

1 Planning Process

The Planning Process section of this document lays out the methods used to prepare the Hazard Mitigation Plan (HMP). This section explains the purpose and need for a HMP and the key stakeholders and their roles in creating the Plan. Since this plan addresses issues within Macomb County, the thoughts and concerns of the public are greatly needed and valued. The Planning Process also explains the methods used to advertise the update of the Plan and reach out and inform the public on the Plan. This section also presents the results of the outreach efforts and lays out the steps for plan preparation leading up to the "Hazard Identification" portion of the process. The next chapter of this Plan will address the methods used to identify and analyze hazards and the vulnerability of the County to those hazards.

1.1 PURPOSE OF HAZARD MITIGATION PLAN

Hazards affect all people in the community either directly by suffering loss or indirectly by experiencing the economic burden of recovery and rebuilding from a disaster. Thus, it is crucial when developing a Hazard Mitigation Plan, to involve all members of the community during the planning process. Numerous opportunities were provided throughout all phases of this process for the public to be informed, educated, and to comment and make suggestions on the Plan. This section will present the methods used to gain a broad, diversified cross-section of public input from various perspectives and individuals throughout Macomb County and its surrounding communities.

1.2 PARTIES INVOLVED

The planning process involved a variety of parties including the Macomb County Office of Emergency Management (OEM), Spalding DeDecker Associates, Inc. (SDA), the Michigan State Police Emergency Management Department (MSP EMD), individual community administration offices and emergency management divisions, police and fire departments, and county residents. Macomb County's Local Emergency Planners Committee (LEPC) utilized the existing Medical subcommittee as the authority on the HMP and kept the participating planning officials abreast of the issues regarding the update of the plan and its implementation. Please refer to Appendix E for meeting minutes for the Hazard Mitigation Plan related meetings.

1.3 PLANNER'S ROLES

The Macomb County OEM was the lead agency. The 2002 Plan served as a baseline Plan. The new Plan has been updated to meet the new requirements established by the federal government and it addresses deficiencies from the 2002 Plan identified by Federal Emergency Management Agency (FEMA) and the MSP EMD.

Spalding DeDecker Associates, Inc. was hired by the county to review, update and revise the Plan to meet with FEMA requirements. SDA spearheaded the effort of obtaining public involvement, and with 50 years of service in and around Macomb County, was able to bring an extensive knowledge of the County to the planning process.

The Macomb County Planning Department provided electronic maps to be used with the Geographic Information System (GIS). These maps allow for easily accessible and critical information and identification dealing with hazard areas and their impact on the community.

The Macomb County Management Information Services (MIS) developed and maintained a web site dedicated to the Hazard Mitigation Plan. This site was updated regularly throughout the planning process to keep the public involved with new information about the plan, methods of reviewing and commenting on the plan, and postings of meetings they could attend.

1.4 PUBLIC INVOLVEMENT METHODS

In order to keep the entire County informed and educated on the Plan revision and its status, various types of media were utilized to reach the people in the communities.

1.4.1 Newspapers

Press releases were sent to four local newspaper publishers within the County. These publications included The Macomb Daily, The Detroit Free Press, The Detroit News, and The Voice. The press releases included general information about the Hazard Mitigation Plan, and also discussed what the public's role would be during the process. The main intent of the articles was to inform the public on the revision process that would be taking place and to advertise the "Town Hall Meetings" scheduled at various locations throughout the County. Additionally, the address of the Hazard Mitigation Plan web site on the County's web page was also provided. Three of the four publications printed an article or an excerpt regarding the HMP. These articles were published in their newspaper distributions as well as on the publications' web sites. (Please see Appendix A for copies of the press releases and the articles, respectively).

1.4.2 Town Hall Meetings

Four (4) Town Hall Meetings were scheduled and conducted at various locations throughout the County. Residents of communities that were determined to have similar hazard issues and characteristics (i.e. – rural, industrial, shoreline, etc.) were instructed to attend a meeting located in their region. However, all meetings were opened to all community residents willing to attend. A table with the meeting locations and times is shown below.

A power point presentation was prepared highlighting the history and importance of the HMP, historical and potential hazards affecting Macomb County, success stories, and community and public involvement. During the presentations, residents were also invited to visit the County's HMP web site for further updates, information, and other ways to stay involved throughout the process. A copy of the presentation is included in Appendix B.

Communities	Meeting Date, Time, & Location
Shelby, Macomb, Clinton, Fraser, Roseville, or Eastpointe	Tuesday, June 22, 2004 at 7:00 p.m. Verkuilen Building 21885 Dunham Clinton Township, MI
Chesterfield, New Baltimore, Mt. Clemens, Selfridge ANGB, Harrison, St. Clair Shores, or Lake	Wednesday, June 23, 2004 at 7:00 p.m. Verkuilen Building 21885 Dunham Clinton Township, MI
Warren, Sterling Heights, Center Line, or Utica	Thursday, June 24, 2004 at 7:00 p.m. Warren Community Center 5460 Arden Warren, MI
Bruce, Armada, Richmond, Memphis, Washington, Ray, Lenox, New Haven, or Romeo	Wednesday, June 30, 2004 at 7:00 p.m. Richmond Township Hall 34900 School Section Road Richmond Township, MI

1.4.3 Web Site

One of the most effective ways to involve many people and gain input is through the Internet. Utilizing the existing Office of Emergency Management site, the County built a number of pages dedicated to the HMP. The site, <http://macombcountymi.gov/OEM/index.asp>, provides links for the following:

- Town Hall meeting locations
- Planning Committee
- Existing Plan
- Public Input
 - Incident Report
 - Comments, Questions Form
- Information Link (additional info sites)
- Community Survey

These tools allowed residents and community officials to review the County's existing plan and look for ways to improve upon it. In addition, upcoming meetings and agendas were posted as well as online forms where questions or comments could be submitted. The Incident Report link allowed residents to report hazards they have experienced.

1.4.4 Community Surveys

In order to identify the hazards affecting the County and gain sufficient knowledge on the vulnerability of the County to these hazards, more detailed information was gathered. The County chose to poll each of the individual communities with a Hazard Survey. The survey addressed many issues pertinent to analyzing risks and hazards and developing mitigation actions. The survey included sections on critical facilities/infrastructure, maps, historical hazard occurrences, hazard rating, and proposed mitigation projects.

The surveys were mailed to each mayor or supervisor of the communities in Macomb County. Surveys were also mailed to the Emergency Management Offices of Clinton Township, Fraser, Harrison Township, Sterling Heights, and the City of Warren. Surveys were also sent to various police and fire departments throughout the County upon request. Electronic versions were also made available on the web page so that lengthier responses could easily be included in the document, printed, and submitted back to the County for review and analysis. Please refer to Appendix D for a sample letter, a copy of the community survey, and a list of community leaders and other officials who worked to complete and return the surveys.

1.4.5 Other Advertisement Methods

In addition to the meeting times being published in the newspapers and posted on the web site, other sources of media were used. The Warren community channel broadcast the meeting information on their local cable television stations. After the press release, Macomb County's Office of Emergency Management was contacted not only by the newspaper reporters but also by News Radio WWJ 950 AM. Pete Locke in the OEM gave an on-air interview about the Plan and how the public could be involved.

1.5 RESULTS OF OUTREACH EFFORTS

Some of the efforts implemented for public involvement proved to be quite effective while others received little response. Several types of media were used to reach multiple demographics. A number of methods were used to accommodate those who prefer television and computers or reading newspapers. In spite of the County's best efforts, public attendance and input was sparse.

The Hazard Mitigation Plan web site was up and running on June 21, 2004, with some pages still under construction. The information regarding the "Town Hall" meetings was posted on this date as well. Additions were made to the site over the course of the next few weeks. A downloadable version of the plan was soon added for people to review. The final pages, which included the Incident Report, Comments & Questions, and Community Survey, were completed and posted on July 9, 2004.

The four newspaper publications were contacted first via phone conversation to inform them of the Plan. Press releases were then faxed to the respective contacts at the publications the same day, June 9, 2004. Articles were published in the Macomb Daily and The Detroit Free Press newspapers and on their web sites on June 17, 2004. The Detroit News ran an article on June 28, 2004, regarding the plan and the meeting dates and locations. The Voice (a weekly publication) did not run an article due to space constraints. The City of Warren was very proactive in advertising the meeting information. They posted the information on their web page and also ran it on their community cable station.

However, in spite of the numerous articles and in papers and the information available online, only a handful of residents showed up to one meeting. Please refer to Appendix C for “sign-in” sheets to document those present at the meetings.

Every participating community within the County completed a Community Survey. However, the exception, Lake Township is covered under Wayne County’s Plan and opted out of the Macomb County Plan. Therefore, this community did not complete a survey. The City of Memphis also opted out of Macomb County’s Plan since it was covered under St. Clair County’s Plan. However, this community still completed and submitted a survey.

1.6 PLAN PREPARATION

The official notice to proceed on the Plan was issued by the County on May 10, 2004. A Local Emergency Coordinators meeting was held on May 19, 2004, where numerous emergency officials within the communities were in attendance. The Plan was discussed as an item during this meeting and was introduced to the emergency planners in the County.

The next step in the planning process was to hold a kick-off meeting. This meeting took place on May 19, 2004, at the Macomb County Office of Emergency Management. The items discussed were public involvement methods, dates and times to hold the meetings, content of the web site, and information to include in the press release.

Following the meeting, the tasks discussed were completed in the following order. The web site layout was started, press releases were distributed, and copies of the published articles were obtained. Web site work continued, Town Hall meetings were held, GIS data was requested from the Macomb County Planning Department, and the Mayors and Supervisors of each community were sent a survey to gain a cross-section of the County and the hazard issues affecting it.

2 Hazard Assessment

This chapter identifies and prioritizes the hazards and risks relevant to Macomb County and its communities for mitigation action. The hazards are identified in a three-step process:

1.) County Profile. The county profile summarizes the location, climate, population, development, and land uses for Macomb County. Unique features and issues are also identified for individual communities.

2.) Hazard Identification. The hazards to which Macomb County is susceptible are identified through the MSP EMD PUB-103, record searches, public hearings, and community surveys.

3.) Hazard Assessment. The hazard assessment is accomplished for each hazard to evaluate impact based on severity, exposure, frequency, and types and extent of damage. The hazard assessment includes an assessment of the risk of occurrence and the vulnerability of the county and communities to each hazard. The vulnerability assessment pulls it all together by comparing and contrasting geographically where hazards overlap populations and development centers to identify where the highest priorities exist.

This organized and logical process provides a credible method for focusing on the hazards that most threaten community property and life safety in Macomb County and allocating resources for mitigation.

In order to determine which proposed mitigation actions should be pursued, a risk assessment needed to be performed. The risk assessment provides a factual basis upon which hazards identified in the jurisdiction can be prioritized and addressed. The risk assessment rates each hazard the County is susceptible to according to certain hazard aspects such as frequency of occurrence, extent, and location. Once the hazards have been rated, they can then be prioritized to determine which ones pose as the most threatening. The most threatening conditions are then addressed with mitigation strategies.

The Michigan State Police (MSP) Emergency Management Division (EMD) has published the "EMD PUB-103: Michigan Hazard Analysis". This publication identifies all the know hazards the entire state of Michigan is likely to experience. All the hazards identified in the manual are applicable to Macomb County. This conclusion was reached by reviewing the existing Plan, soliciting input from County officials, and researching historical disaster information. Historical evidence supports the fact that Macomb County has experienced or has the potential to experience every hazard identified in the EMD PUB-103.

The following pages of this section will profile each hazard by identifying locations, magnitude/severity, historical occurrences, and probability for future occurrences. This section will also investigate the County's vulnerability. The County's vulnerability will be expressed in terms of:

- Hazard areas
- Types and numbers of existing and future buildings, infrastructure, and critical facilities in hazard areas
- Potential dollar losses
- Land uses and development trends

2.1 COUNTY PROFILE

Today, Macomb County encompasses 484 square miles and ranks third in population in the State, with a total of 823,864 persons. The County is recognized as a leader in business and industry, and designated as a “Community of Economic Excellence” by the State of Michigan. Despite its large population and urban characteristics, approximately 50 percent of the County’s land area is vacant or in agricultural use. The County’s location within the state of Michigan lends it to experience warm to hot weather and thunderstorms in the summer to cold weather and snow storms in the winter.

2.1.1 General Profile Information

Macomb County is part of the Greater Detroit Metropolitan Area, which is ranked 6th among the largest 120 metropolitan areas of the United States by the Office of Justice Programs. Integral to the Greater Detroit Metropolitan area, transportation, industry, commerce, recreation, infrastructure, communications, finance, and government facilities exist, which may be targets for domestic and international terrorism. Macomb County is the third largest county in Michigan in population and state equalized value, behind the contiguous counties of Oakland and Wayne. Metro Detroit shares the 74 miles of international border with Ontario, Canada, accessed with border crossings by:

- Bridge from Port Huron to Sarnia, Ont.
- Underwater railroad tunnel from Port Huron to Sarnia, Ont.
- Bridge from Detroit to Windsor, Ont.
- Underwater tunnel from Detroit to Windsor, Ont.
- Ferry service (truck) from Detroit to Windsor, Ont.
- Ferry service from Marine City to Sombra, Ont.
- Ferry service from Algonac to Walpole Island, Ont.
- Underwater pipelines from Marysville and St. Clair to Sarnia, Ont.
- Overhead electrical transmission lines from St. Clair to Sarnia, Ont.
- Numerous public and private marinas and privately owned access points.

The interstate highway system, Detroit Metropolitan Airport, Detroit City Airport, the Port of Detroit and heavy rail systems transiting through Macomb County, provide easy access to county destinations from anywhere in the world.

Fifty percent of the land area in Macomb County is devoted to industrial, commercial and residential use. Appendix F shows a detailed map breakdown of land use within the County as of the year 2000. Significant trends can be seen in development throughout the County. Development is heavily concentrated in the southern region of the County and is spreading outward and upward along the major roads which lead north. A map such as this one can be tracked and updated regularly and problematic areas can be easily identified and dealt with before development occurs. Population growth, supported through immigration, continues to expand. Projections by the Southeast Michigan Council of Government predict a census of 930,420 persons by the year 2030.

Macomb County is heavily industrialized with 97 industrial facilities, with five additional sites pending, reporting the manufacture, storage, or use of Extremely Hazardous Substances (EHS), as defined by Section 302 of the Superfund Amendments and Reauthorization Act (SARA). Led by major corporations such as Ford Motor, DaimlerChrysler AG, General Motors, Dupont Automotive, TRW, and General Dynamics, Macomb County is ultimately tied to the national and international community, both industrially and economically. Also, Macomb County is a major engineering and design center for U.S. industry. Annually, corporations in Macomb County receive millions of dollars in U.S. Department of Defense (DOD) contracts. Presently, the U.S. Government employs 4,314 workers in Macomb County. Additionally, long term defense contracts serviced by regional military contractors include military hardware vehicles, munitions and components to the U.S. military and foreign governments, including Turkey, Egypt and Saudi Arabia.

2.1.2 Infrastructure

Existing generalized sanitary sewer service in Macomb County is provided by the Detroit Metropolitan Water Department, which serves approximately 60% of Macomb County. The City of Warren, the City of Mount Clemens, and the City of New Baltimore operate their own treatment plants. The remaining portions of Macomb County are served by individual septic tank systems. This disposal system shares an international water system, Lake St. Clair and the Detroit River, as the disposal site for treated effluent. This treated effluent also affects the downstream states of Ohio, Pennsylvania, and New York.

Macomb County residents receive water from one of eight public agencies or from private wells. The major supplier is the Detroit Metropolitan Water Department serving 95% of the demand for public water in Macomb County. This utility draws 70% of its water supply from an international body of water, Lake St. Clair that is downstream of the St. Clair River, Lake Huron, and Lake Superior. Other communities draw water from public wells, or Lake St. Clair. In the less urban areas and northern Macomb County, residents use private wells.

Macomb County has electrical power supplied to 100% of the populace, which is serviced by the Detroit Edison Company. Major transmission lines from generating plants serving Southeastern Michigan crisscross through Macomb County to Ontario, Canada. Substantial numbers of sub-transmission lines, power stations and substations exist throughout Macomb County, necessary to serve county consumers and provide electrical service to the Southeast region of Michigan.

Military facilities include the U.S. Army Tank Automotive and Armaments Command (TACOM) and Selfridge Air National Guard Base. These military facilities serve the U.S. military throughout the nation and support U.S. protection of military forces overseas. The 127th Fighter Group is stationed at Selfridge and the TACOM mission supports the U.S. Army in procurement, design and parts maintenance of armored and wheeled vehicles.

Macomb County is included in the Southeast Michigan U.S. Coast Guard area contingency plan as an area of concern. Complex systems are in place supporting transportation, storage, and mining of natural gas and oil products. Utilities that serve Macomb County with natural gas are Consumers Power Company, Southeastern Michigan Gas Company and the Michigan Consolidated Gas Company. These utilities service 100% of the residential, commercial, industrial, and governmental facilities in Macomb County, and to communities throughout Michigan and neighboring states. Michigan Consolidated Gas Company and Southeastern Michigan Gas Company own and operate large gas storage fields in northern Macomb County, in addition to multiple transmission and service lines associated

with this industry, serving natural gas to consumers regionally and in upstate Michigan. Pipelines serving oil and gas suppliers and producers in the U.S. and Canada are maintained by Sun Oil, Shell Oil, Michigan Consolidated Gas and American Natural Resources. These pipelines are present throughout Macomb County as major transmission routes for oil, natural gas and gasoline.

A network of the Interstate Highway System along with major U.S. and State of Michigan highways traverses Macomb County. Continuity for the movement of people, goods and services are linked to Interstate 94 serving Southern Michigan, Indiana and Chicago. Interstate 696 crosses the southern portion of Macomb County, linking I-94, I-75, and I-96. This thoroughfare services the midwestern U.S. region by providing connection between the counties and the industrialized corridors of M-53 and M-97 and the commercial areas of M-102 (southern) and M-59 (middle). I-69, located north of Macomb County, connects Canada to the midwest United States and is connected to highways serving Macomb County.

Buses operated by the Suburban Mobility Authority for Regional Transportation (SMART) and the Detroit Department of Transportation provide public transportation. Bus routes link Macomb, Wayne and Oakland Counties and the City of Detroit.

General aviation in Macomb County is centered upon three privately owned, public use airports. The most well equipped airport in Macomb County is Selfridge Air National Guard Base, a military facility in Harrison Township.

Two heavy rail companies, CSX and Canadian Northern (CN) maintain 70 miles of main line rail tracks in Macomb County. Servicing international and national shippers, the companies transport heavy volumes of chemicals, vehicles, industrial supplies and manufactured products. Canadian Northern serves as the major shipper of chemicals (over 300 hazardous chemicals identified) to the U.S. from Canada, while CSX provides service to large defense contractors, including shipments of armored vehicles, military components and munitions.

There are (8) general care hospitals, (28) nursing and convalescent homes, (4) special medical care facilities and (12) free standing health clinics located in Macomb County. Three (3) of the general care facilities are certified as Trauma Centers by the Academy of Emergency Care Physicians, including Mount Clemens General Hospital which is also certified as an open heart surgical facility. Five (5) of the eight (8) facilities have full emergency room operations, receiving patients from the region. Additional facilities include general care hospitals in Oakland, Wayne and St. Clair counties, which receive and treat Macomb County residents, as well.

Communications are consistent with commercial services provided by AT&T, Ameritech, MCI and Sprint. Cellular telephone systems provide adequate coverage to the entire region. Emergency communications include an enhanced 911 system provided by Ameritech. Central control systems and multiple central communications facilities serving commercial telephone service exist in Macomb County, linking regional, national and international networks.

Land mobile communications, including public safety services use conventional radio spectrum assigned by the Federal Communications Commission. A major problem exists, as there are no inter-operability frequencies licensed between Macomb County public safety resources, either agency to agency, or jurisdiction to jurisdiction.

There are over 5,000 acres of public parks and 1,000 acres of local recreation land in Macomb County. Macomb County ranks first in the State of Michigan in the number of marina facilities and small watercraft registered to private owners. Watercraft from neighboring states as well as international vessels utilize these facilities. Recreational activity utilizes the natural resources of the area, with emphasis on sports, fishing, boating and swimming supported by the

extensive water resources. The Michigan Department of Natural Resources (DNR) issues 200,000 sport hunting licenses to county residents. The northern two-thirds of Macomb County is open to hunters. Numerous gun manufacturers and suppliers are available to support recreational hunting activities.

Macomb County utilizes an early warning siren system. Most areas within the County have total coverage. Some lesser-developed areas are still without coverage. Appendix G shows a map of the siren coverage in Macomb County and also includes a list of the exact addresses and the siren coverage radius for each.

2.1.3 Future Trends

Macomb County has the room and reputation for accommodating development. Appendix H shows a detailed map breakdown of the land, which is undeveloped in the County as of the year 2000. The higher concentration of undeveloped land is located in the northern regions of the County. Planners can use this map to track regions that may become problematic, such as flooding regions, as development continues. New and ongoing construction of full-service industrial parks, manufacturing plants, office centers, research and development facilities, retail centers and residential construction continue to expand the existing economic investment.

Those who have built their facilities in Macomb have found that industrial development is encouraged and supported, with 4,000 acres designated specifically for that purpose. The clustering of these sites along Macomb's industrial corridors allows firms to be close to both their suppliers and their customers.

Macomb has 61 industrial parks, with state of the art appeal for new businesses. Site considerations already addressed to ensure timely start up include internal roads, complete utility service, access to major transportation arteries, security and safety. These industrial parks also present challenges to public safety officials as they increase exposure to hazardous chemicals and the possibilities for chemical accidents. Careful zoning and enforcement of building and fire prevention codes will mitigate these hazards.

In a study undertaken by the Industrial Technology Institute of the University of Michigan, Macomb County and its neighbors, Oakland and Wayne, were named as strongholds for high growth, technology based firms. Macomb County was cited in the same study for its impressive "island of automation."

Although the county has become a popular choice for development with construction costs averaging more than \$420 million per year, room to build is still plentiful with 50 percent of Macomb County's land area still undeveloped. This provides the Office of Emergency Management the opportunity to work with the county's northern community leaders to mitigate hazards.

2.1.4 Census Data

Table 2.1 - Population and Households Overview

Component	1990 Census	2000 Census	Sept 2004 SEMCOG	2030 Forecast
Household Population	711,459	779,288	815,019	915,983
Group Quarters Population	5,941	8,861	8,845	14,437
Total Population	717,400	788,149	823,864	930,420
Households	264,991	309,203	331,338	410,081
Housing Units	274,843	320,276	342,363	n/a
Household Size	2.68	2.52	2.46	2.23

Table 2.2 - Population by Age

Age Groups	1990 Census	2000 Census	2030 Forecast
Age 0-4	48,914 (7%)	51,062 (6%)	56,051 (6%)
Age 5-17	122,739 (17%)	138,722 (18%)	139,578 (15%)
Age 18-34	201,957 (28%)	178,439 (23%)	185,392 (20%)
Age 35-64	255,333 (36%)	312,275 (40%)	316,865 (34%)
Age 65+	88,457 (12%)	107,651 (14%)	232,534 (25%)
Total Population	717,400	788,149	930,420

Table 2.3 - Households by Type

Households	1990 Census	2000 Census	2030 Forecast
With Children	92,427 (35%)	102,743 (33%)	117,803 (29%)
Without Children	172,621 (65%)	206,455 (67%)	292,278 (71%)
Income Quartile 1 – Low ¹	47,378 (18%)	57,226 (19%)	87,329 (21%)
Income Quartile 2	68,575 (26%)	83,326 (27%)	113,318 (28%)
Income Quartile 3	77,992 (29%)	91,616 (30%)	117,448 (29%)
Income Quartile 4 – High	71,103 (27%)	77,030 (25%)	91,986 (22%)
Total Households	265,048	309,198	410,081

¹ - Indicates the number of households in the community whose household income is within each household income quartile of Southeast Michigan.

Table 2.4 - Housing Tenure

Tenure	1990 Census	2000 Census
Owner Occupied Units	204,609 (74%)	243,964 (76%)
Median Housing Value (In 2000 dollars)	\$101,399	\$139,200
Renter Occupied Units	60,382 (22%)	65,239 (20%)
Median Contract Rent (In 2000 Dollars)	\$577	\$543
Vacant Units	9,852 (4%)	11,073 (3%)
Total Housing Units	274,843	320,276

Table 2.5 - Household Incomes

Income Categories as Reported in Each Census	1990 Census	2000 Census
Less than \$10,000	22,961 (9%)	16,841 (5%)
\$10,000 to \$14,999	16,720 (6%)	14,229 (5%)
\$15,000 to \$24,999	37,509 (14%)	31,627 (10%)
\$25,000 to \$34,999	39,360 (15%)	35,120 (11%)
\$35,000 to \$49,999	57,287 (22%)	48,613 (16%)
\$50,000 to \$74,999	59,895 (23%)	70,908 (23%)
\$75,000 to \$99,999	20,342 (8%)	44,675 (14%)
\$100,000 to \$149,999	8,212 (3%)	35,966 (12%)
\$150,000 or more	2,105 (1%)	11,523 (4%)
Total Households ²	264,991	309,203
Median Household Income (In 1999 Dollars)	\$52,171	\$52,102
Households in Poverty	15,146 (6%)	18,341 (6%)
Persons in Poverty	36,642 (5%)	44,010 (6%)

2 - The 100% count of total households shown here may not equal the sum of the sample data.

Table 2.6 - Housing Units by Structure Type

Structure Type	1990 Census	2000 Census
One-Family Detached	190,789 (69%)	219,955 (69%)
One-Family Attached	16,091 (6%)	23,967 (7%)
Two-Family / Duplex	2,974 (1%)	3,103 (1%)
Multi-Unit Apartments	50,566 (18%)	58,647 (18%)
Mobile Homes	12,122 (4%)	14,452 (5%)
Other Units	2,301 (1%)	152 (0%)
Total Housing Units	274,843	320,276 ³

3 - The 100% count of 2000 total housing units shown here may not equal the sum of the 2000 sample data.

Table 2.7 - Residential Building Permits

Structure Type	Annual Average 1993-1997	Annual Average 1998-2002	2003	2004
Single Family / Detached Condo	3,456	4,107	3,153	2,155
Townhouse / Attached Condo	0	624	1,832	1,286
Two-Family / Duplex	123	76	2	46
Multi-Family / Apartments	1,201	522	281	114
Total New Units	4,780	5,329	5,268	3,601
Total Units Demolished	183	182	204	139
Net Total	4,597	5,147	5,064	3,462

Table 2.8 - Land Use / Land Cover

Land Use Type	1990 Acres	2000 Acres
Single-Family ⁴	81,893 (26%)	96,340 (31%)
Multiple-Family	5,150 (2%)	6,631 (2%)
Commercial and Office	10,849 (4%)	12,195 (4%)
Institutional	6,827 (2%)	6,818 (2%)
Industrial	14,179 (5%)	15,312 (5%)
Transportation, Communication, and Utility	7,073 (2%)	7,297 (2%)
Cultural, Outdoor Recreation, and Cemetery	8,121 (3%)	10,269 (3%)
Active Agriculture	101,250 (33%)	86,214 (28%)
Grassland and Shrub	40,301 (13%)	31,430 (10%)
Woodland and Wetland	27,129 (9%)	27,004 (9%)
Extractive and Barren	709 (0%)	718 (0%)
Water	2,702 (1%)	2,831 (1%)
Under Development ⁵	3,459 (1%)	6,583 (2%)
Total Acres ⁶	309,643	309,643

4 - Single-Family land use: areas of single-family houses, and also includes manufactured housing, farmsteads, and portions of developing single-family residential.

5 - Under Development: includes two types of areas, 1. The acreage not built on in areas where new residential construction is partially completed, and 2. Areas where ground breaking has occurred and no land use type could be determined.

6 - 1990 and 2000 total acres may not be the same due to rounding errors and precision differences between 1990 and 2000 GIS layers.

Table 2.9 - Residential Density (Units per Acre)

Density Type	1990	2000	1990-2000 Increment⁷
Single-Family Land Use	2.54	2.46	2.04
Gross Residential Density	3.15	3.11	2.85

12 - 1990-2000 Increment: The density of housing units built 1990-2000, that is, the number of housing units built divided by the area of residential land added 1990-2000. Increment values are not shown for categories in which acreage and/or units decreased, or in which acreage changed by less than 10 acres.

Table 2.10 - Summary of Development Changes (in Acres)

Development Status	1990	2000	1990-2000 Change
Undeveloped	175,550	154,779	-20,771 (-11.8%)
Developed	134,093	154,864	20,771 (15.5%)
Residential	87,043	102,972	15,929 (18.3%)
Nonresidential	47,050	51,892	4,842 (10.3%)
Percent Developed	43.3	50	6.7 (15.5%)

Table 2.11 - Macomb County's Largest Employers

Rank	Name	Employees (2003)	Previous Rank (1999)
1	General Motors Corporation	14,213	1
2	DaimlerChrysler Corporation	10,197	2
3	Ford Motor Company	9,288	3
4	U.S. Government	4,314	4
5	St. John Health	3,506	8
6	Macomb County	2,357	NR
7	Trinity Health	2,140	NR
8	General Dynamics Land Systems	2,000	5
9	Mt. Clemens General Hospital	1,879	NR
10	U.S. Postal Service	1,635	NR
11	Henry Ford Health System	1,544	NR
12	AZ Automotive Corporation	1,400	NR
13	Kroger Company of Michigan Inc.	1,070	19
14	State of Michigan	1,061	15
15	Kmart Corporation	1,000	7
16	TRW Automotive	1,000	NR
17	EDS Corporation	770	10
17	SBC Communications Inc.	770	16
19	Farmer Jack Supermarkets	706	NR
20	DuPont Automotive	700	20

Source: Crain's Detroit Business List, April 21, 2003

2.2 HAZARD IDENTIFICATION

To address the hazards affecting Macomb County, information surveys were sent to each community within the County. These surveys included hazard tables, which allowed community officials to identify the hazards and aspects that are most pertinent to their community. The Macomb County Hazard Mitigation Planning Committee made the decision to use the “Cumulative Ranking by Top Ten” table as the primary priority list to address the hazards. The decision was based on the expertise of the officials who completed the tables, as they are the authority in their particular community, the supporting data obtained from the “Ranking by Hazard Analysis” tables, public opinion, and the frequency and severity with which those hazards occur.

The “Top Ten” Hazard Table was one of the tables included in the survey. This table was filled out directly by community officials with the top ten hazards *they* felt affected their community. The table below shows the cumulative results of the hazard rankings filled out by the community officials.

Top 10 Hazards (Cumulative Ranking)			
HAZARD TYPE	RANK	NUMBER OF VOTES	AVERAGE RANK
Severe Winds	1	15	3.1
Snowstorms	2	14	3.4
Ice & Sleet Storms	3	13	4.3
Tornadoes	4	13	4.7
Transportation Hazmat Incident	5	13	5.7
Fixed Site Hazmat Incident	6	11	5.3
River Flooding	7	9	4.2
Lightning	8	9	4.6
Structural Fires	9	10	5.3
Infrastructure Failures	10	13	6.1

* The term "Number of Votes" refers to the total number of communities within Macomb County which listed the particular hazard somewhere within the Top Ten Ranking in their Community Survey. For example, the "Number of Votes" value of 9 for the hazard 'River Flooding' means 9 communities listed this hazard as one of their Top Ten affecting the community. It does not mean that 9 communities ranked the hazard at #7.

Note: Lake Township is covered under Wayne County's Plan and therefore did not participate in Macomb County's Plan. The City of Memphis is covered under St. Clair County's Plan, but still completed a survey. Not all communities completed every part of the survey.

The other table included in the survey was a “Hazard Rating Analysis” table. This table included seven aspects, which communities rated on a scale of N/A (or zero) to five (5). For evaluation purposes, the seven aspects were also rated (on a scale of 1-5) according to their importance. The more important aspects were assigned a larger weight (percentage) value and multiplied by the rating for each hazard as selected by the community officials. The calculated value of the hazard rating multiplied by the aspect weight was then summed across all seven aspects. The result of the summed value is the overall hazard ranking. In some instances, a

rating value for one hazard tied with that of another. When this happened, both hazards were assigned the same 1-10 value. Thus, a single community could have more than 10 hazards listed for this particular table. Those hazards with larger overall ranking values are considered the most detrimental to the community.

By rating the hazards via the aspects, a more extensive profile of the hazards affecting the community was developed. The data generated from this table served as a supplement to the "Top Ten" table filled out directly by the community officials. The Committee then reviewed the rankings to verify that the analysis data was accurate and consistent with the hazards they felt affected the County. The hazards listed in the "Cumulative Ranking by Top Ten" table were then determined to be the most detrimental to the County.

Hazard Analysis Rankings			
HAZARD TYPE	RANK	NO OF ENTRIES	AVERAGE RANK
Tornadoes	1	25	3.5
Severe Winds	2	24	3.9
Ice & Sleet Storms	3	25	4.6
Snowstorms	4	25	5.0
Energy Emergencies	5	23	5.1
Transportation Hazmat Incident	6	22	5.0
Infrastructure Failures	7	22	5.5
Structural Fires	8	21	5.6
Lightning	9	22	6.2
Terrorism/Sabotage/WMD	10	17	4.8

** The Hazard Table Analysis resulted in 'Overall Hazard Rating' values. These values were also ranked from highest to lowest on a scale of 1-10 (with 1 being the highest and 10 being the lowest). For instances where the resulting value tied with another hazard, both were assigned the same rank on the 1-10 scale. Thus, a community may have more than 10 hazards accounted for in the "Number of Entries" column in this table.

Note: Lake Township is covered under Wayne County's Plan and therefore did not participate in Macomb County's Plan. The City of Memphis is covered under St. Clair County's Plan, but still completed a survey. Not all communities completed every part of the survey.

Although the two tables do not track identically, the first four hazards in each list vary only slightly. The slight inconsistency in the tables arose as a result of some communities not completing the tables or filling them out incorrectly. The "Cumulative Ranking" titles at the top of each table refer to the manner in which the ranked hazards were assigned point values. A cumulative process was utilized to gain a closer representation of the hazards' importance to the communities. Points were summed and the highest point total represented the most detrimental hazards. For each hazard, the values of the rankings were summed and then divided by number of "votes" for each to also obtain an "Average Rank". Tables to compare hazards and ranks across all communities were created. Please refer to Appendix I for these tables and the individual community tables.

2.3 RISK AND VULNERABILITY ASSESSMENT BY HAZARD

Sections 2.3.1 through 2.3.28 of this chapter profile all the hazards affecting Macomb County. Each of the hazards identified in the MSP EMD PUB-103 Michigan Hazard Analysis document have been reviewed and analyzed for their potential impact in Macomb County. This profile portion of the Hazard Mitigation Plan provides the official definition of the hazard, describes the typical locations throughout the County that the hazard could occur, the maximum extent of damage the hazard has the potential to cause, historical occurrences, economic vulnerability, and the probability of future occurrences. The information provided in Sections 2.2.1 through 2.2.28 was largely taken from MSP EMD PUB 103 and is not footnoted further. References, information from various web sites, and historical County information are cited in the body of the text.

River Flooding was originally identified as the top hazard in the 2002 Hazard Mitigation Plan and received an advanced analysis. Although it was only ranked 7th in the community surveys, River Flooding has continued to occur with regularity and in specific areas within the County. Consequently, the advanced analysis conducted in 2002 has been carried forward intact. The advanced analysis identifies, in detail, these areas and the potential and historic dollar losses and damage to the structures within the hazard zone (floodplain). The map included in Appendix AA shows each jurisdiction's critical facilities, which include police and fire stations, schools, local government buildings, and hospitals, in relation to the 100-year flood plain. The Detailed Reports by Community Areas (Section 2.4), cites specific homes in danger of flooding. Since flooding was the only hazard in the County with definable boundaries, the map in Appendix AA is primarily intended for use with mitigating the flooding hazard. The map can, however, be used to locate other critical facilities when developing additional mitigation projects for other hazards. The goals, objectives, and specific actions and projects addressing all hazards are included in the Mitigation Strategy section.

2.3.1 Civil Disturbances

Definition

A public demonstration, gathering, or a prison uprising, that results in a disruption of essential functions, by rioting, looting, arson, or other unlawful behavior.

Large-scale civil disturbances rarely occur, but when they do they are usually an offshoot or result of one or more of the following events:

- 1) Labor disputes where there is a high degree of animosity between the participating parties.
- 2) High profile/controversial judicial proceedings.
- 3) The implementation of controversial laws or other governmental actions.
- 4) Resource shortages caused by a catastrophic event.
- 5) Disagreements between special interest groups over a particular issue or cause.
- 6) A perceived unjust death or injury to a person held in high esteem or regard by a particular segment of society.

Prison uprisings are normally the result of perceived injustice by inmates regarding facility rules, operating policies and/or living conditions, or insurrections started by rival groups or gangs within the facility.

Location

Several locations have been identified as sites for past or potential civil disturbances. The Detroit News facility in Sterling Heights was an area during the newspaper strikes that demanded police intervention. Macomb Community College has two campuses in Macomb County, which have been sites of anti-war demonstrations. U.S. Army Tank Command, Selfridge Air National Guard Base, and General Dynamics are among some of the installations with government contracts that have potential for political unrest.

Hazard Extent

The magnitude of this hazard is relatively low. In most instances a civil disturbance would be limited to a localized area. Based on the historical data, resulting deaths are a possibility, but typically for only a riot or prison uprising. Civil disturbances have also historically monopolized law enforcement forces and possessed a moderate property damage risk.

Historical Occurrences

Labor Disputes

Major labor disputes have occurred in virtually every decade in Michigan and Macomb County. However, some have been worse than others in their overall impact on the communities in which they have occurred. Unfortunately, some disputes have turned violent at times, requiring a response by law enforcement agencies to quell the disturbances and maintain order. A recent example of this occurred in Seattle, Washington during the World Trade Organization Conference.

The most recent period of labor unrest in Macomb County has been the Detroit Newspaper Strike, which started in July 1995 and continued on through 1997. This strike had been marked by periods of sporadic violence. The strike negatively impacted many facets of the community and had required extensive use of law enforcement resources, especially by the

City of Sterling Heights, to supervise strike-related activities and maintain order before the two sides negotiated a final resolution to this long labor dispute. The most likely communities in Macomb County to experience labor disputes disturbances would be the cities of Warren and Sterling Heights on historical data and the industrial base in both communities.

Prison Uprisings

Although violence is a fact of life in Michigan's prisons, large-scale, deadly prison uprisings are relatively rare. Macomb County has one state correctional institution within its boundaries; the Macomb Regional Facility, a medium security facility, located in Lenox Township and one major jail complex, the Macomb County Jail Facility, located in Mount Clemens. Other communities have smaller facilities for detaining potential prisoners.

One of the more notable uprisings occurred over the Memorial Day weekend in 1981 and involved the State Prison of Southern Michigan in Jackson, the Marquette Branch Prison in Marquette, and the Michigan Reformatory in Ionia. The Michigan Corrections Organization attempted to lock down prisoners over the Memorial Day weekend, which sparked the disturbances. The weekend damages across the three facilities totaled 109 inmates injured, 71 staff members, and \$5 million in physical damages to the facilities.

Political Unrest

The potential for political disturbances in Macomb County is high. The City of Warren is home for the South Campus of Macomb Community College. During the late 1960s, MCC students were very involved in the anti-war movement in the United States. Also located in Warren is the military installation, the US Army Tank Command, along with firms that have government contracts. A large defense contractor, General Dynamics, is located in the City of Sterling Heights. In Mount Clemens, the county seat, court rulings have sparked social protest, due to court decisions. Located in Harrison Township is Selfridge ANG Base; protests over governmental policies have occurred in the past. The Center Campus of Macomb Community College can be found in Clinton Township. This is the largest community college campus in Michigan and the potential for political protest is significant.

Economic Vulnerability

Since Macomb County has not had a full-fledged civil uprising in its history, historical numbers on the economic impact cannot be gathered. There are many corollary effects from a civil disturbance that are not a direct result of the event. The incident may deter future development in an area and threaten future and existing businesses. The severity of the economic loss is related to the severity of the incident. Economic value of property damage, recovery costs, and loss of business can range from tens of thousands of dollars to millions of dollars, depending on the seriousness of the incident.

Probability of Future Hazards

Macomb County definitely possesses the potential for a civil disturbance based mainly on the types of facilities located within its borders (mentioned above). Historically, there have been more political unrest incidents and labor strikes than violent riots or prison uprisings. The likelihood of more political unrest is dramatically increased with the current situation in the Middle East and the country's campaign on terrorism. However, the probability, as determined by the "Hazard Rating Table" and the "Top Ten Hazards Table" completed by each community in Macomb County, is relatively low.

2.3.2 Drought

Definition

A water shortage caused by a deficiency of rainfall, generally lasting for an extended period of time.

Drought differs from normal conditions found in low rainfall areas in that aridity is a permanent characteristic of that type of climate. Drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length. The severity of a drought depends not only on its location, duration, and geographical extent, but also on the water supply demands made by human activities and vegetation. This multi-faceted nature of the hazard makes it difficult to define a drought and assess when and where one is likely to occur.

Location

Drought is a normal part of the climate of Michigan, Macomb County, and of virtually all other climates around the world including areas with high and low average rainfall. The range of this hazard can reach from a regional incident (limited to one county) to a statewide scale. Due to the nature of this hazard, all regions of Macomb County either have been or are potentially susceptible to experiencing a drought.

Hazard Extent

Drought impacts are often less obvious than other natural hazards, and they are typically spread over a much larger geographic area. Droughts can cause many severe impacts for Macomb County:

- Water shortages for human consumption, industrial, business and agricultural uses, power generation, recreation and navigation.
- A drop in the quantity and quality of agricultural crops.
- Decline of water quality in lakes, streams and other natural bodies of water.
- Mal-nourishment of wildlife and livestock.
- Increase in wildfires and wildfire-related losses to timber, homes and other property.
- Declines in tourism in areas dependent on water-related activities.
- Declines in land values due to physical damage from the drought conditions and/or decreased economic or functional use of the property.
- Reduced tax revenue due to income losses in agriculture, retail, tourism and other economic sectors.
- Increases in insect infestations, plant disease, and wind erosion; and possible loss of human life due to food shortages, extreme heat, fire, and other health-related problems such as diminished sewage flows and increased pollutant concentrations in surface water.

Historical Occurrences

Based on historical records, major drought events occur approximately once every 10 to 15 years. While the lack of rainfall does not cause direct harm to people, it does, however, take a major toll on the agriculture industry and crop producers. Drought can also lead to major inconveniences among community residents when water restrictions are enforced.

In 1988, a heat wave hit the Central and Eastern United States and caused nearly \$40 billion in agricultural losses. The dry conditions also impacted river transportation, caused shortages in water supplies, and also led to numerous wildfires. To help counter the situation, many communities issued water restrictions to reserve enough for human consumption and necessary services such as firefighting. Outdoor burning bans were also issued by the Governor to curb the occurrence of wildfires.

The summer of 2001 also brought about a damaging heat wave. This dry spell affected most of the Central and Eastern U.S. including Michigan. The drought destroyed nearly one-third of the state's fruit, vegetable, and field crops. This resulted in a U.S. Department of Agriculture Disaster Declaration for 82 of the state's 83 counties. Local officials issued periodic water restrictions during this dry period as well.

Economic Vulnerability

Macomb County has not experienced repetitive occurrences of drought in its history. According to the National Climatic Data Center, the County has experienced only one major drought event since 1950 that resulted in nearly \$150 million in agricultural losses. The current trend of the County is a reduction in active agricultural land and an increase in residential, commercial, and industrial usage. As this trend continues, less agricultural land in the County will be available to be impacted. However, this land will be much more valuable to the County due to the reduced acreage.

Probability of Future Hazards

Drought is a natural occurrence in nature and Macomb County has dealt with past incidents all throughout the County's history. According to the EMD PUB-103, a major drought incident occurs once every 10-15 years. The major impact falls mainly on the agriculture industry and there is a relatively low threat to human life. The continual development in the northern regions of the County and the diminishing farmland is contributing to a lower impact from the hazard. Since drought is a nature-induced phenomenon, there is no reason to believe that the probability or frequency will diminish along with the impact. The potential is always there and it can also lead to other problems, which will indirectly impact people.

2.3.3 Earthquakes

Definition

A shaking or trembling of the crust of the earth caused by the breaking and shifting of rock beneath the surface. Earthquakes range in intensity from slight tremors to great shocks. They may last from a few seconds to several minutes, or come as a series of tremors over a period of several days. Earthquakes usually occur without warning. In some instances, advance warnings of unusual geophysical events may be issued.

The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Most casualties result from failing objects and debris. Disruption of communications systems, electric power lines, and gas, sewer and water mains can be expected. Water supplies can become contaminated by seepage around water mains. Damage to roadways and other transportation systems may create food and other resource shortages if transportation is interrupted. In addition, earthquakes may trigger other emergency situations such as fires and hazardous material spills, thereby compounding the situation.

Location

Earthquakes tend to strike repeatedly along fault lines. The closest fault zone to Michigan is the New Madrid Seismic Zone. This zone extends from approximately Cairo, Illinois through New Madrid, Missouri to Marked Tree, Arkansas. Some regions near upstate New York are also seismic zones.

Hazard Extent

Macomb County lies outside the range of any major event located in these two closest areas and, most likely, only small tremors would be felt in Macomb County. The largest impact to the County would result from damage to natural gas and petroleum pipelines.

Historical Occurrences

No severely destructive earthquake has ever been documented as centered in Macomb County or in the State of Michigan. However, several mildly damaging earthquakes have been felt since the early 1800s. The earliest tremors felt in Michigan were from a series of devastating earthquakes near New Madrid, Missouri in 1811 and 1812. These quakes destroyed the town of New Madrid, created a 17,000-acre lake in northeastern Tennessee, cause ocean-like swells on the Mississippi River (which reportedly ran backwards), and rang church bells as far away as the eastern seaboard. Richter Scale estimates ranged from 8.0 to 8.8 and included hundreds of aftershocks with some magnitudes between 6.5 and 7.6 on the Richter Scale.

Fault lines have been confirmed in the bedrock of Michigan and are now considered relatively stable. However, these fault lines are poorly mapped. According to the U.S. Geological Survey, earthquakes have been reported in Redford and Greenfield Village on August 17, 1877. On February 4, 1883, an earthquake cracked windows and shook buildings at Kalamazoo (intensity VI). On March 13, 1905, a moderate earthquake of intensity V was felt at Menominee, Michigan in the Upper Peninsula.

Economic Vulnerability

An economic impact to the County due to an earthquake is not warranted due to the location of Macomb County in relation to the nearest fault line. The County lies outside of the range of significant impact. However, the potential for economic loss would be expected to result mainly from loss of utilities such as gas, water, and sewer service. It would not be

expected that the entire County would suffer loss, but mainly the south western portion due to its proximity to the New Madrid fault line.

Probability for Future Hazards

Records have been kept regarding earthquakes for approximately 200 years in Michigan and Macomb County. In that timeframe there have been no major destructive incidents originating or even reaching Macomb County. Therefore, the probability, based mainly on historical information, is considerably low for a major earthquake event in Macomb County. The probability for a major event does exist, however, in the Mississippi Valley, near the region of the New Madrid fault line. Should a major event occur here, Macomb County would still only possibly experience minor tremors, as it lies well outside of the New Madrid zone.

2.3.4 Energy Emergencies

Definition

An actual or potential shortage of gasoline, electrical power, natural gas, fuel oil, or propane of sufficient magnitude and duration to potentially threaten public health and safety, and economic and social stabilization.

Three specific types of energy emergencies exist. The first and most frequent type involves the physical destruction of an energy production or distribution facility. This can stem from severe storms, tornadoes, floods, earthquakes, sabotage, human error, accidents, or equipment failure. The second type is caused by a sharp, sudden escalation in energy prices. The third type of energy emergency is a sudden surge in energy when U.S. defense forces need to be mobilized.

Location

Energy emergencies can affect all people, from an individual community, to a state, to the entire nation. Typically any type of energy shortage is going to affect the entire state and thus Macomb County. Therefore, it is safe to say that the entire county is vulnerable to this hazard.

Hazard Extent

Energy emergencies have the potential to develop into severe situations over a long period of time. In most instances, loss of power, gas, or fuel due to a weather-related incident, can be restored relatively quickly with little to no detrimental effects. However, in some instances, like a disruption in fuel import, the effects can reach the entire nation. In the event of a fuel shortage, Macomb County would be most affected by higher gasoline prices. Gas shortages, especially in the winter, can have dangerous effects on people such as no heat. The same can be true of electricity failures or shortages.

Historical Occurrences

Energy emergencies typically occur on a much larger scale than a single county. Nevertheless, Macomb County is certainly affected when an energy crisis plagues the state or the Midwest. Energy emergencies are not dependent on the season of the year, however, their effects can easily be multiplied by the seasons. Many more people will suffer from a gas main break in the winter than in the summer due to loss of heating. Conversely, an electrical black out would have somewhat more harmful effects in hot, summer months due to loss of air conditioning and spoiling of food from no refrigeration.

The most recent energy emergency to strike Macomb County was the blackout of 2003. The power outage occurred on August 14, 2003, just as rush hour traffic was beginning for many cities in the northeastern and midwestern United States. Nearly 2.3 million customers in southeast Michigan were without power for the next two days. Many businesses lost money due to workers being sent home.

During much of the 1970s oil prices skyrocketed. The main factors for the increase was the "Iranian Revolution" (civil war in Iran) and the OPEC oil embargo. These factors and others led to increased oil prices, inflation, long lines at gas stations, and a reaffirmation of America's energy vulnerability. Between 1970 and 1980, oil prices had increased by a factor of nineteen.

On December 12, 1998, a 30-inch water main in the downtown Detroit area burst and crushed a nearby 12-inch gas main. Some 200,000 gallons of water infiltrated and flooded nearly 20 miles of gas line. The incident shut down gas service to an estimated 600 buildings

(including hotels, offices, restaurants, shops, and residences on both sides of I-375. The hotels, restaurants, and businesses were greatly affected economically by the incident due to its occurrence during the normally profitable Christmas season.

Economic Vulnerability

During the Blackout of 2003, numerous economic losses were incurred due to the power outage. According to the Electricity Consumers Resource Council (ELCON), the total loss across all the affected areas was estimated to be between \$7 and \$10 billion. These figures are based on costs per kilowatt-hours, food spoilage, lost production, and overtime wages. Even though Macomb County suffered a fraction of this amount, it was still a substantial economic loss. This potential for economic loss is ever present and can largely impact the County's economy.

Probability of Future Hazards

Macomb County has a rapidly growing population and with that growth, comes higher demand for energy sources. Today's modern society is heavily dependent on natural fuel sources and electrical power. With such a large dependency on these energy sources, the constant demand for power, and the population increasing, energy emergencies are more of a potential threat to the County now than ever before. The more complex the energy system in the County becomes, the more probable an incident will occur.

2.3.5 Extreme Temperatures

Definitions

Prolonged periods of very high or very low temperatures, often accompanied by other extreme meteorological conditions.

Although they are radically different in terms of initiating conditions, the two hazards share a commonality in that they both primarily affect the most vulnerable segments of the population, the elderly, children, impoverished individuals, and people in poor health. Due to their unique characteristics, extreme summer heat and extreme winter cold hazards will be discussed individually.

Extreme Summer Heat

Extreme summer weather is characterized by a combination of very high temperatures and exceptionally humid conditions.

Extreme Winter Cold

Like heat waves, periods of prolonged, unusually cold weather can result in a significant number of temperature-related deaths.

Location

Michigan's climate lends it to both sides of the temperature scale and thus, all portions of Macomb County are subject to the same extremes. The combined effects of high temperatures and high humidity are more intense in urban centers; heatstroke and heat exhaustion are a greater problem in cities than in suburban or rural areas.

Hazard Extent

Extreme Summer Heat

The major threats of extreme summer heat are heatstroke (a major medical emergency), and heat exhaustion. Heatstroke often results in high body temperatures, and the victim may be delirious, stuporous, or comatose. Rapid cooling is essential to preventing permanent neurological damage or death. Heat exhaustion is a less severe condition than heatstroke, although it can still cause severe problems such as dizziness, weakness and fatigue. Heat exhaustion is often the result of fluid imbalance due to increased perspiration in response to the intense heat. Treatment generally consists of restoring fluids and staying indoors in a cooler environment until the body returns to normal. Other, less serious risks associated with extreme summer heat are often exercise-related and include heat syncope (a loss of consciousness by persons not acclimated to hot weather), and heat cramps (an imbalance of fluids that occurs when people unaccustomed to heat exercise outdoors).

Nationwide, approximately 200 deaths a year are directly attributable to extreme heat. Extreme summer heat is also hazardous to livestock and agricultural crops, and it can cause water shortages, exacerbate fire hazards, and prompt excessive demands for energy. Roads, bridges, railroad tracks and other infrastructure are susceptible to damage from extreme heat.

Extreme Winter Cold

Each year in the United States, approximately 700 people die as a result of severe cold temperature-related causes. It should be noted that a significant number of cold-related deaths are not the direct result of "freezing" conditions. Rather, many deaths are the result of illnesses and diseases that are negatively impacted by severe cold weather, such as stroke, heart disease and pneumonia. Hypothermia (the unintentional lowering of core body temperature),

and frostbite (damage from tissue being frozen) are probably the two conditions most closely associated with cold temperature-related injury and death. Frostbite rarely results in death, but in extreme cases it can result in amputation of the affected body tissue.

Hypothermia is usually the result of over-exposure to the cold, and is generally thought to be clinically significant when core body temperature reaches 95 degrees or less. Hypothermia usually occurs in one of two sets of circumstances. One situation involves hypothermia associated with prolonged exposure to cold while participating in outdoor sports such as skiing, hiking or camping. Most victims of this form of hypothermia tend to be young, generally healthy individuals who may lack experience in dealing with extreme cold temperatures. The second situation involves a particularly vulnerable person who, is subjected to only a moderate, indoor cold stress. A common example would be that of an elderly person living in an inadequately heated home. In such circumstances, hypothermia may not occur until days or perhaps weeks after the cold stress begins.

Historical Occurrences

Extreme Summer Heat

Although Macomb County has been fortunate not to have a heat wave that resulted in numerous deaths, the potential always exists for such an event to occur. During the prime summer months of 2001, extreme heat and humidity sent heat indices well above the 100 degree Fahrenheit mark. In mid-June, three elderly residents of a Detroit-area nursing home died and five more were hospitalized due to heat-related stress. (Note: the deaths prompted a bill within the Michigan Legislature to require all nursing homes in Michigan to have air conditioning in resident rooms and common areas.)

Another case of extreme summer heat occurred back in July of 1936. The heat wave that hit Michigan and the metro Detroit area brought with it temperatures which exceeded 100 degrees for several days in a row. The temperature in Mio, Michigan reached 112 degrees, which is a state record that still stands today. Many healthy adults as well as the elderly fell victim to the temperatures. In addition, many deaths and illnesses resulted from spoiled foods, as many people back in that time period relied on the ice in their iceboxes. Statewide, 570 people died from heat-related causes, including 364 in Detroit.

Extreme Winter Cold

Deaths due to extreme winter cold are often not associated with a particular weather event. Rather, they are the result of a one-time overexposure to severe cold weather (a hiker lost in the woods), or more commonly from continuous exposure to moderate cold temperatures by vulnerable persons (such as the elderly or the homeless). In some cases, hypothermia deaths can be linked to severe winter weather such as snowstorms or blizzards, where the victim is caught unprepared for the extreme cold temperatures.

One case of severely cold temperatures occurred in late December of 2000. The cold spell lasted approximately one week and temperatures in and around Macomb County barely reached 4 degrees. Flint set records with all time lows reaching -13 and -11 degrees on consecutive days. The freezing temperatures caused pipes to burst and hindered freight travel on the Great Lakes and the connecting waterways. Lake St. Clair was also greatly impacted by the quick formation of ice, which caused a number of ice jams and blocked ships.

Economic Vulnerability

Extreme temperatures often times result in loss of power or other critical utilities during particular events. According to the National Climatic Data Center (NCDC), Macomb County has only suffered one large-scale incident resulting in \$475,000 due to extreme cold since 1950.

These losses generally stem from pipes breaking, and lost production due to inoperable facilities. Summertime high temperature can result in brownouts in power supply or water shortage due to drought or overload of power grids due to air-condition use.

Probability of Future Hazards

Macomb County exists in a region of the country that experiences both ends of the temperature spectrum. The probability for extreme temperatures, based on the County's history, is extremely high. Although the entire season may not be extreme, there is almost a certainty that extreme temperature spells will occur at some point in the year. This is a hazard that is very likely to occur and certain measures and precautions can be taken to help alleviate the effects.

2.3.6 Scrap Tire Fires

Definition

A large fire that burns scrap tires being stored for recycling/re-use.

Tire disposal sites can be fire hazards due to the large number of tires typically present at a site. This large quantity of "fuel", coupled with the fact that the shape of a tire allows air to flow into the interior of a large tire pile, renders standard fire fighting practices nearly useless.

Scrap tire fires differ from conventional fires in several respects:

- 1) Even relatively small scrap tire fires can require significant resources to control and extinguish
- 2) The costs of fire management are often far beyond that which local government can absorb
- 3) The environmental consequences of a major tire fire are significant
- 4) As alluded to earlier, the extreme heat converts a standard passenger vehicle tire into about two gallons of oily residue, which can leach into the soil or migrate to streams

Location

According to the EMD PUB 103 Michigan Hazard Analysis, there are 53 counties that have scrap tire disposal sites within their jurisdictions. There are no registered scrap tire disposal sites in Macomb County according to the Michigan Department of Environmental Quality. There are, however, two illegal sites listed on the map in Appendix J.

Hazard Extent

Michigan generates some 7.5 to 9 million-scrap tires each year. Issues pertaining to the management of scrap tire disposal sites are difficult and diverse. Whole tires are difficult to landfill because they tend to float to the surface. Whole tires are banned by many licensed landfills due to associated problems. In addition, scrap tires are breeding grounds for mosquitoes, which can reproduce at 4,000 times their natural rate in a scrap tire disposal site. This can lead to several public health issues especially during summer months. From an emergency management perspective, the most serious problem that scrap tire disposal sites pose is that they can be a tremendous fire hazard if not properly designed and managed.

According to the EMD PUB 103, Macomb County has 47,073 known tire quantities as of 2001. This is an issue of significant concern mainly due to the potential for a major fire given the right set of circumstances. Such a fire may require evacuation, sheltering, large amounts of fire suppression assistance, and both short and long term environmental monitoring. Often times a large fire can be extremely costly for the owner/operator and even the community it is located in. These costs are directly related to the difficulty of extinguishing a large fire and the need for a large emergency response presence at the site for a long period of time.

Historical Occurrences

Macomb County has not experienced any major fires at a scrap tire disposal site. However, various other counties in the state have. On October 31, 2000, a tire fire broke out at a recycling center in St. Joseph County. The 250-foot diameter blaze took 10 fire agencies 12 hours to extinguish it. A dirt berm around the pile prevented any run-off from reaching and contaminating the St. Joseph River, which was only 300 feet away. The fire that consumed

10,000 of the 350,000 tires at the site was determined by investigators to have been set by an arsonist.

The worst tire fire incident in Michigan's history occurred on April 16, 1997, in Osceola County. This fire began in a yard with over 6 million tires and required every fire department in a five county area to extinguish it. Two and a half days later, the 478 fire fighters managed to dig a trench around the pile to contain it and cap it off with sand to extinguish it. The final damage report was 1.5 million tires, two buildings, and some trailers lost, and a \$300,000 cost to put the blaze out.

Economic Vulnerability

Macomb County has never experienced a severe incident involving a scrap tire fire. However, according to the historical fires that have occurred in other counties throughout the state, the cost to extinguish and clean up a significant sized fire can reach high into the hundreds of thousands of dollar range. These costs result from environmental contamination, fire extinguishing resources, and overtime wages to response personnel.

Probability for Future Hazards

Macomb County is relatively low on the list of scrap tire producing Michigan counties. With the small number of scrap tires in existence in the County currently, the chance for a large-scale fire to occur is quite small. Macomb County has never had a past occurrence of a scrap tire fire, which also lends to the assumption that a major event resulting from this hazard would be highly unlikely.

2.3.7 Structural Fires

Definition

A fire, of any origin, that ignites one or more structures, causing loss of life and/or property.

In terms of average annual loss of life and property, structural fires, often referred to as the "universal hazard" because they occur in virtually every community, are by far the biggest hazard facing most communities in Macomb County. According to the National Fire Protection Association, structural fires cause more loss of life and property damage than all types of natural disasters combined. Direct property losses due to fire exceed \$9 billion per year and much of that figure is the result of structural fire.

Location

There is no definitive region where structural fires are limited. One aspect of this "universal hazard" is that they can occur anywhere at any time. Therefore, all communities in the entire county are susceptible to structural fires.

Hazard Extent

Although structural fires occur everyday in Macomb County, what is significant about these particular fires is the disastrous impact they have on the communities. In many cases, the very lifeblood of the community's business and retail districts was destroyed or severely damaged, affecting not only the structures themselves, but also the community economy as well. Adding insult to injury is the fact that some of these businesses never re-opened, leaving a permanent scar on the community.

Historical Occurrences

Macomb County's fire experience generally mirrors the national and Michigan's fire situation. According to statistics compiled by the Fire Marshal Division, Michigan Department of State Police, nearly 59,000 structural fires occurred in Michigan in 1996-97, resulting in 290 deaths and 1,385 injuries. Dollar losses for structural fires alone were estimated at nearly \$874 million. The Fire Marshal Division estimated that a structural fire occurred in Michigan every 26 minutes, 29 seconds in 1997. Nationally, Michigan's fire death rate in 1995 of 22 persons per million population puts it in the upper third of all states in the nation.

One very significant case was an arson fire set at the State Office Building in Lansing on February 8, 1951. The fire caused \$7 million in damage, burned for a week, and destroyed thousands of irreplaceable state records and archives, including the Michigan Library. A young employee who thought having a criminal record would prevent him from being drafted into the Korean War started the fire.

Economic Vulnerability

Since Macomb County is one of the larger jurisdictions in the southeastern Michigan region, it has the potential to suffer large economic losses. It can be estimated that of the \$874 million lost between 1996 and 1997 in Michigan, Macomb County's losses were near the tens of million-dollar range. This potential still exists today, and with continued development of industrial, residential, and commercial areas, larger property values may be vulnerable to loss.

Probability for Future Hazards

Structural fires occur for a number of reasons. Since there are so many factors that contribute to this hazard, it can never be fully mitigated against. However, major efforts are already in place to reduce structural fires. Building codes, building inspections, fire prevention, and fire marshals are among some of the preventative measures already implemented. The probability for this hazard to occur in Macomb County is very high and it can occur at any time. This hazard can have a severe impact of property loss as well as loss of life. Therefore, any additional mitigation efforts that can be made towards this hazard should be implemented. These efforts would include but not be limited to the strict enforcement of current building codes as well as fire education.

2.3.8 Wildfires

Definition

An uncontrolled fire in grasslands, brush lands or forested areas.

The immediate danger from wildfires is the destruction of timber, property, wildlife, and injury or loss of life to persons who live in the affected area or who are using recreational facilities in the area.

Location

Outdoor burning is the leading cause of wildfires in Macomb County. Most Macomb County wildfires occur close to where people live and recreate, which puts both people and property at risk. There are numerous parks and a large number of wooded areas in the County. Much of the undeveloped northern regions pose a wildfire threat due to the large forested areas.

Hazard Extent

Although Michigan's landscape has been shaped by wildfire, the nature and scope of the wildfire threat has changed. Because Michigan's landscape has changed substantially over the last several decades due to wildland development, the potential danger from wildfires has become more severe. Increased development in and around rural areas (a 60% increase in the number of rural homes since the 1980s) has increased the potential for loss of life and property from wildfires. There are simply not enough fire suppression forces available in rural areas to protect every structure from wildfire.

Historically, Macomb County has reduced wildfire vulnerability by restricting open burning of trash and yard debris (which causes nearly one-third of the wildfires in the state), and developing evacuation procedures for wildfires in the jurisdictions Emergency Action Guidelines (EAG) to minimize potential injury and loss of life.

Enforcement of present banning of open burning or burning by fire department approval has resulted in Macomb County having one of the lowest wildfire loss rates in the state. One area of concern is the marsh located near Metropolitan Park in Harrison Township. Fires in the marsh are difficult to control due to inaccessibility for fire apparatus. No further mitigation action should be taken. Monitoring reports would be recommended and encouraging strict control of open burning with fire department approval.

According to the Michigan Department of Natural Resources (MDNR) between 1981 and 2000, Macomb County has experienced 6 total wildfires and only 15 acres burned. There are still areas of high and moderate concern in the County when it comes to wildland/urban interface.

Historical Occurrences

Macomb County has experienced minor damage as the result of wildfires. The county's Emergency Management Coordinator will monitor, through the State Fire Marshal Annual Fire Report, any significant increase in the number of wildfires. No other action is recommended at this time.

One of the more significant wildfire events to note was in Champion in Marquette County. In early May 1999, a wildfire near the village of Champion (known as the Tower Lake fire) burned a total of 5,625 acres of forestland, destroyed at least 8 structures. It forced the evacuation of over 400 persons in Champion as well as those in the vicinity of Fish Lake, Perch Lake, Mud Lake, eastern Michigamme, and Van Riper State Park. In addition, the fire forced

the closure of US-41 and M-95 in the area of Champion and Michigamme for several days. Timber losses were estimated at \$12.8 million, with property losses totaling another \$700,000. Aerial firefighting assets were brought in from surrounding areas to help prevent the spread of the fire into Champion, thus saving the town from destruction. At the request of the Governor, the Federal/State Forest Fire Suppression Agreement was activated by the Federal Emergency Management Agency (FEMA) to provide financial assistance to the State and eligible local agencies to cover some of the firefighting costs incurred.

Another major wildfire event occurred in Grayling, in Crawford County. In May 1990, a wildfire near Grayling (known as the Stephan Bridge Road fire) burned 76 homes and 125 other structures, 37 vehicles and boats, and over 5,900 acres of forestland, resulting in property losses of \$5.5 million. The timber losses totaled another \$700,000. The fire originated from a controlled burning of a pile of brush and timber accumulated from recently cleared land. The burning was initiated while snow covered the ground, and it was presumed that the fire was completely extinguished. However, the pile rekindled approximately 7 weeks later, and on May 8, ignited the Stephan Bridge Road fire. Strong winds and dry conditions helped spread the fire at a rate beyond that which could be controlled by human intervention. At one point in the fire, the rate of spreading was an astonishing 277 feet per minute. Fortunately, the combination of human fire suppression and a passing weather front that produced rainfall finally contained the fire before it could do any additional damage. There were no fatalities as a result of this fire, and only one firefighter was injured from smoke inhalation. However, the property losses were significant.

Economic Vulnerability

Much of the undeveloped land remaining in Macomb County consists of agricultural and grassland. There are some regions with heavier woodland cover. The NCDRC has reported that one grass fire in Chesterfield Township burned half a square mile of land and destroyed a barn resulting in \$20,000 in damage. Potential for timber loss exists as well.

Probability for Future Hazards

In the last 20 years, Macomb County has only experienced a handful of minor wildfires. Most of the southern portion of the County is developed industrial, commercial, and residential areas. The northern regions are mostly farmland areas with very little forested area remaining. Therefore, according to the County's past and the land types existing, the likelihood of a major wildfire occurring in the County is quite small. The probability of a fire still exists, especially during dry, hot weather periods. However, the extent of the damage would be minimal.

2.3.9 Dam Failures

Definition

The collapse or failure of an impoundment, resulting in downstream flooding.

Dam failures occur not only during flood events, which may cause overtopping of a dam, but also as a result of poor operation, lack of maintenance and repair, and vandalism.

Location

The National Inventory of Dams (NID) identifies a total of 10 dams within Macomb County as of March 2005. Please refer to Appendix K for a map of the key dam locations.

Listing of Dams in Macomb County

NID ID	Dam Name	City	River	Year Completed	Dam Type	Height (ft)	Storage (acre-feet)	Drainage Area (sq mi)	Hazard
MI00685	Lower Stony Lake Dam	Stony Creek	Stony Creek	1961	Gravity Earth	32	13000	68.2	High
MI00686	Upper Stony Lake Dam	Stony Creek	Stony Creek	1961	Gravity Earth	24	2500	38	High
MI02425	Autumn Ridge Detention Dam	Forest City	Shanahan Drain	1982	Earth	11	23	0	Significant
MI01511	Cory Lake Dam	Mount Clemens	Tributary to Yates Drain		Earth	8	32	0	Low
MI00313	Hidden Lake Dam	Romeo	Tributary to East Pond	1968	Earth	8	70	0.5	Low
MI00607	East Mill Lake Dam	Romeo	Tributary to East Pond Creek	1926	Earth	15	440	0	Low
MI00608	Fisher Dam	Romeo	Tributary to East Pond Creek	1920	Earth	15	290	11.5	Low
MI00609	Clifton Mill Pond Dam	Stony Creek	Stony Creek	1937		12	50	27	Low
MI00670	Sterling Mall Dam	Mt Clemens	Utica Drain	1977	Earth	9	234	0	Low
MI01510	Chestnut Lake Dam	Macomb	Middle Branch Clinton River	1968		15.5	100	3	Low

Sources: National Inventory of Dams (<http://crunch.tec.army.mil/nid/webpages/nid.cfm>),
National Performance of Dams Program (<http://npdp.stanford.edu/index.html>)

Hazard Extent

While dams themselves are fixed sites and easy to locate, the area affected by a failure is more difficult to determine. A dam failure can result in loss of life and extensive property or natural resource damage for miles downstream from the dam. Dams are important components of the county's infrastructure and provide benefits to all residents. However, as history has demonstrated, dams can fail with disastrous consequences. Many existing dams are getting older, and constant repair and maintenance is required. At the same time, development continues in potential inundation zones downstream from dams. There are more people at risk from dam failure than ever before despite better engineering and construction methods. As a result, loss of life and property must continue to be aggressively guarded against.

In Michigan, dam safety is regulated under the Natural Resources and Environmental Protection Act of 1994, Part 315, Dam Safety. In Michigan, dams are not regulated unless at flood elevation, they impound water to a height of 6 feet or more have a surface area of 5 acres or more. Regulated dams are broken into 3 categories, high, significant, and low, based on the impact of a failure. High hazard dams are inspected every three years, significant hazard dams

are inspected every four years, and low hazard dams are inspected every five years. Owners of high and significant hazard dams are required to maintain Emergency Action Plans in the event of a dam failure.

The challenges facing county emergency management officials are:

- Minimize loss of life and property by working closely with dam owners in the development of the Emergency Action Guidelines (EAG) to ensure consistency with the Emergency Operations Plan (EOP) for the jurisdiction.
- Developing procedures in the EOP for responding to a dam failure (including a site-specific standard operating procedure for each dam site).
- Participating in dam site exercises
- Increasing public awareness of dam safety procedures.

Only two of the dams in Macomb County have a High hazard rating. They are the Upper and Lower Stony Creek Dams. These dams are located in series so that if the upper dam fails, it is highly likely that the lower dam will also fail. The Metropark Authority drained the lakes in 1998 and performed repairs to the dam. Interviews with Mr. Mike Brahm-Henkel of the Huron-Clinton Metro Parks Engineering Department and with Mr. Paul Wessel of the Michigan Department of Environmental Quality's Dam Safety Staff indicate that these dams were last inspected in 2002 and are well maintained and in good condition. Like all High hazard dams, they are inspected every three years and are scheduled to be re-inspected in 2005. Mr. Brahm-Henkel will update the Emergency Action Plan for the Stony Creek Dams in 2005 as well.

The Autumn Ridge Detention Dam is classified as significant by the National Inventory of Dams but does not meet the definition of a dam in Michigan due to its one-acre impoundment area. Consequently, it is not regulated or inspected by the State of Michigan. In 2004, the Cory Lake Dam was reclassified from a 'Significant' to 'Low' hazard rating by the State of Michigan.

Historical Occurrences

No catastrophic dam failures have been reported in Macomb County. According to MDEQ's Land and Water Management Division, only two minor dam failures have been documented in Macomb County. It should be noted, however, that the rivers and lakes that dams support often cross jurisdictional boundaries. Many of the rivers and lakes that run through Macomb County run through Oakland County as well. Oakland County ranks #1 in Michigan in both highest risk hazard dams (27 potential dams) as well as dam failures (18 failures). Failures that occur in neighboring counties could very well impact Macomb County and visa-versa.

One of the more significant dam failure events to occur happened on September 10-11, 1986. The rain that fell during those two days ranged from 8 to 17 inches and covered an area of the central Lower Peninsula 60 miles wide by 180 miles long. The result was 11 dam failures, 19 near failures, and 1500 people being evacuated downstream of the dams. There were no deaths or injuries resulting from these failures. The primary reason for the failures was that they were constructed without an emergency spillway and did not have an adequate inspection and maintenance program.

Economic Vulnerability

Due to the small number and size of the dams in Macomb County, the economic impact of a dam failure is minimal. Should a failure occur, some flooding damage could result. These

damages, depending on the extent of the failure, have the potential to reach into the \$100,000 range.

Probability for Future Hazards

The dams located within the borders of Macomb County consist of earth berms and small weirs. Only two of them are classified as have a 'High' hazard rating and both of those are in good condition, well maintained, and being inspected every three years. Additionally, the Emergency Actions Plan is being updated in 2005 to ensure current emergency notification and response procedures are identified. As long as the State and owner continue to manage these dams in accordance with state laws and regulations, the risk of significant damage or incapacitation as a result of a dam failure is minimized.

2.3.10 River/Urban Flooding

Definition

The overflowing of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice.

Development has increased the potential for serious flooding because rainfall that used to soak into the ground or take several days to reach a river or stream via a natural drainage basin now quickly runs off streets, parking lots, and rooftops, and through man-made channels and pipes. Oftentimes, flooding may not necessarily be directly attributable to a river, stream or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall and/or snowmelt, saturated ground, and inadequate drainage. Flooding also occurs due to combined storm and sanitary sewers that cannot handle the tremendous flow of water that often accompanies storm events.

Location

Flood prone areas are found throughout the County, as every lake, river, stream and county drain has a floodplain. The type of development that exists within the floodplain will determine whether or not flooding will cause damage. All of the 63 watersheds in the state experience flooding and the Clinton River watershed is among the top 12 that have experienced the most extensive problems. The 100-year flood prone areas in Macomb County are shown on the map in Appendix L.

Hazard Extent

Floods can damage or destroy public and private property, disable utilities, make roads and bridges impassable, destroy crops and agricultural lands, cause disruption to emergency services, and result in fatalities. People may be stranded in their homes for several days without power or heat, or they may be unable to reach their homes at all. Long-term collateral dangers include the outbreak of disease, widespread animal death, broken sewer lines causing water supply pollution, downed power lines, broken gas lines, fires, and the release of hazardous materials.

The flooding is not restricted to the main branches of these rivers. Most riverine flooding occurs in early spring and is the result of excessive rainfall and/or the combination of rainfall and snowmelt. Ice jams also cause flooding in winter and early spring. Severe thunderstorms may cause flooding during the summer or fall, although these are normally localized and have more impact on watercourses with smaller drainage areas. The water, with no place to go, will find the lowest elevations, areas that are often not in a floodplain. That type of flooding is becoming increasingly prevalent in Macomb County, as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. In Macomb County, the communities of Harrison Township, St. Clair Shores, Fraser, Clinton Twp., Chesterfield Township, Macomb Township, Roseville, Eastpointe, and Mt. Clemens have often experienced this type of problem.

Macomb County is ranked number one of all Michigan counties in flood insurance coverage. Harrison Township (1) St. Clair Shores (2) and Chesterfield Township (8) are in the top ten of Michigan communities in flood insurance coverage. Harrison Township (2) and St. Clair Shores (3) are listed in the top ten of Michigan communities in the number of flood insurance policies.

Historical Occurrences

The most recent flooding event occurred in late May of 2004. Rainfall began on May 20th and continued through May 24th. Macomb County was one of the most severely affected by the rain and numerous areas were flooded. At one point the Clinton River North Branch swelled to a record 20.3 feet before subsiding again. The County incurred \$9 million in road and bridge damage alone and another \$6 million in property damages. The Governor declared a "state of disaster" for 24 counties including Macomb. Nearly 500 homes and over 20 businesses were damaged by floodwaters.

Flooding is a frequently occurring hazard. Some other past instances of flooding in Macomb County are listed below:

- In February 1998, an early winter thaw coupled with an unusually high rainfall caused numerous communities to experience flooded homes and waterways.
- In 1997, unusually high water levels in Lake St. Clair resulted in the initiative "Flood Fight 1997."
- August 1995, major flooding due to heavy rains totally submerged cars on local freeways.
- January 1993, early thaw due to unusually warm weather coupled with heavy rains created major flooding problems.
- February 1986, a Governor's Declaration was issued due to flooding of the Great Lakes and Lake St. Clair.
- September 1986, a Presidential Emergency Disaster was declared due to major flooding.
- April 1985, a Governor's Declaration was declared due to flooding on Lake St. Clair.
- October 1981, major flooding in county due to heavy rains - SBA loans available.
- April 1975, a Presidential Emergency Disaster was declared due to rain, flooding, and tornadoes.

Economic Vulnerability

The economic loss from flood events in Macomb County is quite extensive. Property damage is the primary source of loss for this particular hazard, but corollary effects, such as lost business are also felt. Some sections of this plan discuss more specific areas of potential and historical property damage at risk from flooding. According to the NCDC web site, Macomb County has suffered over \$100 million in property damage from floods in the last 10 years.

Probability of Future Hazards

Flooding in Macomb County has occurred on a regular basis. Continual development of land and especially areas closer to floodplains is leading to more instances of homes and businesses being damaged or threatened. As development continues, watersheds are being altered and run-off water is reaching streams and rivers much faster than in the past. This surge of run-off is leading to overflowing of banks during major rain events and causing considerable damage to homes, property, and businesses. Since the development trend is constantly increasing, and river and floodplain areas will always exist, efforts must be made to reach a stable balance between population and controlling drainage.

2.3.11 Shoreline Flooding and Erosion

Definition

The flooding and erosion of shoreline areas caused by high Great Lakes water levels, storm surges, or winds.

Shoreline flooding and erosion, as natural processes, occur at normal and even low lake water levels. However, during periods of high water, flooding and erosion are more frequent. In addition to natural causes of water level fluctuation, there are three man-made factors that can also affect water levels to some degree:

- 1) Diversion of water for power generation, municipal water supply, and navigation.
- 2) Regulation of water levels via dams and other control structures.
- 3) Dredging of connecting waterways for navigation purposes.

Although these man-made factors do impact water levels, natural factors such as precipitation, evaporation and winds have a far greater overall impact. The vast majority of shoreline flooding and erosion that occurs along the Great Lakes and Lake St. Clair is caused by natural factors.

Note: Macomb County is not bordered by any of the 5 Great Lakes. Lake St. Clair, however, is fed by Lake Huron and in turn, drains to Lake Erie. Therefore, impacts to Great Lakes water levels have a direct impact and correlation to Lake St. Clair.

Location

Michigan has over 3,200 miles of coastline (the longest freshwater coastline in the world) that is home to more than 4.4 million people. Generally, low-lying lands along the coastline, such as the city of St. Clair Shores, New Baltimore, Harrison and Chesterfield Townships, are prone to shoreline flooding during both high and low lake water periods. The Michigan Department of Environmental Quality estimates that approximately 10% of Michigan's Great Lakes shoreline (30 counties encompassing greater than 45,000 acres) is flood-prone.

Hazard Extent

Shoreline flooding can cause serious damage to homes and businesses, roads, water, and wastewater treatment facilities, and other structures in coastal communities. Part 323 of the Natural Resources and Environmental Protection Act is designed to provide protection to Michigan's Great Lakes shoreline. While these fragile and dynamic shorelines are desirable vacation and recreational areas, they also present inherent hazards to development and are vulnerable to the development that it often brings. Part 323 gives the MDEQ responsibility to identify hazardous and fragile coastal areas and establish regulations designed to minimize the impact of development on these areas, and to minimize the hazard facing development. Part 323 identifies three shoreline areas:

- 1) High-risk erosion areas, those shorelines identified as receding at an average long-term rate of one foot per year
- 2) Flood risk areas, those coastal areas that are vulnerable to Great Lakes flooding
- 3) Environmental areas, those coastal areas necessary for the preservation and maintenance of fish and wildlife

Historical Occurrences

In nearly every decade, high water levels on the Great Lakes have caused significant damage and impact to Macomb County's coastal communities. The most recent high water period began in 1997 and resulted in the Great Lakes being at or near record levels set in the mid-1980s'. In response to the threat of severe shoreline flooding and erosion, the U.S. Army Corps of Engineers (USACE), at the request of the Governor, implemented its Advance Measures Program to assist Michigan shoreline communities in their flood and erosion mitigation efforts. As of the publication of the EMD PUB 103 December 2001 edition, over 20 Michigan jurisdictions have taken advantage of this program.

Prior to that, the record-high lake levels in 1985-86 culminated in a Governor's disaster declaration for 17 shoreline counties. The USACE implemented its Advance Measures Program, and the State of Michigan implemented three unique shoreline flooding and erosion mitigation programs aimed at reducing future flood impacts on shoreline communities and homeowners.

The Advance Measures Program allowed for the USACE to provide "self-help" materials (i.e. – sandbags, sand, and plastic sheeting), at 100% federal cost, to participating units of government for use in direct pre-flood mitigation activities. The Corps could also provide assistance with permanent construction projects designed to mitigate potential flood damages. The agreement stipulated a 75% federal and 25% local cost basis, the jurisdiction must furnish all land, easements and rights-of-way, agree to operate and maintain the project for 25 years, and provide interior drainage.

The State administered programs (established only for the '85-'86 high water period and have since been closed out), included the Shoreline Community Protection Program, the Emergency Home Moving Program, and the Emergency Flood Protection Program. The Shoreline Community Protection Program provided grants for 85% of damage prevention project costs. Four hundred seventy-one (471) grants were awarded, totaling approximately \$4.2 million. The remaining two were interest rate buy-down programs. The programs provided a lump sum payment equaling 3% of the interest rate of the secured loan amount for the projects to move houses away from the eroding bluff line or elevate homes in floodprone areas. From 1986 to 1988, a total of \$2 million was made available to interested homeowners. A total of 72 structures were relocated under the program, and 43 were elevated.

Economic Vulnerability

The rivers running through the County all drain to Lake St. Clair. Often times flooding experienced from the rivers also leads to the shoreline areas being flooded. These damages are often grouped with that of river flooding.

Probability of Future Hazards

Shoreline flooding also poses a relatively high risk along with river flooding. Numerous communities in Macomb County exist on the coast of Lake St. Clair. When lake levels are high or when a major rain event occurs, the regions along the lake are very susceptible to flooding. This hazard is likely to occur relatively often and has the potential to impact a large number of people due to the attractiveness of lakefront property.

2.3.12 Hazardous Materials Incidents (Industrial Accidents) - Fixed Sites

Definition

Hazardous materials are materials or substances which, because of their chemical, physical, or biological nature, pose a potential risk to life, health, property, or the environment if they are released.

An industrial accident is a fire, explosion, or other severe accident involving hazardous materials at an industrial facility that results in serious property damage, injury, or loss of life.

Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gasses. Industrial accidents differ from hazardous materials in the scope and magnitude of offsite impacts. Whereas hazardous material incidents typically involve an uncontrolled release of material into the surrounding community and environment that may necessitate evacuations or in-place sheltering of the affected population, the impacts from industrial accidents are often confined to the site or facility itself, with minimal physical outside impacts.

Location

One of the major provisions of SARA Title III is the establishment of a Local Emergency Planning Committee (LEPC) for designated planning districts. Macomb County has a Local Emergency Planning Committee. The LEPC is responsible for developing emergency response plans for those facilities in their jurisdiction subject to SARA Title III emergency planning requirements. A facility is subject to SARA Title III provisions if extremely hazardous substances (as determined by the U.S. Environmental Protection Agency) are present at the facility in quantities at or above the minimum threshold quantities established in Section 302 of the Act.

At the time this plan was formulated, there were 97 locations identified in Macomb County as Section 302 sites and an additional 5 sites to be added to the list were pending. In addition, the Agency for Toxic Substances and Disease Registry has also identified 10 sites in the County where a hazardous material release has occurred or has the potential to occur.

Numerous areas throughout the County also were also identified as industrial zones. These areas are located along the major corridors of Van Dyke Avenue, Mound Road, and Groesbeck Highway (M-97). Please refer to the map in Appendix M for zoning areas marked as "Industrial".

Hazard Extent

In both cases of hazardous material releases and industrial accidents, there is typically some type of threat involving a substance or material which, because of its chemical, physical, or biological nature, poses a risk to health, life, property, or the environment. Most hazardous material incidents are the result of human error. Occasionally, releases can be attributed to natural causes, such as a flood that washes away barrels of chemicals stored at a site. Industrial accidents such as fires, explosions, and excessive exposure to hazardous materials, may cause injury or loss of life to the workers at the facility, and often significant property damage. Industrial accidents can cause severe economic disruption to the facility and to the surrounding community, as well as significant, long-term impacts on the families of the workers injured or killed.

Historical Occurrences

Although Macomb County has a large industrial presence throughout many of its communities, there have been no major hazardous material releases or industrial accidents that resulted in multiple deaths or serious injuries. There have been some minor incidents that have occurred in the County. The following is a brief synopsis of past occurrences involving hazardous material releases and industrial accidents.

No major industrial accidents have occurred in Macomb County, however, there have been some major incidents in surrounding communities, which had indirect impacts on Macomb County. On December 11, 1998, an explosion at the Independence Professional Fireworks Company manufacturing plant near Osseo, in Hillsdale County, killed seven employees and leveled one building at the site. The blast, which occurred in a fireworks shell assembly room, sent debris flying in all directions for about 300 yards and could be heard for at least 20 miles. Fifteen other workers escaped serious injury. Subsequent investigations by the Federal Bureau of Alcohol, Tobacco, and Firearms, the Michigan State Police Fire Marshal Division, and the Michigan Occupational Safety and Health Administration (MIOSHA) were unable to determine a definitive cause of the explosion. This explosion was the worst industrial accident in Michigan in nearly 20 years.

Another devastating explosion occurred at this same plant on March 29, 1999, killing five more employees, and destroying another building at the site. This second explosion, which included among its victims, the company co-owner, was later determined by investigators to be accidental. The devastation brought by these two explosions resulted in a total of 12 deaths. Federal and state regulators have since issued numerous citations to the company for safety violations at the plant, with fines totaling several hundred thousand dollars. Ultimately, the company was forced to permanently shut down the business.

Another major industrial accident occurred on February 1, 1999. An explosion in one of several large boilers at the Ford Motor Company Rouge Power Plant killed six workers, critically injured another 14, and caused extensive structural damage. State officials that investigated the accident concluded that human error played a major part in the explosion when a work crew failed to shut off one of two gas mains leading to the boiler's furnace. That error caused a buildup of natural gas in the boiler that was somehow ignited, causing the explosion. The force of the explosion split open the 60-foot high furnace, blew off the roof of the power plant, ignited fires on five floors, and sprayed surrounding workers with super-heated water that caused severe burns. The blast, which forced the shutdown of the Rouge Complex and other Ford plants for several days, was the second worst industrial accident in Michigan in 20 years and the deadliest at an automobile plant in over 50 years. It also turned out to be the most expensive workplace disaster in U.S. history, with final costs expected to exceed \$1 billion. The seven-month probe by state officials was the largest and most complex in the history of state workplace safety investigations.

No large-scale hazardous material releases have occurred to date in Macomb County. However, some minor incidents have occurred in recent years. On October 24, 1988, a chemical spill in St. Clair Shores, at a plant injured 40 people and forced an evacuation of the site. On June 17, 1983, a fire at a hazardous waste site in Shelby Township caused six injuries and forced the evacuation of 1,200 people. Incidents have occurred in numerous other communities, but Macomb County has sustained a relatively good track record of hazardous material and industrial incidents due to careful regulations set in place by government and private industry officials.

Note: According to the EMD PUB 103 book, 1998 is the last year for which statewide hazardous material incident response statistics are available. A reportable hazardous material incident is one in which all three of the following conditions apply: 1) a material is present that is suspected to be other than ordinary combustible by-product material; 2) the material is in such a state, quantity or

circumstance that, if left unattended, it is presumed to pose a threat to life, health, property, or the environment; and 3) special hazardous material resources were dispatched or used, or should have been dispatched or used, for assessing, mitigating or managing the situation.

Economic Vulnerability

With over 100 sites listed as a SARA Title III site, the economic vulnerability to the County due to a fixed site incident is very high. Numerous commercial and residential areas surround many of the industrial corridors. Should an incident occur, most would be contained primarily within the borders of the site or facility. Other incidents have the potential to spread to outlying areas. In either case, the damages can range anywhere from the tens of thousands to even millions of dollars range.

Probability for Future Hazards

Many regions of southern Macomb County are highly industrialized. With such a large concentration of potential hazardous sites, there is a high probability that a large-scale incident could occur if proper mitigation measures are not taken. Although there have never been any serious fixed site hazardous material incidents, all it takes is one large-scale event to dramatically affect a large area or population. It should be noted that in the highly advanced technological society we live in today, the risk of this type of hazard is very high and efforts to mitigate against it should be made wherever they apply. However, there are many processes in place to address the issue. County and community Hazmat teams perform regular exercises and continued education as to the potential threat of these hazards is continually being administered to employees and responders.

2.3.13 Hazardous Materials Incidents - Transportation

Definition

Hazardous materials are materials or substances which, because of their chemical, physical, or biological nature, pose a potential risk to life, health, property, or the environment if they are released.

As a result of the extensive use of chemicals in our society, all modes of transportation – highway, rail, air, and marine – are carrying thousands of hazardous materials shipments on a daily basis through local communities.

Location

Macomb County is subject to all modes of hazardous material transport. Many major thoroughfares run through the County and are frequented by all types of cargo-carrying trucks. Interstates I-94 and I-696 both run through major portions of the County along with the major State-paved roads of Gratiot Avenue (M-3), Groesbeck Highway (M-97), Hall Road (M-59), and Van Dyke Avenue (Earl Memorial Highway, M-53). These routes dissect much of the County, especially in the major urbanized areas and always pose as a significant risk for hazardous material transportation incidents.

Three major rail lines also extend through most of the County and include Conrail, Grand Trunk Western, and Chesapeake & Ohio. The services of these rail companies include chemical, vehicle, industrial supplies and manufactured products (Please refer to Appendix N for a table listing all the known hazardous materials transported through Macomb County via Canadian National Rail) as well as armored vehicles, military components, and munitions. Lake St. Clair borders the County on the east and is a heavily traveled freighter route between both Canada and the United States. Macomb County also has Selfridge Air National Guard Base and several small airports including Romeo State Airport, Dodge Landing Field, and Ray Community Airport all in Ray Township. While the smaller, local airports typically would not ship hazardous cargo, Selfridge, being a military installment definitely has the potential for its aircraft to carry dangerous substances, chemicals, or explosive materials.

Hazard Extent

Large-scale or serious hazardous material transportation incidents that involve a widespread release of harmful material (or have the potential for such a release) can adversely impact the life safety and/or health and well-being of those in the immediate vicinity of the accident site, as well as those who come in contact with the spill or airborne plume. In addition, damage to property and the environment can be severe as well. Statistics show almost all hazardous material transportation incidents are the result of an accident or other human error. Rarely are they caused simply by mechanical failure of the carrying vessel.

Located on the Great Lakes, one of the most dangerous hazardous material transportation accident scenarios that could occur in Macomb County would be a spill or release of oil, petroleum or other harmful materials into one of the lakes from a pipeline or transportation methods. Such an incident, if it involved a large quantity of material, could cause environmental contamination of unprecedented proportions.

Historical Occurrences

Macomb County has been fortunate to not experience a major hazardous material transportation incident in its history. Minor incidents have occurred, but none that resulted in multiple deaths or injuries. On October 12, 1983, a tanker truck overturned, spilling 5,000

gallons of methylamylketone. The spill forced the evacuation of 600 people and M-97 and 14 Mile Road were closed until the spill could be cleaned up and the site restored. In Chesterfield Township, on December 28, 1982, a tanker truck began leaking nitric acid, resulting in 12 injuries from product exposure and forced the evacuation of 1,200 people in the surrounding area due to the toxic fumes. More recently, in nearby Birmingham and Bloomfield Township, more than 40 cars of a 98-car freight train carrying automobiles and some hazardous materials (yellow phosphorous) derailed. Two rail cars caught fire and forced police and fire officials to warn nearby residents and motorists to stay indoors and keep their windows closed due to possible toxic fumes. None of the cars containing hazardous materials derailed. Some local roads were closed for several hours. The derailment caused an estimated \$6 million in damage.

Economic Vulnerability

Just as the numerous sites located throughout the County pose an economic risk, so do the corridors and routes of transporting the hazardous materials to these sites. In some ways, a transportation hazmat incident can be even more detrimental than a fixed site incident. Spills or explosions can occur while on site or en-route. Costs of clean-up can range anywhere from a few thousand to hundreds of thousands of dollars, depending on the severity of the incident.

Probability for Future Hazards

The large industrial presence throughout the County is supported by the often times even larger transportation presence. For the industrial facilities to operate smoothly, supplies and chemicals are necessary, and these are delivered and removed from the sites in a variety of ways. Transportation methods utilized in Macomb County include train, truck, and even freighters, which pass through Lake St. Clair. Hundreds of hazardous materials are transported through the County and with increased populations comes increased risk for an accident. A major chemical or hazardous material spill is an extremely probable hazard that could occur in the County. Although Macomb County has been fortunate to not experience a major incident, the potential for serious injury or damage is very much present.

2.3.14 Infrastructure Failure

Definition

The failure of critical public or private utility infrastructure resulting in a temporary loss of essential functions and/or services.

Location

With miles of water and sewer pipes, phone and cable lines, and the vast network of generators, transformers, and treatment and distribution facilities, an infrastructure failure can happen virtually anywhere in Macomb County. Often times these incidents are not limited to a small localized region, but rather affect multiple communities and up to the hundreds of thousands of people (in some instances entire regions of the country and into the millions).

Hazard Extent

Macomb County's citizens and businesses are dependent on the public and private utility infrastructure to provide essential life supporting services such as electric power, heating and air conditioning, water, sewage disposal and treatment, storm drainage, communications, and transportation. When one or more of these independent, yet interrelated systems fail due to disaster or other cause, even for a short period of time, it can have devastating consequences. For example, when power is lost during periods of extreme heat or cold, people can literally die in their homes if immediate mitigative action is not taken (Extreme Temperature Section). When the water or wastewater treatment systems in a community are inoperable, serious public health problems arise that must be addressed immediately to prevent outbreaks of disease (Public Health Emergencies Section). When storm drainage systems fail due to damage or an overload of capacity, serious flooding can occur (River/Urban Flooding).

These are just some examples of the types of infrastructure failures that can occur, and all of these situations can lead to disastrous public health and safety consequences if immediate mitigative actions are not taken. Typically, it is the most vulnerable members of society (i.e., the elderly, children, impoverished individuals, and people in poor health) that are the most heavily impacted by an infrastructure failure. If the failure involves more than one system, or is large enough in scope and magnitude, whole communities and possibly even regions can be severely impacted (Dam Failures and Petroleum and Natural Gas Pipeline Accidents).

Historical Occurrences

Unfortunately, Macomb County has had its share of infrastructure failures, mostly due to the effects of natural disasters such as snow and ice storms, severe cold, windstorms, tornadoes and floods.

In 1978, and again in 1980, a large sewer main that served nearly 300,000 residential and business users in northern Macomb and Oakland Counties partially collapsed. The collapses were of such magnitude that continued sewer service to the 300,000 users was in peril. Fortunately, officials were able to install temporary sleeves within the damaged main until it could be properly repaired. However, in order to relieve the backpressure and keep basements from filling with sewage, officials were forced to divert millions of gallons of raw sewage into the Clinton River, fouling miles of Lake St. Clair beaches. Eventually, the damaged sections of sewer main were repaired, but this unfortunate incident caused tremendous disruption and environmental damage to the area. It showed how serious a large-scale sewer infrastructure failure in a densely populated area could be.

On June 7, 1999, a drilling company hired to relocate fiber optic cable for a new highway interchange accidentally broke a water main in the City of Auburn Hills. The incident set off a weeklong water emergency that closed hundreds of businesses and schools and forced thousands of residents to boil water or drink bottled water until repairs could be made. Local officials estimated 118,000 residents in over 44,000 households in Auburn Hills, Orion Township, Lake Orion, and Rochester Hills were affected by the water emergency. The crisis forced the closure of several major business enterprises, including the Daimler-Chrysler headquarters and technology center, the Palace of Auburn Hills sports arena, and the 200 store Great Lakes Crossing Mall, idling thousands of workers. Businesses outside Oakland County were also affected because of a shortage of parts from suppliers with plants in Auburn Hills and Rochester Hills. Economic losses associated with the water shortage emergency were so extensive that local officials gave up trying to calculate the costs. However, officials estimated that the weeklong ordeal likely cause losses in the tens of millions of dollars.

Most recently, the Blackout of 2003 was the largest infrastructure failure to affect not only Macomb County, but also most of the northeastern United States. The series of events that led up to the blackout occurred over only a sixty-minute interval. An exact cause of the outage was never determined, but a series of power units tripping offline in succession led to the major power failures to occur around 4:00 p.m. After the first major power failure, it only took five minutes for all the other primary units on the power grid to fail. Nearly 2.3 million customers in southeastern Michigan were left without power for the next two days. Since these events occurred after the September 11th tragedy, many people went into a panic mode believing the outage to be another attack. Stores were inundated with people trying to buy up supplies. Gas stations that still had power were faced with mile-long lines of people waiting to gas up. One of the major economic impacts resulted from thousands of businesses being immediately shut down and many people being sent home. Millions of people were stranded in some downtown areas because failed traffic signals left roads in gridlock.

Another very recent infrastructure incident occurred on 15 Mile Road in Sterling Heights near the end of August 2004. An 11-foot diameter sanitary sewer interceptor failed some 60' below the surface of the road. The infiltration of the fine soils around the pipe quickly spread to the shallower soils. The reduced sub-grade caused the road above to collapse and begin sinking. The result was a sinkhole 60 feet wide by 160' long and approximately 60' deep. During the drafting of this document, the ground around the problem area had been stabilized and bypass pumping had begun. The next steps would involve inspecting the pipe and determining the best option for repair.

Economic Vulnerability

The economic impact of an infrastructure failure is extremely high. Even small incidents can cause thousands of customers to be without service. Many types of infrastructure such as water, sewer, and cable lines are all buried underground. The costs associated with repairing a damaged or problem area has ranged from the hundreds of thousands to millions of dollars range in some cases.

Probability for Future Hazards

Since Macomb County is one of the most populated in the State, it means the County's infrastructure system is equally large and complex. The more complex the system, the more opportunity there is for failure. This is an extremely probable hazard to affect the County. Historically, Macomb County has experienced many infrastructure failures. As the County continues to expand and develop, the probability and frequency of failures increases. Proper mitigative actions would help to reduce the effects of this hazard.

2.3.15 Nuclear Attack

Definition

Any large-scale hostile action taken against the United States which involves nuclear weapons and results in destruction of military and/or civilian targets.

Note: The United States is vulnerable to a number of national security threats from external, hostile forces. National security threats include nuclear attack, chemical and biological warfare, and terrorism. The potential for damage resulting from a national security emergency ranges from the relatively localized damage caused by a terrorist attack using weapons of mass destruction, to the catastrophic devastation that could be expected following a full-scale nuclear attack. This section focuses on the nuclear attack threat. Information on terrorism and other hostile acts of sabotage or destruction using nuclear and non-nuclear weapons are addressed in the Sabotage/Terrorism section.

Location

The Federal Emergency Management Agency (FEMA) attack planning guidance provided in the document Nuclear Attack Planning Base 1990 (NAPB-90) remains the basis for the population protection strategy adopted for Michigan. The NAPB report identifies potential aiming points or target areas throughout the United States. These targets were categorized into seven classifications:

1. Commercial Power Plants
2. Chemical Facilities
3. Counterforce Military Installations
4. Other Military Bases
5. Military Support Industries
6. Refineries
7. Political Targets

The potential size, or yield, and the height of burst were postulated for each target. Michigan has 25 target areas and 3 of them are located in the Macomb County jurisdiction. According to the Nuclear Attack Planning Base 1990, several other target sites exist in the Metro-Detroit area. Due to the destructive nature of a nuclear warhead an attack from one, let alone several, would have unfathomable effects on the County and many others surrounding it. Please refer to Appendix O for a map of potential target sites in Michigan.

Hazard Extent

Nuclear weapons are intended to create mass destruction. The main difference between a nuclear missile or bomb and a conventional missile or bomb is that the range of the nuclear weapon is typically far greater than the conventional. Ranges may vary depending on the size of the weapon. In any case, hundreds of thousands of lives could be lost from a single weapon, along with buildings, vehicles, and even the landscape. Since most nuclear weapons are created with a radioactive substance, an area struck by a weapon would be inaccessible due to radiation for months or even years.

Historical Occurrences

Macomb County, along with the rest of the country, has never experienced a nuclear attack. However, misunderstandings and small incidents during and after the Cold War era have led to near disasters.

Perhaps the best example of why the threat of nuclear attack cannot be ignored was an incident that occurred on January 25, 1995. The Russians mistakenly believed that the launching of a U.S. scientific rocket from Norway might be the start of a nuclear attack. Not certain whether they were under attack or not, Russian President Yeltsin and other Russian leaders immediately activated their “nuclear suitcases” for the first time in history. (A nuclear suitcase is a portable communications and weapons activation device that allows political leaders to launch a nuclear counter attack from any safe location.) Fortunately, the misunderstanding was cleared up a short time later and a response attack was averted. However, the incident demonstrated how easily an accidental attack could occur and just how vulnerable the United States and the rest of the world still is to nuclear attack – even in the post-Cold War era.

In 1980, a computer malfunction sent a false missile alarm to the North American Aerospace Defense Command (NORAD) – the U.S./Canadian bi-national missile tracking and command center. The error was detected only minutes before the President was to be advised that Soviet missiles had been launched against the United States, which could have triggered a massive counter-attack. Fortunately, the error was discovered in time to avert a response that could have escalated into all out war. It was later determined that someone had mistakenly put military exercise tapes into the computer system, which then generated the false alarm. This had been the second such incident at the NORAD in less than a year. Fortunately, since that time, special safeguards have been instituted that separate military exercise data from real world data.

Economic Vulnerability

Since there has never been a nuclear attack within the country let alone the County, historic economic data for this hazard is not available. It is conceivable, however, to assume the impacts would be severe and damage alone would be near billions of dollars.

Probability of Future Hazards

Recent events throughout the world have escalated the threat of nuclear attack to high levels. Many countries now possess nuclear, chemical, and biological warfare technology. Macomb County has three sites identified (by FEMA in the Nuclear Attack Planning Base 1990), within its borders as being potential nuclear targets. With the County lying outside of the downtown Detroit area, and also largely contributing to the automotive world, a nuclear attack would greatly hinder the County and even the U.S. economy. This huge burden on the economy would make the metro-Detroit area a very probable target. Therefore, the threat from this hazard poses a great risk to not only the County, but to the United States.

2.3.16 Nuclear Power Plant Accidents

Definition

An actual or potential release of radioactive material at a commercial nuclear power plant or other nuclear facility, in sufficient quantity to constitute a threat to the health and safety of the off-site population.

Location

Michigan has four active nuclear power reactor units. These include D.C. Cook 1 & 2 near Benton Harbor, the Palisades unit near South Haven, and Fermi 2 near Monroe. The Fermi 2 unit is the closest to Macomb County and is the only facility that poses as a threat. Michigan also has four nuclear testing and research facilities. These include the MI Tech Graphite Moderator Reactor in Houghton County, the Dow Reactor in Midland County, the MSU Cyclotron & Reactor in Ingham County, and the U of M Cyclotron & Reactor in Washtenaw County. Michigan also has two decommissioned plants: Big Rock Point in Charlevoix County and Enrico Fermi 1 in Monroe County. Please refer to Appendix P for a map of plant locations.

Hazard Extent

Though the construction and operation of nuclear power plants are closely monitored and regulated by the Nuclear Regulatory Commission (NRC), accidents at these plants are considered a possibility and appropriate on-site and off-site emergency planning is conducted. An accident could result in the release of potentially dangerous levels of radioactive materials into the environment that could affect the health and safety of the public living near the nuclear power plant. A nuclear power plant accident might involve both a release of air borne radioactive materials and radioactive contaminate of the environment around the plant. The degree and area of environmental contamination could vary greatly depending on the type and amount of radioactivity and weather conditions.

Historical Occurrences

Fortunately, Macomb County does not have a nuclear power plant within its borders. A commercial nuclear power plant operates nearby (the Enrico Fermi-2 plant near Monroe), but has not had an incident in its existence. However, the potential for disaster still exists and the following historical incidents reinforce why preparedness is essential.

On April 26, 1986 a Soviet nuclear reactor at Chernobyl, Ukraine exploded while conducting experimental testing. This explosion, and the ensuing fire in the graphite core of the reactor, released radioactive debris into the upper atmosphere where wind currents dispersed it around the world. Other radioactive material was deposited in areas around the plant site, contaminating the land and food. Exposure to high levels of radiation on-site immediately killed 32 plant workers and firefighters. The World Health Organization and other public health agencies are still studying the effects of the accident on public health in the Ukraine and adjacent areas.

The long-term impacts of this accident are continuing today. The 30 square kilometer (20 square mile) area around the plant is heavily contaminated with radioactive material to the extent that many of the 4.9 million people that previously resided there have not been permitted to return to their homes. Soil contamination does not allow the consumption of crops grown in these areas. Because residents consumed contaminated crops and milk, studies have indicated significant increases in childhood thyroid cancer in the region around the plant. One of the major lessons learned from this accident is the need for early impoundment of suspected

food and milk that may have been contaminated. The EPA has revised its guidelines for environmental monitoring in affected areas as a result of the Chernobyl experience.

While an event of this nature is not physically possible at a U.S. reactor due to differences in reactor design and safety systems (for example, the Chernobyl reactor did not have a containment building), the event did impact U.S. emergency planning regulations. Lessons learned from this accident have been incorporated into federal guidance (e.g. EPA 400 Ingestion Pathway Protective Action Guidance). Additional emphasis has been placed on the ingestion pathway during nuclear power plant emergency exercises.

On March 28, 1979 the most serious nuclear reactor accident ever to occur at a commercial power plant in the United States occurred at the Three Mile Island nuclear power plant near Harrisburg, Pennsylvania. This incident resulted from a plant malfunction combined with operator override of automatic safety systems. These errors resulted in a partial meltdown of the reactor core. Utility, state and local personnel implemented response plans to protect the public in the area around the plant, while on site efforts were undertaken to cool the reactor and eliminate any possible release of radioactive material. While this accident resulted in no off-site health consequences, it had a major impact on emergency planning regulations in the United States.

Following the accident, new federal regulations were written to mandate specific activities by both on-site and off-site emergency response organizations. These more stringent federal regulations aimed at improving emergency planning efforts at nuclear power plants and providing for additional plant safety systems. Among the new regulations was NUREG 0654, which forms the basis for state and local government planning, training and emergency exercises. The U.S. Environmental Protection Agency (EPA) also issued new guidance on environmental monitoring and protective actions.

Economic Vulnerability

There have been no reactor or power plant accidents in or around Macomb County. Therefore, there is no historic data available regarding this hazard. It can be assumed that the immediate areas around a nuclear plant would suffer damages in the millions of dollars. There would be considerable damage also resulting from public health issues stemming from radiation and after effects.

Probability of Future Hazards

The closest nuclear power plant to Macomb County is the Enrico Fermi 2 plant in Monroe County, which is located approximately 35 miles from the County's southwest border. This plant has never had an incident in its existence. Strict regulations at nuclear facilities have drastically reduced the potential for incidents. However, should a catastrophic event occur, Macomb County could be effected by it. The historical records and strict regulations lend this hazard to be of a very low probability. It should also be noted that the other plants located on the west side of the state could also pose some risk. Should an incident occur at one of these plants, the winds coming from the west could carry toxic and radioactive fumes, smoke, and debris for miles. This contamination could reach the County or somehow affect surrounding areas or natural resource supplies such as rivers and streams and contaminate and pollute the region.

2.3.17 Oil and Gas Well Accidents

Definition

An uncontrolled release of oil or natural gas, or the poisonous by-product hydrogen sulfide, from production wells.

Location

Oil and natural gas are produced from fields scattered across 63 counties in the Lower Peninsula. Many oil and natural gas wells exist throughout Macomb County. In addition, there are also many storage and disposal sites for the resources as well. Underground gas storage fields in Macomb County are located in Lenox, Richmond, Ray, and Washington Townships. The detailed map in Appendix Q shows locations of wells, pipelines, and other important natural resource information.

Hazard Extent

The petroleum and natural gas industry is highly regulated and has a fine safety record, but the threat of accidental releases, fires and explosions still exists. In addition to these hazards, many of Macomb County's oil and gas wells contain extremely poisonous hydrogen sulfide (H₂S) gas. Hydrogen sulfide is a naturally occurring gas mixed with natural gas or dissolved in the oil or brine and released upon exposure to atmospheric conditions.

Within humans, small concentrations can cause coughing, nausea, severe headaches, irritation of mucous membranes, vertigo, and loss of consciousness. Hydrogen sulfide forms explosive mixtures with air at temperatures of 500 degrees Fahrenheit or above, and is dangerously reactive with powerful oxidizing materials. Hydrogen sulfide can also cause the failure of high-strength steels and other metals. In addition, accidents at these wells can cause serious environmental damages, especially to an ecosystem.

Physiological Response to H₂S	
10 ppm	Beginning eye irritation
50-100 ppm	Slight conjunctivitis and respiratory tract irritation after 1 hour exposure
100 ppm	Coughing, eye irritation, loss of sense of smell after 2-15 minutes. Altered respiration, pain in the eyes and drowsiness after 15-30 minutes followed by throat irritation after 1 hour. Several hours of exposure results in gradual increase in severity of these symptoms and death may occur within the next 48 hours.
200-300 ppm	Marked conjunctivitis and respiratory tract irritation after 1 hour of exposure.
500-700 ppm	Loss of consciousness and possibly death in 30 minutes to 1 hour.
700-1000 ppm	Rapid unconsciousness, cessation of respiration and death.
1000-2000 ppm	Unconsciousness at once, with early cessation of respiration and death in a few minutes. Death may occur even if the individual is removed to fresh air at once.

Source: American National Standards Institute, Standard: 237.2-1972

Historical Occurrences

To date, Macomb County has been fortunate not to have an oil or natural gas well accident that resulted in loss of life or significant property damage. However, several recent, significant oil and natural gas well accidents have occurred that required an emergency response by the drilling company and state and local officials. There have been, however, some significant incidents throughout other areas of Michigan.

On February 3, 1994 an explosion and fire occurred when a pipe released under pressure at an American Oil Company (AMOCO) production facility in Ogemaw County. One service company employee was killed and another employee was injured. The situation was immediately brought under control with no additional injuries, damage, or threat to public safety.

On June 15, 1993 a natural gas explosion occurred at a Michigan Consolidated Gas Company (MICHCON) underground storage facility in Columbus Township, St. Clair County. One worker was injured in the explosion, two vehicles were burned, and several homes in the immediate vicinity of the facility were evacuated.

On January 9, 1989 a natural gas well blew out in Au Gres Township, Arenac County. Although there was no fire, methane, butane, and hydrogen sulfide leaked from the wellhead. The surrounding area was evacuated while attempts were made to seal the leak with mud and concrete and replace the wellhead. On January 11, a new valve was successfully installed and the community resumed its normal activities.

Economic Vulnerability

There has never been a significant incident regarding this hazard in Macomb County. Therefore, no further economic investigation is recommended at this point.

Probability of Future Hazards

Macomb County has several oil and gas wells located within its borders. Production in the County of these natural resources has decreased in recent years. This fact coupled with the fact that no major incidents have occurred in the County's history, supports the claim that the probability for a major incident would be very low.

2.3.18 Petroleum and Natural Gas Pipelines

Definition

An uncontrolled release of petroleum or natural gas, or the poisonous by-product hydrogen sulfide, from a pipeline.

This hazard is very closely related to Oil and Natural Gas Well Accidents. The pipeline hazard deals mainly with the transport of these natural resources and the potential problems that have and can arise.

Location

Macomb County is both a major consumer and producer of natural gas and petroleum products. Vast quantities of petroleum and natural gas are extracted from, transported through, and stored in the County, making many areas vulnerable to petroleum and natural gas emergencies. Macomb County's gas and petroleum networks are highly developed and extensive, representing every sector of the two industries, from wells and production facilities, to cross-country transmission pipelines that bring the products to market, to storage facilities, and finally to local distribution systems. The maps in Appendix R show the major pipelines traversing through the state and Macomb County.

Hazard Extent

Several major petroleum and natural gas pipelines traverse Macomb County. Petroleum and natural gas pipelines can leak or fracture and cause property damage, environmental contamination, injuries, and even loss of life. The vast majority of pipeline accidents that occur are caused by third party damage to the pipeline, often due to construction or some other activity that involves trenching or digging operations. In addition to these hazards, there is the danger of hydrogen sulfide (H₂S) release. This is the same potential problem that exists in the Oil and Gas Well hazards mentioned earlier. Please refer back to the Oil and Gas Accidents section for a more detailed report on the dangers of hydrogen sulfide.

Historical Occurrences

Petroleum and natural gas pipeline accidents occur with some regularity, but they usually have a limited impact and are quickly and adequately handled by pipeline company emergency crews and local and state responders. While it is true that Macomb County has been free of catastrophic pipeline accidents, the possibility is always there for a significant accident to occur. The following are some accounts of petroleum and natural gas pipelines in and around Macomb County.

An apparent natural gas explosion destroyed a portion of a plastics factory in Warren on March 18, 2001. Fortunately, the building was empty at the time of the explosion, which collapsed the roof and blew out parts of the wall at the loading dock, causing significant damage.

On the morning of June 7, 2000 a Wolverine Pipeline Company gasoline pipeline ruptured in Jackson County's Blackman Township, releasing 75,000 gallons of gasoline into the environment and forcing the evacuation of more than 500 homes in a one square mile area around the spill. The leak was detected when a drop in pressure was recorded at a metering station along the 80-mile pipeline that runs through Blackman Township from Joliet, Illinois to Detroit. The spill caused significant environmental and public safety problems and shut down 30% of the state's gasoline supplies for nine days. (The pipeline carries approximately seven million gallons of gasoline per day.) Most of the evacuees were allowed to return to their homes

within five days of the accident. Wolverine Pipeline Company has expended in excess of \$10 million, to date, in response to this pipeline accident.

On May 20, 1992 a natural gas explosion occurred in a two-story commercial building in Rochester, in Oakland County, killing one person and injuring 17 others. Estimated property damage was nearly \$1 million. The explosion occurred when the gas service line to the building was damaged during excavation in the sidewalk. The service line separated under the sidewalk and gas migrated into the building, where it was ignited by an unknown source, causing the explosion.

Economic Vulnerability

Although the County has not experience a major event regarding this hazard, the historical occurrences in other areas of Michigan have demonstrated that the potential costs can reach into the millions of dollars.

Probability of Future Hazards

Several pipelines travel throughout Macomb County. There has never been a history of large, catastrophic accidents in the County, but incidents have occurred. These types of accidents, if not controlled properly, can create a very unstable environment and pose as a very dangerous threat. With continued industrial and residential development placing more and more demand on these pipelines and ground being redisturbed near them due to the additional development, this hazard will continue to pose as a significant and very probable event.

2.3.19 Public Health Emergencies

Definition

A widespread and/or severe epidemic, incident of contamination or other situation that presents a danger to or otherwise negatively impacts the general health and well being of the public.

Public health emergencies can take many forms: disease epidemics, large scale incidents of food or water contamination, extended periods without adequate water and sewer services, harmful exposure to chemical, radiological or biological agents, and large scale infestations of disease carrying insects or rodents, to name just a few.

Location

There is no specific location where a public health emergency could be limited. A public health emergency can occur in any region of the County at any time. Certainly some emergencies may be more localized due to their nature. For instance, mosquito borne illnesses could occur anywhere, but there may be a much higher likelihood in an area near water where the mosquito population would be much larger.

Hazard Extent

Public health emergencies can occur as primary events by themselves, or they may be secondary events to another disaster or emergency such as a flood, tornado, or hazardous material incident. The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people. Public health emergencies can be statewide, regional, or localized in scope and magnitude.

Perhaps the greatest emerging public health hazard would be the intentional release of a radiological, chemical or biological agent to adversely impact a large number of people. Such a release would most likely be an act of sabotage aimed at the government or a specific organization or segment of the population. Fortunately, to date, Macomb County has not yet experienced such a release aimed at mass destruction.

Historical Occurrences

Macomb County is fortunate in that it has an excellent public health system and a professional management team that constantly monitors the threats that could lead to a widespread or significant public health emergency. However, even the best monitoring and surveillance programs cannot always prevent such incidents from occurring.

The most recent minor occurrence in the County has been the threat of West Nile Virus. The virus is a mosquito-borne illness, which has affected birds, horses, and humans. The virus affects the brain, causing inflammation in the membranes and the fluid surrounding the brain and spinal column. In some cases it has led to death, especially in senior citizens, but in most, the ill have made full recoverys.

In 1977, the worst outbreak of botulism in U.S. history was linked to home canned jalapeno peppers served by an Oakland County restaurant. (Botulism is caused by a bacterium that grows from spores in an atmosphere without oxygen. Improperly canned foods are a primary source of the botulism bacterium. Botulism attacks the neuromuscular system and is one of the most dreaded of food poisoning agents, with a high mortality rate.) The restaurant used 200 jars of home canned peppers because a crop failure the preceding winter had created a shortage of commercially prepared peppers. Fifty-nine (59) restaurant patrons reportedly fell ill from the botulism poisoning, though no one died. Many of those affected required intensive

care level treatment and horse serum botulism antitoxin. (Note: The supply of horse serum botulism antitoxin is limited, and it must be transported to a hospital in need of it from regional depots. Because the amount of toxin required to paralyze a person is so low, the potential for a very large botulism outbreak always exists.)

A breakdown of critical water and sewer infrastructure can (if not immediately abated) result in a public health emergency for the affected area. That is exactly what happened in Oakland County in 1999. Due to a water main break, boil-water advisories were issued in many communities due to the potential for water contamination from lack of adequate system pressure. Fire safety hazards were also prevalent due to the lack of adequate system pressure.

One of Michigan's most serious statewide public health emergencies occurred in 1973 when a chemical company inadvertently sent bags of a fire retardant containing polybrominated biphenyl (PBB), a highly toxic chemical, along with a shipment of livestock feed supplement to Michigan Farm Bureau Services. After being mixed with the livestock feed, the contaminated mixture was distributed statewide for use by farmers in feeding livestock herds. The result was an environmental and public health disaster of unprecedented magnitude in Michigan. Thousands of cattle and other animals died from the poisoning and serious questions were raised regarding the long-term effects of this contamination on all Michigan residents. The exposed populations continue to be followed, although studies to date have not shown any serious health consequences from that exposure.

Economic Vulnerability

A large-scale public health event could have a large economic impact resulting mainly from health care issues. Lost work or production from numerous employees being ill, medical expenses, loss of customers and business would be the primary reasons for economic loss. Since there has never been a case of large scale public health in the County in recent years, the actual dollar amounts resulting from this hazard are not available.

Probability of Future Hazards

Although the County has never experienced a total countywide outbreak of any kind, the potential for serious illness is still very much an issue. Illnesses can stem from chemical ingestion from hazardous materials, disease, and bacteria. Highly populated areas such as Macomb County are especially susceptible due to the many ways in which illness can be spread. Introduction of exotic animals, improper food storage, shipping incidents are only some of the means that would result in a public health emergency.

2.3.20 Sabotage/Terrorism

Definition

An intentional, unlawful use of force, violence or subversion against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political, social, or religious objectives.

Location

The metropolitan Detroit area, with its automotive facilities, is known as the Motor Capital of the world. Along with that distinction, comes industrial and manufacturing power as seen during the historical period of World War II, where it was known as the "Arsenal for Democracy". That makes this area a prime target for a terrorist attack. There are many other factors that make Macomb County ideal for a terrorist attack:

- Two key military installations, Selfridge A.N.G. Base and the U.S. Army Tank Command.
- Easy international access from Canada via bridges, tunnels, ferries, and ships and boats. Large foreign freighters use the Great Lakes waterways. This area has experienced difficulties from ships releasing foreign substances into the environment (i.e. zebra mussels).
- Industrial and commercial complexes which conduct business on a global level.
- Engineering and Design Centers such as the General Motors Technology Center, General Dynamics Land Division, and the U.S. Army Tank Command.
- Significant ethnic population base and work force.
- Large infrastructure base for gas, oil, electric, water supply, highways, waterways, railways, hospitals and medical treatment centers proximity to Detroit.
- Utilities such as water, electricity, and gas could be affected by terrorist attacks from outside of Macomb County.
- Key government and public facilities - office buildings of governmental units along with corporations with government contracts, police, fire, and EMS units, water treatment facilities, post offices, churches, and schools.

Hazard Extent

In the past, most incidents of terrorism or sabotage were associated with bombings. Today, the scope and magnitude of sabotage/terrorism methods and threats, which now, in addition to bombings include:

1. Nuclear, chemical, and biological weapons.
2. Information warfare.
3. Ethnic/religious/gender intimidation (hate crimes).
4. State and local militia groups that advocate the overthrow of the U.S. Government.
5. Eco-extremism, designed to destroy or disrupt specific research or resource-related activities.

6. Pre-meditated attacks upon schools, workplaces, transportation systems, or other places of public assembly.
7. Organized criminal enterprises and activities.

All these methods can, in some way, hinder a government or population and lead to extremely threatening conditions for all people involved and even the innocent people who unfortunately get caught up in the path.

Historical Occurrences

The most significant incident of terrorism in U.S. history occurred on Tuesday, September 11, 2001. On that morning, terrorists hijacked four commercial airliners originating from Boston Logan Airport, Newark International Airport, and Washington Dulles International Airport. After seizing control of the planes, they crashed the aircraft into the World Trade Center in New York City, the Pentagon in Washington, D.C., and a field near Shanksville, Pennsylvania, killing an estimated 3,200 persons, injuring 9,000 others, and causing billions of dollars in property damage. This coordinated attack was the worst act of terrorism in the history of the United States. The attack would have been even worse had the fourth aircraft hit its intended target – presumed to be the White House in Washington, D.C. Instead, passengers held hostage on the flight apparently regained control of the aircraft and were able to steer it off course before it crashed in a remote field near the town of Shanksville, Pennsylvania.

On August 28, 2000, police detonated a bomb found by a child outside a senior citizen complex in Roseville. The child picked up the homemade bomb and carried it home, then brought it back to the apartment complex. Police indicated the bomb had the potential to do serious bodily harm, had it detonated. No one was injured in the incident and no property was destroyed.

On July 25, 2000, a saboteur with knowledge of the Detroit lighting system ripped wiring out of 100 street lights in downtown Detroit, leaving the live wires exposed and forcing city officials to shut off power to more than 600 downtown street lights to ensure public safety. The exposed wires carried 400 volts each. In one case, a wire was attached to a fence along the Fisher Freeway, electrifying the fence. Damages were estimated at \$26,000. One person was arrested and charged in the case.

These instances, especially the September 11th attacks, are evidence enough that Macomb County is just as susceptible as any other region of this nation to a terrorist incident. There have been countless measures implemented since the 9/11 event and countless more to continue. The one common effective measure in all of them is a diligence to keep the country safe.

Economic Vulnerability

Even though a large-scale act of terrorism has not occurred in the County, the events of September 11, 2001, have demonstrated that billions of dollars in property damage can be caused from a single event. Along with the initial property damages, corollary effects such as lost businesses or clientele can be felt years after an event.

Probability of Future Hazards

The probability of sabotage or terrorism is even higher than the probability of a nuclear attack for many of the same reasons. There are also many additional factors that make a terrorist or saboteur incident that much more likely. One of the biggest differences between this hazard and a nuclear attack is that a terrorist incident often times is completely unpredictable and can occur on a multitude of levels. Macomb County and the metro-Detroit area is a

probable target for terrorism or a sabotage incident because of the strong influence the area has on the automotive industry. The world is highly dependent on the automotive industry for transportation as well as a strong factor in the global economy. The probability of a catastrophic incident has dramatically risen especially in the wake of the September 11th attacks on the World Trade Centers. Several critical sites exist in Macomb County with ties to the automotive industry as well as other significant military and political facilities.

2.3.21 Subsidence

Definition

The lowering or collapse of the land surface caused by natural or human-induced activities that erode or remove subsurface support.

Natural subsidence occurs when the ground collapses into underground cavities produced by the solution of limestone or other soluble materials by groundwater. Human-induced subsidence is caused principally by groundwater withdrawal, drainage of organic soils, and underground mining.

Location

In Michigan, the primary cause of subsidence is underground mining. Although mine subsidence is not as significant a hazard in Michigan as in other parts of the country, many areas in Michigan are potentially vulnerable to mine subsidence hazards. The principal types of underground mining that occurs, or has occurred in Michigan include coal mining, metallic mineral mining, salt mining, gypsum mining, and solution mining. Macomb County has some very small regions where subsidence could occur due to mining (See Appendix S).

Michigan has one of the world's largest underground salt accumulations. The thickest salt beds lie under most of the Lower Peninsula. A large deposit lies under the City of New Baltimore and Chesterfield Township. These formations are, in some places, over 3,000 feet thick and composed of layers of salt and other minerals.

Hazard Extent

Generally, subsidence poses a greater risk to property than to life. Mine subsidence occurs when the ground surface collapses into underground mined areas. In addition, the collapse of improperly stabilized mine openings is also a form of subsidence. Mine subsidence can cause damage to buildings, disrupt underground utilities, and be a potential threat to human life. In extreme cases, mine subsidence can literally swallow whole buildings or sections of ground into sinkholes, endangering anyone that may be present at that site. Subsidence can also occur as a result of the existence of underground utilities. Unknown water main leaks or sewer leaks can lead to water and other liquids eroding soil away from under a roadway and cause a collapse.

Historical Occurrences

During the production of this document, a major sinkhole incident occurred in Sterling Heights on 15 Mile Road between Hayes and Moravian in late August 2004. A 160-foot long by 60-foot wide sinkhole opened up on 15 Mile Road right over an 11-foot diameter sanitary sewer interceptor. The 11-foot interceptor was believed to have been infiltrated by the fines and silt in the surrounding soil. The progression of the soil entering the pipe resulted in a reduced sub-grade, which caused the road above to collapse. Currently, bypass pumping is being done and a full inspection of the pipe will be performed to determine the exact cause of the failure. A permanent solution for repair will be designed once the inspection is complete.

There are areas in the County where mineral deposits exist and therefore, the potential for subsidence to occur also exists. Other incidents near Macomb County and throughout the state have also occurred.

On February 9, 2000, a 15-foot sinkhole opened up on Senaca near Mack on Detroit's east side. The sinkhole swallowed a half-ton pickup truck. Fortunately, the truck's two

occupants escaped serious injury. Officials believe a leaking underground pipe may have caused the subsidence.

On June 29, 1999, northbound traffic on U.S.-23 at Milan was diverted for approximately 10 hours after the pavement sank eight (8) inches over a 30-foot stretch of highway. The subsidence and traffic diversion caused traffic to backup for several miles throughout the day. Although a definitive cause of the subsidence was not established, officials believe a leaking storm sewer may have contributed to the problem.

On July 27, 1999, an abandoned mineshaft in Iron Mountain, Dickinson County, caved in, exposing a 50-foot diameter by 1,600-foot deep shaft. The cave-in occurred directly adjacent to the Cornish Pumping Engine and Mining Museum, a popular tourist attraction in the downtown area. The structure was in danger of collapsing into the opening until temporary stabilization measures were taken. Officials were also concerned that further subsidence could have damaged nearby infrastructure, including a roadway. Because the cave-in posed a significant threat to public safety, a Governor's Emergency Declaration was granted to provide state assistance in securing the site and permanently capping the opening.

Economic Vulnerability

Subsidence is a hazard that puts many underground utilities and even building foundations at risk. Very high costs could be incurred to stabilize a building over where a sinkhole occurred. The most recent example of the 15 Mile Road incident has already cost millions of dollars to repair. Man hours, materials, lawsuits, repair, and loss of local and nearby business have all contributed to the overall cost of this particular hazard.

Probability of Future Hazards

Although Macomb County has regions within its borders where mining used to take place and subsidence could occur, the chances of a large population or structure being affected are small. Based on the County's historical record as well as the relatively small portion, which was subject to mining, a subsidence hazard is of low concern and probability. The 15 Mile Road incident was a result of a failed sanitary sewer interceptor. The sinkhole that developed was a corollary effect of the primary hazard, which was an infrastructure failure.

2.3.22 Hail Storms

Definition

A condition where atmospheric water particles from thunderstorms form into rounded or irregular lumps of ice that fall to the earth.

Hail is formed when strong updrafts within the storm carry water droplets above the freezing level, where they remain suspended and continue to grow larger until their weight can no longer be supported by the winds.

Location

Hail is a product of the strong thunderstorms that frequently move across the county. As one of these thunderstorms passes over, hail usually falls near the center of the storm, along with the heaviest rain. Although it is often times difficult to predict when hail will form or even fall to the earth, we do know that storms and the possibility of hail are most frequent during the warm spring and summer months, typically May through September. The potential thunderstorm threat is measured often measured by the number of "thunderstorm days" – defined as days in which thunderstorms are observed. According to the map in Appendix T, Macomb County is subject to 30-40 thunderstorm days per year.

The National Weather Service began recording hail activity in Michigan in 1967. Statistics since that time indicate that approximately 50% of the severe thunderstorms that produce hail have occurred during the months of June and July, and nearly 80% have occurred during the prime growing season of May through August.

Hazard Extent

Most hailstones range in size from a pea to a golf ball, but hailstones larger than baseballs have occurred with the most severe thunderstorms. Sometimes, strong winds occurring at high altitudes in the thunderstorm can blow the hailstones away from the storm center, causing an unexpected hazard at places that otherwise might not appear threatened. When hail falls to the earth, it has the potential to batter crops, dent automobiles, and injure wildlife and people. Large hail is a characteristic of severe thunderstorms, and it may precede the occurrence of a tornado.

Historical Occurrences

Macomb County has had several occurrences of hail, and often times several per year. On September 6, 1999, a slow moving cold front drifted into southeast Michigan during the late afternoon and early evening hours, igniting thunderstorms as it went. Only one storm became severe, dumping quarter-sized hail in Shelby Township, just north of Utica. The storms were slow moving, and so produced locally heavy rain. A spotter in Shelby Township measured 3.41 inches of rain as the storms passed. No significant damage from the hail was reported.

On July 28, 2000, storms organized as they moved slowly but steadily eastward, evolving into a squall line that crossed southeast Michigan in the late afternoon and early evening hours. Several of the thunderstorms became severe. Only a couple of storms produced damaging wind; large hail was the most common type of severe weather. An isolated storm ahead of the squall line produced silver dollar sized hail in Shelby Township (Macomb County); this was the largest hail report of the day. The same storm downed trees in that area. Trees were also downed in Bancroft due to severe thunderstorm winds. The rest of the severe weather was composed of dime to quarter sized hail events.

Outside of Macomb County, on the afternoon of July 14, 2000, severe thunderstorms producing large hail struck St. Clair County. Hailstones as large as baseballs (2.75") fell in Algonac, causing \$125,000 in damage to cars and homes. The hailstones damaged roofs, ripped gutters off of homes, dented air conditioning units, and broke windows. The force of impact when the hailstones landed in the canals in Algonac caused the water to splash five feet into the air.

Economic Vulnerability

According to the NCDC database for Macomb County, even though the County has experienced numerous hailstorms in the last 50 years, none have been reported to result in extensive property or crop damage. Agriculture, automobiles, and homes are vulnerable to suffering damage and a greater economic strain would be felt if a large number of crops were lost.

Probability of Future Hazards

According to the National Weather Service in White Lake, Michigan, Macomb County is subject to approximately 30-40 thunderstorm days per year. Macomb County resides in an area of Michigan where the climate lends itself to generating significant storm conditions, especially during the spring and early summer seasons. Moist air from the south and the cooler air from the north provide ideal conditions for hail to be formed. Therefore, Macomb County possesses a moderate possibility for hail to occur and cause significant property damage.

2.3.23 Lightning

Definition

The discharge of electricity from within a thunderstorm.

The energy in the storm produces an intense electrical field like a giant battery, with the positive charge concentrated at the top and the negative charge concentrated at the bottom. Lightning strikes when a thunderstorm's electrical potential (the difference between its positive and negative charges) becomes great enough to overcome the resistance of the surrounding air. Bridging that difference, lightning can jump from cloud to cloud, cloud to ground, ground to cloud, or even from the cloud to the air surrounding the thunderstorm.

Location

In the United States, approximately 100,000 thunderstorms occur each year, and every one of those storms generates lightning. It is not uncommon for a single thunderstorm to produce hundreds or even thousands of lightning strikes. As seen in the previous hazard "Hail", Macomb County is subject to 30-40 thunderstorm days per year. This translates to thousands of lightning strikes in the County alone each year. Statistics compiled by the National Oceanic and Atmospheric Administration (NOAA) and the National Lightning Safety Institute (NLSI) for the period 1959-1994 revealed the following about lightning strike locations.

Location of Lightning Strikes

- 40% are at unspecified locations
- 27% occur in open fields and recreation areas (not golf courses)
- 14% occur to someone under a tree (not on golf course)
- 8% are water-related (boating, fishing, swimming, etc.)
- 5% are golf-related (on golf course or under tree on golf course)
- 3% are related to heavy equipment and machinery
- 2.4% are telephone-related
- 0.7% are radio, transmitter and antenna-related

Months of Most Strikes

July (30%); August (22%); June (21%)

Days of Most Strikes

#1 – Sunday; #2 – Wednesday; #3 – Saturday

Time of Most Strikes

2:00 PM – 6:00 PM

Hazard Extent

Lightning is a random and unpredictable product of a thunderstorm's tremendous energy. Lightning strikes can generate current levels of 30,000 to 40,000 amperes, with air temperatures often superheated to higher than 50,000 degrees Fahrenheit (hotter than the surface of the sun) and speeds approaching one-third the speed of light. Lightning damages many structures and kills and injures more people in the United States per year, on average,

than tornadoes or hurricanes. Many lightning deaths and injuries could be avoided if people would have more respect for the threat lightning presents to their safety.

The electrical force shocking the heart into cardiac arrest or throwing the heartbeat out of its usual rhythm usually causes lightning deaths. Lightning can also cut off breathing by paralyzing the chest muscles or damaging the respiratory center in the brain stem. It takes only about one-hundredth of an ampere of electric current to stop the human heartbeat or send it into ventricular fibrillation. Lightning can also cause severe skin burns that can lead to death if complications from infection set in.

Lightning-Related Deaths in Michigan: 1959-July 2001

Number of Deaths	Location	Percent of Total
28	Open fields, ball fields	28%
26	Under trees (not golf)	27%
11	Boats / water-related	11%
10	Golf course	10%
4	Near tractors / heavy equipment	4%
2	At telephone	2%
18	Other location / unknown	18%
99	Total Lightning Deaths	100%

Source: Storm Data, National Climatic Data Center

Lightning-Related Injuries in Michigan: 1959-July 2001

Number of Injuries	Location	Percent of Total
240	Open fields, ball fields	35%
104	Under trees (not golf)	15%
35	Golf course	5%
26	Boats / water-related	4%
19	At telephone	3%
19	Near tractors / heavy equipment	3%
250	Other location / unknown	36%
693	Total Lightning Related Injuries	100%

Source: Storm Data, National Climatic Data Center

Historical Occurrences

According to the National Climatic Data Center, only eleven lightning incidents were reported in Macomb County between 1950 and April of 2004. Of these incidents, no deaths and only five injuries reported.

On July 21, 1998, the south half of neighboring Macomb County was hit hard by severe thunderstorms. Spotters in the south part of Sterling Heights reported dime sized hail and 76 mph winds. In Warren, spotters reported gusts up to 75 mph. The stretch of county between 10 and 12 Mile Roads, from Warren east to St Clair Shores, took the brunt of the storms. Damage was extensive in Warren, Roseville, and St Clair Shores, with hundreds of downed trees and power lines. Newspaper stands and store signs were knocked over in Warren. In Roseville and Fraser, windows and roofs were removed from stores. Further north, an office building in Mt Clemens was declared a total loss after it was deroofed by severe winds. In nearby Harrison Township, power lines were downed. The storms also produced over 4300 cloud-to-ground lightning strikes. Overall, all counties suffering from this storm incurred \$275,000 in damages. Wayne County and parts of Macomb County received both state and federal disaster declarations.

On June 30, 1995, in Harrison Township, lightning struck an apartment complex. Nearly \$30,000 in damage was incurred. On June 12, 1999, storms moved through southeast Michigan. Lightning struck several homes in Clinton and Macomb Townships. Bricks were torn off a chimney on one home, and an attic fire was started in another. Damages totaled \$15,000 from the storm.

Economic Vulnerability

Lightning strikes have the potential to cause damage in many ways. Many fires are started in fields, forests, and homes after storms due to lightning strikes. The NCDC database reports that in the last 10 years, Macomb County has suffered a total of \$1.4 million in property damages. Lightning strikes have also been known to cause power outages which also result in large economic impacts.

Probability of Future Hazards

Lightning occurs in virtually every thunderstorm on earth. Most occurrences remain in the clouds. Many times though, lightning will discharge and either strike the ground or even occur in the reverse direction (ground to cloud) if the charge difference is great enough. Since Macomb County is subject to a relatively high number of thunderstorms each year, the probability of lightning strikes to occur during these storms is very high. According to the location breakdown above, lightning strikes can also be very unpredictable in that they can occur virtually anywhere. This is a very probable problem affecting the County.

2.3.24 Severe Winds

Definition

Non-tornadic winds of 58 miles per hour or greater.

Location

Typically severe winds are spawned by thunderstorms or the right blend of humid and cool air masses moving across the state. Since the mixture of these air masses occurs on such a large scale, windstorms cannot be solely associated with one county or community. Usually, several counties are affected by a windstorm. Some of the more violent wind events have occurred in the summer months where humid air is more common. However, the state has experienced late fall and sometimes winter high wind events. Therefore, all of Macomb County is susceptible to a severe windstorm at any time of the year.

Hazard Extent

During the period 1995 through 2004, the National Oceanic and Atmospheric Administration's National Climatic Data Service reports a total of 109 severe wind incidents in Macomb County and neighboring counties and states. Of these events, 93 were part of thunderstorm activity that took place, typically but not always, during the summer months. Winds reported ranged from 40 to 95 knots in speed. While only 20 of the 27 communities in Macomb County were singled out in the 109 incidents, there were 15 multi-county incidents that involved the entire Macomb County area. In addition, Mt Clemens, Romeo, St Clair Shores, Sterling Heights, and Utica are all communities that have each experienced 9 or more severe wind incidents over the past 10 years.

Strong winds have the potential to cause severe damage to building structures, automobiles, topple or uproot trees, send objects into projectile flight, destroy crops, and injure people. Windstorms often cause downed power lines and widespread power outages, disable traffic signals creating major traffic problems, and result in falling tree limbs, awnings, and other large objects that can result in injuries and deaths.

Historical Occurrences

Macomb County has certainly experienced numerous storms involving high winds. In November 2003, a strong low pressure system moved across lower Michigan producing gusts ranging from 50 to 88 miles per hour. An estimated 250,000 customers in Southeast Michigan lost power and the region experienced a total of \$21.0M property damage.

On July 21, 1998, severe thunderstorms passed through the metro-Detroit area, producing strong winds that killed three persons, damaged or destroyed nearly 200 homes, and downed trees and power lines. Wind speeds were estimated at 70-80 miles per hour, roughly equivalent to a weak hurricane. The storms affected 34 jurisdictions in Wayne County, and five jurisdictions in Macomb County. Over 430,000 electrical customers were left without power. Total storm-related public damage was in excess of \$6.8 million. A Presidential Major Disaster Declaration was granted for the two counties, providing both public and hazard mitigation assistance to affected local jurisdictions.

During the afternoon and evening hours of May 9, 2000, an outbreak of severe thunderstorms (with winds gusting to 70 miles per hour) struck southeast Michigan, causing considerable damage across the region. In Lenawee County, strong winds destroyed several barns, flipped over a mobile home and recreational vehicle, caused numerous trees to fall on homes, destroyed grain bins, and destroyed one airport hangar and damaged two others. In

Monroe County, dozens of trees were downed and a 150-year old historic railroad depot was destroyed. In Washtenaw County, hundreds of trees were downed, a church steeple was destroyed, a fire station was partially deroofed, a camper van was sliced in half, and a grocery store had its front doors blown off. In Wayne County, a hangar at Detroit Metropolitan Airport collapsed, damaging the plane inside. Numerous other localities within Wayne County suffered damage to homes and businesses. Some communities were without power for up to a week. A school in Livonia had its air conditioning units blown over, and the walls of a connecting corridor were displaced. Oakland County was the other county that saw widespread damage. A 64-mph wind gust occurred in White Lake. Winds to 70 mph deroofed a trailer home in Highland. In Milford, falling trees crushed a car and damaged a home. Farmington saw a garage damaged by a tree, and phone poles were snapped. In Novi, a trailer at a construction site was destroyed, with another trailer and a wall under construction sustaining damage; the air conditioning units on the roof of a business were ripped off. Power poles were snapped in Auburn Hills. Dozens of trees were downed in Pontiac, destroying a garage and damaging several homes. All totaled, the storms left more than 200,000 electrical customers without power, injured at least six persons, and caused several million dollars in property damage.

Amazingly, with all the widespread damage throughout the region, Macomb County only had minor incidents or damages to report. The extent of the damages suffered by Macomb County was limited to downed power lines and fallen tree branches. Although the County escaped this particular storm without suffering major damage, the evidence of the other counties is clear that this hazard can be extremely dangerous and costly.

Economic Vulnerability

The 109 incidents reported in National Climatic and Data Center's data base between 1995 and 2004 resulted in a total of \$37.9M in property damages across Macomb County and neighboring states and counties. At the same time, no property damage was documented for 63 of the 109 incidents. Consequently, economic vulnerability is difficult to predict from event to event. Nevertheless, the potential always exists for property damage, injuries, and loss of life as a result of severe winds. All of Macomb County is subject to this hazard and its economic vulnerability to major incidents is high.

Probability of Future Hazards

Severe winds are a naturally occurring hazard with a long documented history in Macomb County and its communities. Macomb County is situated in an area that is subject to drastically changing weather patterns, and severe winds occur as a result of these patterns. While there are methods for mitigating against severe winds to limit the damage they can cause, severe winds can not be prevented or eliminated. The probability of future hazards is extremely high.

2.3.25 Tornadoes

Definition

An intense rotating column of wind that extends from the base of a severe thunderstorm to the ground.

A tornado may have winds up to 300+ miles per hour and an interior air pressure that is 10-20 percent below that of the surrounding atmosphere.

Location

Tornadoes in Macomb County are most frequent in the spring and early summer when warm, moist air from the Gulf of Mexico collides with cold air from the polar regions to generate severe thunderstorms. These thunderstorms often produce the violently rotating columns of wind that are called tornadoes. Macomb County lies at the northeastern edge of the nations primary tornado belt, which extends from Texas and Oklahoma through Missouri, Illinois, Indiana, and Ohio.

Hazard Extent

Most of a tornado's destructive force is exerted by the powerful winds that knock down walls and lift roofs from buildings in the storm's path. The violently rotating winds then carry debris aloft that can be blown through the air as dangerous missiles. The Fujita Scale rates the intensity of a tornado based on damaged caused, not by its size.

The Fujita Scale of Tornado Intensity

F-Scale Number	Intensity Descriptor	Wind Speed (mph)	Type/Intensity of Damage
F0	Gale tornado	40-72	Light damage. Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112	Moderate damage. The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206	Severe damage. Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
F4	Devastating tornado	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318	Incredible damage. Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged; incredible phenomena will occur.
F6	Inconceivable tornado	319-379	These winds are very unlikely. The area of damage they might produce would be unrecognizable.

NOTE: When describing tornadoes, meteorologists often classify the storms as follows: F0 and F1 - weak tornado; F2 and F3 - strong tornado; F4 and F5 - violent tornado
(Source: The Tornado Project; Storm Data, National Climatic Data Center)

Typically, tornadoes last only a few minutes on the ground, but those few minutes can result in tremendous damage and devastation. Historically, tornadoes have resulted in tremendous loss of life, with the mean national annual death toll being 111 persons. Property damage from tornadoes is in the hundreds of millions of dollars every year.

Historical Occurrences

According to the National Climatic Data Center, 17 tornadoes have been reported in Macomb County between 1950 and 2004. However, the County has experienced substantial damage as well as deaths and injuries resulting from tornadoes.

On July 2, 1997, a series of intense thunderstorms went through south-central and southeast Michigan. These storms spawned a total of 16 tornadoes, 13 of which occurred in the southeastern Michigan counties of Genesee, Lapeer, Livingston, Macomb, Oakland, Saginaw and Wayne. The total for southeast Michigan is the highest number for a single day since records have been kept from 1950. The tornadoes damaged or destroyed over 2,900 homes and nearly 200 businesses, and caused over \$25 million in public damage and nearly \$30 million in private damage. A total of 16 deaths were attributed to this storm front, but only 2 of those deaths were caused by the tornadoes. Another 120 persons were injured in the storm event.

Another notable tornado occurred in Macomb and St. Clair counties on May 8, 1964. This F4 tornado inflicted \$2.5 million in damages, killed 11 people, and injured another 224 people.

The June 8, 1953, Flint tornado, Michigan's worst storm to date, is ranked 9th on the top ten list of single killer tornadoes that have occurred in the United States. It was also the last single tornado, as of this writing, to cause over 100 deaths in the U.S. The storm began its destructive path approximately two miles north of Flushing, moved east-northeast and devastated the north part of Flint before ending two miles north of Lapeer. The tornado obliterated homes on both sides of Coldwater Road for about one mile. It was there that the damage swath was over one-half mile wide and most of the deaths occurred. There were multiple deaths in at least 20 families. The final death toll stood at 115 in Flint alone, along with 785 injuries and total damage estimated at \$19 million. Several tornadoes touched down in other locations in Michigan on that day as well, resulting in an additional six deaths and 129 injuries statewide.

Typically, the most common type of tornadoes to pass through the County have been either F1 or F0 magnitude. Although these are relatively small tornadoes, larger ones have and still can pass through leaving destruction in their wake. Tornadoes are a very deadly and historically, relatively frequent hazard to affect Macomb County, and they should be planned for as such.

Economic Vulnerability

Even though tornadoes do not occur in Macomb County as frequently as severe wind events, they can be equally or exceedingly dangerous and deadly. In the past 50 years, Macomb County has suffered over \$58 million in property damages. As development continues to increase within the County, the vulnerability to the economic base of the County also increases. This trend shows that in the future, there will not only be more property and buildings at risk, but many more lives as well.

Probability of Future Hazards

Tornadoes are often associated with severe thunderstorms and many times are spawned from them. Macomb County often times experiences violent thunderstorm patterns in the spring and summer months. The charts in Appendix U reflect the trend of tornado activity in the County. Tornadoes are a very likely by-product of these weather patterns. Tornadoes are never entirely predictable. Certainly if they can occur in numerous areas in the southeast Michigan area, there is a high probability they can occur in Macomb County as well. Tornadoes may also cross more than one county line, as well. Even if a tornado begins in an outside county, Macomb County may still be adversely affected by it.

2.3.26 Transportation Accidents

Definition

A crash or accident involving an air, land or, water-based commercial passenger carrier.

Location

Macomb County has several airfields. The City of Detroit, Marine City, and Oakland County airports are located near Macomb County. There is frequent use of helicopters by law enforcement, military, emergency medical services, and media. Macomb County has experienced many transportation accidents involving military aircraft as Selfridge ANG Base is the oldest military air facility in the US and is used today primarily as a training facility. There are four circumstances that can result in an air transportation accident:

- 1) An aircraft colliding with another aircraft in the air;
- 2) An aircraft crashing while in the cruise phase of a flight due to mechanical problems, sabotage, or other cause;
- 3) An aircraft crashing while in the takeoff or landing phases of a flight; or
- 4) Two or more aircraft colliding with one another on the ground during staging or taxi operations.

Please refer to Appendix V for a map of southeastern Michigan's traffic flow densities. The following sites are Macomb County's high-crash street intersections, over a 5-year study from 1997 to 2001, done by Southeast Michigan Council of Governments. A map citing the areas of these accident zones can be found in Appendix W:

Macomb County's high-crash street intersections

1. Van Dyke & 18 Mile Road (No. 1 in Michigan)
2. Groesbeck and 16 Mile Road (No. 2 in Michigan)
3. Gratiot and 16 Mile Road (No. 3 in Michigan)
4. Hall and Hayes (No. 4 in Michigan)
5. Gratiot and 23 Mile Road (No. 7 in Michigan)
6. Hall and Schoenherr (No. 9 in Michigan)

Land accidents have often involved commercial railroad lines as well as commercial bus travel:

Railroad Crossing Crashes, Injuries and Fatalities in Michigan: 1996-2000

Year	Total Crashes	Fatalities	Injuries
1996	132	17	69
1997	134	13	73
1998	87	11	37
1999	98	14*	37*
2000	93	13	40

*2 fatalities and 1 injury occurred at a private crossing
Source: Michigan Department of Transportation

The only location that Water Transportation accidents could occur would be on Lake St. Clair. This is the only body of water in and around Macomb County where commercial and recreational water travel is legal.

Hazard Extent

The one commonality all transportation accidents share, whether air, land or water-based, are that more often than not they result in mass casualties. Air transportation accidents, in particular, can result in tremendous numbers of deaths and injuries and major victim identification and crash scene management problems. Water transportation accidents, on the other hand, may require a significant underwater rescue and recovery effort. Harrison Township Fire Department is well trained for handling water (ice) rescues. Selfridge ANG Base Fire Department is part of the county's mutual aid pact and provides excellent fire fighting equipment and a well-trained crash/rescue team.

A land transportation accident in Macomb County could involve a commercial passenger bus, a local public transit bus, a school bus, or a train. Although these modes of land transportation have a good safety record, accidents do occur. Typically, bus accidents are caused by the bus slipping off the roadway in inclement weather, or colliding with another vehicle. Train accidents usually involve a collision with a vehicle attempting to cross the railroad tracks before the train arrives at the crossing. Unless the train accident results in a major derailment or carries hazardous materials, serious injuries are usually kept to a minimum. Bus accidents, on the other hand, can be quite serious, especially if the bus has tipped over. Numerous injuries are a very real possibility in those types of situations.

Historical Occurrences

Numerous transportation accidents have occurred throughout Macomb County and other surrounding counties. A Northville High School bus carrying 34 football players, 14 cheerleaders, and several coaches collided with an automobile. The car's driver was killed and the car's passenger was injured. Ten bus passengers suffered injuries.

A commercial skydiving plane crashed shortly after takeoff from Marine City Airport, killing all 10 persons aboard. The plane was carrying the pilot and nine skydivers, who were

about to make an early morning jump. The plane cleared a 90-foot power line on takeoff, then sharply veered left before crashing and exploding in a hay field adjacent to the end of the runway. The National Transportation Safety Board determined that pilot error was the probable cause of the crash.

Michigan's worst commercial passenger airplane crash, and the fifth worst in U.S. aviation history, occurred on August 16, 1987, at Detroit Metropolitan Airport. In that incident, Northwest Airlines Flight 255 was unable to gain sufficient altitude at takeoff and crashed onto a nearby highway, killing 156 passengers and crew. A small child was the lone survivor. A Governor's Disaster Declaration was granted to the City of Romulus and numerous state resources were mobilized to assist in the recovery.

Economic Vulnerability

Transportation accidents typically involve personal vehicles and property. Some cases involve public transportation such as busses. In most cases, there is not a large economic impact felt as a result of a traffic accident. However, the vulnerability still exists. An incident involving a large commercial airplane would have a very large impact. Also, increased numbers of traffic accidents make insurance rates increase.

Probability of Future Hazards

Since Macomb County is one of the more heavily populated regions in the state, there are also high traffic volumes associated with it. The higher volumes would very easily lead to more frequent accidents. Six of Michigan's top ten high crash intersections lie within Macomb County; four of which hold the top four slots. The population's future trend is continuing to increase. Continued increases in volumes of people will definitely increase the potential for more transportation accidents. Many other modes of transportation are also used in and around Macomb County and could also lead very easily to transportation accidents. This is a hazard that can range from mild to extremely severe in terms of the number of people affected and it can also occur very frequently. The County is currently working in conjunction with American Automobile Association (AAA) and the Michigan Department of Transportation (MDOT) to develop a traffic study. This study will help identify any changes in problem areas and provide information to help in the development of solutions for this issue.

2.3.27 Ice and Sleet Storms

Definition

A storm that generates sufficient quantities of ice or sleet to result in hazardous conditions and/or property damage.

Ice storms are sometimes incorrectly referred to as sleet storms. Sleet is similar to hail only smaller and can be easily identified as frozen rain drops (ice pellets) which bounce when hitting the ground or other objects. Sleet does not stick to trees and wires, but sleet in sufficient depth does cause hazardous driving conditions. Ice storms are the result of cold rain that freezes on contact with the surface, coating the ground, trees, buildings, overhead wires and other exposed objects with ice, sometimes causing extensive damage.

Location

According to the EMD PUB-103, Michigan is susceptible to moderate snowfall and extreme cold, averaging 90 to 180 days per year of below freezing temperatures in the Lower Peninsula. All areas of Macomb County are subject to these conditions.

Hazard Extent

One of the most detrimental effects of an ice storm is the build up of ice on buildings, radio towers, power lines, trees, and other tall objects. During a major storm event, the build up can become so great that the excess weight added by the ice, causes the power lines to snap and can pull chunks of buildings off and topple trees. When electric lines are downed, households may be without power for several days, resulting in significant economic loss and disruption of essential services in affected communities.

Both sleet and ice can cause major problems on roadways. Roads, which normally travel at high speeds, are immediately reduced to a snail's pace. Accelerating, breaking and steering a vehicle become exponentially difficult on slick roads. These conditions many times lead to automobile accidents. Excessive amounts of ice can also clog waterways and trap ships out on the water.

Historical Occurrences

Macomb County has a consistent history of severe winter weather, including ice storms. During the period from 1995 to 2004, the National Climatic Data Center documented six ice storms that caused a total of \$180M in property damage, most of it from one event in April 2003.

Thunderstorms brought heavy freezing rain to southeastern Michigan between April 3 and April 5 of 2003. Spotter reports indicated that up to 3 inches of freezing rain occurred in some places. By the morning of the 5th, ice accumulations ranged from one half to one inch. Sleet had also accumulated up to two inches in and around Flint and the Saginaw Valley. The ice accumulations led to considerable tree damage and widespread power outages across the entire area. Locations hardest hit, with around an inch of ice reported on the trees, were across northern Oakland County, northern Macomb County, and throughout Lapeer, St Clair, Sanilac and Huron counties. Approximately 450,000 people lost power, one person was killed by a falling tree branch, two others injured, with a final damage tally of \$161.1 million as a result of the ice storm.

On March 13, 1997, low pressure tracked from the central Plains northeast across southeast lower Michigan. The storm brought widespread precipitation to southeast Michigan from late on the 13th through midday on the 14th. North of Detroit, nearly all of the precipitation fell in the form of freezing rain, with small amounts of snow and sleet noted in a few spots.

From Detroit and Ann Arbor south to the state-line, the freezing rain changed to rain, but not before heavy ice accumulations occurred. Total precipitation amounts ranged from 1.5 to nearly 2.5 inches from Detroit and Ann Arbor south to the Ohio state-line. From the northern suburbs of Detroit north to Flint and Port Huron, amounts ranged from 0.8 to 1.5 inches. North of that area, amounts ranged from 0.40 to 0.80 inches. In the Detroit Metropolitan area, the ice storm resulted in power outages to over 425,000 homes and businesses; the 3rd largest outage in history, and the worst ever for an ice storm. Several thousand residents were without power for as long as 4 days. In addition to powerlines, falling trees damaged dozens of cars and houses throughout the area. Most schools were closed, and there were numerous auto accidents. Total property damage resulting was \$19.0M.

Economic Vulnerability

Many older communities within Macomb County, especially in the southern regions, utilize above ground utilities. Ice and sleet storms can have an extremely detrimental effect on infrastructure and can easily down power lines. Toppled trees can also cause significant damage to businesses, power lines, homes, and vehicles. Although infrequent, ice and sleet storms have the potential to result in very large property damage losses.

Probability of Future Hazards

Macomb County is located in a region of the state, which experiences a fairly large number of wintry, cold days. An ice or sleet storm weather event is very probable and typically associated with this type of weather climate. Macomb County has experienced numerous ice and sleet storms in the past and the probability for more to occur is very high. Throughout the winter season, the conditions are very favorable for precipitation and then quickly changing to a colder temperature. This is a hazard that occurs with a significant regularity and should be mitigated against as much as possible.

2.3.28 Snowstorms

Definition

A period of rapid accumulation of snow often accompanied by high winds, cold temperatures, and low visibility.

Blizzards are the most dramatic and perilous of all snowstorms, characterized by low temperatures and strong winds (35+ miles per hour) bearing enormous amounts of snow. Most of the snow accompanying a blizzard is in the form of fine, powdery particles that are wind-blown in such great quantities that, at times, visibility is reduced to only a few feet.

Location

As a result of being near the Great Lakes, Macomb County experiences large differences in snowfall in relatively short distances. The annual mean accumulation ranges from 22 to 40 inches of snow. The highest accumulations are in the northern and western parts of the Macomb County due to the higher elevation in Washington and Bruce Townships. All regions of the County, however, are subject to heavy snowfall.

Hazard Extent

Blizzards have the potential to result in property damage and loss of life. Just the cost of clearing the snow can be enormous. When roads become treacherous or impassable due to accumulating snow, the impacts tend to fall greatest on the economy. People cannot make it to the workplace, businesses suffer fewer customers because many people remain home, and airline flights may become grounded. When schools close and children have to remain home, many parents must also remain home, regardless of if they can make it to work or not, to watch their children. When power lines or other utilities fail, workers often have to work around the clock to repair them.

Historical Occurrences

Macomb County has suffered regularly from severe winter storms and blizzards. During the 10 year period from 1995 to 2004, the National Climatic Data Center recorded fourteen heavy snows, typically with greater than 6 inches of accumulation at a time, and another four lighter snow storms. Often times, the snowfall impacts multiple counties and joint efforts are required to restore roads and downed utilities to operation conditions. The following are just some of the accounts of severe snowstorms in and around Macomb County.

A storm system passed across the northern Ohio Valley on April 7, 2003. This produced an area of snowfall across the metro Detroit region. The heaviest snow fell across Oakland and Macomb counties, where snowfall of 5 to 7 inches was measured. The rest of the Detroit area received four inches or less. Some of the highest snowfall totals include 6.5 inches in Royal Oak (Oakland County), 6.5 inches in Troy (Oakland County), and 6.2 inches in Richmond (Macomb County). Although the NCDC did not document property damage for this storm, the snowfall led to dozens of traffic accident across the metro area and exacerbated the cleanup efforts from an earlier ice storm in Oakland and Macomb counties.

A low-pressure system developed in the Ohio River Valley during the early morning hours on February 26, 2002. This low-pressure system moved across central Ohio and into eastern Ontario on the 26th. Snow fell on the backside of this storm system, affecting most of southeastern Michigan. Snowfall began late in the evening on the 25th and continued through the morning of the 26th. Portions of southeast Michigan received around 6 inches of snowfall from this storm system. Six to seven inches of snow were reported across central Livingston,

northern Oakland, northern Macomb, southern Lapeer, and northwestern Washtenaw counties. Six inches of snow was reported around Flint, Sebawaing, and much of Shiawassee county. The rest of southeast Michigan received 3 to 5 inches of snowfall. Again, several traffic accidents resulted from this storm system, many area schools cancelled classes, and 4,000 homes and businesses lost power, but no property damages were documented by the NCDC.

In the early morning hours of December 11, 2000 a severe winter storm moved through the state, inflicting its heaviest wrath on the southern two-thirds of the Lower Peninsula before moving out of the state on the morning of December 12. That storm produced record or near-record 24-hour snowfall levels in 31 counties, paralyzing the entire region. High winds and frigid temperatures created blizzard conditions that lasted in some areas until late in the day on December 13. The storm produced great hardships for many Michigan communities. Schools across much of southern Lower Michigan were closed for several days, idling hundreds of thousands of school children. The storm also forced the cancellation of hundreds of airline flights in and out of Detroit Metro Airport and at other airports across the region, and forced many businesses to close at the height of the Christmas shopping season (the most profitable shopping period of the year).

In addition to the big snowstorms on January 2nd and 12th-13th, 1999, several smaller snow events resulted in an accumulation that neared historic proportions. As the snowpack grew toward two feet deep across southeast Michigan, it became more and more difficult to find places to put additional snowfall. In snowbound Detroit, postal carriers would drive as close to customers as possible and honk for residents to come out and get their mail. Many Detroit residents did not receive mail during several weeks in January. A large number of roofs collapsed under the immense weight of the snow during this period and tens of thousands of buildings suffered leaks, resulting in a barrage of calls to both roofers and insurance agents. Leakage got into the Clements Library of the University of Michigan in Ann Arbor, damaging or destroying several rare maps and atlases. Total property damage from this snowfall was documented at \$1.8M.

Economic Vulnerability

A review of the NCDC data for snow storms shows that the true costs of heavy snow storms are not well documented. While sometimes, the NCDC is able to document related property damages, impacts to the local economy due to closed businesses, lost sales, interruption of utilities, etc. are not effectively captured. While historically, the property damages for snow storms tend to be lower than for ice and sleet storms, impacts to the local economy can be very similar.

Probability of Future Hazards

Snowstorms are a naturally occurring climatic event that will continue to occur in Macomb County. While normally, property damage due to snow storms is minimal, extended snow accumulation over a period of weeks can lead to failure of roofs and other property damage. Other elements of a snowstorm such as high winds and very cold temperatures often time make for very treacherous travelling and even lead to health issues. Macomb County is extremely susceptible to this hazard during the winter season and efforts to mitigate against it should be made.