MICHIGAN DOT CLIMATE VULNERABILITY ASSESSMENT

Transportation Data Gaps

Task 3 Technical Report

prepared for

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1.0 INTRODUCTION

1.1 Overview of the Project

This study presents an opportunity to use a risk management to examine the impact of climate change on Michigan's transportation infrastructure. The study will help the Michigan Department of Transportation (MDOT) understand how to address more frequent and severe weather events that are impacting the transportation system today and are expected to grow in magnitude and consequence in the future. This project will identify potential climate change and extreme weather risks and address how this information can be integrated into MDOT's asset management systems and decision-making processes.

A standard risk management approach considers both the likelihood and consequence of a given risk. This approach focuses attention on risks that are both more likely and more consequential (i.e., they have more significant impacts).

Figure 1.1 The Basic Framework for Risk Analysis

LIKELIHOOD	CONSEQUENCE				
	1	2	3	4	5
A	L	L	L	M	S
B	L	L	M	S	H
C	L	M	S	H	H
D	M	M	S	H	H
E	M	S	H	H	H
F	S	H	H	H	H
SCALE: Low, Moderate, Significant, High					

Source: Federal Highway Administration, 2012

A climate vulnerability assessment for a transportation system requires several elements to assess both likelihood and consequence of a particular set of risks, including:

- An understanding of the potential climate risks – these are addressed in a separate technical memorandum; and
- An understanding of the potential vulnerabilities of the transportation system due to location, elevation, lack of redundancy, and other transportation related factors. This memorandum considers these transportation factors.

1.2 Purpose of This Technical Report in Supporting the Project

Obtaining relevant, accurate transportation and terrain data will help MDOT appropriately characterize the risks from climate change. The data collection process first required the identification of applicable asset categories (e.g., modes), then the collection of the best available spatial and attribute data in a Geographic Information System (GIS). This technical memorandum summarizes the transportation data identified for this study, including a review of the attributes needed to conduct a robust vulnerability assessment. Section 2 summarizes of the data requested for the study. Section 3 identifies current data gaps.

1.3 Data Gathering Process

Early in the project, a data request matrix was sent to MDOT (Appendix A). This matrix identified the various GIS layers—grouped by mode—useful for the vulnerability assessment. MDOT provided a DVD with a Geodatabase and spreadsheet to CS at the first Technical Advisory Committee meeting. Additional data were downloaded from Michigan's Geographic Data Library. All items were components of the statewide geographic framework (version 13a). The Bureau of Transportation Statistics National Transportation Atlas Database (NTAD (2013)) was also utilized.

The data items received from MDOT included 13 shapefiles and 1 spreadsheet. Polygon features include the Adjusted Census Urban Boundaries and hydrography layers. Line features include all roads, culverts, other hydrology, PASER data (where available), rail, and sufficiency layers. Point features include two culvert layers, pump stations, and a bridge layer. In addition to GIS data, MDOT also provided an HPMS spreadsheet and a data dictionary for layers derived from the state's geographic framework. All data items cover the entire state of Michigan.

2.0 TRANSPORTATION DATA NEEDS

2.1 Transportation Data Needed to Support Climate Vulnerability Assessment

Several types of transportation data are useful to conducting the vulnerability assessment. Table 1.1 describes the importance of different categories of data to the success of the project.

Table 2.1 Data Importance, by Category

Data Category	Example Data Items	Importance to the Study
Roadway Network	Highway shapefile, HPMS data, PASER	Helps in the identification of critical assets; when intersected with stressor inputs, shows where vulnerable assets are located and the condition of those assets
Bridge/Culvert/Drainage Infrastructure Locations and Attributes	Bridge shapefile, Culvert shapefile, NBI data, pump station locations	Aids in the identification of critical assets; when intersected with stressor inputs, shows where vulnerable assets are located and the condition of those assets.
Data on the Physical Environment	Elevation, hydrography, floodplains	Helps with the assessment of asset vulnerability (for example, elevation and floodplain data can be intersected with roadway and bridge data to identify areas at risk for flooding based on various climate scenarios)
Multimodal Network	Rail network shapefiles, intermodal facility locations	Describes the breadth of the State's transportation system, including key freight corridors. Primarily to be used opportunistically to examine non-highway modes where feasible.
Management System Data	Traffic Management System data, Maintenance Management System Data	Potentially useful for understanding current weather-related challenges. Provides information about current conditions that may be helpful. Note that these data sources were not available for the study.
Demographic/Employment Data	Population, employment (by TAZ, Census Tract)	Useful for determining critical assets by focusing on the transportation assets in and around areas of high population/employment density
Activity Center Data	Military installations, schools/universities, tourism centers, public/significant buildings	Helpful for determining critical assets by focusing on the transportation assets that connect with activity centers

2.2 Data Requested

Tables 2.2 – 2.6 identify the requested data items, grouped in each table by the categories discussed in Section 2.2 and sub-grouped by mode/topic where applicable, indicating whether or not the item was received and the source of each item. The tables also describe the coverage for each item. Data gaps are discussed in Section 3.

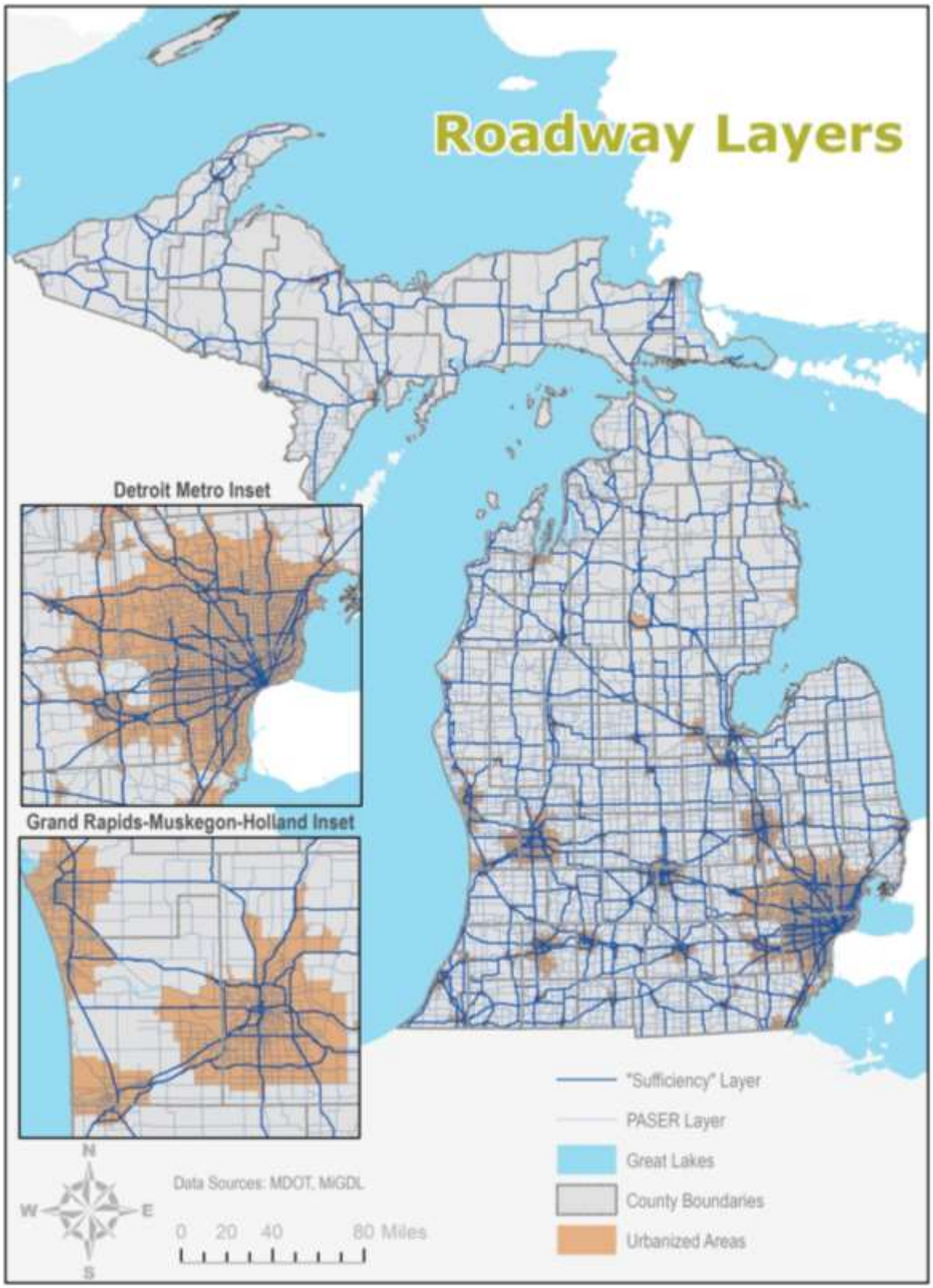
2.2.1 Highway Data

Table 2.2 identifies highway network data requested and received. Highway network data are important for understanding location, condition, criticality and other relevant information. MDOT has comprehensive highway network data that includes the location of all roads, pavement condition, volume data, and other roadway attributes. Data are also available for highway ramps. Additional national data provide information useful for criticality. Figure 2.1 presents the coverage of roadway network data received.

Table 2.1 Requested Data Items - Roadway Network Category

Data Item Requested	Item Received?	Source	Coverage/Attributes
Highway Network	Yes	MDOT	All public roads within the state. Includes roadway names, beginning/end mileposts (where applicable).
HPMS (Spreadsheet and shapefile)	Yes	MDOT and NTAD	All public roads within state. Data available varies by section.
PASER	Yes	MDOT	MDOT's highway system. Includes surfacing type, condition, number of lanes, and functional classification.
"Sufficiency"	Yes	MDOT	Michigan state highway trunk line system. Includes HPMS surface condition data, number of lanes, lane widths, median width, shoulder width, AADT, Level of Service.
Maintenance Management System	No		
Traffic Management System	No		
Intersections	No		
Interchanges	No		
STRAHNET	Yes	NTAD	Includes roads deemed necessary for emergency mobilization and peacetime movement of heavy armor, fuel, ammunition, repair parts, food, and other commodities to support U.S. military operations.
STRACNET	Yes	NTAD	Includes railroads deemed necessary for emergency mobilization and peacetime movement of heavy armor, fuel, ammunition, repair parts, food, and other commodities to support U.S. military operations.
Evacuation routes	No		
Emergency detours	No		

Figure 2.1 Michigan Roadway Layers



2.2.2 Bridge and Culvert Data

Table 2.3 presents the complementary bridge network data. As with the base roadway network, MDOT provides comprehensive data on bridge locations. Some data are also available on culverts and pumping stations. Figure 2.2 shows the bridge and culvert data provided by MDOT.

Table 2.2 Requested Data Items - Bridge/Culvert/Drainage Infrastructure Category

Data Item Requested	Item Received?	Source	Coverage/Attributes
Roads			
Roadway bridges ("Structures" layer)	Yes	MDOT	All roadway bridges within the state. Includes location and Michigan Geographic Framework ID.
Culverts	Yes	MDOT	All culverts. Includes material, liner material, dimensions, shape, waterway type, scour, roadway type, and orientation.
Large culverts	Yes	MDOT	Subset of culverts layer.
Pumping stations for below-grade highways	Yes	MDOT	All pump stations. Includes power company, road name, and year built.
Drainage Management System	No		
Bridge Management System	No		
Roadway tunnels	No		

Figure 2.2 Michigan Bridge/Culvert Data

2.2.3 Physical Environment Data

Table 2.3 presents the data requested for related to the physical environment. Critical data here include elevation, which is important for assessing issues related to precipitation, erosion, and flooding. MDOT does not have elevation data readily available for its highway network, but elevation data were available from the Michigan Geographic Data Library (MiGDL). These data are derived from the state's Digital Elevation Model (DEM). The highest resolution available from MiGDL is 30 meters by 30 meters. While elevation data at this resolution will allow for some analysis, a more detailed analysis would require a higher DEM resolution, such as 10 meters by 10 meters. MDOT also provided data on lakes, rivers, and streams that are useful for examining flooding and erosion. The geographic coverage is statewide; however, without any metadata or attribute data for this layer, there is uncertainty regarding the definitions of, or cutoffs for, features included in this dataset.

Table 2.3 Requested Data Items – Physical Environment Category

Data Item Requested	Item Received?	Source	Coverage/Attributes
Digital Elevation Model	Yes	MiGDL	Entire state. 30 meter by 30 meter resolution elevation.
Lakes/Rivers/Streams	Yes	MDOT	Hydrological features within state. Includes object ID, framework classification code.
Freshwater wetlands	No		
Floodplain	No		

2.2.4 Data for Other Modes

While the focus of this study was on the highway network, data were requested on other modes to examine whether they could be addressed as part of the study effort. Table 2.4 presents the items requested and received. Because this study will focus on the state's highway network, none of these layers are critical for conducting the vulnerability assessment. However, the vulnerability of the multimodal network will be examined to the extent possible.

Table 2.4 Requested Data Items - Multimodal Network Category

Data Item Requested	Item Received?	Source	Coverage/Attributes
Rail			
Amtrak	Yes	NTAD	All Amtrak alignments within the state. Location data.
Intercity passenger rail stations	Yes	NTAD	All intercity passenger rail stations with in the state. Name and location data.
Class I freight rail	Yes	MDOT	All class I freight rail within the state. Includes location, owner, track rights, and rail density (proxy for rail volume).
Class 2/3 freight rail	Yes	MDOT	All class 2/3 freight rail within the state. Includes location, owner, track rights, and rail density (proxy for rail volume).
Rail yards/spurs	Yes	NTAD	Location of rail yards/spurs.
Abandoned Right of Ways (ROW)	Yes	NTAD	Location of abandoned ROWs. Includes year of abandonment.
Intermodal facilities	Yes	NTAD	Location of intermodal facilities. Includes type of facility, owner.
Rail bridges	No		
Rail tunnels	No		
Water-based Freight			
Ports	Yes	NTAD	Includes location of all ports, depth information.

2.2.5 Additional Data to Support Criticality Assessment

Table 2.5 shows the requested data items that fall within the demographic/employment category. These data are useful for determining the critical assets upon which the vulnerability assessment will focus. Transportation assets in and around areas of high population/employment density are an especially critical component of the state's transportation system.

Activity center data are also helpful for identifying critical assets, and were included in the initial data request for this reason (Table 2.6). Transportation assets that lead to significant activity centers—such as power plants, schools/universities, and military installations—can be considered especially critical to the transportation system. These layers help create a more detailed picture of which assets are critical. They are not, however, entirely necessary for the project, and are less important to obtain than high quality transportation asset data.

Table 2.5 Requested Data Items - Demographic/Employment Category

Data Item Requested	Item Received?	Source	Coverage/Attributes
Adjusted Census Urban Boundaries	Yes	MDOT	All urbanized area boundaries within the state. Includes name, code.
Traffic Analysis Zones (Jobs/Employment)	Yes		All TAZs within state. Includes township name, population.
Population	Yes		Included within TAZ layer.
Production jobs	No		
Goods distribution space (SF)	No		

Table 2.6 Requested Data Items - Activity Center Category

Data Item Requested	Item Received?	Source	Coverage/Attributes
Power plants	No		
Schools/Universities	No		
Government employment centers	No		
Tourism/recreation (# of visitors)	No		
Public/significant buildings	No		
Activity centers of regional significance	No		
Emergency shelters	No		
Recipients of Federal research grants	No		
Agricultural facilities (production)	No		
Military installations	No		

3.0 KEY DATA GAPS

The data received from MDOT represent a strong foundation for completing the criticality and vulnerability assessments. The robust transportation asset data that were provided will prove especially valuable as the study progresses. There are, however, several key data gaps that may limit the analysis conducted as part of this effort. These gaps are as follows:

- **Gap 1: Detailed physical environment data, specifically floodplain and elevation.** High resolution floodplain data are important for helping determine which assets are most vulnerable to flooding. While MDOT may not have these datasets on hand, the data should be obtained from partner agencies, such as the Department of Environmental Quality. Similarly, digital elevation data can also help in the identification of assets that are susceptible to flooding at various climate thresholds. In order to undertake a more accurate, fine-grain analysis, Digital Elevation Model (DEM) data at 10 meter resolution are preferable to the current 30 meter resolution data that are readily available. The study can proceed with available data and provide MDOT with the implications of the current short comings on the analysis.

- **Gap 2: Transportation system data, especially evacuation routes and tunnels.** Tunnels are potentially at risk from extreme weather events, so understanding their location and characteristics would be valuable for this analysis. While the study can proceed without these data, future studies may want to address these issues. The location of evacuation routes can provide useful insight into asset criticality. Evacuation routes may not be available in GIS format, but are nonetheless useful for the study.

- **Gap 3: Activity center data.** Any additional activity center data that MDOT can provide—such as the location of power plants, schools/universities, and military installations—will enhance the criticality assessment. Some activity center data may be derived from partner agencies. The criticality assessment will be described in a separate technical report, which will describe how various data items may be used. The criticality assessment can be simple or complex, and the level of data required varies accordingly.