss ratio.

Table 2.9.b

Estimate of Potential Losses to Earthquake								
Region 2								
County	**2009 Pop.**	**Total Building Value**	**Slight Damage Count**	**Moderate Damage Count**	**Extensive Damage Count**	**Complete Damage Count**	**Income Loss**	**Property Loss**
Ashtabula	102,728	$7,704,000,000	914	262	30	3	$3,310,000	$20,400,000
Cuyahoga	1,393,978	$126,156,000,000	4,395	1,184	138	11	$27,930,000	$132,920,000
Geauga	90,895	$7,865,000,000	2,046	702	112	13	$11,180,000	$107,350,000
Lake	227,511	$19,802,000,000	5,900	1,901	320	39	$35,850,000	$348,670,000
Trumbull	225,116	$17,584,000,000	474	121	12	1	$1,590,000	$6,630,000
TOTAL	**2,040,228**	**$179,111,000,000**	**13,729**	**4,170**	**612**	**67**	**$79,860,000**	**$615,970,000**

Although HAZUS evaluations of the 1811/1812 New Madrid Event cannot be conducted due to software constraints, the potential for damage from a similar earthquake exists. As part of preparations for a multi-state evaluation of the New Madrid hazard potential, the USGS developed an updated damage evaluation for Ohio (see Map 2.9.d). The area marked in solid red would experience the greatest impact with moderate damage (broken windows, damaged chimneys, cracked walls) from a hypothetical 7.6 event.

Map 2.9.d

One consideration which is beyond the scope of this analysis is the impact a New Madrid event would have on the highly landslide-prone areas in Hamilton and Clermont counties. These counties are heavily urbanized, containing the greater-Cincinnati metropolitan area with millions of inhabitants and billions of dollars in development. In the case of Hamilton County, significant damage, including the temporary closure of Interstate-75 resulting from roadway slippage, has occurred due to landslide, without the impetuses of ground shaking or liquefaction. When a major New Madrid event occurs affecting Hamilton County, the impact could include the closure of multiple interstate highways, rail lines, and significant building losses including many displaced inhabitants. There could also be significant secondary impacts if an event occurs during the winter months that disrupts utility infrastructure.

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

Methodology

The state-owned and state-leased facility data do not contain all of the attributes necessary for incorporation into HAZUS to assess risk. Therefore, the HAZUS results shown in Tables 2.9.a and 2.9.b were used to develop a "percent building loss." This calculation was based on "Property Loss" / "Total Building Value." The values calculated for each county were then used to estimate the state-owned and state-leased facility losses. While this does not represent a structure-by-structure risk assessment, it does provide a better look than the "governmental structures" values that HAZUS generates via 2000 census block data. Tables 2.9.c and 2.9.d list the results.

Results

The earthquake modeled in the HAZUS analyses affected only portions of Region 1 and 2, which are listed in Tables 2.9.c and 2.9.d. For Region 1, the highest critical facility losses could be expected in Allen County, with over $800,000. The second highest would be in Shelby County, where nearly $730,000 could be lost. There were no state-leased critical facilities affected in this Region. Concerning state-owned non-critical facilities, Allen and Auglaize County losses were the highest in Region 1, with $116,000 and $90,962, respectively. Overall, Allen County exhibited the largest state-owned facility loss, with nearly $1 million in assets vulnerable.

Region 2 had much lower losses than demonstrated in Region 1. For state-owned critical facilities, Ashtabula County had the highest with nearly $100,000 in losses, while state-leased critical facility losses were negligible. Geauga County had the greatest vulnerability for state-owned non-critical facilities. Overall, Geauga County exhibited the greatest losses in Region 2 for state-owned facilities with over $141,000.

Table 2.9.c

Estimate of Potential Losses to Earthquake for State-Owned and State-Leased Facilities in Region 1											
County	**Percent Building Loss**	**State-Owned Critical Facility Value**	**State-Owned Critical Facility Loss**	**State-Owned Non-Critical Facility Value**	**State-Owned Non-Critical Facility Loss**	**State-Leased Critical Facility Value**	**State-Leased Critical Facility Loss**	**State-Leased Non-Critical Facility Value**	**State-Leased Non-Critical Facility Loss**	**Total Estimated State-Owned Losses**	**Total Estimated State-Leased Losses**
Allen	0.66%	$129,644,317	$856,724	$17,589,855	$116,238	$0	$0	$584,976	$3,866	$972,962	$3,866
Auglaize	2.97%	$4,306,792	$127,786	$3,065,702	$90,962	$0	$0	$20,388	$605	$218,748	$605
Darke	0.42%	$4,098,855	$17,207	$12,776	$54	$0	$0	$0	$0	$17,261	$0
Hardin	0.07%	$1,236,823	$879	$5,500	$4	$0	$0	$0	$0	$883	$0
Logan	1.16%	$4,056,192	$46,885	$612,000	$7,074	$0	$0	$0	$0	$53,959	$0
Mercer	0.75%	$3,365,812	$25,407	$366,365	$2,766	$0	$0	$0	$0	$28,173	$0
Shelby	7.21%	$10,118,878	$729,273	$306,000	$22,054	$0	$0	$123,684	$8,914	$751,326	$8,914
TOTAL	**--**	**$156,827,669**	**$1,804,161**	**$21,958,198**	**$239,151**	**$0**	**$0**	**$729,048**	**$13,385**	**$2,043,312**	**$13,385**

Table 2.9.d

Estimate of Potential Losses to Earthquake for State-Owned and State-Leased Facilities in Region 2											
County	**Percent Building Loss**	**State-Owned Critical Facility Value**	**State-Owned Critical Facility Loss**	**State-Owned Non-Critical Facility Value**	**State-Owned Non-Critical Facility Loss**	**State-Leased Critical Facility Value**	**State-Leased Critical Facility Loss**	**State-Leased Non-Critical Facility Value**	**State-Leased Non-Critical Facility Loss**	**Total Estimated State-Owned Losses**	**Total Estimated State-Leased Losses**
Ashtabula	0.26%	$36,672,165	$97,107	$4,399,911	$11,651	$0	$0	$47,232	$125	$108,758	$125
Cuyahoga	0.11%	$19,815,718	$20,878	$57,101,659	$60,163	$0	$0	$1,882,083	$1,983	$81,041	$1,983
Geauga	1.36%	$3,749,863	$51,182	$6,585,511	$89,886	$0	$0	$11,400	$156	$141,068	$156
Lake	1.76%	$3,150,402	$55,472	$503,069	$8,858	$0	$0	$176,676	$3,111	$64,330	$3,111
Trumbull	0.04%	$28,726,632	$10,831	$12,032,218	$4,537	$10,716	$4	$49,152	$19	$15,368	$23
TOTAL	**--**	**$92,114,780**	**$235,470**	**$80,622,368**	**$175,095**	**$10,716**	**$4**	**$2,166,543**	**$5,393**	**$410,565**	**$5,397**

2.10 COASTAL EROSION

Coastal erosion is defined as the gradual wearing away of the earth's surface by the natural forces of wind and water. The constant action of wind, waves, and ice flow has affected the coastline of Lake Erie[1]. Primarily, it is the waves and gravity that cause erosion. Waves undercut the land along the shore and gravity causes the land to slip into the water. As material from the bluff or bank slides into the lake, it too is eroded by waves. As this process continues, the shore moves farther landward[2]. Many natural factors affect erosion of the lakeshore, including shore and nearshore geology, shore relief, nearshore bathymetry, beaches, shoreline orientation, lake level fluctuations (long-term, annual, and storm surges), and climate changes (storm frequency, temperature, and precipitation)[3].

Lake Erie owes its fundamental existence to the presence of a basin or lowland that originated long before the Pleistocene Ice Age began 2 million years ago. This lowland was known as the valley of an east-flowing river, known as the Erigan River. This geology in the basin included Silurian and Devonian carbonates (limestone and dolomite) on the west and by Devonian shales on the east. Glacial ice was able to erode the less resistant shales (than the more resistant carbonate rocks) to a greater extent in the central basin and eastern basins. The first of the 4 major glacial advances during the Pleistocene obliterated this drainage system and deepened and enlarged the basin. Succeeding glaciations further deepened and enlarged it. Lake Erie, the southernmost of the Great Lakes, is also the shallowest because the ice was relatively thin (therefore lacking significant erosive power) when it reached so far south[4]. During the advancement of the glaciers, they eroded rock and soil and carried them with the flowing ice to the glacier edge where they were deposited as till released from melting ice. Laminated silt and clay were also deposited in proglacial lakes that formed along the margin of the glacier. These geologic materials are exposed in Lake Erie's bluffs and banks[5]. Upon final retreat of the glacier moving out of Ohio, the water started to discharge via the Niagara River. Glacial rebound raised the Niagara outlet and increased the water level in the Lake Erie basin. Due to a rapid glacial rebound in the upper Great Lakes, these lakes began to drain through the Lake Erie Basin [6]. There has been a continued slow rise following the rapid rise that has brought Lake Erie to its current mean level of 571 feet above sea level.

The geologic settings vary throughout the length of Ohio's coast. From the Ohio-Pennsylvania border to Huron, Ohio, moderate to high relief shore consists of bluffs and slopes composed of glaciolacustrine sands, silts, clay, till, and/or shale. From Huron around Sandusky Bay to Marblehead peninsula, the shore is

[1] Lake Erie Coastal Erosion Areas, included with 1998 CEA Designation packet
[2] Questions and Answers Regarding Ohio's Coastal Erosion Areas
[3] Updating Lake Erie Coastal Erosion Area Maps, Donald E. Guy, Jr., July 2005
[4] The History of Lake Erie by Michael C. Hansen
[5] Erosion of Coastal Bluffs in the Great Lakes, Mickelson, Edil, and Guy, USGS Professional Paper 1693
[6] The History of Lake Erie by Michael C. Hansen

a low-relief plain composed of glaciolacustrine sediments and till, with shale exposed west of Huron and limestone exposed around Marblehead peninsula. At Sandusky Bay, two barrier beach complexes extend across the bay mouth. Around Marblehead Peninsula and Catawba Island, low to moderate banks/bluffs are composed of rock and till. West of Catawba Island, the landscape consists of low-relief lake plain and coastal wetlands (remnants of the Black Swamp). Nearshore slopes are generally gentle and are composed of the same materials in bluff or bank. Beaches are typically narrow (<50 feet per 15 meters wide) to non-existent along much of the shore. Man-made features have affected the longshore transport of sand trapping sand on the updrift side at harbor jetties, power plant intakes, and long groins. Shore parallel structures have altered sand transport as well[7].

Climate affects overall physical setting in the nearshore, beach, and shore zones. Long-term and annual fluctuations in lake level are due to changes in the volume of the lake resulting from changes in precipitation in the Great Lakes Basin. Short-term fluctuations are due to wind-driven storm surges, changes in barometric pressure, or inertial surges of water (seiches) that occur after lake level has been set up by either of the two previous agents. The greatest storm surges occur when the wind blows parallel to the long axis of the lake. Under extreme conditions, lake level at the confined ends of the lake may rise or fall more than six feet from pre-storm levels. Passage of storm systems through the Great Lakes can cause lake levels at the ends of the lake to fluctuate 10 to 11 feet over a period of several days. The most important storm surges along the western part of the Central Basin and all of the Western Basin are those generated by northeast winds because these storm surges are accompanied by large storm waves[8].

The size of wind-generated waves depends upon wind speed and duration, open-water fetch distance, and water depth. The largest waves affecting the Ohio lakeshore are those generated by storm winds from the west through the northeast. Wave energy is highest from late fall through spring; however, lake level is at its lowest and shorefast ice typically forms a barrier between the waves and erodible shore material. Most wave erosion occurs during storms in early spring when the greatest amount of wave energy is expended on the shore. The largest waves to strike the shore are generated by onshore storms winds from the west to the northeast[9]. Wave erosion causes undercutting of the bluff or bank, mass wasting including block falls, rotational slumps, and debris flows, and lakebed downcutting of cohesive materials. Bedrock is not as easily eroded as the cohesive glacial sediments.

[7] Geologic Setting and Processes Along Lake Erie From Fairport Harbor to Marblehead, Ohio, D. Guy and L. Moore, 2006
[8] Geologic Setting and Processes Along Lake Erie From Fairport Harbor to Marblehead, Ohio, D. Guy and L. Moore, 2006
[9] Geologic Setting and Processes Along Lake Erie From Fairport Harbor to Marblehead, Ohio, D. Guy and L. Moore, 2006

Although erosion of the bluff is necessary to sustain beaches, excessive erosion of the Lake Erie shoreline can be considered a hazard exposure.

Risk MAP (Mapping, Assessment and Planning)

In March 2013, FEMA published a basin-wide Discovery Report of Lake Erie as part of a Great Lakes Coastal Flood Study. This report was the result of several stakeholder meetings that involved three states (Ohio, Michigan and Pennsylvania), eleven counties (eight in Ohio) and numerous jurisdictions (44 in Ohio) that have Lake Erie shores. The Lake Erie stakeholder group includes representatives from FEMA, other Federal agencies, State agencies, local government, and several other technical focus groups.

The Lake Erie Discovery Report provides users with a comprehensive understanding of historical flood risk, existing coastal data, and current flood mitigation activities within the Lake Erie basin. The report also summarizes FEMA's intent to proceed with a coastal flood hazard study under FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program and the Great Lakes Coastal Flood Study (GLCFS) project.

Data collection efforts in the Discovery phase include base map data, coastal data, historic flood data, risk assessment, flood mitigation information, community plans, projects along the shoreline, and other comments based on local knowledge of flood risk. Additionally, certain useful datasets are being developed for use in this study. These datasets include oblique imagery, topography and bathymetry data, a shoreline feature dataset to classify shoreline characteristics, a draft transect layout, and a storm surge and wave study, all of which will feed into the coastal flood hazard analysis for Lake Erie.

In addition to identifying and assessing flood risk along the Great Lakes, the GLCFS project will provide communities with tools and information that encourage identification and implementation of mitigation actions to reduce risk. Mitigation is a critical foundation on which to reduce loss of life and property by avoiding or reducing the impact of hazard events, and it is an essential part of this coastal flood study process.

As part of the Discovery process, local Hazard Mitigation Plans were reviewed to better understand existing flood risk within the Lake Erie communities, as well as the strategies and actions that have already been developed as part of the local planning processes to mitigate that risk. By first obtaining a better understanding of existing local risk and mitigation actions during this Discovery phase, FEMA intends to begin working with communities to identify new mitigation actions and strengthen existing actions throughout the coastal flood study.

RISK ASSESSMENT

Location

Lake Erie comprises 312 miles of the northern coast of Ohio bordering Lucas, Ottawa, Sandusky (Sandusky Bay), Erie, Lorain, Cuyahoga, Lake, and Ashtabula Counties. Lake Erie, the 12th largest (area) lake in the world, is about 210 miles long, 57 miles wide, and has a shoreline length of 871 miles (including the islands). With the exclusion of government-owned park and reserve areas, the coast is highly prized for commercial and residential development. In many cases, human activity has disrupted the natural function of beach formation and aquatic habitats. According to the Ohio Geological Survey, 95 percent of Ohio's Lake Erie shoreline is eroding.

LHMP Data

All of the LHMPs for the counties that border Lake Erie (Ashtabula, Cuyahoga, Erie, Lake, Lorain, Lucas, Ottawa, and Sandusky), indicate that coastal erosion is a recognized hazard and ranked them either fourth or fifth for their county. Almost all of the plans reference the same data (Figure 2.10.a) provided by the Ohio Geological Survey. Erie County's LHMP indicated that they had completed a structural inventory in the late 1990's; but those data were not available to them at the time of writing their plan.

Ashtabula County. The HIRA of the Ashtabula County Countywide All Natural Hazards Mitigation Plan of August 2012 describes that 28 miles of Lake Erie coastline form the northern border of the County. The HIRA also explains that factors such as high lake levels, long shore currents, high winds, water runoff over cliffs, bluff recession and seasonal fluctuations are driving forces that lead to coastal erosion. The risk is classified as a Moderate Probability and Moderate Impact. The plan's vulnerability analysis determined 2,619 structures would be affected with a loss estimate of $78,295,582.

Cuyahoga County. The Cuyahoga County Countywide All Natural Hazards Mitigation Plan of 2011 lists there are 22.4 miles of shoreline in the County. There are seven jurisdictions that share this coastline with Bay Village and Euclid having the two longest lengths of coastline. Records on coastline recess have been maintained since 1973. Within the past 24 years, it has been estimated that 4.4 acres have been lost to coastal erosion, with half in Bay Village and Euclid. The average anticipated recession distance is estimated to be over a 3.1 foot distance. However, the Maximum recession distance is anticipated to be over a 31 foot distance.

Lucas County. According to the Lucas County Countywide All Natural Hazards Mitigation Plan of March 2013, lake surges (also referred to as storm surges) are associated with extreme weather events and are responsible for coastal flooding and erosion along Lake Erie within Lucas County. The storms that generate the large waves of lake surges can develop year-round, however within Lucas County, these events have typically occurred in the early spring and late fall months. Storm surges inundate coastal floodplains by dune over-wash, the rise

in water levels in inland bays and harbors, and backwater flooding through river mouths. Coastal erosion is generally associated with storm surges, windstorms, and flooding hazards, and may be exacerbated by human activities such as boat wakes, shoreline hardening, and dredging. Conversely, actions to supplement natural coastal processes, such as beach nourishment, dune stabilization, and construction of shore protection structures can greatly modify and reduce erosion trends within an area.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Only two counties (Lake and Ashtabula) provided data for coastal erosion. This limited amount of data reflects that there are a few counties who have yet to populate their HIRA in SHARPP. Once these are populated, Ohio EMA will be better able to assess the local risks associated with this hazard. Even given limited data, coastal erosion ranked the highest for response duration, requiring between one week and one month for response. For all other factors, this hazard ranked in the lower 50 percent, which resulted in an overall ranking of eighth out of 15 hazards. These and additional HIRA data queried from SHARPP can be found in Append J.

Unlike many of the other hazards affecting Ohio, Lake Erie is consistently undergoing coastal erosion. Although particular storms or development creates periods of increased occurrence, the shore is eroding slowly every day. To easure erosion, the net landward movement of the shore over a specific time is calculated. The position of characteristic shore features such as bluff lines can be determined from maps and aerial photographs. By analyzing the position of

Table 2.10.a

Ohio Lake Erie Erosion Statistics by County

Long and Short-term Recession Data by County
Long-term: 1877 to 1973 Short-term: 1973 to 1990

County	Long-term Distance (ft.)	Long-term Rate (ft/yr)	Short-term Distance (ft.)	Short-term Rate (ft./yr.)
Ashtabula	82	0.9	28	1.6
Lake	160	1.7	32	1.9
Cuyahoga	60	0.6	8	0.4
Lorain	80	0.8	12	0.7
Erie (lake)	103	1.6	42	2.5
Ottawa (lake)	208	2.0	27	1.6
Lucas	520	5.4	46	2.7
Erie (bay)	241	2.8	32	1.9
Ottawa (bay)	61	2.0	21	1.2

Source: Ohio Division of Geological Survey http://dnr/state.oh.us/geosurvey/

these features (recession lines) through time, the amount of recession can be determined and rates of recession can be calculated. Long-term and short-term recession data have been developed for each county (see table 2.10.a).

During 1929-30, the mid-1940s, 1952, the fall of 1972, the spring of 1973, and 1985, storms and high lake levels caused property damage along the low-lying areas, such as low glacial till bluffs, low glaciolacustrine banks, and barrier beaches and eroded high glacial till or glaciolacustrine bluffs inducing mass wasting in Erie, Lake, Cuyahoga, and Ashtabula counties. The short-term and long-term rates indicate that the low-lying areas have been extremely affected.

Probability of Future Events

With shore structures increasing along the coastline, the shoreline becomes increasingly modified. Reports and studies suggest that wave erosion and mass wasting caused by Lake Erie will continue to erode the Ohio shore for the foreseeable future. Damage to the built environment is inevitable without intervention and will warrant the full understanding of coastal processes within each stretch to rehabilitate the shoreline.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

The Ohio Geological Survey continues the process of reassessing Ohio's vulnerability to coastal erosion. According to the Ohio Revised Code, coastal erosion area designation must be conducted every 10 years and parcels at risk must be listed as Coastal Erosion Areas. The initial evaluation utilized 1973 and 1990 data and the results were published in 1998. Researchers utilize aerial photography to delineate exposure based on observed shoreline characteristics.

Once the preliminary designations of the coastal erosion areas are determined with extensive quality checking and ground proofing support, GIS layers are reated and preliminary maps generated. Impacted property owners are contacted by mail of their inclusion and public meetings are held to provide an opportunity to see the risk assessment. Property owners may dispute the determination, if they believe that the shore features were not picked correctly and with proof that erosion did not occur. After all comments have been addressed, final maps are generated and final notifications are sent by mail to the coastal erosion area property owners.

Results

After examining limited data in county hazard mitigation plans and in SHARPP, the following vulnerability estimates are provided. As more of the plans are revised and assessments are updated, then more accurate vulnerability assessments can be projected.

Estimated Vulnerability Assessment		
Structure Type	**Structures at Risk**	**Damage in Dollars**
Residential	14,200	$734,378,954
Non-Residential	372	$62,836,701
Critical Facilities	43	$4,925,596
Total	14,615	$802,141,251

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

Previous versions of this plan indicated that coastal erosion had limited potential to affect any state-owned structures or critical facilities. All state facilities near the Lake Erie Coast were evaluated for their proximity to coastal erosion areas using the DAS data within a GIS. No state-owned or state-leased facilities were located in the coastal erosion areas, which represents no change since the last plan update.

2.11 DROUGHT

Drought is a normal, recurrent feature of climate that originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. Within the State of Ohio, drought is equally as possible to occur in one section of the state as it is in another. The effects of drought within the state vary though, based on land use (farming and cattle production as opposed to urban areas), economy (dependence on drought-impacted business (farming), geology (presence of an aquifer or ground structure that limits well production), and water source (public water supply, private well, cistern).

There are four primary types of drought: meteorological, hydrological, agricultural and socioeconomic. The State of Ohio is most often affected by agricultural and hydrological types of drought, and is often affected by both simultaneously. Below, these two types of drought are described in more detail.

Agricultural Droughts. Agricultural drought links characteristics of hydrological drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, and reduced ground water or reservoir levels. The amount of water available for agricultural use demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil. A good definition of agricultural drought accounts for the variable susceptibility of crops during different stages of crop development, from emergence to maturity. Deficient topsoil moisture at planting may hinder germination, leading to low plant populations per acre and a reduction of final yield.

Hydrological Drought. Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply – stream flow, reservoir and lake levels and ground water. The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system.

Hydrological droughts are usually out of phase with, or lag the occurrence of, meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, stream flow, and ground water and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors. For example, a deficiency in reservoir levels may not affect hydroelectric power production or recreational uses for many months.

Water in hydrologic storage systems (e.g., reservoirs, rivers) is often used for multiple and competing purposes (e.g., flood control, irrigation, recreation, navigation, hydropower, wildlife habitat), further complicating the sequence and quantification of impacts. Competition for water in these storage systems

escalates during drought and conflicts between water users increase significantly.

Although climate is a primary contributor to hydrological drought, there are other factors such as changes in land use, deforestation, land degradation, and the construction of dams which can all affect the hydrological characteristics of a basin. Because regions are interconnected by hydrologic systems, the impact of meteorological drought may extend well beyond the borders of the precipitation-deficient area.

The flow chart, below, illustrates the progression of drought, and the relationship between meteorological, agricultural, and hydrological drought. Economic, social and environmental impacts are shown at the bottom of the chart, independent of the time scale, indicating that such impacts can occur at any stage during a drought.

Figure 2.11.a
The Drought Cycle

Source: National Weather Service – Public Fact Sheet, August 2006
http://www.nws.noaa.gov/om/brochures/climate/Drought.pdf

National Drought Mitigation Center, http://www.drought.unl.edu/whatis/concept.htm

Measuring Drought

The Palmer Drought Severity Index (PDSI) is a soil moisture algorithm. The PDSI was d*eveloped by* W.C. Palmer in 1965. Many U.S. government agencies and states rely on the PDSI to trigger drought relief programs and responses. Most of the agency-based actions within the Ohio Emergency Operation Plan's Drought Incident Annex are triggered by the PDSI.

Figure 2.11.b
Palmer Drought Severity Index Classifications

4.0 or greater	Extremely Wet
3.0 to 3.99	Very Wet
2.0 to 2.99	Moderately Wet
1.0 to 1.99	Slightly Wet
0.5 to 0.99	Incipient Wet Spell
0.49 to -0.49	Near Normal
-0.5 to -0.99	Incipient Dry Spell
-1.0 to -1.99	Mild Drought
-2.0 to -2.99	Moderate Drought
-3.0 to -3.99	Severe Drought
-4.0 or less	Extreme Drought

Source: Palmer Drought Severity Index
http://www.math.montana.edu/~nmp/materials/ess/mountain_environments/intermediate/ystone/palmer_more.html

The PDSI is based on the supply-and-demand concept of the water balance equation, taking into account more than just the precipitation deficit at specific locations. The objective of the PDSI is to provide standardized measurements of moisture conditions, so that comparisons using the index can be made between locations and between time periods (usually months). The PDSI is calculated based on precipitation and temperature data, as well as the local Available Water Content of the soil. The Palmer Index is designed so that a -4.0 in South Carolina has the same meaning in terms of the moisture departure from a climatological normal as a -4.0 does in Ohio.

The Palmer Index is typically calculated on a monthly basis, and a long-term archive of the monthly PDSI values for every climate division in the United States exists with the National Climatic Data Center from 1895 through the present. Weekly Palmer Index values are calculated for climate divisions (the State of Ohio has ten climate divisions) during every growing season.

RISK ASSESSMENT

Location

The National Drought Mitigation Center (NDMC) has calculated values showing the spatial extent of drought based on historical Palmer Drought Severity Index (PDSI) data. The annual average of 18.1% was calculated by selecting the month of each year from 1895 to 1995 with the greatest spatial extent of severe or extreme drought and averaging the values.

Using PDSI data, the NDMC created data indicating the percent of time each climate division in the United States was in severe or extreme drought, from 1896–1994. The data show the spatial extent of drought for various time periods.

The worst recent drought event occurred in July 1988, with 36% of the country in severe or extreme drought. The worst drought event ever recorded occurred in July 1934, with 65% of the United States experiencing severe to extreme drought.

Figure 2.11.c

Source: National Climatic Data Center, Understanding Your Risk and Impacts – A Comparison of Droughts, Floods, and Hurricanes in the United States. http://www.drought.unl.edu/risk/us/compare.html.

LHMP Data

Scioto County. The Scioto County Hazard Mitigation Plan of 2012 states a drought of any length of time can cause significant damage to crops and harm the local economy. Drought impact would prompt marked decreases in agricultural production, which is the most prevalent industry in the county. This would also cause consumers to pay more for food and negatively impact the whole county. An exact cost could not be determined, however, it is projected that the loss of one year's crops would total several hundreds of thousands of dollars for the farm community.

Medina County. The updated 2011 All Hazard and Flood Mitigation Plan provides a description of similar impacts from a prolonged drought as the Scioto County Plan. According to the HIRA, the rural and farm areas not served by public water systems will be affected the most. Significant impacts may also occur to the municipalities that utilize wells due to their lack of recharge. In addition to the lack of water, power outages are also likely to occur due to the reduced electric transmission efficiency and the significant increase in demand for power as the use of air conditioning. The plan goes on to identify that the county has a large agricultural base and viewed as a countywide industry. Economic impact will be felt on losses from crop failure, undernourished livestock and wildlife, land value decline and potential unemployment.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. As indicated in Chart 2.2.a, drought ranks relatively low in terms of frequency. However, this hazard ranked second for magnitude, with a few respondents indicating significant impact countywide. This is most likely due to the effects drought can have on agriculture in counties with a large agricultural base. For most factors, this hazard ranked in the lower 50 percent, which resulted in an overall ranking of 10th out of 15 hazards. These and additional HIRA data queried from SHARPP can be found in Appendix J.

Past Occurrences

The table below lists the number of years that the United States has had severe or extreme drought in the 100 years from 1896 to 1995, based on the Palmer Drought Severity Index (PDSI). The data is divided and analyzed based on NOAA river basins. The chart shows that some part of the United States has experienced a severe or extreme drought in each year from 1896 to 1995, and that in 72 years, droughts covered more than 10% of the country.

2012 North American Drought

The 2012-2013 North American Drought was an expansion of the 2010-2012 United States drought which began in the Spring of 2012, when the lack of show caused very little melt water to absorb into the soil. The drought included most of the United States and all of Ohio. Several counties in the state were designated with moderate drought conditions by mid-June of 2012. Its effects were equal to similar droughts which occurred in 1930s and 1950s, but the 2012 event did not last as long. None the less the 2012 North American Drought inflicted catastrophic economic ramifications on the state. In most measures, the 2012 drought exceeded the 1988-1989 North American Drought, which was the most recent comparable drought.

On July 30, 2012, the Governor of Ohio sent a memorandum to the U.S. Department of Agriculture State Executive Director requesting primary county natural disaster designations for eligible counties due to agricultural losses caused by drought during the 2012 crop year. The USDA reviewed the Loss Assessment Reports and determined that there were sufficient production losses in 85 counties to warrant a Secretarial disaster designation on September 5, 2012. By December 2012, all 88 counties received such a designation.

Secretarial Disaster Designations - CY 2012
Primary and Contiguous Counties Designated for 2012 Crop Disaster Losses
Alaska
1:58,102,399
Hawaii
Puerto Rico
Total All Crop Approved Designations
State Boundary
County Boundary
Tribal Lands
December 12, 2012
Primary Counties: 2300
Contiguous Counties: 435
1:23,520,203
USDA FSA
USDA Farm Service Agency
Production, Emergencies and Compliance Division
Washington, D.C.
December 12, 2012

The USDA – National Agricultural Statistics Service (NASS) was used to compare a regular crop production period (Crop Year 2011) and the affected crop production period during drought conditions. Commodities were selected through the NASS Program Survey, Crops sector and then by Group: Field Crops, Vegetables, and Fruit & Tree Nuts:

Field Crop Losses					
Commodity	**Measurement**	**2011 Quantity**	**2012 Quantity**	**Difference**	**Trend**
Grain Corn - Planted	Acres	3,400,000	3,900,000	500,000	More
Grain Corn - Harvested	Acres	3,220,000	3,650,000	430,000	More
Grain Corn- Production	Bushels	508,760,000	448,950,000	59,810,000	Less
Grain Corn - Yield	BU/ Acre	158	123	35	Less
Hay - Harvested	Acres	1,120,000	1,100,000	20,000	Less
Hay - Production	Tons	2,772,000	2,330,000	442,000	Less
Hay - Yield	Tons/ Acre	2.48	2	0.36	Less
Maple Syrup	Number of Taps	405,000	410,000	5,000	More
Maple Syrup - Production	Gallons	125,000	100,000	25,000	Less
Maple Syrup - Yield	Gallons/ Tap	0.309	0	0.065	Less
Soybeans - Planted	Acres	4,550,000	4,600,000	50,000	More
Soybeans - Harvested	Acres	4,540,000	4,590,000	50,000	More
Soybeans - Production	Bushels	217,920,000	206,550,000	11,370,000	Less
Soybeans - Yield	BU/ Acre	48	45	3	Less
Tobacco, air-cured light burley - Harvested	Acres	1,600	1,800	200	More
Tobacco, air-cured light burley - Production	Bushels	3,360,000	3,600,000	240,000	More
Tobacco, air-cured light burley - Yield	BU/ Acre	2,100	2,000	100	Less

Source: U. S. Department of Agriculture - National Agricultural Statistics Service

Fruit and Vegetable Losses					
Fruit	**Measurement**	**2011 Quantity**	**2012 Quantity**	**Difference**	**Trend**
Apples	Acres Bearing	4,300	4,000	300	Less
Apples - Production	Pounds	66,600,000	33,000,000	33,600,000	Less
Apples - Yield	Pounds/Acre	15,500	8,250	7,250	Less
Grapes	Acres Bearing	1,900	1,900	0	(No Change)
Grapes - Production	Tons	7,480	5,335	2,145	Less
Grapes - Yield	Tons/Acre	3.94	2.81	1.13	Less
Peaches	Acres Bearing	1,200	1,400	200	More
Peaches - Yield	Tons	6,030	4,960	1,070	Less
Peaches - Production	Tons/Acre	5.03	3.54	1.49	Less
Vegetable	**Measurement**	**2011 Quantity**	**2012 Quantity**	**Difference**	**Trend**
Cucumbers - Planted	Acres	2,600	7,100	4,500	More
Cucumbers - Harvested	Acres	2,600	7,000	4,400	More
Cucumbers - Production	Cwt (Hundredweight)	17,910	31,290	13,380	More
Cucumbers - Yield	Cwt/Acre	6.89	4.47	2.42	Less
Bell Peppers - Planted	Acres	3,200	3,200	0	(No Change)
Bell Peppers - Harvested	Acres	3,100	3,100	0	(No Change)
Bell Peppers -Production	Cwt (Hundredweight)	1,004,000	567,000	437,000	Less
Potatoes - Planted	Acres	2,000	1,500	500	Less
Potatoes - Harvested	Acres	1,700	1,400	300	Less

Potatoes - Production	Cwt (Hundredweight)	459,000	308,000	151,000	Less
Potatoes - Yield	Cwt/Acre	270	220	50	Less
Squash - Planted	Acres	1,900	1,800	100	Less
Squash - Harvested	Acres	1,800	1,700	100	Less
Squash - Production	Cwt (Hundredweight)	360,000	304,000	56,000	Less
Squash - Yield	Cwt/Acre	200	180	20	Less
Sweet Corn - Planted	Acres	15,900	16,400	500	More
Sweet Corn- Harvested	Acres	15,100	15,100	0	(No Change)
Sweet Corn - Production	Cwt (Hundredweight)	1,737,000	1,586,000	151,000	Less
Sweet Corn - Yield	Cwt/Acre	115	105	10	Less
Fresh Market Tomatoes - Planted	Acres	4,500	4,300	200	Less
Fresh Market Tomatoes - Harvested	Acres	3,200	4,100	900	More
Fresh Market Tomatoes - Production	Cwt (Hundredweight)	752,000	697,000	55,000	Less
Fresh Market Tomatoes - Yield	Cwt/Acre	235	170	65	Less

Source: U. S. Department of Agriculture - National Agricultural Statistics Service

Probability of Future Events

The probability of future occurrences of drought in Ohio is difficult to predict; however, there are two factors that may influence future drought conditions: ENSO, and climate change.

El Nino and La Nina Southern Oscillation

A great deal of research has been conducted in recent years on the role of interacting systems, or teleconnections, in explaining regional and even global patterns of climatic variability. These patterns tend to recur periodically with enough frequency and with similar characteristics over a sufficient length of time that they offer opportunities to improve our ability for long-range climate prediction, particularly in the tropics.

Table 2.11.a
Number of Years with Severe or Extreme Drought between 1896 to 1995

% area of basin/region	>0%	>10%	>25%	>33%	>50%	>66%	>75%	>90%	100%
United States	100	72	27	13	1	0	0	0	0
Upper Mississippi	77	55	43	30	19	12	9	3	1
Mid-Atlantic	69	49	32	24	12	5	4	0	0
South Atlantic/Gulf	79	47	25	15	9	3	3	0	0
Ohio	67	51	34	28	16	12	9	4	3
Missouri	90	70	43	33	17	10	4	3	0
Pacific Northwest	86	61	42	33	23	14	9	1	0
California	53	45	40	30	14	9	5	3	3
Great Basin	71	65	43	37	19	6	3	1	1
Lower Colorado	56	54	35	28	16	11	10	4	3
Upper Colorado	50	50	42	34	27	25	16	9	8
Rio Grande	58	47	32	24	15	8	5	2	2
Texas Gulf Coast	49	48	38	26	22	13	10	9	7
Arkansas–White–Red	65	48	27	23	14	7	4	0	0
Lower Mississippi	56	38	19	15	4	1	0	0	0
Souris–Red–Rainy	66	57	38	29	19	10	8	5	2
Great Lakes	73	58	32	23	9	3	2	2	0
Tennessee	31	31	27	24	21	16	13	5	5
New England	56	44	27	13	8	5	4	0	0

Source: National Climatic Data Center, Understanding Your Risk and Impacts – A Comparison of Droughts, Floods, and Hurricanes in the United States. http://www.drought.unl.edu/risk/us/compare.html.

Every 2 – 7 years off the western coast of South America, ocean currents and winds shift, bringing warm water westward, displacing the nutrient-rich cold water that normally wells up from deep in the ocean. The invasion of warm water disrupts both the marine food chain and the economies of coastal communities that are based on fishing and related industries. Because the phenomenon peaks around the Christmas season, the fishermen who first observed it named it El Niño ("the Christ Child"). In recent decades, scientists have recognized that El Niño is linked with other shifts in global weather patterns. The intensity and duration of an ENSO event is varied and hard to predict. Typically, it lasts anywhere from 14-to-22 months, but it can be much longer or shorter. El Niño often begins early in the year and peaks between the following November.

During an El Niño–Southern Oscillation (ENSO) event, the Southern Oscillation is reversed. Generally, when pressure is high over the Pacific Ocean, it tends to be low in the eastern Indian Ocean, and vice versa. It is measured by gauging

sea-level pressure in the east (at Tahiti) and west (at Darwin, Australia) and calculating the difference. El Niño and Southern Oscillation often occur together, but also happen separately. High positive values of the SOI indicate a La Niña, or "cold event". La Niña is the counterpart of El Niño and represents the other extreme of the ENSO cycle. La Niña years often (but not always) follow El Niño years. A table listing the El Niño and La Niña events since 1900 can be found on the next page.

Table 2.11.b
ENSO Phases Since 1900

		Negative PDO: 1900-1924, 1947-1976, 1999-2002	**Warm phase PDO: 1925-1946, 1977-1998, 2003-2005**
ENSO Phase	La Niña (cool)	1904, 1907, 1909, 1910, 1911, 1917, 1918, 1921, 1923, 1950, 1951, 1955, 1956, 1963, 1965, 1968, 1971, 1972, 1974, 1975, 1976, 1999, 2000, 2001	1925, 1932, 1934, 1938, 1939, 1943, 1944, 1945, 1984, 1985, 1986, 1989, 1996
	ENSO Neutral	1901, 1902, 1908, 1913, 1916, 1922, 1947, 1948, 1949, 1953, 1954, 1957, 1960, 1961, 1962, 1967, 2002	1927, 1928, 1929, 1933, 1935, 1936, 1937, 1946, 1979, 1981, 1982, 1990, 1991, 1993, 1994, 1997, 2004
	El Niño (warm)	1900, 1903, 1905, 1906, 1912, 1914, 1915, 1919, 1920, 1924, 1952, 1958, 1959, 1964, 1966, 1969, 1970, 1973	1926, 1930, 1931, 1940, 1941, 1942, 1977, 1978, 1980, 1983, 1987, 1988, 1992, 1995, 1998, 2003, 2005

Source: Climate Impacts Group, Joint Institute for the Study of the Atmosphere and the Ocean, University of Washington, http://www.cses.washington.edu/cig/pnwc/compensopdo.shtml.

Understanding the connections between ENSO (and La Niña) events and weather anomalies around the globe can help in forecasting droughts, floods, tropical storms and hurricanes. NOAA estimates that the economic impacts of the 1982–83 El Niño, perhaps the strongest event in recorded history (see map, below), conservatively exceeded $8 billion worldwide, from droughts, fires, flooding, and hurricanes. This event and its associated disasters have been blamed for 1,000 - 2,000 deaths. In addition, the extreme drought in the United States' Midwest during 1988 has been linked to the "cold event", or La Niña, of 1988 that followed the ENSO event of 1986–87.

It is possible that the direct impacts of climate change on water resources might be hidden beneath natural climate variability. With a warmer climate, droughts and floods could become more frequent, severe, and longer-lasting. The potential increase in these hazards is a great concern given the stresses being placed on water resources and the high costs resulting from recent hazards. The drought of the late 1980s showed what the impacts might be, if climate change leads to a change in the frequency and intensity of droughts across the United States. From 1987 to 1989, losses from drought in the United States totaled $39 billion. More frequent extreme events such as droughts and floods could end up

being more cause for concern than the long-term change in temperature and precipitation averages.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Drought risk is based on a combination of the frequency, severity, and spatial extent of drought and the degree to which a population or activity is vulnerable to the effects of drought. The degree of a region's vulnerability depends on the environmental and social characteristics of the region and is measured by their ability to anticipate, cope with, resist, and recover from drought.

Society's vulnerability to drought is determined by a wide range of factors, both physical and social, such as demographic trends and geographic characteristics. People and activities will be affected in different ways by different hazards.

There is a sequence of impacts associated with meteorological, agricultural, and hydrological droughts in Ohio. When drought begins, the agricultural sector is usually the first to be affected because of its heavy dependence on stored soil water, which can be rapidly depleted during extended dry periods. If precipitation deficiencies continue, then people dependent on other sources of water will begin to feel the effects of the shortage. Those who rely on surface water (reservoirs and lakes) and subsurface water (ground water) are usually the last to be affected. A short-term drought that persists for 3-to-6 months may have little impact on these sectors, depending on the characteristics of the hydrologic system and water use requirements.

When precipitation returns to normal and meteorological drought conditions have abated, the sequence is repeated for the recovery of surface and subsurface water supplies. Soil water reserves are replenished first, followed by stream flow, reservoirs and lakes, and ground water. Drought impacts may diminish rapidly in the agricultural sector because of its reliance on soil water, but linger for months or even years in other sectors dependent on stored surface or subsurface supplies. Ground water users, often the last to be affected by drought during its onset, may be last to experience a return to normal water levels. The length of the recovery period is a function of the intensity of the drought, its duration, and the quantity of precipitation received as the episode terminates.

Socioeconomic definitions of drought associate the supply and demand of some economic good with elements of meteorological, hydrological, and agricultural drought. It differs from the other types of drought because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods, such as water, forage, food grains, fish, and hydroelectric power, depends on weather. Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply.

FEMA estimated in 1995 that drought costs the United States $6–8 billion annually. Other studies have indicated that drought losses average $200 million to $1.24 billion annually in the Great Plains. This range is based on crop losses and other direct and indirect losses. According to NOAA's National Climatic Data

Center, in 1999, a drought that affected twenty-eight Ohio counties caused $200 million in crop damages.

The Dust Bowl years of the 1930s and the drought of 1988–89 are both contenders for the worst drought on record in the United States. Economic losses are often hard to calculate and compare for a variety of reasons: lack of historical records and economic models, and past and present costs that are often based on different criteria. Today, many different types of losses are often included in an economic analysis, such as energy losses, ecosystem losses, and consumer purchasing losses, but they were not typically included in previous analyses and are difficult to assess in retrospect.

A 1975 study noted that the 1930s droughts were considered to be the most economically damaging droughts to affect the United States. It is estimated that total costs due to the 1988 drought, including losses in agriculture, energy, water, ecosystems, and other sectors of the economy, were roughly $39 billion, making it the most expensive natural disaster ever to affect the nation.

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

Drought does not pose a specific threat to state-owned or state-leased facilities. The larger threat from drought would be based on the agricultural and drinking water demands with a limited supply. Additionally, drought can play a major role in occurrences of wildfires throughout the state (Section 2.7).

2.12 SEVERE SUMMER STORMS

Severe summer storms traditionally precede an approaching cold air mass. In the northern hemisphere, the spin of the earth naturally produces weather patterns affecting North America, which travel from west to east across the continent. Key components to the formation of storms are a low pressure zone, high pressure zone and the jet stream.

The troposphere is the lowest portion of Earth's atmosphere containing approximately 75% of the atmosphere's mass and almost all of its water vapor. Air at this level is acted upon by the earth surface (land and water) and the heating cycle associated with sunlight. Unlike other portions of the atmosphere which are largely homogenous, at the surface discrete areas or bubbles exist of differing temperature, water vapor content and pressure. Warm areas (low pressure) tend to rise, pressing on the borders of surrounding cool areas (high pressure). It is where the pressure zones interface that temperature changes cause water vapor in the air to condense creating precipitation. The warmer the overall temperature of the atmosphere and the greater the volume of water vapor present, the larger the associated perception event.

Jet streams are fast flowing, relatively narrow air currents found in the atmosphere around 11 kilometers (36,000 ft) above the surface of the Earth. They form at the boundaries of adjacent air masses with significant differences in temperature, such as of the polar region and the warmer air toward the equator. These air currents migrate north and south in a snakelike pattern changing their relative location as the planet’s axis tilts with each passing year. These winds act on the high and low pressure zone moving them across the continent and shifting them north and south.

Thunderstorms develop when large differences exist between adjacent zones combined with significant water vapor. As warm air begins to lift, it eventually starts to cool and condensation takes place. When the moisture condenses, heat is released which further aids in the lifting process. If enough instability is present in the atmosphere, this process will continue long enough for cumulonimbus clouds to form, which supports lightning and thunder (see Diagram 2.12.a). As water droplets rise into the colder air, they can freeze. When the velocity of wind becomes great enough, the ice pellets are repeatedly lifted and dropped in the storm adding layers of ice with each cycle. Once the wind cannot support the weight of the ice pellet it falls the ground in the form of hail.

One key component to a thunderstorm is lightning, an atmospheric discharge of electricity. High speed videos (examined frame-by frame) show that most lightning strikes are made up of multiple individual strokes. A typical strike is made of 3 to 4 strokes. The sudden increase in pressure and temperature from lightning produces rapid expansion of the air surrounding and within a bolt of lightning. In turn, this expansion of air produces a sonic shock wave which produces the sound of thunder. Lightning, other storm components, often seeks a path though the tallest object available. Trees, utility line/poles, tall buildings and even humans can be sought as a pathway for the discharging electricity.

Summer storms are considered high wind events by the National Climactic Data Center when surface winds meet or exceed 50 knots or 57.6 miles per hour. It is possible for winds in strong storms to exceed 100 miles per hour, with gusts even stronger.

Source: Wikipedia http://en.wikipedia.org/wiki/Thunderstorm

Figure 2.12.a

Hurricane IKE Inland Effects in Ohio (September 2008 Windstorms)(FEMA DR-1805-OH)

The effects of Hurricane Ike in inland North America were unusually intense and included widespread damage across all or parts of eleven states, which included Ohio. The storm had rapidly become an extratropical cyclone and was enhanced by an adjacent frontal boundary and produced widespread winds with gusts to hurricane-force in several areas. The severe winds were reported across the Midwestern States, although little or no rain fell in many of those areas. They were as a result of a combination of factors, including the strength and size of Ike the location on the east side of the storm where the winds are usually stronger in a northward-moving system, its fast forward motion (approximately 40 miles per hour), and the warm air ahead of the storm. All of these factors most likely allowed the high winds aloft to reach the surface easier, resulting in areas reporting wind gusts nearing or topping hurricane force.

Ohio was hit extremely hard by the storm starting on September 14, 2008. The remnants of Ike caused a total of 2.6 million power outages in the state, including 370,000 outages in Columbus (Franklin County). Many of the citizens in Columbus were without power for 5 – 7 days, because many electric company workers were in Texas helping crews restore electricity to the millions who lost power from Hurricane Ike.

Wind gusts of over 75 miles per hour were recorded in Cincinnati (Hamilton County), Dayton (Montgomery County) and Columbus. Additionally, a State of Emergency was declared by Governor Strickland on September 15, 2008. On September 16th and 17th, the Governor took a tour of the heavily damaged areas, particularly in Cincinnati, Columbus and Dayton to survey the damage.

The Cincinnati metropolitan area was hit very hard, with approximately 2.1 million people losing power. A Duke Energy spokesperson said "We have never seen anything like this. Never. We're talking about 90 percent of our customers without power." September 15th through 17th, most of the schools in Hamilton and Butler Counties had classes cancelled because of power outages. In the Dayton, Ohio area 300,000 of 515,000 Dayton Power & Light Company's (DP&L) customers lost power following severe wind storms on the afternoon of September 14th, according to a company spokesperson. As of Thursday morning, September 18th, 90,000 DP&L customers remained without power. Also hit hard were central Ohio (over 350,000 customers losing power) and northeastern Ohio (over 310,000 customers losing power). A water emergency was also declared in Butler County as the water supply diminished due to the lack of power. A "Level 1 Emergency" was declared in the county to encourage people to remain at home. A curfew was implemented on September 17th in Carlisle (Warren County) due to increased looting as a result of the lengthy power outage.

Agricultural damage was severe, with as much as 20% of the state's total corn crop lost as a result of wind. Some fields were nearly flattened by the hurricane-force wind gusts. Tens of thousands of people also lost power in northwest Ohio, where widespread damage was reported, especially in the Lima (Allen County) and Findlay (Hancock County) areas. Some of the most significant damage in these communities included a radio tower that collapsed and a church that was heavily damaged.

RISK ASSESSMENT

Location

Severe summer storms and associated high wind / hail events are common throughout Ohio and reported hundreds of times each year. Analysis of the number of reported occurrences from 1997 to 2007 by the NCDC shows a clear concentration in north-central and northeast Ohio (Map 2.12.a). The five counties with the highest number of reported occurrences (150 – 200 over ten years) are Richland, Lorain, Cuyahoga, Summit and Stark Counties (all in Region 2). Conversely, a concentrated area of low reported occurrences (0 – 49 over ten years) exists in south-central Ohio, with most in Region 3.

Map 2.12.a

State of Ohio Summer Storm and Hail 1997 - 2007 Events

Number of Events

- 0 - 49
- 50 - 99
- 100 - 149
- 150 - 200

"NCDC Storm Data" is an official publication of the National Oceanic and Atmospheric Administration (NOAA) which documents the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce.

Data shown on this map were developed from 2008 NCDC climatological data, which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

Over one half of the counties in Ohio have between 50 and 99 reported summer storm events over the course of 10 years. These counties are predominantly in the western and central portions of the state. Based on the dispersion pattern generated, it can be reasonably concluded the number of summer storm events in Ohio is influenced by the proximity to Lake Erie.

FEMA-1805-DR, Ohio
Disaster Declaration as of 10/24/2008

Map 2.12.b

Statewide High Winds – September 2008 (FEMA DR-1805-OH).

Usually, tropical storms and hurricanes directly affecting other states result in extended rainfall in Ohio. NOAA Operational Significant Event Imagery shows that the windstorms of 2008 were a legacy from Hurricane IKE, which arced clockwise from the Gulf of Mexico to the western basin of Lake Erie and the Saint Lawrence Seaway. Ohio was affected from Hamilton County in southwest Ohio to the northeastern counties of Ashland, Carroll and Summit. Unlike other secondary effects of a diminishing hurricane, high winds in excess of 65 miles per hour were primarily the cause of damage for many counties, causing power outages across these portions of the state. It was reported that winds equal to a Category 1 hurricane (winds up to 74 miles per hour) caused at least $1.255 billion in insured losses.

FEMA-4002-DR, Ohio
Disaster Declaration as of 07/13/2011

<u>Severe Storms,Flooding and Landslides – April through May 2011 (FEMA DR-4002-OH).</u>

The impact of this event was widespread and costly due to the prolonged and record-setting spring rainfall during the months of March, April and May. According to the National Weather Service (NWS), a persistent upper valley weather channel over the eastern U.S. led to an active storm track over the Ohio Valley. During the month of April and into mid-May, the local NWS offices serving Ohio issued flood watches, flood warnings, flash flood watches and advisories and/or special weather statements for the Ohio River Watershed and Drainage Basin for 31 of the 44 days. Eighty-one percent of the watches, warnings and advisories were issued directly for the impacted counties, however,

all of the counties had high stream levels on their watersheds. Also during this time period, there were road closures almost every day due to flooding and/or high water. A notable incident was a small plane crashed near Ravenna, Ohio with three injuries due to saturated soil absorbing much of the impact. According to the Highway Patrol, had it not been for soft, soaked earth and mud, all three on board would have perished upon impact. Other incidents included 7,630 customers in power outages, trees uprooted, parts of buildings sustaining moderate damage and the loss of a countywide 911 system. As a result, the 21 affected Ohio counties received $44,506,071 in public assistance funds.

FEMA-4077-DR, Ohio Disaster Declaration as of 09/20/2012

<u>Severe Storms and Straight Line Winds – June 2012 (FEMA DR-4077-OH).</u>

An anomalously strong storm ridge centered across the Southeast and brought record heat to the Upper Ohio Valley with the area in a flow on the northern edge of the ridge. A weak frontal boundary extended from northern Indiana into western Pennsylvania. Abundant moisture, strong instability, moderate shear, and a short wave just south of the boundary provided the ingredients for a long-

tracked mesoscale convective system, classified by the Storm Prediction Center as a derecho, to track all the way from northern Indiana across eastern Ohio, southwestern Pennsylvania, northern WV, and western Maryland. As the system crossed the area, widespread wind damage was reported across areas primarily south and west of Pittsburgh. There were several reports of structural damage and damage led to a fatality when a barn collapsed in Muskingum county. Power outages were widespread with up to 130,000 outages reported immediately after the storms passage, most of which, were in Ohio. Muskingum and Guernsey counties sustained $712,000 and $500,000 in damages respectively. This also became one of the costliest disasters to hit Ohio, right behind Hurricane Ike in 2008. Two fatalities and eight injuries occurred during this event with $40,440,000 in property damage and $105,000 in damage to crops. As a result, of this event, 37 affected Ohio counties received $22,538,519 in public assistance funds.

FEMA-4098-DR, Ohio Disaster Declaration as of 01/03/2013

<u>Hurricane SANDY – October 2012 (FEMA DR-4098-OH).</u>

On October 29, 2012, Hurricane Sandy made landfall near Atlantic City, New Jersey, however, the storm continued to produce significant wind, storm surge, rainfall and inland-flooding hazards across the Northeastern United States. High

wind warnings as well as flood and flash flood watches and warnings for portions of Ohio and Indiana. The National Weather Service reported winds up to 80 miles per hour during the height of the storm system. First Energy Nuclear Operating Company reported sirens without AC power near Perry Nuclear Power Plant (Lake County-15 sirens, Geauga County-1 siren, Ashtabula-1siren) and Beaver Valley Power Station (Beaver County, PA-1siren). In Cuyahoga County, 80 people with functional needs were evacuated to a high school in Cleveland Heights, while another 11 shelters were being opened. The storm delivered a blow to Ashtabula County, but it wasn't the big uppercut some people had feared. As expected, strong wind toppled trees and dropped power lines, causing power outages across the county. Incessant rain toppled trees and flooded some thoroughfares in the area. Some of the hardest-hit areas were along the lakeshore, including Conneaut, North Kingsville, and Saybrook Township. Outages were reported in every city, village and township in the county, according to Illuminating Company information. Trees and limbs that collapsed on power lines were a big culprit, officials said. Lake County had residents from 142 homes near the mouth of the Chagrin River evacuated to the Mentor Community Center with another 70 evacuated to a shelter in Painesville. First Energy reported 55,516 customers without power in northeast Ohio. No fatalities were reported, however there was one injury that occurred. Property damage was estimated at $55,234,000 with no damage to crops. As a result, of this event, 37 affected Ohio counties received $17,810,815 in public assistance funds.

Past Occurrences

In 2003 the largest recorded event caused $145,000,000 in hail damage to the central Ohio counties of Franklin and Delaware. The area impacted is urbanized with a large number of high valued residences. The largest single-county event recorded occurred in 2006 with $100,000,000 in estimated property damage in Licking County. Hail stones 1.75 inches in diameter damaged many homes and vehicles during a 15-minute period. In a similar event the Montgomery County, the City of Huber Heights experienced $70,000.000 in damages in 2001. Of the varied forces involved in summer storms, hail has been the most destructive.

High wind events are more destructive from the perspective of transportation and utilities. Although the dollar value of the most destructive wind event is reported at $750,000 (Erie County), power outages and disabled telephone lines that accompany the inaccessibility of emergency services creates potentially life threatening situations.

<u>Hurricanes and tropical storms.</u>

Not much detail can be found without extensive research about hurricanes and tropical storms significantly affecting Ohio. However, in September 2003, the effects of Hurricane ISABEL dropped light to moderate precipitation on the eastern half of Ohio with isolated areas reporting over 3 inches of rainfall. Tropical Storm BRET created 1 to 3 inches of rainfall in the extreme southwest

and southeast counties of the state. Again, only isolated areas received 3 inches of rain.

Probability of Future Events

The historical period used for severe summer storm analysis began with April 30, 1997 and closed April 30, 2007 based on statistics tabulated by the NCDC. During this period over 5,000 events are documented with over 15,000 documented since 1950. Based on available documented occurrences, severe summer storms are the most prevalent natural hazard events in Ohio.

From January 1997 to August 2007 Ohio has received 19 presidential declarations. Of the declared events, 16 specifically cite severe storms as part of the description. Additionally, the only year Ohio did not receive a federal declaration for a severe storm was 1999. Based on historical trends, Ohio can reasonably expect at least one storm every two years large enough to trigger a federal declaration, as well as numerous smaller events.

Hurricanes and tropical storms.

In the 208 years that Ohio has been a State, there has been only one hurricane or tropical storm resulting in a Presidential Declaration. Therefore, 1 event in 208 years is equivalent to 0.005% or one half of one percent of hurricane or tropical storm affecting Ohio, which is an extremely low probability of this type of event occurring in the future.

LHMP Data

Henry County. The county's updated Hazard Mitigation Plan states that one of the most notable storms was on March 19, 1947 when an event caused thousands of dollars of damage ($1,000 in 1947 is equal to nearly $11,000 today) in Deshler, Ohio. Streets were blocked with debris and downed power line poles and trees causing power outages and impeding traffic.

Another storm system affected the southern portion of the county in the villages Hamler, New Bavaria and Holgate on August 8, 1979. This storm caused over $20,000 in property damage, but no significant damage occurred to field crops.

Hail-producing storm systems occurred on September 25, 1994 caused $500,000 in property damage and $500,000 in crop damage due to 2-inch hail falling throughout the county.

Darke County. The 2011 Updated Hazard Mitigation Plan cites that there have been a total of 2 lightning events, 64 hail events, and 148 thunderstorm/wind events in Darke County from June 9, 1958 through December 31, 2010. Based on NCDC data, Darke County can expect at least four severe summer storm events each year along with smaller events. Some of the significant events are described in the following paragraphs.

On Friday, August 13, 1976, Thunderstorm and lightning that struck the Darke County Home Assisted Living Center, destroying the 1897 historic brick structure and causing over $1 million dollars in damages and leaving its 49 residents

homeless. Another event during that same day caused hundreds of thousands of dollars damage to the historic Darke County Tile Company built in 1878.

Thunderstorms caused $300,000 in property damages on November 7, 1996 near Ithaca, Ohio, with an estimate of $20,000 in crop damage. Trees were downed, barns were destroyed, roofs were blown off, and cornfields were severely damaged.

On May 12, 2002, severe thunderstorm winds struck south of Greenville. Mobile homes in the Sherwood Forest Mobile Home Park were severely damaged. A roof was blown off one home on Hogpath Road. Over $100,000 in property damage was reported.

Farifield County. The March 2011 Farifield County Natural Hazards Mitigation Plan references 189 severe thunderstorm events since 1950. During the period from January 2000 to August 2010, there were 71 thunderstorm wind incidents in Fairfield County according to NCDC. The County had as many as 36 severe thunderstorm warnings in a single year. The jurisdictions of the county have all been affected by these dangerous fast moving storms at one time or another. Property damage during this period was reported as $462,000.00 with crop damages listed as $3,000.00.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Severe summer storms ranked third for frequency when compared to all 15 hazards evaluated in this plan (Chart 2.2.a), and they ranked fifth in terms of magnitude. However, this hazard scored relatively low for all other factors, and was given an overall ranking of sixth. While this may seem low, it should be noted that severe summer storms can be associated with tornadoes or flooding, which were evaluated elsewhere in this plan. Both of these hazards ranked high for most factors evaluated in SHARPP, indicating significant threats from each. According to records and data entered to date into vulnerability assessments, losses from severe storms are estimated at 374,484 residential structures ($13,322,159,583), 20,236 non-residential structures ($3,718,335,490) and 960 critical facilities ($1,872,336,618). These and additional HIRA data queried from SHARPP can be found in Appendix J.

VULNERABILITY ANALYSIS AND LOSS ESTIMATION

Methodology

During data development for the thunderstorm/high wind and hail hazard, it quickly became apparent the two must be addressed separately. Hail events, as stated earlier, are far more costly and have a much greater financial impact in urbanized areas. Events of the same magnitude can create $10,000,000 worth of damage in an urban setting, or as little $50,000 in forested or agricultural area. Of the 88 counties in Ohio, 22 percent reported no hail loss while two counties reported $100,000,000 or more.

The extreme range of the data for hail would skew any useful thunderstorm/high wind analysis. As a result, the vulnerability and loss estimate for summer storms

considers only thunderstorms/high wind events while hail is addressed at the state level.

The 10-year summer storm losses (1997 to 2007) for each county provided the basis for estimating potential vulnerability and losses. To yield the per capita 10-year damage total for each county, the total damage for the decade was divided by the 2001 population. That figure divided by ten, resulted in the annual per capita damage figure for severe summer storms in each county (in raw dollar unadjusted for inflation). This is the figure that appears in the column on the right.

Statewide High Winds – September 2008 (FEMA DR-1805-OH).

Following this event, the Ohio Insurance Institute (OII) conducted a windstorm loss survey in which 24 property and casualty companies participated. This represented:

- 68% of Ohio's personal auto insurance market
- 72% of the homeowners' market
- 33% of the state's commercial lines market based on 2007 Ohio premium volume

Results of the survey were reported on September 11, 2009.

Results

With an annual summer storm loss figure of $1.67 per capita, based on the population of 11,381,725, Ohio can expect an annual statewide summer storm loss of approximately $19,007,481 any given year. The 10-year loss includes all residential, commercial, governmental structures, as well as infrastructure and public facilities for each county. Table 2.12.a shows severe summer weather per capita loss.

Table 2.12.a

Estimate of Potential Losses to Summer Storms by Region

Region 1

County	2001 Pop.	10-Year Cumulative Summer Storm Losses	Per-Capita Annual Summer Storm Losses
Allen	108,522	$2,307,000	$2.13
Auglaize	46,453	$231,000	$0.50
Champaign	39,210	$333,000	$0.85
Clark	143,969	$380,000	$0.26
Clinton	41,277	$1,614,000	$3.91
Crawford	46,695	$2,386,000	$5.11
Darke	53,178	$482,000	$0.91
Defiance	39,195	$218,000	$0.56
Erie	79,321	$3,637,000	$4.59
Fayette	28,387	$291,000	$1.03
Fulton	42,334	$355,000	$0.84
Hancock	71,745	$1,250,000	$1.74
Hardin	31,945	$287,000	$0.90
Henry	29,090	$99,000	$0.34
Huron	59,775	$3,235,000	$5.41
Logan	46,115	$241,000	$0.52
Lucas	454,029	$1,969,000	$0.43
Madison	40,158	$224,000	$0.56
Marion	65,639	$1,474,000	$2.25
Mercer	40,886	$287,000	$0.70
Miami	99,329	$308,000	$0.31
Morrow	32,319	$920,000	$2.85
Ottawa	41,036	$5,708,000	$13.91
Paulding	20,163	$397,000	$1.97
Preble	42,344	$310,000	$0.73
Putnam	34,741	$1,138,000	$3.28
Sandusky	61,653	$5,538,000	$8.98
Seneca	58,314	$2,079,000	$3.57
Shelby	48,233	$523,000	$1.08
Union	40,909	$328,000	$0.80
Van Wert	29,432	$503,000	$1.71
Williams	39,200	$167,000	$0.43
Wood	121,680	$9,263,000	$7.61
Wyandot	22,956	$966,000	$4.21
TOTAL	**2,200,232**	**$49,448,000**	**$2.25**

Region 2

County	2001 Pop.	10-Year Cumulative Summer Storm Losses	Per-Capita Annual Summer Storm Losses
Ashland	52,786	$2,476,000	$4.69
Ashtabula	102,729	$2,331,000	$2.27
Butler	335,992	$418,000	$0.12
Cuyahoga	1,384,252	$5,735,000	$0.41
Delaware	118,215	$367,000	$0.31
Fairfield	125,109	$479,000	$0.38
Franklin	1,081,784	$915,000	$0.08
Geauga	92,294	$1,735,000	$1.88
Greene	148,530	$377,000	$0.25
Hamilton	838,134	$1,240,000	$0.15
Knox	55,250	$2,663,000	$4.82
Lake	227,324	$1,827,000	$0.80
Licking	149,080	$476,000	$0.32
Lorain	285,798	$4,698,000	$1.64
Mahoning	254,810	$1,467,000	$0.58
Medina	154,718	$2,864,000	$1.85
Montgomery	553,579	$671,000	$0.12
Pickaway	52,840	$396,000	$0.75
Portage	153,056	$4,405,000	$2.88
Richland	128,549	$2,741,000	$2.13
Stark	378,098	$6,215,000	$1.64
Summitt	542,899	$3,734,000	$0.69
Trumbull	223,513	$2,432,000	$1.09
Warren	168,229	$5,035,000	$2.99
Wayne	112,274	$2,759,000	$2.46
TOTAL	**7,564,327**	**$53,649,000**	**$0.71**

Region 3

County	2001 Pop.	10-Year Cumulative Summer Storm Losses	Per-Capita Annual Summer Storm Losses
Adams	27,225	$768,000	$2.82
Athens	62,792	$324,000	$0.52
Belmont	69,605	$539,000	$0.77
Brown	43,425	$453,000	$1.04
Carroll	29,011	$406,000	$1.40
Clermont	180,970	$1,181,000	$0.65
Columbiana	111,684	$790,000	$0.71
Coshocton	36,803	$289,000	$0.79
Gallia	30,929	$149,000	$0.48
Guernsey	40,899	$849,000	$2.08
Harrison	15,813	$370,000	$2.34
Highland	40,875	$300,000	$0.73
Hocking	28,241	$265,000	$0.94
Holmes	39,539	$2,174,000	$5.50
Jackson	32,743	$567,000	$1.73
Jefferson	72,705	$645,000	$0.89
Lawrence	62,017	$202,000	$0.33
Meigs	22,920	$85,000	$0.37
Monroe	15,141	$212,000	$1.40
Morgan	14,961	$48,000	$0.32
Muskingum	84,783	$461,000	$0.54
Noble	14,052	$214,000	$1.52
Perry	34,212	$254,000	$0.74
Pike	27,982	$137,000	$0.49
Ross	73,437	$424,000	$0.58
Scioto	78,428	$271,000	$0.35
Tuscarawas	91,521	$838,000	$0.92
Vinton	12,953	$68,000	$0.52
Washington	62,798	$1,321,000	$2.10
TOTAL	**1,458,464**	**$14,604,000**	**$1.00**

The total 10-year cumulative summer storm loss for Region 1 is $49,448,000, and an annual per-capita loss of $2.25, which is the highest in the state. Within the Region, Ottawa and Sandusky Counties have historically had the highest 10-year loss each exceeding $5,000,000 affecting approximately 102,689 people. Henry County historically had the lowest 10-year loss at $99,000 affecting 29,090 people.

Region 2 has the highest 10-year cumulative summer storm loss in the state at a total of $53,649,000. However, this is the most populous Region in the state, and exhibits the lowest annual per-capita loss of $0.71. Within the Region, Geauga County has historically had the highest 10-year per-capita loss of $1.88 (Table 2.12.a). Franklin County has historically had the lowest 10-year per-capita loss at $0.08, but has the second highest population in the state.

Region 3 has a 10-year cumulative summer storm loss of $14,604,000, which has affected a population of approximately 1,458,464 persons (annual per-capita of $1.00). Holmes County has had experienced the highest 10-year loss at a total of $2,174,000 affecting approximately 39,539 persons (Table 2.12.a). Morgan County has had the least 10-year loss to summer storms at $48,000, which affected approximately 14,963 persons (Table 2.12.a).

Hail events cannot be assessed by county; however, historical trends indicate Ohio will experience hail storms generating $25,000,000 or more of damages once in a two year period. Predominantly rural areas range from no reported losses in 19 counties to a high of $975,000 in Gallia County. The highly sporadic nature of hail events makes county-to-county comparisons misleading. With 2,491 hail events and $463,571,600 in damages over the analysis period, the mean event would cost $186,062. However, the usefulness of such a statistic is highly debatable, as it is provided for illustration only.

Property damage is not the only loss associated with summer storms and hail. Over the analysis period 13 deaths and 98 injuries were attributed to these events. Of the injuries reported, 20 are attributed to a single event in Franklin County which involved a campground.

Statewide High Winds – September 2008 (FEMA DR-1805-OH).

The OII survey concluded Ohio's insured losses totaled $1.255 billion and government costs for protection and clean-up were $38.6 million. Insurance companies reported a record-high number of claims filed across the state. At least 270,000 were filed in Ohio, including 220,000 homeowners, 30,000 commercial and 20,000 auto insurance claims.

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

Since severe summer storms are non-spatial hazards and have the potential to affect all state-owned structures, the determination was made to assess total replacement costs for the two categories of state-owned facilities (critical and non-critical). Additionally, many state-government facilities are leased, and the

replacement costs associated with these structures are based on the annual rental fees. Supplemental information for these state datasets can be found in section 2.1 of this plan. All facility numbers and at-risk dollars referenced in this section are listed by county in Appendix C. Maps C-1 and C-2 show the at-risk values for state-owned and state-leased critical facilities, and these maps are located in Appendix C.

Tables 2.1.a – 2.1.c list state-owned critical and non-critical facility numbers and replacement values within each county. Currently, there are a total of 4,456 state-owned facilities (2,343 critical and 2,113 non-critical) throughout Ohio worth an estimated $4.3 billion. For Region 1 there are 906 critical and 635 non-critical worth approximately $845 million and $354 million, respectively. The county with the largest dollar exposure of state-owned facilities is Marion with $421,369,273, mostly related to a large correctional facility. Marion County also has the highest dollar exposure of critical facilities at $368 million.

Presently, there are a total of 1,709 (900 critical and 809 non-critical) state-owned facilities in Region 2, worth an estimated $2.4 billion. The estimated worth for the critical facilities is over $1.5 billion, and non-critical is over $930 million. As would be expected, Franklin County, which contains the state capital, represents the majority of the dollar value with $994 million in state-owned facilities that include 99 critical in nature, worth approximately $675.5 million.

The lowest total number (1,206) of state-owned facilities is located in Region 3, representing over $633 million. The estimated worth for critical facilities is nearly one-fifth of that in Region 2 ($389 million), and $273 million in non-critical facilities. Ross County accounts for nearly one third of the dollars at risk ($137 million) in the entire Region, which is mainly due to a large correctional facility.

Tables 2.1.d – 2.1.f list state-leased critical and non-critical facility numbers and their respective annual rental costs within each county. Currently, there is a total of 296 state facilities that are leased annually, of which 30 are critical to response and recovery following a disaster. For Region 1, there are three critical and 39 non-critical with approximately $654,528 and $2,851,641 in annual rent, respectively. Region 2 has 24 critical and 168 non-critical leases with annual rental costs of $7,841,431 and $43,721,216, respectively. In Region 3 numbers are similar to those in Region 1 with three state-leased critical facilities ($476,832) and 59 state-leased non-critical facilities ($3,063,305).

<u>Statewide High Winds – September 2008 (FEMA DR-1805-OH).</u>

An Ohio Department of Jobs and Family Services structure was damaged at the Fifth Avenue facility in Columbus (Franklin County). Additionally, due to power and telecommunication issues, some facilities had trouble coordinating through traditional means. The Ohio Department of Transportation reported 46 state roads and hundreds of local roads were impacted by debris. Power outages and physical damage to traffic signal systems also were caused by the storm. At the storm's peak, 490 state-controlled traffic systems were non-functional with tens of thousands locally-controlled systems without power.

2.13 INVASIVE SPECIES

According to the ODNR, Division of Wildlife, of the approximately 3,000 species of plants known to occur in Ohio, about 75 percent are native or have occurred in Ohio before the time of substantial European settlement, which was about 1750. The other 25 percent is not native to Ohio, having been introduced from other states or countries.

Most of these species never stray far from where they are introduced (gardens, urban areas, agricultural fields), yet some become very invasive and displace native plants in woodlands, wetlands, prairies, and other natural areas. Non-native plants have been introduced for erosion control, horticulture, forage crops, medicinal use, and wildlife foods as well as by accident. The top 10 species invading Ohio are:

1. Bush Honeysuckle
2. Autumn Olive
3. Buckthorn
4. Common Reed
5. Garlic Mustard
6. Japanese Honeysuckle
7. Japanese Knotweed
8. Multiflora Rose
9. Purple Loosestrife
10. Reed Canary Grass

Without natural predators or controls, invasive, non-native plants are able to spread quickly and force out native plants. In Ohio, several non-native plants are invading woodlands and displacing native spring wildflowers. Other non-native plants are impacting our wetlands by creating monocultures. Native plant diversity is important for wildlife habitat, as many animals depend on a variety of native plants for food and cover.

According to the Aquatic Nuisance Species Task Force, which is a nationwide cooperative effort between many federal departments, the species listed below are a few of the many aquatic nuisance species that are potentially harmful to North American environments in which they are not native. (* not currently in Ohio)

1. Zebra Mussel
2. Ruffe
3. Chinese Mitten Crab
4. European Green Crab
5. Brown Tree Snake*
6. Eurasian Water Milfoil
7. New Zealand Mudsnail
8. Asian Swamp Eel*
9. Lionfish*
10. Round Goby
11. Sea Lamprey
12. Snakehead
13. Nutria*
14. Hydrilla
15. Applesnail
16. Water Hyacinth
17. Rusty Crayfish
18. Giant Salvinia

Lastly, according to the ODNR, Division of Forestry one of the most invasive insect species in Ohio is the Emerald Ash Borer. This Asian pest is part of a group of insects known as metallic wood-boring beetles. Emerald Ash Borer affects all species of native ash found in Ohio. Because North American ash trees did not coexist in association with this pest, they have little or no resistance to its attack. This ash tree-killing insect from Asia was unintentionally introduced to southeastern Michigan several years ago. In February of 2003, it was first found feeding on ash trees in northwest Ohio.

Emerald Ash Borer larvae feed on the living portion of the tree, directly beneath the bark. This eating habit restricts the tree's ability to move essential water and nutrients throughout the plant. In three to five years, even the healthiest tree is unable to survive an attack.

RISK ASSESSMENT

Location

The area invaded by each plant species varies based on its preferred environment. Those with the fewest limitations have spread to nearly every county in Ohio. Following is a description of each plant from the ODNR, Division of Natural Areas and Preserves along with a map of known impacted counties from The Nature Conservancy.

Bush Honeysuckle
Lonicera Morrowii Displayed

Found in 47 out of Ohio's 88 counties. Its range is shown here in yellow.

Autumn Olive

Found in 34 out of Ohio's 88 counties. Its range is shown here in yellow.

Source: The Nature Conservancy

Bush Honeysuckles consist of a number of upright shrubs which can grow 6-15 feet in height. Each has dark green, egg-shaped leaves. The tubular flowers are white on the Amur and the Morrow (changing to yellow with age), and pink on the Tatarian. Berries range from red to orange, occasionally yellow, and are eaten and dispersed by birds.

Habitat: The bush honeysuckles inhabit abandoned fields, roadsides, woodlands, and edges of marshes. Morrow is currently a problem in northern Ohio; Amur is found mostly in southwestern Ohio; and Tatarian is widespread in Ohio.

Management: The best control method is to cut and treat stumps with systemic herbicide. Sprouts from cut stems may be treated with a foliar application of systemic herbicide. Young shrubs are easy to pull or dig up. Be aware there is a native bush honeysuckle in Ohio (Diervilla lonicera).

Autumn-Olive is a fast-growing shrub or small tree reaching up to 20 feet tall. Its leaves are small and oval, dark green on the upper surface and silvery below. Small coppery dots occur on stems and leaves. This shrub has light yellow, aromatic flowers and produces large quantities of small, round red fruits that are readily eaten and spread by birds.

Habitat: Autumn-olive can survive in very poor soils because of its nitrogen-fixing root nodules. It grows in disturbed areas, roadsides, pastures, and fields throughout Ohio.

Management: Stems may be cut and treated with systemic herbicide. Resprouting will occur, so follow-up control is necessary. A combination of hand-pulling, digging and herbicide treatments is usually necessary.

Buckthorn
Rhamnus Frangula Displayed

Found in 30 out of Ohio's 88 counties. Its range is shown here in yellow.

Common Reed

Found in 43 out of Ohio's 88 counties. Its range is shown here in yellow.

Source: The Nature Conservancy

Buckthorns are tall shrubs or small trees that grow up to 20 feet tall. The smooth, gray to brown bark is distinctively spotted. Glossy buckthorn has shiny leaves with smooth edges. It has solitary red to purple berry-like fruits. Common buckthorn has black fruits and dull green smooth leaves. Both species are abundant seed producers.

Habitat: Glossy buckthorn usually occurs in wetlands, such as fens or bogs, but it is also found in forests, fencerows, edges, prairies, and old fields. Common buckthorn occurs in a range of upland habitats, such as forests, woodland edges, fencerows, prairies, and old fields. Both species are most prevalent in central and northern Ohio.

Management: Cutting and treating stumps with systemic herbicide is the best method of control. Buckthorns are very difficult to control due to vigorous resprouting and a large seedbank.

The Common Reed, or Phragmites, is a grass that reaches up to 15 feet in height. The leaves are smooth, stiff and wide with coarse hollow stems. The big, plume-like flower head is grayish-purple when in fruit. Common reed spreads mostly vegetatively forming huge colonies by sprouting new shoots through underground stems (rhizomes).

Habitat: Common reed grows in open wetland habitats and ditches primarily in northern Ohio. It occurs in still water areas of marshes, lake shores, riverbanks, and disturbed or polluted soils, often creating pure stands. Some populations are not invasive and may be native, however there is no reliable method to tell the two apart.

Management: Long-term management is necessary for control of this persistent plant. Cutting and/or treating stems with systemic herbicides is generally the most effective, grass-specific herbicides are recommended in areas where native plants occur.

Garlic Mustard

Found in 69 out of Ohio's 88 counties. Its range is shown here in yellow.

Japanese Honeysuckle

Found in 66 out of Ohio's 88 counties. Its range is shown here in yellow.

Source: The Nature Conservancy

Garlic Mustard is a biennial herb. It begins as a rosette of leaves in the first year, overwinters as a green rosette of leaves, flowers and fruits in the second year, and then dies. First-year rosettes consist of kidney-shaped, garlic-smelling leaves; the second-year plant grows a stem up to four feet tall with triangular, sharply-toothed leaves. The small, four-petaled flowers are white and grow in clusters at the top of the stem. Garlic mustard produces large quantities of seeds which can remain viable for seven years or more.

Habitat: This woodland plant prefers some shade but is occasionally found in full sun. It invades upland and floodplain forests, savannas, yards, streams, trails, and roadsides throughout Ohio.

Management: Repeated prescribed burns in oak forests may be effective. Light infestations of garlic mustard can be hand pulled before or at flowering time. Plants should be removed from the site after pulling, as the seeds may continue to mature. Systemic herbicides can be applied to the rosettes in early spring or late fall.

Japanese Honeysuckle is a woody semi-evergreen vine with opposite, oval leaves. The flowers grow in pairs, are white to yellow, and very fragrant. Fruits, also in pairs, are purple to black berries. This vine climbs and drapes over native vegetation, forming dense patches.

Habitat: Japanese Honeysuckle thrives in disturbed habitats, such as roadsides, trails, fencerows, abandoned fields, and forest edges primarily in southern Ohio. Disturbances such as logging, road building, floods, and windstorms create an opportunity for this vine to invade native plant communities.

Management: Burning in combination with systemic herbicide application may be an effective control method. Herbicides can be applied to the leaves when native plants are dormant. Be aware there are native climbing honeysuckles in Ohio, such as Lonicera Dioica.

Japanese Knotweed is a shrub-like herb that grows up to 10 feet tall. Stems are smooth and the pointed leaves vary from broadly oval to almost triangular. Flowers are greenish-white and very small. The seeds are dispersed by wind. Once established, the plants spread by a system of underground stems reaching 60 feet.

Habitat: Japanese Knotweed can grow in a wide variety of habitats. It is found in open areas, such as roadsides, streambanks, and woodland edges, primarily in eastern Ohio. It spreads quickly and forms dense thickets.

Management: Knotweed is very difficult to control. Leaves may be sprayed or stems cut and treated with systemic herbicide.

Reed Canary Grass reaches 2-5 feet tall. The hairless stems gradually taper to flat and rough leaf blades 3-10 inches long. The flowers occur in dense clusters and are green to purple, changing to beige and becoming more open over time. The plant spreads aggressively both by seed and by forming a thick system of underground stems (rhizomes).

Habitat: This grass occurs in wetlands, such as marshes, wet prairies, meadows, fens, stream banks, and seasonally wet areas throughout Ohio. Reed Canary Grass has been planted widely for forage and erosion control. Native strains possibly occur, however introduced strains are thought to be more invasive. There is no reliable method to tell the two strains apart.

Management: A combination of burning or mowing with systemic herbicides is the best method of control; grass-specific herbicides applied with wick applicators are recommended in areas where native plants occur.

Multiflora Rose is a dense spreading shrub with widely arching canes and stiff, curved thorns. This shrub grows up to 15 feet tall with alternate, compound leaves of seven to nine oval leaflets. Multiflora Rose has numerous white flowers that produce clusters of small, red fruits. The fruits (called hips) are eaten by birds and mammals which help disperse the seeds. An individual plant can produce up to 500,000 seeds per year!

Multiflora Rose

Found in 78 out of Ohio's 88 counties. Its range is shown here in yellow.

Source: The Nature Conservancy

Habitat: Multiflora rose was formerly planted as a "living fence" to control livestock, stabilize soil and create barriers for roadways. It has also been planted as a wildlife cover and food source. This rose occurs in a wide range of habitats throughout Ohio but prefers sunny areas with well-drained soils.

Management: A long-term management program of mowing or cutting and treating stems with systemic herbicide several times during the growing season is recommended. Digging or hand-pulling small shrubs may also be effective.

Purple Loosestrife

Found in 51 out of Ohio's 88 counties. Its range is shown here in yellow.

Source: The Nature Conservancy

Purple Loostrife grows 3-7 feet tall and has a dense bushy growth of 1-50 stems. Long spikes of flowers are purple to magenta; linear-shaped leaves grow opposite along the square stems. Purple Loosestrife spreads aggressively by underground stems (rhizomes) and can produce as many as a million seeds per plant. Supposedly sterile strains of L. virgatum will outcross with this plant and produce seeds.

Habitat: Purple Loosestrife grows in a variety of wetland habitats including marshes, river banks, ditches, wet meadows, and edges of water bodies, primarily in northern Ohio. Loosestrife can invade both natural and disturbed wetlands, replacing native vegetation

with nearly pure stands of Loosestrife.

Management: Small stands of Purple Loosestrife can be controlled by hand-pulling, digging, or applying systemic herbicides to the foliage. Herbicides may be used to control large populations. Biological controls using insects are being researched in Ohio and other states and may be helpful in reducing infestations.

Of the 18 aquatic invasive species noted at the national level there are three the Ohio Department of Natural Resources specifically notes: the Round Goby, Eurasian Ruffe and Zebra Mussel. The Round Goby and Eurasian Ruffe are species of fish which have proven in all Great Lakes region to rapidly increase in numbers and some have seen a decrease in native fish populations. Exact counts and range of impacted waters are difficult to determine. Often sport fishermen are the first to confirm their presence. The Zebra Mussel is a mollusk found throughout Lake Erie and in a few inland lakes that will attach to any unprotected surface which may include native clams. All three species pose the greatest threat to Lake Erie with the potential of moving inland. The counties immediately impacted are Lucas, Ottawa, Sandusky, Erie, Lorain, Cuyahoga, Lake and Ashtabula.

The Emerald Ash Borer is currently found in 50 of Ohio's 88 counties, six neighboring states and the province of Ontario. From its initial detecting in Northwest Ohio the insect has spread south to the Ohio River in the south and Pennsylvania in the East. One of the greatest problems increasing the spread of the insects is the transport of infected firewood. Quarantine areas have been established making the transport of firewood across county lines illegal. As of September 8, 2010, all 88 counties in the state comprise Ohio's quarantine area.

LHMP Data

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Invasive species ranked 13th for frequency when compared to all 15 hazards evaluated in

this plan (Chart 2.2.a), and it ranked last for onset. However, this hazard scored high for response duration, with several respondents indicated response would take more than one month. For the remaining factors, this hazard scored in the bottom four hazards, and had a final ranking of 12th out of the 15 hazards evaluated. These and additional HIRA data queried from SHARPP can be found in Appendix J.

Past Occurrences

Invasive species of plants, fish and insects have been arriving in Ohio since the establishment of European settlers in the 1750s. With each improvement in the scale and speed of human transportation, the potential for unintended introduction of invasive species has increased. Organisms which could not survive the month-long journey from Europe or Africa to America can make the journey in a matter of hours today. Several examples of species introduction pathways follow:

The Round Goby species was introduced from Eurasia into the St. Clair River and vicinity on the Michigan-Ontario border where several collections were made in 1990 on both the U.S. and the Canadian side. Speculation exists the Goby was transported from its native Caspian Sea by way of ballast tanks on ocean going vessels. Today the Goby is found in all the Great Lakes and is making inroads in all contiguous state watersheds.

The Multiflora Rose was introduced to the U.S. from Japan in 1886 as an under-stock for ornamental roses. Birds are responsible for spreading the seeds, which remain viable for a number of years. In the 1930s, the Soil Conservation Services advocated the use of Multiflora Rose for erosion projects and as a way to confine livestock. Hedges of Multiflora Rose have also been used as a crash barrier and to reduce headlight glare in highway medians.

The Emerald Ash Borer was introduced into North America sometime in the 1990's. The insect is believed to have been introduced into the U.S. in wood packing material from China. It was first reported killing ash trees in the Detroit and Windsor areas in 2002. Only species of ash are hosts for the beetle, which usually kill infested trees within a couple of years. Since then, infestations have been found throughout Lower Michigan, Ohio, northern Indiana, the Chicago area, Maryland and recently in Pennsylvania.

Considering the thousands of plant, dozens of aquatic and unknown number of insect species introduced into Ohio over the past 250 years samples of the most often cited transfer media are provided here. Exotic species can arrive by a nearly endless number of vectors making a complete listing impossible.

Probability of Future Events

Since the beginning of European colonization non-native species have been arriving in Ohio. With the increase in global trade and travel the probability of new and unexpected species arriving in Ohio will continue to grow. Legislation is in place around the world in an attempt to control the migration of unwanted

species between ecosystems. The ODNR is currently battling the entrance of wild boars from Kentucky and West Virginia. In addition, there are several species of carp currently migrating up the Mississippi watershed from the Gulf Coast. Although not currently reported in any Ohio waterways, the probability of future infestations is near certain.

It is certain that new wanted and unwanted species will arrive in Ohio. The importance of controlling the integrity of existing ecosystems will require ongoing state, national and international efforts to avoid unwanted infestations.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

Impacts of invasive species tend to have commercial operational impacts, as opposed to many built environment impacts of the other hazards covered. Due to this unique situation, rather than a matrix listing county losses, the loss estimates will be presented using historical response costs to predict future losses in unadjusted dollars.

Results

From the perspective of invasive plant species the Multiflora Rose is one of most expensive to combat in Ohio. Each individual plant's ability to produce 500,000 seeds a year allows this invasive species to spread over large area with incredible speed. Agricultural groups are facing the highest exposure and expense in the form of infiltration of crop lands and eradication programs. According to agricultural experts associated with The Ohio State University, Ohioans are estimated to spend millions of dollars combating the Multiflora Rose. Precise dollar figures are not available due to the majority of response activities being performed by non-governmental entities.

Four known methods of responding to the species exist. First, the removal of the plant as a whole, including the roots, can be cost effective in small applications. Second, repeated defoliation or mowing down the plants will eventually kill almost any plant. Third, the use of herbicides can be effective if applied at specific stages of the plant's growth. All of the above management techniques can be expensive and labor intensive. The last method is the use of Rose Rosette Disease, a mite-vectored virus, which is giving rise to a hope for a lower cost control agent.

Turning to invasive aquatic species, the Zebra Mussel is one of the most expensive to control. The mussels naturally collect on any solid surface and create significant problems for drinking water processing facilities and utilities. All in-water structures are impacted including, but not limited to, piers, breakwalls, vessel hulls and vessel engines cooled with external water. Estimates for controlling infestations run between $2 and $10 million per year depending on how many sources are aggregated. Should the Zebra Mussel

effectively invade the river systems of Ohio, it is suggested the annual control costs could rise 10-fold.

Invasive insect species are both the direct source of damage to trees and a vector for other parasites. In the last century the North American population of Elm trees was decimated by a fungus which arrived on infected trees shipped to an Ohio furniture company. One of the primary transport methods is though beetles which the fungus uses as a host to move from tree to tree. The beetle's ability to fly exponentially increased the number of trees impacted. Trees located in non-urban areas posed financial impact only to loggers; however, the Elm was a popular urban tree and the cost to remove them ran into the millions over the years.

The Emerald Ash Borer, which is currently impacting the North American Ash tree, has already cost millions of dollars in attempts to identify and isolate infected trees. In Ohio alone there are an estimated 5 billion Ash trees at risk. Although many research centers are searching for an effective means of combating the insect, the only method currently available is the use of insecticides which have to be applied annually. The un-captured cost to treat Ash trees in Ohio will likely reach into the millions, as urban areas combat the insect.

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

Similar to drought in Section 2.11, invasive species have very limited impact on state-owned or state-leased facilities. The most prominent impact to state facilities relates to the maintenance of marinas in Zebra Mussel impacted areas. These mussels can clog inlets that could affect facilities, but not in the same manner as many of the other hazards. Also, Emerald Ash Borer could result in significant increases in fuel for wildfires in Region 3, which could adversely affect state facilities.

2.14 LAND SUBSIDENCE

Subsidence is motion of the Earth's surface as it shifts downward relative to a benchmark (often sea-level) of the surrounding terrain. There are a number of causes for this effect. In Ohio the two primary causes are abandoned underground mines (AUMs) and karst.

Underground mining of coal began in the early 1800's and continues to current day. In the 1900's underground salt, limestone and gypsum mining began. Most mining is accomplished by direct human action utilizing heavy machinery to remove the material; however, with salt there are cases where pressurized water is used to wash-out the deposit (solution mining). All of these mines create voids under the Earth's surface. Several key factors determining the potential for these voids to collapse include depth, mining technique used, types of rock and or soils and development on the ground surface.

Abandoned underground coal mines in Ohio have the added environmental impact of discharging acidic water. It is common for coal mines to become charged with water. The collected water interacts with the remaining coal deposit and other materials becoming acidic. If acidic mine water is discharged into creeks or streams it can alter the chemical composition of the water habitat. Cases exist where changes in water acidity have caused sensitive aquatic life considerable harm.

Karst topography in Ohio is a landscape shaped by the dissolution of a soluble limestone or dolomite layers of bedrock. As surface water percolates down to the water table, it slowly dissolves away the limestone or dolomite creating voids under the Earth's surface. In cases where a visible depression is present, surface water may flow directly to the water table. Depending on the depth of the void, there may be no observable ground surface deformation. Deep voids may exist at or below the water table and, as a result, the rock is replaced by water. Long-term changes in the water table could destabilize deep voids resulting in surface deformation as observed in southern Missouri and northern Arkansas. Shallow voids are often underground caves or caverns, which lack any replacement support. With time, the roof of these voids may collapse and result in ground failure.

Once a hole or fissure appears in a karst area, surface water can travel directly to the aquifer bypassing the natural filtration and cleaning processes. The result has been contamination of aquifers from farm chemicals, animal waste, along with oil and gasoline from roadway runoff. Cases exist where aquifer contamination resulted in making the water unfit for human consumption. Also, karst topography can result in unusual flooding when water tables are high. Such flooding issues are difficult to address.

The last form of land subsidence in Ohio is associated with soils, which dramatically expand when wet and contract when dry. Structures built on these soils can experience significant shifting as the ground saturates and dries.

Currently there are no commercial insurance carriers which offer mine subsidence coverage in Ohio. In response to gaps in commercial insurance availability, the Ohio FAIR Plan underwriting association was established in 1968 to provide a variety of essential insurance products for eligible properties unable to obtain insurance through the voluntary market. The Ohio Mine Subsidence Insurance Underwriting Association provides eligible Ohio counties with mine subsidence insurance (see Map 2.14.a). Under the program 26 primarily Appalachian counties (Region 3) are required to carry mine subsidence insurance at a cost of one dollar annually. Additionally, eight counties in Region 2 and three counties in Region 1 are eligible to obtain insurance at the owner's discretion at a cost of five dollars annually. The remaining 51 counties are not eligible for mine subsidence insurance.

HAZARD PROFILE

Location

Beginning in the 1700s and continuing to today there has been considerable coal mining in the Appalachian region of Ohio. In addition to coal, several salt, clay and gypsum mines opened in counties close to Lake Erie. Finally in central and southwestern Ohio there are several isolated mines (see Map 2.14.a).

The majority of abandoned mines are located in, or directly adjacent to, Region 3, and most of these were coal mines. Coal mine depths can range from less than 100 feet below the surface to 1,000 feet or more. There are a number of methods which can be employed to remove a coal deposit, whether accomplished by hand/pick or machines. As the coal vein is removed, oftentimes pillars of coal are left at intervals to support the mine roof. In some cases as the mine vein is depleted and miners withdraw, the pillars were removed. In these situations the depth of the mine becomes important. Deeper mines, with solid layers of rock (*i.e.*, strata) above the void and limited soil at the surface, are less likely to fail than those closer to the surface. The ODNR, Division of Geological Survey and the Ohio Department of Transportation (ODOT) have developed profiles of voids, support strata composition and surface soils for a limited number mines to assist in understanding the potential for subsidence events. Analysis requires experts trained in geology and significant time, which limits the number of sites assessed.

Other minerals mined include gypsum, clay and limestone, primarily in Ottawa, Preble and Butler Counties. Finally, very limited exposure to abandoned mines exists in Hamilton, Lucas, Erie, Delaware and Licking Counties, where the mineral being extracted was not available.

Karst features are associated with the western third of Ohio, excluding the far northwestern counties of Williams, Fulton and Defiance (see Map 2.14.b). Nearly all of Region 1 and the far western sections of Regions 2 and 3 are impacted by karst geology. The limestone, shale and dolomite layers were deposited between 408 and 505 million years ago as the floor of an ancient sea. Later, the continental plate would rise above the existing sea level creating dry land and

vast salt deposits. These sedimentary rock layers are naturally porous and dissolve into the water which passes through them.

The current landscape in the karst region of Ohio was created by glaciers as they advanced from the north reaching to the Ohio River roughly 14,000 years ago. When the last glacier receded it left behind a layer of unconsolidated material in a wide range of depths. The shallower the loose material layer, the greater the chance of water penetrating to the underlying bedrock, resulting in a void or ground deformation occurring. This is represented by the probable karst areas on the map which group into two significant clusters. In the south, the greatest impacted counties include Brown, Adams and Highland. In the north, the greatest impacted counties include Seneca, Huron, Erie, Sandusky and Ottawa.

Areas which are reclaimed strip mines and other type of soils poorly suited for development are often mapped by local communities and the Ohio Department of Natural Resources. Ohio's built environment exposure to this type of hazard is very limited.

LHMP Data

The City of Bellevue is located within the Bellevue-Castalia Karst Plain and resides within four counties; Erie, Huron, Sandusky, and Seneca. Of these counties, only Sandusky County's LHMP indicated that land subsidence was a hazard risk. They recognized that land subsidence, in the form of sinkholes, has a potential to occur; but also notes that there have been no incidents of land subsidence that has resulted in the damage of structures, personal injury, or loss of life. An area of concern for Sandusky County, in regards to land subsidence, is a Class I dam that is located in the southeastern portion of the county.

However, Sandusky County, at this time, considers land subsidence and dam failure as having a low mitigation potential and have no current mitigation activities or plans for them.

SHARPP. Hazard identification data were queried from SHARPP to evaluate each hazard and its frequency. Land subsidence ranked 11th for frequency when compared to all 15 hazards evaluated in this plan (Chart 2.2.a), and it ranked very low for all other factors as well. Overall, this hazard ranked 15th out of 15 hazards evaluated, which indicates a very low priority at the local level for land subsidence. This ranking correlates with the limited number of occurrences and overall effects throughout east and southeast Ohio. These and additional HIRA data queried from SHARPP can be found in Appendix J.

1
2
2
3
State of Ohio
Abandon Mine Locations
Insurance Availability
Legend
Region Boundaries
Known Mine Locations
Suspected Mine Locations
County
Insurability
Insurance Not Available
Insurance Optional
Insurance Mandatory
Produced by the Ohio EMA
Disclaimer: The information presented on this map has been compiled through various sources. The Ohio EMA doesn not guarantee its accuracy.
Source: Ohio Geological Survey
N
0 15 30 60
Miles

Map 2.14.a

Map 2.14.b

State of Ohio
Karst Geology Impacted Area by Bedrock and Glacial Drift Overlay

Legend

- County
- Region Boundaries
- Karst Probable

Karst Geology

Bedrock & Drift Overlay

- Carbonate < 20 Feet
- Carbonate > 20 Feet
- Limestone/Shale < 20 Feet
- Limestone/Shale > 20 Feet

Produced by the Ohio EMA
Disclaimer: The information presented on this map has been compiled through various sources. The Ohio EMA doesn not guarantee its accuracy.

Source: Ohio Geological Survey

N

0 15 30 60
Miles

Past Occurrences

Abandoned underground mines in Ohio are monitored by the Ohio Department of Natural Resources, Division of Mineral Resources Management, which is primarily federally funded. Within the division, two programs exist to address mine subsidence: one for emergencies and a second for non-emergencies. Inspectors institute an investigation for every reported occurrence. The inspector uses several criteria to classify the emergency status of the event by determining first if it is mine related, second if there is an imminent and substantial threat to the public or the environment and finally if the onset was sudden and not part of a prolonged event. The emergency program gives priority to events which are directly affecting a structure (within 300 feet) or transportation route. Each year between 50 and 60 investigations are completed generating 25 to 30 projects. Of those investigations, approximately five or six represent damage to a structure (see Map 2.14.c). When an event is classified as an emergency, federal concurrence is requested followed by a streamlined engineering evaluation and hiring of a contractor. The time between the event and response is often within one week. Projects are undertaken to protect lives and property and can range from simple precautions to filling the void with cement to stabilize the area affected.

Subsidence events that do not qualify as emergencies (where people and infrastructure are not directly involved) must follow the standard state project development and bid process. Repeated emergency incidents can lead to larger non-emergency response. The City of North Canton (Region 2), Village of Cadiz (Region 3) and Village of New Lexington (Region 3) each experienced repeated emergency events culminating in area-wide engineering studies to address the problems. In each case comprehensive mitigation activities, including the installation of in-mine support columns and the filling of voids, stabilized large areas which were subsidence-prone.

The ODOT has inventoried over 1,200 sites where abandoned underground mines underlie state highways, U.S. routes, and interstate highways. Since 1998, ODOT has been actively inventorying these geologic hazards and conducting risk assessments to determine the potential impact on the state's transportation infrastructure. The statewide inventory and risk assessment of these mine sites continues. However, there are an estimated 7,000+ underground mines across Ohio. As of 2005, only 50% of these mines had been recorded in the state's (ODNR) database. Approximately 2,700 of the 7,000 underground mines are unmapped. Both mapped and unmapped underground mines pose a continuing threat of subsidence to Ohio's transportation system.

1
2
2
3
State of Ohio
Mine Subsidence Events
and Investigations
Legend
Region Boundaries
Investigation
County
County Designations
Counties Without Mines
Counties With Mines
Produced by the Ohio EMA
Disclaimer: The information presented on this map has been compiled through various sources. The Ohio EMA doesn not guarantee its accuracy.
Source: Ohio Geological Survey
N
0 15 30 60
Miles

Map 2.14.c

Whenever an event affecting transportation infrastructure occurs, an initial site investigation is launched. The first step in the process involves the collection of basic information on the location, type of event, geologic setting, mining information for the area, impact on the roadway, and how it was discovered. The next step involves a site reconnaissance and the completion of a series of data collection forms starting with the Initial Site Evaluation. Compiled information is then used by the geologist or engineer to complete the risk assessment rating form. Each inventoried site receives a matrix score based on standardized criteria and scoring methods. Some examples of key scoring criteria are: number of surface deformation features, number of mine openings, thickness of unconsolidated material over the mine, thickness of rock overburden, height of the mine void(s), average daily traffic volume, hydrology, and secondary mining evidence. The overall rating provides ODOT a planning tool to prioritize sites across the state for remediation. With limited resources and the large number of mine subsidence problems, the abandoned underground mine inventory and risk assessment provides ODOT the means to direct expenditure of funds in a cost-effective and logical manner.

The most notable event occurred in 1986 when an abandoned mine located in Guernsey County collapsed underneath Interstate 70 resulting in the closure of the entire interstate. Remediation included stabilizing the void and repairing the damaged roadway costing over $10 million dollars.

Underground salt mining under Lake Erie has not generated any known subsidence to date; however, solution mining in Lake, Summit and Medina Counties has. The most dramatic case in Ohio is in the Lake County community of Painesville where an abandoned mine is responsible for a six foot surface depression. Due to the proximity of the impacted area to Lake Erie, it is now filled with water. Other solution mines in Summit and Medina counties have experienced minor surface impacts. The potential effect of salt mining is epitomized in the failure of the Retsof mine in New York. The event was first misinterpreted as an earthquake. The collapse of the mine roof resulted in several 50-foot deep sinkholes, which closed roadways, produced changes in the aquifer, and caused the release of methane and hydrogen sulfide gases.

Until recently, Karst events in Ohio had very little direct impact from a subsidence perspective on the built environment; however, they have been very costly in terms of pollution and flooding. Two well documented karst related events deal with contamination of aquifers. The oldest researched event in Ohio is associated with the Village of Bellevue straddling the Huron / Sandusky County border. The 1961 study documents how from 1919 to 1946 the community permitted untreated wastewater injection wells and unimpeded groundwater runoff into sink holes as an acceptable water management program. In 1946 after the groundwater was determined unfit for human consumption, the Village abandoned its last well and has since spent millions of dollars to develop a potable system based on piping water from safe sources. In February 2008, more than 200 homes experienced flooding in Bellevue when runoff from heavy snows and spring rains flooded underground karst chambers. Experts believed

building pressure caused the pent-up water to surge up existing sinkholes and cracks, flooding homes and yards. A section of State Route 269 was swamped from February through June 2008.

The Village of Put-In-Bay, located on South Bass Island in Lake Erie, was the site of an extensive gastrointestinal illness outbreak in 2004. The island is a popular warm-weather tourist destination and, at the height of the season, over 1,000 cases of digestive related maladies were documented in people who had recently vacationed there. The investigation began with the municipal systems and quickly shifted to a number of transient non-community public water systems used for geothermal cooling, flushing toilets and outdoor cleaning. These systems were found interconnected to the main water system. The karst topography allowed groundwater to travel quickly between locations and is easily affected by seasonal precipitation.

The only known karst-related subsidence impact to the built environment is roadway damage. In 2007 State Route 19 was closed in Crawford County when an adjacent karst feature expanded destabilizing the road bed. Engineering studies including sonar and LIDAR analyses of the associated void are underway to determine the extent of the developing cavity and to determine a long-term solution. Although this is the first documented event where damage to the built environment can be directly attributed to karst formations, there is an effort underway thought the ODOT to collect detailed historical data of karst-related roadway impacts to better understand and address future events.

During the construction of U.S. Route 33 near East Liberty, karst was encountered. Construction crews had to perform considerable back-filling and reinforcing, creating a land-bridge to make sure the highway was secure.

Another example of the impact of karst was the construction of tunnels for sewage pipelines by the City of Dublin (Franklin County). Sinkholes, filled with clayey overburden caused the expensive rock-boring machinery to clog and break, resulting in tremendous cost overruns.

Finally, one housing development in the City of Westerville (Franklin County) contains homes which have been dislodged and damaged by the effects of soils which dramatically expand when wet and contract when dry. Since 2000 the Ohio EMA has purchased 6 damaged homes; however, this is the only known impact from this form of land subsidence.

Probability of Future Events

Mine-related land subsidence is an annual event impacting an average of five homes or roadways. Approximately 20 additional events occur each year that do not impact the built environment, yet may require remediation.

Unlike mine-related events, karst events historically have manifested their impact in the form of groundwater contamination. Based on past exposure, a significant event occurs approximately each decade. As the ODOT begins to collect detailed data regarding the impact of karst events on federal highways, both the

profile of the hazard and frequency of occurrence may experience significant change.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

The only predictable impact which can be quantified for analysis is damage to Ohio's roadways. The Ohio Department of Transportation, Office of Geotechnical Engineering has a comprehensive inventory of the federal and state routes which intersect with known and estimated abandoned mines. The location, length of each segment, potential for failure, along with a host of other data is maintained in a database. The failure potential is broken into three categories: high, with failure expected within 50 years; medium, with failure expected within 100 years; and low, with failure expected beyond 100 years. The segments are reported by length of the segment, with a 500-foot buffer, and the number of road lanes. The final and key piece of information supplied is the proven cost of $1,000,000 per lane mile to replace roadways impacted by mine subsidence. For loss estimates that full cost per-mile is used, with 50% and 25% used for medium and low, respectively.

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

Land subsidence is a spatial hazard, but is spatial-specific in that it would only affect very small areas given an occurrence. Therefore, this hazard has a very limited potential of affecting any state-owned or state-leased facilities. However, it should be noted that such events could impact lifelines, which could have significant effects on the functionality of various state facilities.

2.15 FUTURE POTENTIAL AREAS OF RISK

There are several potential areas of risk which will impact the natural hazards of the state, but are not easily categorized within any of the existing natural hazards located within the HIRA. The following potential areas of risk will be addressed in this Section:

- Future growth
- Hydraulic fracturing
- Climate change

FUTURE GROWTH

Of the future potential areas of risk that this section will address is the future growth throughout Ohio and what impact it will have on the natural hazards. To determine growth patterns, Ohio EMA evaluated two data sources: 2010 US census data in tabular format and National Urban Change Indicator (NUCI) data in a GIS environment.

The Ohio Department of Development's Office of Strategic Research published individual county statistics evaluating the 2010 census data. The county profiles cover an array of characteristics ranging from demographics to taxable land value. The percentage of population change between 2000 and 2010 was calculated for all counties. Overall, the State of Ohio has seen very little change in population, showing an estimated 1.6 percent increase. This increase can be attributed to the significant increases in southwest and central Ohio, which include counties from Regions 1 and 2.

NUCI data were obtained from FEMA Headquarters, who purchased a license from a private firm specializing in essential information solutions. Using satellite imagery, the firm used a proprietary process that evaluated when and where land areas had undergone human-induced changes during last 25 years; change usually indicated new or modified construction. These data correlate well with the 2010 census data in that they show where changes occurred between 2000 and 2007, and these changes were focused in the Columbus and Cincinnati Metropolitan Areas (Maps 2.15.a and 2.15.b).

Both datasets showed significant landscape changes in central (Columbus Metropolitan Area) and southwest Ohio (Cincinnati Metropolitan Area). Specifically, the greatest changes in central Ohio took place in Delaware County (58.4 percent) and Union County (34.3 percent) (Table 2.15.a), and the greatest in southwest Ohio included Warren (34.3 percent) and Butler (10.6 percent) Counties.

The Delaware county multi-jurisdictional mitigation plan clearly describes the difficulties associated with double digit increases in population and the associated growth of the built environment. Large sections of farmland are being developed into residential housing, retail commercial facilities and office parks with the necessary infrastructure to support them. Increased runoff and shorter time available for natural attenuation has resulted in greater water levels and

flows near existing neighborhoods. The county has a clear understanding of the problems, their implications and is working to address them through mitigation planning and educational outreach. Part of the difficulty in addressing the situation is that the growth areas are creating high-value real estate for Ohio, while the impacted areas range from manufactured home parks to older, residential structures built in or near the floodplain. Over time the size of the regulatory floodplain can be expected to increase due to development. Two other central Ohio counties, Union and Fairfield, experienced moderate growth; however, no adverse impacts were observed.

Table 2.15.a

Ohio Counties Showing Significant Population Growth (2000-2014)		
Ohio Region	**County**	**Percent Increase**
2	Delaware	58.4%
2	Warren	34.3%
1	Union	27.8%
2	Fairfield	19.1%
2	Licking	14.4%
2	Butler	10.6%

Considering the rapid growth in southwest Ohio, the Warren County Regional Planning Commission has planned for structured growth, which has resulted in minimal adverse impact. The Warren County multi-jurisdictional mitigation plan outlines the program objectives to:

- Discourage small, isolated subdivisions where soil conditions and lot size are not conducive to on-site wastewater disposal systems, where applicable;
- Encourage a logical pattern of residential development where future growth would occur in proximity to existing residential areas, within the designated Urban Service Areas of the township;
- Build multi-family housing at a scale that can accommodate the need, combined with prudent use of the Planned Unit Development process, to

accomplish quality development, mitigating the impact of county utilities and other public services;

- Develop adequate, well designed and affordable housing for the elderly population, the handicapped and families with children;
- Give a stronger emphasis to establishing open space/green belt areas, separating developing residential areas from incompatible uses;
- Establish a system to encourage housing maintenance through a coordinated, ongoing inspection program by county and local officials;
- Encourage the repair or removal of dilapidated/substandard structures;
- Identify, document and protect older homes or residential areas of historical and/or architectural significance from unwanted, incompatible land uses; and
- Explore the establishment of an historical zoning district to protect individual structures or neighborhoods of historical and/or architectural significance.

Mitigation planning and associated strategies have been adequately developed to minimize adverse effects from the significant growth experienced in central and southwest Ohio and aid in community resilience.

Map 2.15.a

Central Ohio National Urban Change Indicator 1987 - 2008

Year of Change

1987	1998
1988	1999
1989	2000
1990	2001
1991	2002
1992	2003
1993	2004
1994	2005
1995	2006
1996	2007
1997	2008

The National Urban Change Indicator (NUCI) data show areas that have undergone human-induced changes sometime in the last 25 years, which usually indicate new or changed construction. They were developed through the analysis of satellite imagery for urban sprawl. Copyright MDA Ltd. (2011)

Data shown on this map represent 2011 NUCI data developed by MDA Ltd., which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

Map 2.15.b

Southwest Ohio National Urban Change Indicator 1987 - 2008

Year of Change

1987	1998
1988	1999
1989	2000
1990	2001
1991	2002
1992	2003
1993	2004
1994	2005
1995	2006
1996	2007
1997	2008

The National Urban Change Indicator (NUCI) data show areas that have undergone human-induced changes sometime in the last 25 years, which usually indicate new or changed construction. They were developed through the analysis of satellite imagery for urban sprawl. Copyright MDA Ltd. (2011)

Data shown on this map represent 2011 NUCI data developed by MDA Ltd., which are not maintained by Ohio EMA. Therefore, Ohio EMA does not guarantee their accuracy.

Projection: Lambert Conformal Conic
Map produced by Ohio EMA, 2011.

OHIO BALANCED GROWTH STRATEGY

One of the primary strategies that the State of Ohio adopted to address future growth throughout state is the Ohio Balanced Growth strategy. (http://balancedgrowth.ohio.gov) This strategy is a voluntary, incentive based program that provides local governments with a regional planning framework based upon watersheds and water resource protection. The fundamental principle to guide the action of state agencies is that if local governments within a watershed can agree upon areas where development is to be encouraged and which are to be conserved, Ohio will align state programs to support these locally based decisions and conversely will not utilize state programs to violate them.

The Ohio Water Resources Council (OWRC) has implemented this initiative statewide based upon a previous program development by the Ohio Lake Erie Commission (OLEC). The program has many elements that encourage balanced growth throughout the state, specifically:

- Focusing on land use and development planning in Ohio's watersheds. The goal is to link land use planning to the health of watersheds and major bodies of water.
- Creation of Watershed Planning Partnerships to encourage regional cooperation on the issues of land use planning and development.
- Production of Watershed Balanced Growth Plans, which will guide how growth and conversation would be promoted by both local and state policies.
- The development of model regulations to promote local land use practices that minimize development impacts on water quality.
- Align state policies, incentives and other resources to support Watershed Balanced Growth planning and implementation.

WATERSHED BALANCED GROWTH PLANS

One of the primary aspects of the Ohio Balanced Growth Strategy is the creation and adoption of a Watershed Balanced Growth Plan. These plans are intended to provide a framework for regional decision-making on growth, conservation, stormwater issues and water quality. Each of these plans is based upon the 10 guiding principles for sustainable Ohio watersheds, the guiding principles are:

1. Maximize investment in existing core urban areas, transportation, and infrastructure networks to enhance the economic vitality of existing communities.

2. Minimize the conversion of green space and the loss of critical habitat areas, farmland, forest, and open spaces.

3. Limit any net increase in the loading of pollutants or transfer of pollution loading from one medium to another.

4. To the extent feasible, protect and restore the natural hydrology of the watershed and flow characteristics of its streams, tributaries, and wetlands.

5. Restore the physical habitat and chemical water quality of the watershed to protect and restore diverse and thriving plant communities and preserve rare and endangered species.

6. Encourage the inclusion of all economic and environmental factors into cost / benefit accounting in land use and development decisions.

7. Avoid development decisions that shift economic benefits or environmental burdens from one location within a region to another.

8. Establish and maintain a safe, efficient, and accessible transportation system that integrates highway, rail, air, transit, water, and pedestrian networks to foster economic growth and personal travel.

9. Encourage all new development and redevelopment initiatives to address the need to protect and preserve access to historic, cultural, and scenic resources.

10. Promote public access to and enjoyment of our natural resources for all Ohioans

These Watershed Balanced Growth plans are not intended to supersede either local comprehensive plans or local hazard mitigation plans, but to harmonize with them. Each Watershed Balanced Growth Plan must identify or include the following:

- Priority Conservation Areas (PCA), which are critical areas to protect within the watershed. This includes areas which provide flood control, are susceptible to significant natural hazards and offer areas for ecological / open space restoration in urban areas.
- Priority Development Areas (PDA), which are areas where development should be encouraged. This included area which will maximize development potential and efficient use of infrastructure.
- The related documentation for justifying the designation of any PCAs or PDAs.
- Plans for the implementation of any developed strategies and a description of the governance structure.
- A specific statement noting how the plan will meet the 10 guiding principles for sustainable Ohio watersheds.

STATE INCENTIVES

One of the challenges of the Balance Growth Program is that the State of Ohio is a home rule State. Therefore all land use, zoning, and planning decisions are made solely at the local level. State agencies do, however, influence the location of development in many ways through infrastructure investments, economic

development incentives, tax policies and other policies and programs. In order to encourage local watershed groups to undertake the Balanced Growth Program process, the state created an incentive package that is available to Watershed Planning Partners and their participating local jurisdictions with an endorsed plan. These are the 26 state programs that include special consideration for Balanced Growth participating communities, these programs are offered by various state agencies including the OEPA, ODNR, ODSA, ODOT and several other State agencies. More information about the specific state sponsored incentives is available at http://balancedgrowth.ohio.gov/BalancedGrowthStrategy.aspx

BEST LOCAL LAND USE PRACTICES

In addition to providing incentives for the adoption of Balance Growth Plans, the State has created several best local land use practices that address the following subject matters:

- Stream, Floodplain, and Wetland Protection
- Storm Water Management/Erosion and Sediment Control
- Comprehensive Planning
- Compact Development
- Conservation Development
- Natural Areas Establishment and Management
- Source Water Protection

These best local land use practices are available for download at http://balancedgrowth.ohio.gov/BestLocalLandUsePractices/BestLocalLandUsePractices2012.aspx

LOCAL ADOPTION OF WATERSHED BALANCED GROWTH PLANS

Since 2008, 12 local State endorsed Watershed Balanced Growth Plans have been adopted throughout the State of Ohio and over half of those plans were adopted in the past three years. The plans must be adopted at the local level with support from local governments that represent at least 75% of the geographic land area of a watershed, and 75% of the local governments in the watershed and 75% of the population in the watershed. Once local support requirements are met, the state conducts a final review prior to endorsing the plan to ensure compliance with the criteria of the program.

The following Watershed Balanced Growth Plans have been adopted at the local level and endorsed by the State of Ohio:

- Chippewa Creek Watershed (December 2008)
- Upper West Branch Rocky River Watershed (June 2009)
- Chagrin River Watershed (September 2009)
- Swan Creek Watershed (September 2009)

- Big Creek Watershed (June 2011)
- Eastern Lake County Coastal Tributaries (December 2011)
- Furnace Run (December 2011)
- Middle East Fork (February 2012)
- Lower Mosquito Creek (February 2012)
- Upper Chippewa Creek (April 2012)
- Olentangy River (April 2012)
- Walnut Creek (February 2013)

These 12 endorsed Watershed Balanced Growth Plans are spread across 18 different counties throughout the State. The following Counties have at least one State Endorsed Watershed Balanced Growth Plan within their borders:

- Clermont
- Cuyahoga
- Delaware
- Fairfield
- Franklin
- Fulton
- Geauga
- Lake
- Licking
- Lucas
- Marion
- Medina
- Morrow
- Pickaway
- Portage
- Summit
- Trumbull
- Union

The majority of the endorsed plans in the State are primarily located within central and north eastern parts of the State. Of these 18 Counties, two counties (Franklin, Medina), have specifically incorporated the State Endorsed Watershed Balanced Growth Plan into their Local Hazard Mitigation Plan and nine of counties have references to local watershed and storm water management plans throughout their Local Hazard Mitigation Plans. The continued adoption of the Watershed Balanced Growth Plans throughout the State will encourage sound planning and land use development Statewide. These activities will promote linkages between Balanced Growth Plans and local hazard mitigation plans which will minimize adverse effects of future growth and contribute to more resilient communities.

Balanced Growth Planning Partnership Watersheds

N

Map created with the assistance of ODNR - Office of Coastal Management and ODNR - Division of Soil and Water Resources. June 2013.

Miles
0 12.5 25 50 75 100

balancedgrowth.ohio.gov

NATURAL GAS DRILLING IN THE MARCELLUS AND UTICA SHALE

Together, the Marcellus and Utica Shale regions extend across New York, Pennsylvania, Maryland, West Virginia, Ohio and portions of Kentucky and these deposits sit between 7,000 and 12,000 feet below ground. Both the Marcellus and the Utica shale regions are important geologic formations because they hold large reserves of natural gas. Researchers estimate the Marcellus Shale alone could contain as much as 363 trillion cubic feet of natural gas. Ohio is experiencing far less Marcellus Shale drilling than several of the neighboring states because the Marcellus Shale is much thinner on its western edge.

Ohio has and will continue to see a significant increase in drilling as much of the State sits over the Utica Shale Formation. The extraction of natural gas from the Shale is a two-step process of horizontal drilling and hydraulic fracturing. The process starts with a production well, which is drilled thousands of feet downward and then gradually angled out horizontally through the Shale deposit. After the well is drilled, a mixture of water, sand and chemicals additives is injected at very high pressure to fracture the Shale. This part of the process called hydraulic fracturing or fracing, is a technique used in the oil and gas industry since the 1950's.

Per the ONDR Division of Geological Survey, resource estimates indicate the Devonian-age Marcellus Shale is the largest exploration play in the eastern United States. Recently, the application of horizontal drilling combined with multi-staged hydraulic fracturing to create permeable flow paths from wellbores into shale units has resulted in a drilling boom for the Marcellus in the Appalachian Basin states of Pennsylvania, West Virginia, southern New York, and eastern Ohio. Fracturing technology also may have application in other shale units, such as the Ordovician-age Utica Shale, which extends across much of the Appalachian Basin region. While limited production has occurred in the Utica up to this point, thickness and widespread geographical extent indicate it may also have great oil-and-gas potential.

ORGANIC-THICKNESS MAP OF THE MARCELLUS SHALE IN OHIO
EXPLANATION
data point (oil and gas well)
10-ft contour
25-ft contour
Western limit of Marcellus
Thickness in feet
91
0
25 12.5 0 25 Miles
25 12.5 0 25 Kilometers
Recommended bibliographic citation:
Erenpreiss, M.S., Wickstrom, L.H., Perry C.J., Riley, R.A., Martin, D.R., and others, 2011, Organic-thickness map of the Marcellus Shale in Ohio: Ohio Department of Natural Resources, Division of Geological Survey, scale 1 inch equals 27 miles.
4/6/2011
10
20
30
40
50
75
CUYAHOGA
LORAIN
MEDINA
SUMMIT
WAYNE
HOLMES
TUSCARAWAS
COSHOCTON
MUSKINGUM
NOBLE
MORGAN
ATHENS
MEIGS
BELMONT
JEFFERSON
HARRISON
WASHINGTON
MONROE
LUCAS
OTTAWA
WOOD
SANDUSKY
ERIE
SENECA
HURON
HANCOCK
WYANDOT
CRAWFORD
RICHLAND
ASHLAND
HARDIN
MARION
MORROW
LOGAN
UNION
DELAWARE
CHAMPAIGN
KNOX
LICKING
CLARK
FRANKLIN
MADISON
FAIRFIELD
PERRY
PICKAWAY
FAYETTE
HOCKING
ROSS
VINTON
HIGHLAND
PIKE
JACKSON
SCIOTO
GALLIA
LAWRENCE
MASON
ROANE
CALHOUN
WIRT
WOOD
RITCHIE
DODDRIDGE
TYLER
PLEASANTS
WETZEL
MARSHALL
OHIO
BROOKE
HANCOCK
BEAVER
ALLEGHENY
WESTMORELAND
FAYETTE
GREENE
SOMERSET
BEDFORD
BLAIR
CAMBRIA
INDIANA
ARMSTRONG
BUTLER
LAWRENCE
MERCER
VENANGO
CLARION
ELK
CLEARFIELD
CENTRE

Thickness Map of the Point Pleasant - Utica Interval in Ohio
EXPLANATION
data point (oil and gas well)
fault
Utica extent
Point Pleasant extent
50-ft contour
250-ft contour
Western limit of Utica hydrocarbon generation based on CAI
Thickness in feet
350
87
300
250
200
150
100
25 12.5 0 25 Miles
25 12.5 0 25 Kilometers
Modified from Patchen and others, 2006 and Repetski and others, 2008
4/6/2011

CURRENT STATE OF NATURAL GAS AND OIL DRILLING IN THE STATE

The Ohio Oil & Gas Summary issued each year reflects the most up to date information and trends effecting Ohio's oil and gas industries. The 48th edition of this Summary noted that 553 oil and gas wells were drilled in the state is 2012 and this is down from a peak of 1089 new wells drilled in 2008. The spike of wells drilled from 2005-2008 was related to the exploration of the Devonian Shale. Of the 553 wells drilled in 2012, 198 or 36% of all wells were drilled to the Utica/Point Pleasant Shale formations.

According to an analysis of "The Economic Potential for Shale Formations in Ohio" authored by a joint partnership of Cleveland State University, Ohio State University and Marietta College, the future growth of the drilling in the Utica-Point Pleasant Shale will occur at an extremely rapid rate in the next several years.

Projection of Wells Drilled

Year	Number of Wells	Total Wells in Production
2011 (actual)	33	4
2012	160	193
2013	650	843
2014	1,075	1,918

Source: "Analysis of the economic potenial for shale formaiton in Ohio" CSU, OSU and Marietta College

The attachment provided the ONDR Division of Oil and Gas Resources Management indicates the activity of horizontal well drilling in the Utica-Point Pleasant Shale in the State. As this map indicates the current and future activity will occur in the eastern and southeastern portions of the State.

ENVIRONMENTAL CONCERNS

Some citizens and local governments are becoming aware and concerned about the potential environmental and societal impacts of drilling activity in their communities. The primary concerns noted in "Drilling for Natural Gas in the Marcellus and Utica Shales: Environmental Regulatory Basics" by ODNR & OEPA dated November 2012 are:

- The possible impacts of brine or flowback water on ground water resources
- The hydraulic fracturing fluid compositions and there possible health effects
- Increased road traffic and higher road maintenance costs
- Method of disposal for the brine, hydraulic fracturing fluid and other substances related to the drilling
- Possible increase in seismic activity from injection wells
- Possible increase in air pollution from the drilling related activities

REGULATION OF NATURAL GAS DRILLING IN THE MARCELLUS AND UTICA SHALE

The regulation of Natural Gas Drilling in the Marcellus and Utica Shale lies with primarily two bodies in the State of Ohio, the Ohio Department of Natural Resources (ODNR) and the Ohio Environmental Protection Agency (OEPA). The table below is a summary of ODNR and OEPA regulatory authorities over oil/gas drilling and production activities.

Summary of ODNR and Ohio EPA regulatory authority over oil/gas drilling and production activities

	Ohio Department of Natural Resources	Ohio Environmental Protection Agency
Drilling in the shale deposits	✓ Issues permits for drilling oil/gas wells in Ohio. ✓ Sets requirements for proper location, design and construction requirements for wells. ✓ Inspects and oversees drilling activity. ✓ Requires controls and procedures to prevent discharges and releases. ✓ Requires that wells no longer used for production are properly plugged. ✓ Requires registration for facility owners with the capacity to withdraw water at a quantity greater than 100,000 gallons per day.	✓ Requires drillers obtain authorization for construction activity where there is an impact to a wetland, stream, river or other water of the state. ✓ Requires drillers obtain an air permit to install and operate (PTIO) for units or activities that have emissions of air pollutants.
Wastewater and drill cutting management at drill sites	✓ Sets design requirements for on-site pits/lagoons used to store drill cuttings and brine/flowback water. ✓ Requires proper closure of on-site pits/lagoons after drilling is completed. ✓ Sets standards for managing drill cuttings and sediments left on-site.	✓ Requires proper management of solid wastes shipped off-site for disposal.
Brine/flowback water disposal	✓ Regulates the disposal of brine and oversees operation of Class II wells used to inject oil/gas-related waste fluids. ✓ Reviews specifications and issues permits for Class II wells. ✓ Sets design/construction requirements for Class II underground injection wells. ✓ Responds to questions/concerns from citizens regard safety of drinking water from private wells from oil/natural gas drilling.	
Brine/flowback water hauling	✓ Registers transporters hauling brine and oil/gas drilling-related wastewater in Ohio.	
Pumping water to the drill site from a public water supply system		✓ Requires proper containment devices at the point of connection to protect the public water system.

The ODNR Division of Oil and Gas summarizes below the impacts and effects of the two the primary legislative acts that created the current framework for have regulating the oil and gas industry in the State of Ohio.

SENATE BILL 165

On March 31, 2010 Governor Ted Strickland signed Substitute SB 165, the first major revision to Ohio oil and gas law in twenty-five years. Many significant

changes were implemented as a result of passage of this new legislation which became effective on June 30, 2010.
The bill provided for enhanced permitting authority in urban areas, strengthened funding for operations and orphan well plugging, added additional notification requirements by the industry and expanded enforcement provisions.

SENATE BILL 315

On June 11, 2012, Governor John Kasich signed landmark oil and gas regulatory legislation. This law established one of the nation's toughest regulatory frameworks for overseeing the new technologies that allow for the exploration of natural gas in deep shale rock formations**.** The new law builds on recently approved well construction standards, which are extremely protective of groundwater and the environment. SB 315 does the following:

- Creates the nation's first combined well construction and hydraulic fracturing chemical disclosure requirement. The law requires chemical disclosure during all aspects of the initial drilling process and during hydraulic fracturing, while adhering to existing federal and state trade secret/proprietary laws. However, ODNR can upon request obtain proprietary chemical formulas to conduct an investigation or in response to a spill. The public has the ability to view hydraulic fracturing fluid compositions used at specific wells at the website "fracfocus.org".
- Requires the sharing of all chemical information with doctors. Doctors may share even proprietary chemical information with the patient and other medical professionals directly involved in treating a patient.
- Allows appeals to the Ohio Oil & Gas Commission for certain permitting concerns prior to perusing court action.
- Establishes mandatory daily fines for well operators who violate the law.
- Requires well operators to take pre-drilling water samples within 1,500 feet of a proposed horizontal well and disclose the results in permit applications.
- Requires well operators to disclose the proposed source of water used in the well drilling and hydraulic fracturing process.
- Encourages well operators to enter into a Road Use Maintenance Agreement (RUMA) with local government. The agreement also stipulates designated travel routes for heavy equipment haulers to ensure safety and minimize impact. SB 315 requires ODNR and ODOT work with local officials to review and report on the effectiveness of the RUMA process.
- Requires injection well owners to electronically transmit quarterly reports to ODNR with information about each shipment.

LOCAL LAND USE, ZONING REGULATION, AND HOME RULE

In the state, municipal corporations (cities and villages) have certain powers granted to them in Article XVIII of the state Constitution that exist outside their authority found in the Revised Code. Because these powers originate in the Constitution, laws passed by the General Assembly that interfere with them are invalid as applied to municipal corporations unless those laws otherwise are sanctioned by the Constitution. These constitutionally granted powers, known as "home rule" power include the power of local self-government, the exercise of certain police powers, and the ownership and operation of public utilities. "Police power" has been defined as the authority to make regulations for the public health, safety, and morals and the general welfare of society. Keep in mind any Municipal laws for the exercise of municipal police powers cannot be in conflict with general laws. Included in these "Police power" regulations are local land use and zoning regulation. http://www.lsc.state.oh.us/membersonly/128municipalhomerule.pdf

The Ohio Supreme Court recently heard arguments whether municipal corporations have the authority to regulate and approve the location of oil and gas wells through local zoning code. The city of Munroe Falls in northeastern Oho is asking the court to reverse an appellate-court ruling that stated the city had no authority to impose zoning restrictions on hydraulic fracturing and negligible authority to regulate drilling. Beck Energy Corporation and the Ohio Department of Natural Resources argued before the court that state law gives ODNR exclusive authority to determine where drilling and hydraulic fracturing occurs in state. The city of Munroe Falls countered that the city's home-rule powers give it some of the authority in deciding where hydraulic fracturing rigs should be located. The city objects to Beck Energy's receipt of an ODNR permit to drill at the rear of 5-acre plot without complying with city ordinances and zoning that prohibits drilling in a residential-zoned area. The outcome of this case before the Ohio Supreme Court is as of yet undetermined, but its outcome will greatly affect the future regulation of drilling and hydraulic fracturing throughout the state.

SEISMIC EVENTS IN YOUNGSTOWN

A preliminary report was released by ODNR in March 2012 on the Northstar 1 Class II Injection Well and the Seismic Events in the Youngstown, Ohio Area. The reports show that since March 2011, the Youngstown area has experienced 12 low-magnitude seismic events along a previously unknown fault line. These events ranged from 2.1- to 4.0-magnitude and were recorded by the Ohio Department of Natural Resources' (ODNR) Ohio Seismic Network (OhioSeis). The OhioSeis network works closely with the U.S. Geological Survey to monitor and study all seismic activity within the state. Prior to the network's establishment in 1999, monitoring earthquakes in Ohio was sporadic at best. In fact, before the network was operational, the Ohio Geological Survey was unable to accurately determine any seismic events below an approximate magnitude of 3.0. A station at Youngstown State University joined the network in 2003.

Before 2011, OhioSeis had not recorded earthquake activity with epicenters located in the Youngstown area. Also, no fault line had been previously mapped within the boundaries of Youngstown or Mahoning County. However, the broad geographical area does have a history of seismic activity, and Mahoning Valley residents have felt earthquakes from nearby faults. In fact, the area has experienced at least three prior earthquakes in the past 25 years.

NORTHSTAR 1 CLASS II DEEP INJECTION WELL

The 2011 earthquakes are distinct from previous seismic activity in the region because of their proximity to a Class II deep injection well, known as the Northstar 1 well. In fact, all of the events were clustered less than a mile around the well. Northstar 1 is one of 177 operational Class II deep injection wells primarily used for oil and gas fluid waste disposal. (Ohio Disposal Wells) The well is drilled 200' into the rock formation known as the Precambrian layer at a depth of 9,184' and began injection in December 2010. The below table, provide by the US E.P.A, describes the six categories or "classes" of injection wells, along with the estimated national inventory for each class. The six classes are based on similarity in the fluids injected, activities, construction, injection depth, design, and operating techniques. This categorization ensures that wells with common design and operating techniques are required to meet appropriate performance criteria for protecting underground sources of drinking water.

Classes	Use	Inventory
Class I	Inject hazardous wastes, industrial non-hazardous liquids, or municipal wastewater beneath the lowermost Underground Sources of Drinking Water (USDW).	680 wells
Class II	Inject brines and other fluids associated with oil and gas production, and hydrocarbons for storage.	172, 068 wells
Class III	Inject fluids associated with solution mining of minerals beneath the lowermost USDW.	22,131 wells
Class IV	Inject hazardous or radioactive wastes into or above USDWs. These wells are banned unless authorized under a federal or state ground water remediation project.	33 sites
Class V	All injection wells not included in Classes I-IV. In general, Class V wells inject non-hazardous fluids into or above USDWs and are typically shallow, on-site disposal systems. However, there are some deep Class V wells that inject below USDWs.	400,000 to 650,000 wells Note: an inventory range is presented because a complete inventory is not available.
Class VI	Inject Carbon Dioxide (CO2) for long term storage, also known as Geologic Sequestration of CO2.	6-10 commercial wells expected to come online by 2016. (Interagency Task Force on Carbon Capture and Storage)

Ohio runs its Class II deep injection program on behalf of the U.S. EPA. As a result, the state meets and in many instances far exceeds U.S. EPA standards and regulations for the program. Since the program's inception in 1983, more than 202 million barrels of oilfield fluids have been disposed of, with no reports of subsurface ground water contamination incidents. In addition, no seismic event had been previously linked to operations at any of the state's Class II wells.

The earthquakes and their potential link to the Northstar 1 deep injection well were closely scrutinized by state geologists and regulators, who performed 35

separate inspections of the well from April 26 to Dec. 15, 2011. Each inspection indicated the well was operating within its permitted injection pressure and volume. In addition, ODNR regulators conducted additional testing of the well to determine if injection fluids were entering permitted injection zones. Tracer tests showed injections were reaching appropriate zones and were within permitted injection intervals. However, the tests proved inconclusive with regard to the volume of fluid entering the Precambrian layer. As a result, state regulators requested the well owner plug the Precambrian section of the Northstar 1 borehole, and the well operator voluntarily agreed to the procedure, albeit on a delayed timetable. With only one seismometer deployed in the Youngstown area, state geologists lacked the necessary data on the earthquakes' depth and exact location to draw a direct correlation between the seismic events and the deep injection well.

LAMONT-DOHERTY EARTH OBSERVATORY AT COLUMBIA UNIVERSITY

In November 2011, the ODNR Director ordered the Ohio Geological Survey to seek an outside research partner and deploy the needed portable seismometers around the Youngstown area. The Lamont-Doherty Earth Observatory at Columbia University had the available equipment and was willing to assist the state. The seismometers were deployed on Dec. 1, 2011. On Dec. 24, the newly deployed equipment recorded a 2.7-magnitude earthquake in the area. Data from

the portable seismometers was downloaded and analyzed by experts at Lamont-Doherty. On Dec. 29, Lamont-Doherty presented ODNR with their preliminary findings, which indicated the seismic event depth was 2,454' below the injection well.

Based on the Lamont-Doherty data, ODNR regulators ordered the immediate halt of injections at Northstar 1, either voluntarily by the operator or by agency order. The next day, the Youngstown area experienced a 4.0-magnitude seismic event. Gov. John Kasich immediately placed an indefinite moratorium on three drilled deep injection wells and one well with a permit pending in the vicinity of the Northstar 1 well.

INDUCED SEISMICITY

Geologists believe it is very difficult for all conditions to be met to induce seismic events. In fact, all the evidence indicates that properly located Class II injection wells will not cause earthquakes. To induce an earthquake a number of circumstances must be met:

- A fault must already exist within the crystalline basement rock and that fault must already be in a near-failure state of stress.
- An injection well must be drilled deep enough and near enough to the fault and have a path of communication to the fault.
- The injection well must inject a sufficient quantity of fluids at a high enough pressure and for an adequate period of time to cause failure, or movement, along that fault (or system of faults).

A number of coincidental circumstances appear to make a compelling argument for the recent Youngstown-area seismic events to have been induced:

- The Northstar 1 well began injection operations in December 2010. Roughly three months later, the first seismic events were noted and were fairly close to the well.
- Subsequent seismic events were clustered around the vicinity of the wellbore.
- Evidence of permeability zones within the Precambrian basement rock is interpreted in some of the geophysical logs obtained from within the Northstar 1 well; and (Logs A, B, C, D).
- Once sufficient monitoring equipment was in place, the focal depths of events were found to be about 4,000' laterally and 2,500' vertically from the wellbore terminus.

It appears there are observed permeability zones within the Precambrian basement rock in the drill coring logs recorded by the Battelle Memorial Institute during the drilling of Northstar 1. These logs were not available to inform regulators of possible issues in geological formations prior to well operation. Instead, Battelle produced and made the logs available to provide geologists with additional information on the region's geological formations. In the future, ODNR

will require the Class II well owner to provide a suite of geophysical logs germane to the respective injection well.

To establish a better understanding of what may have happened, further analysis and detailed modeling of all factors must be completed on the Northstar 1 well and the surrounding geology. This work is already underway through ODNR and cooperating agencies and institutions.

FUTURE EVENTS

The number of wells that will be drilled over the next several years in Region 3 is expected to grow exponentially. As the number of oil, gas, and injection wells in the state increases, so does the potential for environmental impacts. The state is mitigating this risk by enhancing regulatory and monitoring programs for well drilling and waste disposal operations.

Additional information on these efforts can be found at the ODNR Division of Oil and Gas website: http://oilandgas.ohiodnr.gov/. The state's direction will be to continue to take steps to ensure that oil and natural gas development benefits the citizens of the state and does not adversely impact human health and the environment.

CLIMATE CHANGE

The Intergovernmental Panel on Climate Change defines climate change as "A change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use." The National Oceanic Atmospheric Administration defines climate change as "a non-random change in climate that is measured over several decades or longer. The change may be due to natural or human-induced causes."

The climate studies and models reviewed for this section predict multiple impacts from the effects of climate change on the state, these include warmer temperatures, shifting rain and snow patterns, increased flood events and an increased likelihood of extreme weather events by the end of the 21st century. An excerpt of an article from the Ohio State University Climate Change Webinar Series in which State Climatologist Dr. Jeffery Rogers was interviewed, gives an excellent introduction to some of the climate change challenges that the state will be facing in the upcoming years and decades.

> Dr. Rogers suggests that the climate in Ohio has been getting steadily warmer over the years, and will likely continue to do so in the future. While the warmest summers on record are still those of the 1930s Dust Bowl, recent summers like 2002, 2005 and 2010 will be very high on that list, according to Dr. Rogers. But greenhouse gases in

the atmosphere are not the only reason why summers are getting hotter across the Great Lakes region. "I see it continuing also because in Ohio, there's a very strong link between humidity and moisture, which will ensure that temperatures will keep going up," Rogers explains. "Humidity traps more heat, air then retains more humidity, and so on. I think the temperature changes are here to stay," he adds. The effect of humidity on Ohio's climate is especially visible when looking at nighttime temperatures in the state…

The article also states that increased humidity as part of a changing climate in Ohio goes along with another weather phenomenon: precipitation extremes – very large or very small amounts of rain or snowfall in a given time period – have become much larger. Especially in the summer, the state goes without rainfall for long periods of time, followed by heavy rainstorms… "We keep going back and forth like this; a couple of days of heavy rain, then things dry out quite a bit,"…

To understand how global warming and pollution affect the earth's climate, one first has to understand how the planet's temperature is regulated. Radiant energy from the sun strikes the earth's surface and warms it up. Naturally occurring greenhouse gases such as carbon dioxide (CO2) and water vapor absorb radiation coming from the earth that would potentially go to space and allow the planet to cool. This interplay regulates the overall average temperature on earth at around 59 degrees Fahrenheit – 60 degrees warmer than on an earth without greenhouse gases – and thereby makes life on the planet possible. The current problem with climate change is related to an increase in temperature beyond the 59 degree average, which is caused by an excess of greenhouse gases produced by burning fossil fuels like coal or oil. Burning these fossil fuels also produces sulfates and other aerosols that would contribute to "global dimming," or a cooling effect. Human produced aerosols like sulfates scatter solar radiation, making it less able to warm the planet's surface…

However, studies have shown that the net effect of carbon dioxide and sulfates is still one of warming temperatures overall…These higher temperatures caused by additional CO2 trapping more heat close to the earth's surface can result in both droughts and increased precipitation due to higher evaporation of surface waters.

While the term "precipitation" includes both rain and snow, Dr. Rogers also explains that Ohio winters are likely to include more rainfall and less snowfall as climate change continues. In the Great Lakes region, scientists are seeing a delicate balancing act between precipitation and evaporation, which both influence the Great Lakes' hydrologic

cycle, or how water travels between the atmosphere and the ground. "As temperatures increase due to global warming, the lakes will tend to evaporate, but there is also a tendency towards heavier precipitation," Dr. Rogers says, adding that in the worst case scenario the Great Lakes probably won't experience enough precipitation increases to offset the evaporation from higher temperatures. Water levels would tend to go down in this scenario, causing problems not only for recreational areas on the shore, but also because some of the drinking water supply in the region comes from the Great Lakes. http://changingclimate.osu.edu/assets/pubs/articles/studying-world-climate.pdf

OHIO EMERGENCY MANAGEMENT AGENCY SUMMARY ANALYSIS

The scientific studies and data referenced within this section come to one cohesive conclusion, climate change will have an impact on the natural hazards in the state through 2100. The greatest impact to the natural hazards in the state from climate change will be from the changes in precipitation rate and variability. To put it simply, these changes will lead to increased flooding in the spring and fall and increased periods of drought in the summer. Another impact on the state from the effects of climate change is a warming trend that will enhance the possibility of extended and increased extreme heat wave events. This climate change related warming trend will likely lead to an increased evaporation / transpiration feedback cycle, which will lead to reduced availability of water resources.

Since the many of the anticipated effects of climate change exacerbate or accelerate existing natural hazards, many of the possible mitigation and adaptation strategies already exist. Based upon the best available scientific date and studies, Ohio EMA would make the following general mitigation and adaption strategy recommendations:

1. Develop greater built environment resilience
2. Improve stormwater infrastructure
3. Increase water quality and resource protection
4. Enhance essential utility resilience

These recommendations will be useful and positive actions regardless of the long term impacts of the climate change on the state. Each of these recommendations will be addressed in greater detail later in this section.

LITERATURE AND STUDIES REVIEW

The preponderance of available climate change data does not mean that there are not challenges in synthesizing the data from the available scientific sources into both the state and local hazard mitigation plans. There is a considerable amount of climate change data and related studies available, but the spatial context of the majority of these studies can make it very challenging to use both at the state and the local levels. The majority of these studies use a spatial

resolution of the entire United States or a regional approach such as focusing on the Great Lakes or Midwest Regions. There is a limited amount of data available that specifically address the impacts and effects of climate change at the state, watershed or local level.

The fact that climate change is occurring is not disputed. The current scientific data and modeling suggest that climate change has and will impact the state. The challenges in determining the probability and severity of future impacts can make it difficult to determine with an absolute degree of certainty the full degree of impact climate change may have on the state. This is also further complicated by the fact that information gathered is continually evolving. Therefore, this section will not attempt to estimate potential losses. This section will only provide information on the potential impacts climate change may have on some of our already existing hazards profiled within the SOHMP. This section incorporates basic scientific findings and the most current projections for global climate change as they have the potential to impact the state and the Great Lakes Region.

This section will not address any one specific jurisdiction or region in an attempt to determine risk as has been completed for other hazards within this plan update. In some instances examples of potential impacts to specific areas are incorporated. It is important to note that in such instances, the analysis has been conducted by scientists and subject matter experts as referenced, and not by Ohio EMA Staff.

There are exciting and promising studies and initiatives happening in the state right now, which will continue to improve both our knowledge about and our response to the impacts of climate change. Many of these studies are currently only in a draft phase or do not provide enough downscaled data to warrant full inclusion within this current iteration of the plan update. As climate science evolves and improves, future updates to this plan will incorporate any new or improved relevant climate change data.

CLIMATE CHANGE RESEARCH AT THE OHIO STATE UNIVERSITY

The Ohio State University has long been a leader in global climate change research, from physical drivers to impacts to adaptation and mitigation. Research teams across the university are investigating many aspects of global change, including:

- Glaciers, climate change and sea level, atmospheric sciences, contemporary and paleo climate.
- Ecosystem and biodiversity impacts, greenhouse gas monitoring and mitigation, freshwater quantity and quality, economic modeling, coastal community adaptation and mitigation.
- Changes in ecosystem services, risk and decision science, education and community engagement, agricultural impacts and strategies.

THE OHIO STATE CLIMATE CHANGE OUTREACH TEAM
http://changingclimate.osu.edu/

The Ohio State University Climate Change Outreach Team is a partnership among multiple departments within Ohio State University; the team's goal is to help localize the climate change issue by bringing related research and resources to residents of Ohio and the Great Lakes region. The team is comprised of leading academics from Ohio State Extension, the Department of Agricultural, Environmental, & Development Economics, Byrd Polar Research Center, School of Environment and Natural Resources (SENR), Department of Geography, Department of Evolution, Ecology & Organismal Biology, Ohio Agricultural Research and Development Center (OARDC) and the Ohio Sea Grant College Program & Stone Laboratory.

The team provides regular webinars that address various climate change related topics, with a focus on the Great Lakes region and the State of Ohio. Some of the more recent webinars have covered topics such as:

- Climate Change Impacts on Fisheries in Lakes Michigan and Huron
- Climate Change & Harmful Algal Blooms in Lake Erie
- Climate and Carbon Impacts on Productivity, Chemistry, and Invasive Species in the Great Lakes
- Making Climate Change Data Relevant at a Local Level
- Movement of Climate Change Knowledge Through Social Networks
-

UNITED STATES ARMY CORP OF ENGINEERS (USACE) - NATIONAL WEATHER SERVICE - RESPONSES TO CLIMATE CHANGE PROGRAM PILOT STUDY OF THE OHIO RIVER BASIN
http://www.ohioriverbasin.org/wp-content/uploads/2010/10/RCC-ORB-Task-5.pdf

This study is currently being undertaken by the National Weather Service with funding provided by the USACE through the Corp's Institute for Water Resources. This pilot study's primary focus is on the Ohio River Basin and the possible impacts of climate change on Federal water resources infrastructure and systems. This pilot study is one of the first studies that has developed a downscaled model using current climate change data. This model was developed using archived CMIP3 and CMIP5 Climate and Hydrology Projections, which were in turn downscaled to the river basin level. The pilot study is currently in the draft phase, but the downscaled modeling results have been released. The downscaled modeling results included both observed data for the 1951-2001(R1) and three 30 year forecast periods; 2011-2040(F1), 2041-2070(F2) and 2071-2099(F3). The pilot study produced stream flow outputs for the following nine measures:

1. Annual % change mean flow
2. Annual % change maximum flow
3. Annual % change minimum flow
4. March % change mean flow
5. March % change maximum flow
6. March % change minimum flow
7. October % change mean flow
8. October % change maximum flow
9. October % change minimum flow

Thematic basin maps have been created to represent the above noted data, these maps highlight the percent changes for the three 30-year periods which are referenced in the maps below as F1 (2011-2040), F2 (2041-2070) and F3 (2071-2099). The thematic basin maps for the percent change in annual maximum stream flow and percent change in October maximum stream flow have been included for reference. The remainder of the thematic basin maps are available in the draft study.

The downscaling of these ensemble climate models suggest the overall mean, maximum and minimum flows will generally be within range of recent history through the year 2040. After the year 2040, the increases occur in the mean and maximum flows in the 10% to 40% range. There are some watersheds in the northern and eastern Ohio that appear to experience greater than 40% increases in mean and maximum flows. This appears to occur primarily from later summer until early winter. The autumn increases in maximum flows may enhance early cool season flood events in late autumn and early winter. These increases could lead to worsening spring flooding beyond 2040. The models suggest that droughts could lengthen or shift more between spring, summer and autumn beyond 2040. The models also suggest that the overall variability is also likely to increase with time as well. The final draft of this study will not be complete until 2015 and any additional data provided in the final study will be incorporated into future plan updates.

Percent Change in Annual Maximum Stream Flow: In terms of the annual % change in the annual max flows; F1 shows an increase in the max flows across portions of PA and WV within the basin. In F2, this higher max discharge trend continues, but spreads into OH and IN and the Cumberland River watershed.

The % change in max flow increases markedly in the Kanawha and Big Sandy River sub-basins. In F3, the annual % change in max flows increases substantially across PA, WV, OH, IN and IL. The increase in annual % change in max flows appears significant in the Big Sandy River watershed during this third period. The progression of these flow changes is shown below in the three figures.

Percent Change in October Maximum Stream Flow: Period F1 shows increases in % change of max flow over much of the basin and substantially higher October flows in the Allegheny River and Little Wabash River watersheds and significant increases in the Kanawha, Scioto, Big Sandy and White River watersheds over the base condition.

Period F2 shows some relaxing of the wetter October conditions but the Kanawha, White River and Little Wabash remain higher than the base condition flows. Period F3 shows a return to higher October flows across the basin with the exception of central OH and KY. Substantial increases during this period are seen in the Big Sandy River, White River and Wabash River watersheds.

THE IMPACT OF CLIMATE CHANGE AND POPULATION GROWTH ON THE NFIP THROUGH 2100

http://www.aecom.com/deployedfiles/Internet/News/Sustainability/FEMA%20Climate%20Change%20Report/Climate_Change_Report_AECOM_2013-06-11.pdf

This study was funded by FEMA at the request of the Government Accountability Office. The goal of the study is to gain a better understanding of the potential impacts of climate change on the National Flood Insurance Program. This study focused on both riverine and coastal flooding throughout the U.S. with estimates at 20-year intervals through the year 2100. The study relied on existing data, studies, reports, and research. Although no new climate modeling was performed for this study, the methods used to evaluate the data were innovative. The study found that in riverine environments the, typical 1% annual change of floodplain, nationwide is projected to grow by about 45% with areas in the northwest and the Great Lakes region experiencing growth that may exceed 100%. Nationally, 30% of that 45% increase in floodplain is due solely to population growth and would occur without the effects of climate change. That study suggests that 70% of that 45% increase in floodplain riverine areas is due solely to climate change and would occur even if there was no population growth. For reference, the below maps indicate the projected increases in both the percent change in 1% annual flood discharge through 2100 and the median projected percent change in special flood hazard areas through 2100. These results reflect nation averages only and are not intended to be interpreted locally.

Figure 4-5. The median (50th percentile) relative change of the 1%-annual flood discharge at epoch 5 (2100). Changes are with respect to current conditions.

Figure 4-10. The median (50th percentile) relative change of the SFHA at epoch 5 (2100). Changes are with respect to current conditions.

CONFRONTING CLIMATE CHANGE IN THE U.S. MIDWEST - OHIO
http://www.ucsusa.org/assets/documents/global_warming/climate-change-ohio.pdf

The Union of Concerned Scientist produced a report which has new projections showing some of the potential impacts of climate change on Ohio, including severe summer heat, more dangerous storms and floods, and new threats to agricultural production. The report's analysis projects hotter summers for the state, including increased threats of drought or prolonged heat waves. The report suggests flood patterns will change with winters, springs and falls becoming wetter, while the drought patterns indicate that summers will become drier. The report projects more frequent downpours and that precipitation is more likely to come in the form of heavy rains. The changes in precipitation, drought and heat patterns will cause more heat related stress on crops and livestock. The changing weather patterns may also lead to a greater amount of crop pests and pathogens ranging farther northward.

CLIMATE CHANGE IN THE MIDWEST: IMPACTS, RISKS, VULNERABILITY, AND ADAPTATION

S.C. Pryor, Provost's Professor of Atmospheric Science at Indiana University Bloomington and editor of the Journal of Geophysical Research Atmospheres edited and released Climate Change in the Midwest: Impacts, Risks, Vulnerability, and Adaptation in 2013. This book presents research that focuses on identifying and quantifying the major vulnerabilities to climate change in the

Midwest. The book addresses the key sectors that may have vulnerabilities amplified by the effects of climate change, including agriculture, human health, water, energy and infrastructure.

The climate vulnerability assessment performed in the book came to the following conclusions for the Midwest:

1. The average temperature may increase 1 to 3 degrees Celsius over the next several decades. Projected change in the climate models indicate a clear tendency towards increased frequency of heat waves. Further cold-air outbreaks and other extreme cold spells will still occur but with reduced likelihood.
2. That rainfall will increase variably across the Midwest over the next several decades. The rainfall potential will increase 20-30% in the spring and winter months and there will be a significant increase in variability of precipitation events in the summer and fall months. There is evidence to suggest a split in future rainfall events, leading to a greater likelihood of droughts in the summer months and floods in the fall months.
3. Some other affects include the likelihood of warmer nights and possibly warmer days leading to an increased susceptibly to pests. The warming will likely cause a reduction in crop yields and the evaporation / transpiration feedback will lead to less available water resources.
4. The projected soil loss through erosion is expected to be significant and greater than anything that has occurred in the previous century.
5. The most direct impact of climate on human health is heat-related morbidity and mortality. The climate models indicate that an increase in heat stress across all models over the course of the 21st century.
6. Using the concepts of stream flow elasticity, projected increases in precipitation over much of the Midwest are estimated to increase by 16-20%

CLIMATE CHANGE'S IMPACT ON NATURAL HAZARDS

This plan update will not address any one specific jurisdiction or region in an attempt to determine risk as it has been completed for other hazards within this plan update. This section will only supply already existing information on how changes in the climate have the potential to affect our state's natural hazards.

DROUGHT, EXTREME SUMMER WEATHER AND INVASIVE SPECIES

The studies and reports referenced above indicate that a warming trend will increase over the next several decades up to the extent of the studies/reports which is 2100. This warming trend will increase the possibility of extended and increased extreme heat wave events. The average temperature may increase 1 to 3 degrees Celsius over the next several decades throughout the Midwest. The projected change in the climate models indicate a clear tendency towards increased frequency of heat waves. Further cold-air outbreaks and other extreme cold spells will still occur but with reduced likelihood. The studies

suggest that a warming trend combined with increased variability of rainfall events in the summer months will lead to increasing periods of drought in the state and the great lakes region. The models suggest that droughts could lengthen or shift more between spring, summer and autumn beyond 2040. The warming trend will likely cause a reduction in crop yields and the evaporation / transpiration feedback will lead to less available water resources for human consumption, recreation and agricultural purposed. The changes in precipitation, drought and heat patterns will also create more heat related stress on crops and livestock. The changing weather patterns may also lead to a greater amount of crop pests and pathogens ranging farther northward.

FLOODING, SEVERE THUNDERSTORMS, SEVERE WINTER/ICE STORMS

The studies and reports reference above indicated that one of the primary impacts on the state from climate change will be the changes in precipitation rates and variability. The studies also indicated that rainfall will increase variably across the Midwest over the next several decades. The increased variability of precipitation events will mostly occur in the summer and fall months. There is evidence to suggest a split in future rainfall events, leading to a greater likelihood of droughts in the summer months and floods in the fall months.

The studies also indicated that after the year 2040, the increases occurring in the mean and maximum stream flows will be in the 10% to 40% range with the north and northeast parts of that state experiencing greater than 40% increases. These increases appear to occur primarily from later summer until early winter, with the autumn increases in maximum stream flows enhancing early cool season flood events in late autumn/early winter. These increases also indicated the possibility of worsening spring flooding beyond 2040.

MITIGATION AND ADAPTION STRATEGIES

As the climate change data specific to the state becomes more readily available, one of the focuses of dealing with the impacts will be mitigation and adaptation. Ohio EMA has recommended four mitigation and adaption strategies that will help alleviate the future impacts of climate change on the natural hazards within the state. These strategies are recommended because they will have positive impacts regardless of climate change and its predicted long term impacts.

DEVELOP GREATER BUILT ENVIRONMENT RESILIENCE

The built environment refers to the any buildings or structures which are manmade as opposed to the natural environment. Developing resilience in the built environment is an important mitigation action, especially when you factor for the probability of increasing precipitation rates and variability. Examples of actions that increase resilience of the building environment include:

- Reduce the number of pre-FIRM flood prone, repetitive Loss and severe repetitive loss structures through FEMA mitigation grant programs.
- Adopting building, zoning and floodplain regulations that include higher standards than the minimum regulatory requirements.
- Encourage resilient local land use regulation through the Ohio Balanced Growth Initiative.

IMPROVE STORMWATER INFRASTRUCTURE

Stormwater infrastructure is normally designed to convey or capture flows associated with a designed storm event, the scale of which is based on a probability distribution of observed rainfall events. One of the underlying assumptions of the atypical design approach is that the rainfall probability distribution is static. The best available climate change models indicate in the future larger precipitation events will occur with an increasing frequency. The existing stormwater infrastructure which was designed with current storm approach cannot be expected to provide the intended level of protection throughout its lifetime service. Examples of actions that improve stormwater infrastructure are:

- Encourage increased green infrastructure and the use of low impact development strategies to reduce stormwater.
- Seek to minimize impervious surfaces such as parking lots, roads, and rooftops in sensitive areas.
- Encourage riparian buffers along streams, rivers, and waterways to maintain natural floodplains.
- Protect and reestablish wetlands to hold runoff and recharge groundwater.
- Implement the separation of combined storm and sanitary sewer overflows to reduce pollution from sewage, bacteria, and E. Coli entering waters during storm events.

INCREASE WATER QUALITY AND RESOURCE PROTECTION

The current climate change models indicate that its effects will have a variety of impacts on ground water resources and water quality. The higher water and air temperatures and changes in the timing, intensity, and duration of precipitation will impact water quality and ground water resources. Examples of actions that can be pursued to increase water quality and provide ground and surface water resources protection include:

- Encourage effective water-conservation strategies the general public during summer months, and consider year-round water-conservation strategies for water-intensive users.
- Implement the separation of combined storm and sanitary sewer overflows to reduce pollution from sewage, bacteria, and E. Coli entering waters during storm events.

- Recommend sewer and septic systems be upgraded to reduce non-point source pollution from urban areas, farmland, and other sources.
- Ensure that water extractions and diversions are appropriately planned and factor the future impacts of climate change.

ENHANCE UTILITY AND ENERGY RESILIENCE

Water, electricity, and wastewater treatment are three utility services that are essential for modern daily life. These three utilities support business, industry, recreation, housing, hospitals and schools in communities across the state. These essential utility services have been traditionally planned, designed and operated with an assumption that the future environment is mostly static and predictable. The scientific climate change models show that increasingly variable and extreme precipitation patterns and temperature increases crises will intensify the risks faced by these essential utility services. With these risks in mind, essential utilities need to be working to strengthen their resilience to extreme climate events, also seeking ways to mitigate the impacts of climate change. Examples of actions that can be pursued to assist utilities services in increasing their resiliency include:

- Engage and educate stakeholders, having their active engagement will help to build shared a understanding and support for utility initiatives
- Strengthen existing utility transmission generation networks so they are able to cope with the future demand resulting from climate change.
- Encourage the development and construction of green infrastructure to help lessen the impact of the increasing extreme climate events.
- Support the upgrade neglected infrastructure networks to provide an efficient supply of utilities.

CLIMATE CHANGE ADAPTATION LITERATURE AND STUDIES REVIEW

There are several current studies that suggest various climate change adaption strategies for the Great Lakes or Midwestern region. Many of these studies do not provide enough downscaled data or go into sufficient detail to warrant full inclusion within this current iteration of the plan update. As climate science evolves and improves, future updates to this plan will incorporate any new or improved relevant climate change adaption strategies.

CLIMATE CHANGE ADAPTATION IN GREAT LAKE CITIES STUDY

http://deepblue.lib.umich.edu/handle/2027.42/97435

This study looks at the anticipated impacts of climate change and how those impacts affected different communities throughout the state. Researchers have identified a variety of resources, assets, and governance structures that increase the ability and likelihood of successful adaptation, even in the face of significant uncertainty. In order to anticipate and successfully respond to these impacts,

cities in the state need to better understand the opportunities and constraints within their own organizations.

To evaluate this capacity, an Integrated Assessment was conducted for four cities in the state (Toledo, Dayton, Elyria, and Avon Lake). The study takes a broad view of the political, social, and ecological causes, consequences, and potential solutions to climate vulnerability and impact reduction. The results of the study describe the capacities and constraints each city possesses, as well as identifies best practices cities can implement to take advantage of these capacities and overcome constraints. Each city had specific capacities and constraints based on the analysis, several overarching themes emerged. Decision-makers in each city expressed interest in adapting to climate change. Leaders within city governments are working to connect issues of sustainability and adaptation to the core mission of their departments, as well as forming policy networks across the city. Overall, leadership and the quality of current city employees emerged as key capacities throughout the study, but there are significant constraints to adaptation as well. Two broad trends identified are scarce financial resources and limited access to scientific knowledge. The lessons learned in this study could be applied to future plan updates as additional appropriate climate change data become available statewide.

ADAPTING TO CLIMATE CHANGE: A PLANNING GUIDE FOR STATE COASTAL MANAGER'S – A GREAT LAKES SUPPLEMENT

http://coastalmanagement.noaa.gov/climate/docs/adaptationgreatlakes.pdf

This report for the Great Lakes region is intended to provide additional detail and supplement the Adapting to Climate Change: A Planning Guide for State Coastal Managers, which the National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resources released in 2010. The report included information on climate change and steps to help set up a planning process, assess vulnerability, devise a strategy, and implement a plan to minimize climate change impacts on the Great Lake's coasts. The planning guide also provides an extensive list of resources to help throughout the planning and implementation process.

The report provides updated data and information on the potential climate change impacts and effects for Great Lakes coastal areas. It highlights case examples of adaptive actions taking place in the Great Lakes region today, many of which are still in the planning and policy development stages.

CLIMATE CHANGE IN THE MIDWEST: IMPACTS, RISKS, VULNERABILITY, AND ADAPTATION

S.C. Pryor, Provost's Professor of Atmospheric Science at Indiana University Bloomington and editor of the Journal of Geophysical Research Atmospheres edited and released Climate Change in the Midwest: Impacts, Risks, Vulnerability, and Adaptation in 2013. This book's research focuses on

identifying and quantifying the major vulnerabilities to climate change in the Midwest. The book also makes several adaption recommendations for the Midwest as well. The recommendations are representative of some of the adaption recommendations that future plan updates may include once the climate change data related to the state coalesces.

1. Management of water resources should be a priority; this includes building resilience to flooding, addressing issues related to the Great Lakes, and addressing the results of changing precipitation regimes in the implications for flooding.
2. Eliminating combined sewer and stormwater systems in large population centers may help improve resiliency to the extreme precipitation events.
3. Climate change will also influence the supply and demand for energy and the ability of critical distribution networks to deliver electricity to consumers, and thus the energy sector must be a key and continuing focus for measures to reduce vulnerability to climate change, variability and extreme events.

CONCLUSION

The Ohio State University's climate outreach team provided an excellent summation of climate change, "Climate change, two words that are already synonymous with changes in weather patterns across the world, from global warming to increased rainfall and severe storms. But climate change affects different areas in different ways – while some regions will see increased precipitation in the form of snow or rain, others will dry out because of reduced rainfall. And while overall temperatures across the globe are likely to increase, climate change can also be related to an increase in freezing temperatures and severe winter storms. Ohio is likely to be affected by a number of these phenomena, and adapting to different weather conditions will be important to maintain quality of life in the area."

Climate change acts as an amplifier of existing natural hazards. The fact that climate change is occurring is not disputed and over the past several decades there has been a marked increase in the frequency and severity of weather-related disasters both nationally and in the state. This trend is being driven in part by changing global and regional climate conditions. The preponderance of available scientific evidence for anthropogenic forcing of climate change is overwhelming, or simply stated climate change is, in part, being caused by human actions, rather than natural factors alone. It is important that all levels of government and all sectors of society have at least a basic understanding of the potential impacts of climate change. The best available scientific data and modeling suggest that climate change has and will continue to impact natural hazards in the state. While the impacts of climate change may vary by regions and jurisdictions throughout the state, it is clear that the potential

consequences of climate change will have significant impacts on all the citizens of the state.

As downscaled climate change data becomes more readily available the state will assess its vulnerability in terms of population, structures and critical facilities at risk. The state will also encourage the inclusion of such data in local hazard mitigation plans once the data is granular enough to support the analysis.

2.16 CONSEQUENCE ANALYSIS

The EMAP standard for a HIRA requires the state program to include a consequence analysis for hazards identified in state HIRAs. The consequence analysis should consider the impact on the public; responders; continuity of operations including delivery of services; property, facilities and infrastructure; the environment; the economic condition of the state; and, public confidence in the state's governance.

Impact on the public

Based on the HIRA in the SOHMP, there is neither record of a historical event or impacts as identified in the vulnerability analysis that would be considered catastrophic from a statewide perspective. Historically, other than emerging disease/pandemic outbreaks, hazard events in Ohio tend to be moderate in size – possibly approaching widespread, but not necessarily rising to the level of catastrophic. Three natural hazard events that may have a broader impact on the public would be a large earthquake on the New Madrid fault, a statewide blizzard (such as the blizzard of 1978) or a widespread flood (Great Flood of 1913). Still, the impacts on the public from these three events would be moderate. Perhaps the hazard with the greatest impact on the public (in terms of numbers of individuals adversely affected) would be an emerging disease/pandemic outbreak or a terrorism event that included a nuclear dispersion device.

Impact on responders

Because it is unlikely that hazard event would be widespread enough in Ohio to be "catastrophic," existing mutual aid mechanisms and the ability to exercise Emergency Management Assistance Compact (EMAC) should be sufficient to handle any hazard event. The exception to this may be an emerging disease/pandemic outbreak.

Continuity of Operations (COOP)

Communities and the State of Ohio continually develop and update COOP plans in the event facilities and/or agencies are impacted. State agencies also maintain disaster recovery plans which are largely IT focused. It is expected that affected agencies would exercise their COOP plans as appropriate. Private sector businesses are encouraged to develop business continuity plans, but such planning is not mandated by the state.

Property, facilities, and infrastructure

The SOHMP has attempted to collect and create risk assessments and vulnerability analyses for the various hazards profiled. One note of caution in utilizing these data is that aggregate dollar damage amounts and facilities affected by a multi-county region are for purposes of comparison in the SOHMP only. The SOHMP does not imply that a whole region would actually have an

event occur where the maximum damages are sustained in all of the counties identified in the region.

Environment

Any hazard event has the potential for environmental impact. Flood events, for example, may result in pollution of streams and rivers due to combined sewage overflows, or a tornado/wind event will disperse debris over a widespread area. A drought may affect the environment in a different way by drying up wetlands, and weakening/killing trees and forestlands. Four hazards that have a significant potential for environmental impact are: nuclear detonation/dispersion, emerging disease/pandemic outbreak, flooding, and invasive species. The latter two hazards were profiled and evaluated for risk in this plan.

Economic condition of the state

Because most hazards in Ohio would not result in a statewide catastrophe, the economic impacts, while potentially severe, would be recoverable. Also, Ohio has a diverse economy with geographic concentrations of various industries (*e.g.*, manufacturing in Cleveland/Akron/Youngstown). From a geographic perspective, an event that would affect the greater Cleveland, Columbus, or Cincinnati area would have a greater impact than would a hazard affecting other portions of the state since these are major metropolitan areas. Similarly, an invasive species or pest that could affect the corn or soybean crop statewide, or a drought, might result in a more widespread deterioration of the economic condition of the state. Finally, an event affecting Columbus (Franklin County), as it is the seat of state government, could have a significant impact, as centralized processing of payments to citizens for a variety of programs could be interrupted.

Public confidence in state governance

As has been demonstrated in catastrophic events in other states and countries, public confidence in state governance is tightly linked to the government's response to a hazard event. Even in more regionalized or local disasters this is the case; although, the effect of the disaster on public confidence is similarly regionalized or localized. The hazards most likely to have a widespread effect on public confidence in state governance are those that either have the probability of statewide effect (drought, blizzards), those that have a high impact or consequence (terrorism, nuclear detonation/dispersion, emerging disease/pandemic outbreak) and those that have a short speed of onset (terrorism or earthquakes).

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Appendix I: Ohio Hazard Identification & Risk Assessment

Appendix J: State Hazard Analysis, Resource and Planning Portal (SHARPP)

Appendix K: Rural Electric Cooperative Addendum

(E) Indicates requirement for State Enhanced Plan

LIST OF ACRONYMS

Acronym	Definition
AFRRI	Appalachian Flood Risk Reduction Initiative
ARC	Appalachian Regional Commission
AUM	Abandon Underground Mine
BCA	Benefit Cost Analysis
BOCA	Building Officials and Code Administrators International
CAR	Communities At Risk
CCC	Civilian Conservation Corps
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
CHIP	Community Housing Improvement Program
CRS	Community Rating System
DAE	Disaster Assistance Employee
DAS	Ohio Department of Administrative Services
DMA 2000	Disaster Mitigation Act of 2000
DOW	Division of Water (Ohio Department of Natural Resources)
DSP	Dam Safety Program
EAP	Emergency Action Plan
EMAP	Emergency Management Accreditation Program
ENSO	El Niño - Southern Oscillation
EOC	Emergency Operations Center
EPL	Estimate of Potential Losses
FD	Fire Department
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Map
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance

Acronym	Definition
FPM	Flood Plain Management
GAR	Governors Authorized Representative
GIS	Geographic Information System
HAZUS-MH	Hazards United States - Multi-Hazard
HIRA	Hazard Identification & Risk Assessment
HMGP	Hazard Mitigation Grant Program
HSIP	Homeland Security Infrastructure Program
HUD	Housing & Urban Development
IA	Individual Assistance
ICC	Increased Cost of Compliance
JCARR	Joint Committee on Agency Rule Review
LHMP	Local Hazard Mitigation Plan
LULC	Land Use/Land Cover
MCD	Miami Conservancy District
MHIRA	Multi-Hazard Identification and Risk Assessment
MMI	Modified Mercalli Intensity
MSA	Metropolitan Statistical Area
NCDC	National Climatic Data Center
NDMC	National Drought Mitigation Center
NEHRP	Nation Earthquake Hazards Reduction Program
NFIP	National Flood Insurance Program
NID	National Inventory of Dams
NOAA	National Oceanic Atmospheric Administration
NPDP	National Performance of Dams Program
NUCI	National Urban Change Indicator
NWS	National Weather Service
OAC	Ohio Administrative Code
OAKS	Ohio Administrative Knowledge System
OBBC	Ohio Basic Building Code
OBC	Ohio Building Code
OBM	Office of Budget and Management
ODC	Ohio Department of Commerce
ODH	Ohio Department of Health
ODI	Ohio Department of Insurance
ODNR	Ohio Department of Natural Resources

Acronym	Definition
ODNR-DDS	Ohio Department of Natural Resources - Division of Dam Safety
ODNR-DOW	Ohio Department of Natural Resources - Division of Water
ODNR-FPM	Ohio Department of Natural Resources - Flood Plain Management
ODOD	Ohio Department of Development
ODOT	Ohio Department of Transportation
ODSA	Ohio Development Services Agency
OEPA	Ohio Environmental Protection Agency
Ohio EMA	Ohio Emergency Management Agency
OHPO	Ohio Historical Preservation Officer
OHS	Ohio Historical Society
OLCA	Ohio Lake Communities Association
OLEC	Ohio Lake Erie Commission
OMB	Office of Management and Budget
OMHC	Ohio Manufactured Homes Commission
OMPAT	Ohio Mitigation Plan Advisory Team
OMSIUA	Ohio Mine Subsidence Insurance Underwriting Association
OPWC	Ohio Public Works Commission
ORC	Ohio Revised Code
ORM	Office of Risk Management
OSU	The Ohio State University
OWRC	Ohio Water Resources Council
PA	Public Assistance
PAS	Planning Assistance to States
PDA	Preliminary Damage Assessment
PDM	Pre-Disaster Mitigation Grant Program
PDM-C	Pre-Disaster Mitigation-Competitive Grant
PDSI	Palmer Drought Severity Index
POC	Point of Contact
PUCO	Public Utilities Commission of Ohio
REC	Review of Environmental Consideration or Rural Electric Cooperative
RFC	Repetitive Flood Claim
SBA	Small Business Administration
SCIP	State Capital Improvements Program
SFHA	Special Flood Hazard Area

Acronym	Definition
SHARPP	State Hazard Analysis Resource and Planning Portal
SHMO	State Hazard Mitigation Officer
SHMP	State Hazard Mitigation Plan
SHMT	State Hazard Mitigation Team
SOHMP	State of Ohio Hazard Mitigation Plan
SOI	Southern Oscillation Index
SRL	Severe Repetitive Loss
STORMS	State of Ohio Rain/Snow Monitoring System
SWL	Still Water Level
SZEA	State Zoning Enabling Act
TRAC	Transportation Review Advisory Council
U.S.C.A.	United States Code Annotated
USACE	United States Corps of Engineers
USFW	United States Fish & Wildlife Service
USGS	United States Geological Survey
VOAD	Voluntary Organizations Active in Disasters
WMAO	Water Management Association of Ohio
WPCLF	Water Pollution Control Loan Fund
WUI	Wildland Urban Interface
WWTP	Waste Water Treatment Plant